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2007-2008

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CENTRAL INSTITUTE OF POST HARVEST ENGINEERING & TECHNOLOGY

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ANNUAL REPORT

2007-2008

CENTRAL INSTITUTE OF POST HARVEST ENGINEERING & TECHNOLOGY

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PREFACE

The Institute made good progress in research and extension activities during the reported period of 2007-08. Research and extension activities were accelerated with more projects. The institute worked on 54 in house on-going projects. The research projects covered the areas of value addition of horticultural crops, food grains, oilseeds, spices etc., assessment of losses, pre-harvest management practices, effects of mulching, utilization of crop residues and development of hardware (hand tools and machines) for improving post harvest technology operations.

The research outputs were quality index for fresh apple on the basis of non-destructive techniques, roasting and popping unit for processing of makhana (gorgon nut) seeds, process to prepare ready to eat *makhana kheer* mix, modified atmosphere packaging of okra and betel leaves, modified atmosphere packaging of minimally processed cabbage, diced carrots and fresh cut french beans, development and testing of banana comb cutter, foam mat drying of tomato aonla and kinnow juice, solar drying of henna leaves, standardization for making beetroot and carrot powder, packaging of pomegranate fruits, studies on edible coatings (*Aloe vera*)to enhance shelf life of strawberry, hand tool for safe breaking of pomegranate and consequent easy separation of arils from its peel, osmo-convective dehydration of pineapple and banana, ready to serve beverages from soybean milk whey and ready to constitute *mustard saag*.

Tenderization of goat meat was tried using pomegranate seed powder (PSP), pomegranate rind powder (PRP) and mechanical pressing. Immobilization of enzymes and micro organisms was done through micro encapsulation. A unit for pelleting the small seeds at farm scale was fabricated.

Studies were conducted on development of ready to eat breakfast cereals from sorghum. Modeling of temperature of oil and oilcake during mechanical expression of sunflower and mustard was attempted and it was found in the range of 57 ^{0}C to 88 ^{0}C during initial 60 min of observations. Shelled maize cobs (*Zea mays* Linn.) were gasified in throatless gasifier having 15, 22.5, 30 and 36 cm diameter reactors. The optimum specific gasification rate (SGR) was observed to be 165 kg $h^{-1}m^{-2}$. A mechanical device for detection of insects in stored grains was developed to facilitate the detection of the presence of live or dead insects in stored grain.

The performance of various plastic mulches on growth and yield of okra and strawberry was evaluated. Fruit yield of okra and strawberry were observed to be highest by mulching with black ordinary plastic film. Studies on organic production of vegetables in polyhouses were conducted using vermicompost. Application of vermicompost increased the quality and quantity of tomato, capsicum and strawberry. Effect of irrigation, fertigation levels and mulching on growth and yield of Bt-cotton in semi-arid region was evaluated. Weed population and weed dry matter were observed to be least in plots mulched with black polymer film. Studies on soil solarization for vegetable nursery were conducted. Solarization for 30 days resulted in 100 per cent mortality of fungus species responsible for damping off and other nursery diseases. Solarization treatments significantly reduced the emergence of weed population and resulted in higher germination and seedling survival.

The AICRP on Post Harvest Technology and Application of Plastics in Agriculture have developed many useful technologies.

A good number of research papers, technical bulletins, project profiles and extension leaflets were published. The scientists of the institute participated in various conferences, meetings and workshops. The liaison with farmers and entrepreneurs was improved through entrepreneurship developemnet programmes,

interface meetings, visits under AKI, one day workshops, sensitization programmes, national seminars etc. The institute offered fourteen technology based entrepreneurship development programmes for upcoming entrepreneurs, farmers and women. These programmes were on value addition of horticultural crops, pomegranate, date palm, guava, grading and shrink wrapping of fruits and vegetables, food products, processing of onion, ginger and garlic, dehydration of fruits and vegetables, vermicompost etc. The sensitization and awareness programs on agricultural marketing infrastructure, warehousing (development and regulation) bill, intellectual property rights etc. were organized.

I acknowledge with thanks the support and cooperation extended by Dr. Nawab Ali, DDG (Engg.), Dr. Pitam Chandra, ADG(PE) & Dr. S.K. Tandon, ADG (Engg.), ICAR, New Delhi. The help rendered by Drs. S.K. Nanda, PC(PHT), P.R. Bhatnagar, PC(APA), K.K. Singh, M Parsad, R.K.Gupta, R.K. Goyal, D.Dhingra, Sh. Tej Ram, Sh. Vijay Kumar, Sh. J.S. Paul, all scientific, administrative technical and supporting staff at CIPHET in institute activities and preparation of this report is highly appreciated.

R T Patil
Director, CIPHET

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कार्यकारी सारांश

कार्यकारी सारांश

संस्थान ने सत्र 2007–2008 में अनुसंधान एवं प्रसार में उल्लेखनीय प्रगति की। संस्थान में 54 परियोजनाओं पर कार्य किया गया। अनुसंधान परियोजनाओं में अनाज, दलहन, मसालों, तेल बीजों व बागवानी फसलों के कटाई उपरान्त मूल्य संवर्धन पर विशेष बल दिया गया। इसके साथ कटाई उपरान्त होने वाली क्षति का मूल्यांकन, कटाई पूर्व प्रबंधन के अधिनियमों, मल्चिंग के प्रभाव, फसलों के अवशेषों के उपयोग व कटाई उपरान्त कार्यों को सुधारने के लिए यंत्रों व मशीनों के विकास की ओर भी ध्यान दिया गया।

अविनाशक (नानडिस्ट्रक्टटिव) तकनीक के आधार पर सेब की गुणवता नापने के लिए तालिका विकसित की गयी। परिणामतः दृष्टिदर्शी रंगो की तुलना में एन. आई.आर. पारदर्शी अधिक प्रभावी पाया गया।

मखाना बीज को भूनने एवं लावा (फुलाने) के लिये 25 कि.ग्रा. प्रतिघंटा क्षमता वाला प्रसंस्करण सयंत्र विकसित किया गया। बना बनाया (रेडीमेड) मखाना खीर का मिश्रण विकसित करके एकस्व (पैटेंट) हेतु मिसिल किया गया।

छेद युक्त प्लास्टिक परत से बनाये गये परिवर्तित वातावरणीय पैकेटों में भिण्डी पैक कर भिण्डी के गुणों और संरचना में होने वाले बदलावों का अध्ययन किया गया। पेरीकार्प में हरितलवक की मात्रा, बीजों में एसकार्बिक अम्ल की मात्रा तथा बीटा–कैरोटीन की मात्रा के आधार पर 300 तथा 400 ग्राम के पैकटों में रखे भिण्डी के नमूने बेहतर पाये गये।

पान की पत्तियों को पौलिप्राप्लिन परत से बने परिवर्तित वातावरणीय पैकेट(250, 500, 750 ग्राम) में 20 डिग्री से0 तापमान एवं 75 प्रतिशत सार्थक आर्द्रता पर रखा गया। जिसका निष्कर्ष देखा गया कि पान की पत्तियों में 10 दिनों तक हरितलवक (हरापन) बना हुआ था। इसी प्रकार छोटे स्तर पर बंदगोभी, कटी हुई गाजर, लोबिया की फलियो के प्रसंस्करण पर भी अध्ययन किया गया।

अनार के बीज एवं छिलकों के पाउडर और यान्त्रिक दाब से बकरी के माँस को मुलायम करने पर प्रयोग किये गये। संवेदिक मूल्यांकन में यान्त्रिक दाब वाले नमूने, अनारदाना पाउडर से उपचारित नमूनों की तुलना में बेहतर तथा अधिक मुलायम पाये गये।

सूक्ष्म कैप्सूलन विधि द्वारा एंज़ाइम और सूक्ष्म अवयवों को स्थिर किया गया। खमीर का एल्जीनेट में कैप्सूलीकरण किया गया जिसकी दक्षता लगभग 41 प्रतिशत आँकी गई।

लघु आकार के बीजों की गोली बनाने के साधारण सयंत्र का निर्माण किया गया। जीरा बीज को चिकनी मिटट्ी के साथ गोली बनाकर, बीज का आकार 1.5 गुना बढ़ाया जा सकता है।

बीज अवतरित मक्के के भुटटे का नलिका विहीन 15, 22.5, 30 एवं 36 सेमी. व्यास वाले रिएक्टर में सफलतापूर्वक वाष्पदाहन तैयार किया गया। जिसकी वास्तविक वाष्पदाहन क्षमता 165 किग्रा प्रति घंटा प्रति वर्ग मीटर पायी गई। उत्पादितगैस में ज्वलनशील गैसों का प्रतिशत 31–38 % पाया गया।

ज्वार से रेडीमेड जलपान सामग्री विकसित करने पर अध्ययन किया गया। जिसके तहत 0, 10 एवं 15 प्रतिशत दलहनों को मिलाकर उत्पाद के भौतिकी–रसायनिक गुणों के मूल्यांकन के साथ–साथ संवेदिक मूल्यांकन भी किया गया।

केलों के गुच्छो को कांदी से अलग करने के यंत्र को विकसित करके परीक्षण किया गया। इसके

प्रयोग से 2–6 प्रतिशत फलों का कटने से होने वाला परिकरट नुकसान कम पाया गया। जिसका आकल्पन डिजाइन एकस्व (पेटेंट) हेतु मिसिल किया गया।,

केलों के टुकड़ो के स्पंदन निर्जलीकरण का अध्ययन किया गया। निरीक्षण के तहत द्रव की संतृप्ता, टुकड़ों की मोटाई, और स्पंदन अवधि का प्रभाव महत्वपूर्ण पाया गया।

स्पंजीय चटाई विधि द्वारा टमाटर एवं किन्नू के रस को सुखाने का अध्ययन किया गया। अंडे के सफेद पदार्थ (एल्बुमिन) को (0–20%) स्पंजकारक के रूप में प्रयोग कर 60, 65 और 70 डिग्री से. तापमान पर सुखाया गया। दस प्रतिशत अंडे के सफेद पदार्थ को 5 मिनट तक फेटने पर उच्च स्तर का उत्पाद प्राप्त किया गया।

आंवला फलों को के.एम.एस. डाल कर जीवाणुरहित करके प्लास्टिक की टंकी में छः माह तक रखा गया। आंवला फलों को 12–15 मिनट तक गरम कर आंवला का गूदा तैयार किया गया। निचोड़े गये आंवला के गूदे का निर्जीवीकरण करके 0.3 प्रतिशत के.एम.एस. के साथ परीक्षण के उपरान्त प्लास्टिक की बाल्टी में छः माह तक रखा गया। आंवले के रस को 10 प्रतिशत अंडो की सफेदी के साथ 20 मिनट तक 60 डिग्री सेंटीग्रेड के तापमान पर सुखाकर 1, 2 व 3 मिमी. पतली परत में अत्याधिक रूप से सूक्ष्म रसायनिक गुणों वाला आंवला पाउडर प्राप्त किया।

सतहीय रेस्पोंस विधि द्वारा फलों पर आधारित एक्सटॅरूडेड उत्पाद के अवयवों को निर्धारित किया गया। इसके तहत, दाल, दलिया, व चावल के अलावा 10–15 प्रतिशत तक सेब का पाउडर मिलाया जा सकता है ।

मेंहदी की पत्तियों को धूप में सुखाने का अध्ययन किया गया। सत्तर प्रतिशत नमी वाली मेहंदी की पत्तियों को धूप में सुखाने के लिए 12 से 14 घन्टे की अवधि उपयुक्त पायी गई।

सूरजमुखी एवं सरसों के बीजों से यांत्रिक द्योतक द्वारा तेल निकालते समय तेल एवं खली का तापमान मापा गया। शुरूआत के एक घंटे मशीन को चलाने पर तेल एवं खली का तापमान 57–88 डिग्री सेंटीग्रेड के भीतर पाया गया। पहली बार तिलहनों को मशीन में दबाने पर उसकी घणता 1200 कि.ग्रा. प्रति घण मीटर पायी गयी।

हरी मिर्च की प्यूरी एवं पाउडर के विकास के लिए अध्ययन किया गया। प्रसंस्कृत प्यूरी एवं पाउडर की गुणवत्ता का मूल्यांकन किया गया।

चुकन्दर और गाजर के पाउडर को प्रसंस्करण कर लक्षणों का मापदंड बनाया गया। चुकन्दर एवं गाजर पाउडर की विलायकता क्रमशः 77.3 से 79.9 और 64.2 से 69.8 प्रतिशत तक पायी गई।

विभिन्न प्लास्टिक मल्चिंग के द्वारा भिंडी एवं स्ट्रॉबेरी के आकार वृद्वि एवं उपज के लिये प्रक्षेत्र प्रयोग कर मूल्यांकन किया गया। बायोडिग्रेडेबिल परत की तुलना में काली प्लास्टिक परत वाली मल्च में भिंडी एवं स्ट्रॉबेरी के फलों की उपज को उच्चतम पाया गया।

प्लास्टिक गृहों में कार्बनिक (आर्गेनिक) सब्जियों के उत्पादन में वर्मीकम्पोस्ट के प्रयोग पर अध्ययन किया गया। वर्मी कम्पोस्ट के प्लास्टिक गृह में प्रयोग से टमाटर, स्ट्रॉबेरी और शिमला मिर्च के गुणों और उपज को खुले प्रक्षेत्र के प्रयोग की तुलना में ज्यादा बेहतर पाया गया।

अर्द्ध सूखाग्रस्त क्षेत्र में विभिन्न स्तर पर सिंचाई एवं उर्वरक के प्रयोगों के साथ मल्चिंग के प्रभाव का मूल्यांकन किया गया। काली प्लास्टिक एवं बायोडिग्रेडेबिल परत के प्रयोग करने से खरपतवार नहीं के बराबर पाये गये।

शाक–सब्जियों की पौधशाला के लिये मिट्टी के सौरीकरण पर अध्ययन किया गया। तीस

दिनों तक मिट्टी का सौरीकरण करने से शत् प्रतिशत पौधे जीवित रहे जिससे पौधशाला विषाणु प्रजाति के रोगों से दूर रही। सौरीकरण बहुत ही महत्वकारी पाई गई, क्योकि नियंत्रित की तुलना में खरपतवारों की वृद्धि कम रही। सौरीकरण पौधशाला की जमीन में अत्याधिक अंकुरण एवं पौधों को जीवित पाया गया, साथ ही सब्जियों की जड़ें एवं तने की लम्बाई अच्छी पायी गई।

संशोधित अनार के फलों को गत्तों की पेटियों में भरकर समान्य एवं शीत अवस्था में रखा गया। 4 प्रतिशत कैल्शियम क्लोराइड और 0.1 प्रतिशत कार्बनडाजिम सें संशोधित कर फलों को 30 दिनों तक कमरे के तापतान पर और 48 दिनों तक निम्न तापमान पर रखना संभव रहा।

स्ट्रॉबेरी फलों पर खाद्यीय तह लपेटकर (एडीबल कोटिंग) उनकी भण्डारण अवधि बढ़ाने पर अध्ययन किया गया। एलोवेराजेल से फलों को लपेटकर, पन्नेट में भरने के पश्चात् 5 डिग्री सेंटीग्रेड और 25 डिग्री सेंटीग्रेड तापमान पर रखा गया। नियंत्रित फलों की तुलना में एलोवेराजेल से संशोधित फलों के भार में अपेक्षाकृत कमी (9.9 प्रतिशत) पायी गयी। विभिन्न परीक्षणों के दौरान रंग, टी.एस. एस., विटामिन 'सी' और कठोरता का मूल्यांकन किया गया।

अनार के फलों को तोड़ने और दानों को सुविधापूर्वक गूदों से अलग करने का हस्त औजार विकसित किया गया। हस्त औजार के डिज़ाइन को एकस्व हेतु मिसिल किया जा रहा है।

गोदामों में रखे अनाज में कीटों का पता लगाने हेतु एक यंत्र का विकास किया गया। इस साधारण यंत्र से गोदाम में रखे अनाज में जीवित एवं मृत कीटों के पता लगाने की व्यवस्था के साथ–साथ अनाज के नमूनों में कीटों के अंडों की मात्रा को भी जाना जा सकता है।

सोया–मट्ठा एवं फलों के रस से पेय विकसित किया गया। अनन्नास, अमरूद और आम का प्रयोग करके यह पेय बनाया गया। सोया मट्ठा के भौतिक–रसायनिक गुणों का भी मूल्यांकन किया गया।

EXECUTIVE SUMMARY

The Institute made good progress in research and extension activities during the reported period of 2007-08. Research and extension activities were accelerated with more projects. The institute executed 54 in house projects. The research projects covered the areas of value addition of horticultural crops, food grains, oilseeds, spices etc., assessment of losses, pre-harvest management practices, effects of mulching, utilization of crop residues and development of hardware (hand tools and machines) for improving post harvest technology operations.

Quality index for fresh apple was developed on the basis of non-destructive techniques. The results obtained on the basis of NIR spectra were better than those obtained using visible colour.

A roasting and popping unit for processing of makhana (gorgon nut) seeds has been developed. The capacity of the machine is 25kg/h. The process to prepare ready to eat makhana kheer mix was developed and filed for patent.

Changes in quality and texture of okra pods under modified atmosphere packaging in perforated film packages were studied. Okra pods stored in 300 and 400 g packages were observed to be much superior in terms of maintenance of chlorophyll (green colour) in the pericarp, â-carotene and ascorbic acid in the seeds and other qualitative parameters.

Modified atmosphere packaging of betel leaves (250, 500, 750 g samples) in polypropylene films having 35 µm thickness and stored at 20°C temperature and 75% RH resulted in retention of chlorophyll content upto 10 days of storage. Studies on modified atmosphere packaging of minimally processed cabbage, diced carrots and fresh cut French beans were also conducted.

Tenderization of goat meat was tried using pomegranate seed powder (PSP), pomegranate rind powder (PRP) and mechanical pressing. Samples treated with PRP scored less during sensory evaluation. Samples passed through rollers scored better sensory scores in comparison to control and were also tender.

Immobilization of enzymes and micro organisms was done through micro encapsulation. Yeast was encapsulated in alginate with an efficiency of about 41%.

A unit for pelleting the small seeds at farm scale was fabricated. Cumin seeds were coated with clay using the unit and the size of the seed could be increased to 1.5 times.

Shelled maize cobs (Zea mays Linn.) were successfully gasified in throatless gasifier having 15, 22.5, 30 and 36 cm diameter reactors. The optimum specific gasification rate (SGR) was observed to be 165 kg $h^{-1}m^{-2}$. The combustible gases were observed to be 31-38% of the producer gas at optimum SGR.

Studies were conducted on development of ready to eat breakfast cereal from sorghum. Legumes were incorporated at 0,10 and 15 % levels and various physicochemical characteristics were evaluated. Sensory evaluation of the products was also carried out.

Banana comb cutter was developed and tested. It was observed that its use can reduce the post harvest loss of banana fruit by 2-6 %, caused due to injury during cutting of banana bunches. A patent on its design has been filed.

Studies on osmotic dehydration of banana slices were conducted. Effect of syrup concentration, thickness of banana slices and time of osmosis was observed to be highly significant on weight loss and solid gain.

Foam mat drying of tomato and kinnow juice was studied. Egg albumen (0-20 %) was used as foaming agent. The foamed juices were dried at temperatures of 60, 65 and 70 °C. The optimum level of wet egg albumin was found to be 10 % with whipping for 5 minutes.

Blanched aonla fruits treated with KMS and packed in sterilized plastic tank could be stored upto 6 months. Aonla pulp was prepared by heating the fruits for 12-15 min. The extracted pulp was pasteurized, treated with 0.3 % KMS and packed in

plastic bucket. It could be stored for 6 months. Aonla juice foamed with 10 % egg albumin for 20 min and dried at 60 ^{0}C in thin layers of 1,2 and 3 mm thickness yielded aonla powder with maximum biochemical qualities.

Response surface methodology was used to optimise different ingredients of fruit based value added extruded products. Besides, dhal, dalia & broken rice, 10-15% apple powder could be incorporated.

Studies on solar drying of henna leaves were conducted. Solar drying took 12 to 14 hour to dry henna leaves samples, having initial moisture content of 70 % (w.b).

Buildup of temperature of oil and oilcake during mechanical expression of sunflower and mustard was measured. The temperature of oil and oilcake increased during 60 min of observations and were observed to be in the range of 57 ^{0}C to 88 ^{0}C. Density of mustard seeds after first pass was observed to be 1200 kg/m^3. Maximum compaction took place during first pass through oil expeller.

Process parameters were standardized for making beetroot and carrot powder. The solubility of beetroot and carrot powder was observed in the range of 77.3-79.9 % and 64.2-69.8 % respectively.

Field experiments were conducted to evaluate the performance of various plastic mulches on growth and yield of okra and strawberry. Fruit yield of okra and strawberry were observed to be highest by mulching with black ordinary plastic film followed by black biodegradable film. Studies on organic production of vegetables in polyhouses were conducted using vermicompost. Application of vermicompost increased the quality and quantity of tomato and capsicum, in comparison to control. Similar results were observed for strawberry.

Studies to evaluate effect of irrigation, fertigation levels and mulching on growth and yield of Bt-cotton in semi-arid region were conducted. Weed population and weed dry matter was observed to be least in plots mulched with black polymer film closely followed by black bio-degradable film.

Studies on soil solarization for vegetable nursery were conducted. Solarization for 30 days resulted in 100 per cent mortality of fungus species responsible foe damping off and other nursery diseases. Solarization treatments significantly reduced the emergence of weed population compared to control. Solarization of nursery beds resulted in higher germination and seedling survival. It also resulted in better root and shoot length of different vegetables.

Treated fruits of pomegranate were packed in CFB boxes and stored under ambient and cold conditions. The shelf life of fruits treated with 4 % calcium chloride and carbendazim 0.1 % could be extended up to 30 days at room temperature and 48 days when stored at low temperature.

Studies on effect of edible coatings on shelf life of strawberry were conducted. The fruits were coated with aloe vera gel, packed in punnets and stored at 5 ^{0}C and 25 ^{0}C temperature. Weight loss of aloe vera gel treated samples was significantly lower (9.9 %) in comparison to control (13.79 %). Colour, TSS, Vitamin C and firmness were evaluated under different treatments.

A hand tool for breaking pomegranate and consequent easy separation of arils from its peel has been developed. A patent application has been filed to protect the design of the hand tool.

A mechanical device for detection of insects in stored grains has been developed. The simple device facilitate the detection of the presence of live or dead insects in stored grain and also allows to visualize the egg infestation in the grain sample. A patent has been filed for this device.

Ready to serve beverages were developed from soybean milk whey. Pineapple, guava and mango were used to prepare the beverages. The physico-chemical characteristics of soybean milk whey were also evaluated.

The AICRP on Post Harvest Technology and Application of Plastics in Agriculture have developed many useful technologies.

A good number of research papers, technical bulletins, project profiles and extension leaflets were published. The scientists of the institute participated in various conferences, meetings and workshops. The liaison with farmers and entrepreneurs was improved through various programmes and activities.

CIPHET - AN OVERVIEW

CIPHET - AN OVERVIEW

The Central Institute of Post Harvest Engineering and Technology (CIPHET) was established under the aegis of the Indian Council of Agricultural Research (ICAR), New Delhi on 29 December 1989 at Ludhiana in the state of Punjab as a nodal institute to undertake lead researches in the area of post harvest engineering and technology appropriate to agricultural production catchment and agro-industries. The Institute has another campus at Abohar (Punjab), which was established on 19 March 1993. The Abohar campus is primarily responsible for conducting research and development activities on fruits and vegetables and commercial crops. The Institute is catering to the need of both growers and processors.

The Central Institute of Post-Harvest Engineering and Technology (CIPHET) was established on 29 December 1989 at the PAU Campus, Ludhiana, Punjab, India as a nodal institute to undertake lead researches in the area of the post-harvest engineering and technology appropriate to agricultural production catchments and agro-industries. The institute's second campus was established on 19 March 1993 at Abohar, Punjab, India that is primarily responsible for conducting research and development activities on fruits and vegetables, and commercial crops. CIPHET is also headquarters for two All India Coordinated Research Projects (AICRPs) viz. AICRP on Post-Harvest Technology (PHT) with 33 Centres and AICRP on Applications of Plastics in Agriculture (APA) with 9 Centres.

Mandate

To undertake basic, applied, strategic and adaptive engineering and technology research in post production sector of produce of plant origin, livestock and aquaculture produce including agriculture structures and environmental control, quality and safety.

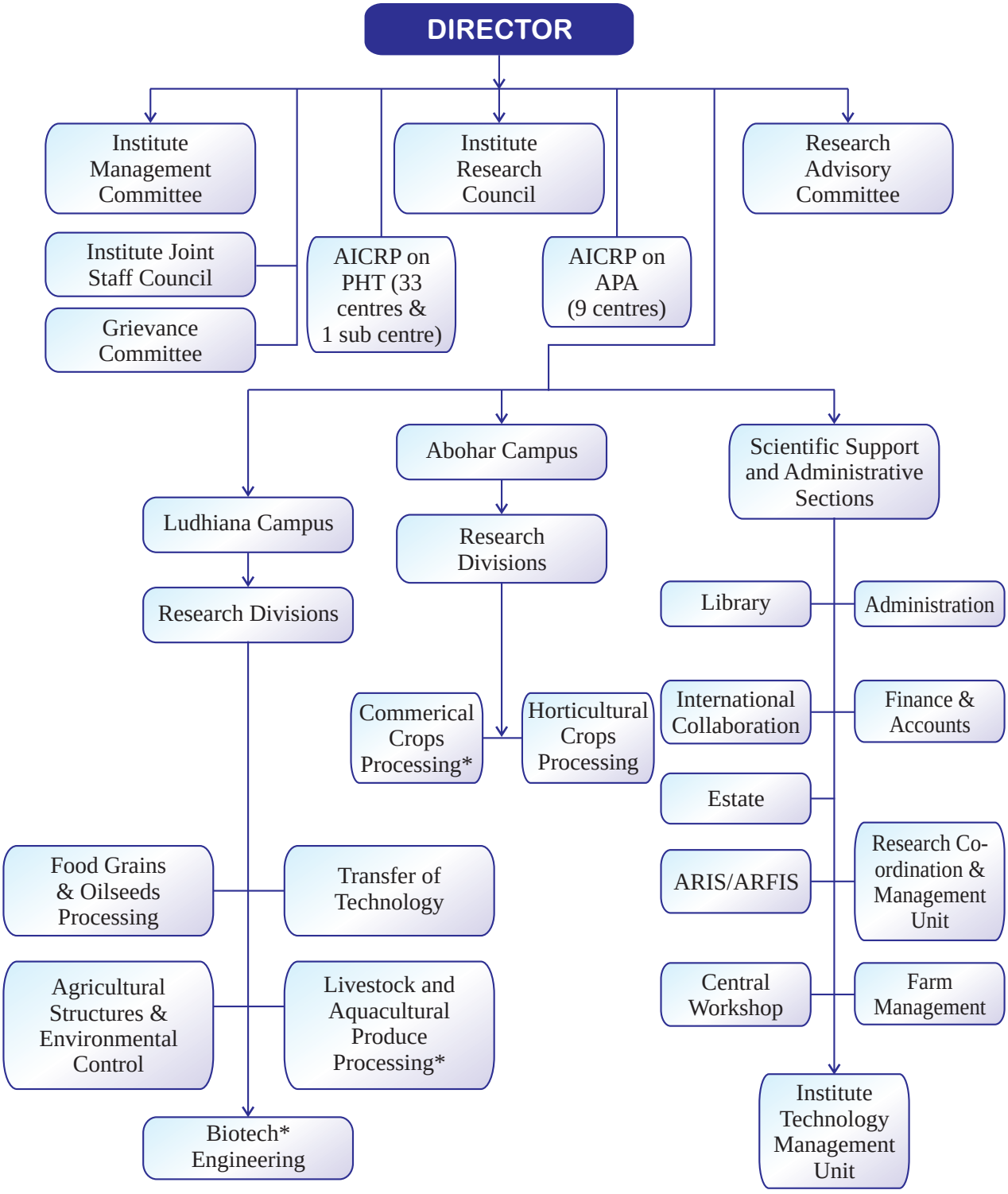
To act as national institute for research, education/teaching and training in post harvest engineering and technology.

To act as national repository of information on processes, equipment, products and technologies on post harvest engineering and technology.

To transfer technology and provide advisory and consultancy services and promote entrepreneurship.

To develop and strengthen linkages with the growers/farmers, private and public sector food processing enterprises in the mandated areas.

ORGANIZATIONAL STRUCTURE



** Proposed to be established*

RESEARCH DIVISIONS

Ludhiana Campus

1. Food Grains and Oilseeds Processing
2. Agricultural Structures and Environmental Control
3. Transfer of Technology
4. Livestock and Aquacultural Produce Processing*
5. Biotech Engineering*

Abohar Campus

6. Horticultural Crops Processing
7. Commercial Crops Processing*

** Proposed to be established*

INFRASTRUCTURE

LIBRARY

CIPHET library plays as important role in serving the scientific information in the areas of Post Harvest Engineering & Technology. The current stock of books is 3083, gratis publications 372, annual reports and research highlights etc. 1106 as on 31.03.2006. 26 Indian journals & 15 foreign journals were subscribed during the year. In this financial year 60 books have been added in the stock. Apart from the purchase of books and periodicals, Institute library is rendering the following services to the readers:

CIPHET Library plays an important role in serving scientific information in the areas of Post Harvest Engineering & Technology. The current stock of books is 3023, Gratis Publications 372, Annual Reports and Research Highlights etc. 1106 as on 31.03.2008. 22 Indian Journals, 15 Foreign Journals were subscribed during the year. The Institute Library is also rendering following services to the members.

Current list of journals & new arrivals are circulated regularly among CIPHET staff and ICAR institutes.

Library consultation services: Faculty members and students from other Institutes and Universities are also welcomed to consult CIPHET Library.

Sale of publications: The Library puts on sale, the Technical Bulletins and Books published by the Institute.

Reference service: The Library also receives photocopy of research articles from other libraries on payment basis as per reader's request. Library also arranges references and abstracts of research papers/articles as per request of the readers on a specific subject/keyword from SAARC Agricultural Information Centre, Dhaka (Bangladesh).

ARIS Cell

The Institute has an Agricultural Research Information System Cell for the scientists for their data analysis and electronic communication. The unit has six computers including one LAN server. The Institute computers are connected through Local Area Network (LAN). The Internet connectivity is available through VSAT provided by council under ICARNet project and 128 kbps leased line from BSNL.round the clock. The Internet is provided to different nodes through proxy server Cyberoam Management. The Cyberoam manages Internet bandwidth; user details and provides security and stability on the network. Besides this the ARIS cell houses a number of analysis and design software. Pro/E was made available to users for CAD/CAM. The Computational Fluid Dynamics from Ansys was also made available for analysis. The facilities in the cell were strengthened through more number of analysis and general software. The Institute operate its website under domain name www.ciphet.in. the site is updated monthly basis.

At present following services are offered by ARIS Cell.

Provide electronic communication in the Institute for the scientists.

Provide data analysis facility for the scientists.

Provide assistance in software application in different research works.

Internet browsing.

Software and computer hardware support to the scientists, administrative and other staff.

Assisted in online patent search through various databases.

Website updation

STAFF POSITION (AS ON 31.03.2008)

CIPHET, Ludhiana

Details of Personnel	Sanctioned Posts	Posts in Position
Scientific	77*	30*
Technical	28	28
Administrative	19**	19**
Supporting	6	4
Total No. of Posts	124	81

* including Director

** Including Administrative Officer

AICRP on Application of Plastics in Agriculture, CIPHET, Ludhiana and Abohar

Details of Personnel	Sanctioned Posts	Posts in Position
Scientific	4	1
Technical	1	1
Administrative	2	2
Supporting	1	1
Total No. of Posts	8	5

AICRP on Post Harvest Technology, CIPHET, Ludhiana

Details of Personnel	Sanctioned Posts	Posts in Position
Scientific	2	1
Technical	1	1
Administrative	1	1
Supporting	11	0
Total No. of Posts	5	3

STATEMENT OF BUDGET ESTIMATES AND EXPENDITURE (2007-2008)

PLAN

(Rs. in lakhs)

S.No.	Head of Account	Revised Budget Estimates	Expenditure up to 31.03.2008
1.	Establishment Charges (TS/OTA)	-	-
2.	Travelling Allowance	7.00	6.27
3.	Other charges including equipment	260.90	84.44
4.	Revenue Resources	-	-
5.	Works (Major)	100.10	74.06
	a. Office building	-	-
	b. Residential building	-	-
6.	Other items (HRD)	2	1.0
	Total	**370.00**	**265.77**
7.	Pension & Retirement Benefits		

NON - PLAN

(Rs. in lakhs)

S.No.	Head of Account	Revised Budget Estimates	Expenditure up to 31.03.2008
1.	Establishment Charges (TS/OTA)	210.10	168.72
2.	Travelling Allowance	2.00	2.00
3.	Other charges including equipment	30.90	30.20
4.	Revenue Resources		
5.	Works (Major)	-	-
	a. Office building	-	-
	b. Residential building	3.00	3.00
6.	Other items (HRD)	-	-
	Total	**253.00**	**240.81**
7.	Pension & Retirement Benefits	0.20	0.15

RESEARCH ACHIEVEMENTS

RESEARCH ACHIEVEMENTS

Development of a nondestructive technique for prediction of quality of apple

S N Jha and D R Rai

Physical and biochemical properties such as size, sphericity, color, density, TSS and acidity of 114 apple fruits were determined and correlated with storage period. The average size of the fruit was found to be 64 mm with sphericity of about 0.95. The average colour L, a, b values were found to be 52, 19.36 and 20.18 respectively. These values may be used to find out the quality of apples. The acidity of apple decreased due to ripening during storage. TSS varied in cyclic order, which showed that the sweetness of apple changes with storage period.

Quality index of apple was defined as the ratio of product of acidity (%) and TSS (°Brix) to the mode of that of *a* and *b* colour values of apple. Its relationship with eating quality was also verified and found that when quality index was about 1, the apple was fully acceptable, but it was almost rejected by the panel when this index came down to about 0.28 (Table 1). Expressions for computing quality index nondestructively using gloss, yellowness index and storage period etc. were developed and found to be reasonably good with correlation coefficients about 0.80 or more.

In order to find the taste of apple in terms of sweetness (TSS), sourness (titratable acidity, %), and acid brix ratio, they were correlated with colour values, visual and NIR spectra. Amongst these methods, NIR spectroscopy using the set up shown in Fig. 1, gave the best results for all the parameters followed by colour values (Table 2). Amongst the colour values L was only needed for TSS whereas a, b and a^2 in form of linear equation was found to be the best for acidity and acid brix ratio with R values for calibration and validation of 0.767 and 0.679 respectively for acidity and 0.674 and 0.604 for acid brix ratio. NIR and visual

Table 1 Sensory scores for tasting fresh and stored apple with their computed quality index.

Predicted Iq, %	Percentage of respondents of sensory panel				
	Liked extremely	Liked moderately	Disliked moderately liked nor disliked	Disliked extremely	Comments
1.00 – 0.90	64	35	1	0	Good taste and appeal
0.89 –0.80	58	33	7	4	Good taste but, not fresh
0.79 – 0.70	44	30	19	9	Taste Ok, but fainted
0.69 – 0.60	31	28	28	13	Dull colour
0.59 – 0.50	26	25	33	16	Shrinkage, rotting spots
0.49 – 0.40	11	18	24	47	Part of samples rotted
0.39 – 0.30	0	0	8	92	Major portions rotted
0.29 – 0.20	0	0	0	100	Mostly apple rejected

*Apples' storage conditions: Room temperature 35±1°C and relative humidity 65±1 %

Fig. 1 NIR spectra acquisition setup for apple

spectra were calibrated using PLS and MLR regression methods and it was found that MLR is the best after treating the data with MSC techniques in case of NIR and without any treatment in case of visual spectroscopy. The best correlation coefficients for calibration and validation were found to be 0.887, 0.745 for TSS, 0.890, 0.752 for acidity and 0.893, 0.751 for acid brix ratio of apple, respectively (Table 2). SEC, SEP, Biases and differences in respective values in these cases were found to be reasonably low, negligible, and scatter plots (Figs. 2-5) indicated that NIR has potential to predict internal quality of apple nondestructively, however for commercial use more varieties and apples produced in different years should be included in these models.

Table 2 Comparative performance of different methods for prediction of quality of apple

Parame-ters	Colour				Visual spectroscopy				NIR spectroscopy			
	Calibration		Validation		Calibration		Validation		Calibration		Validation	
	SEC	R	SEP	R	SEC	R	SEP	R	SEC	R	SEP	R
TSS	1.604	0.589	1.682	0.534	1.548	0.572	1.632	0.507	**0.829**	**0.887**	**1.258**	**0.745**
Acidity	0.019	0.767	0.02	0.740	0.021	0.679	0.023	0.627	**0.016**	**0.890**	**0.024**	**0.752**
Acid brix ratio	0.002	0.674	0.002	0.656	0.002	0.608	0.002	0.538	**0.001**	**0.893**	**0.002**	**0.751**

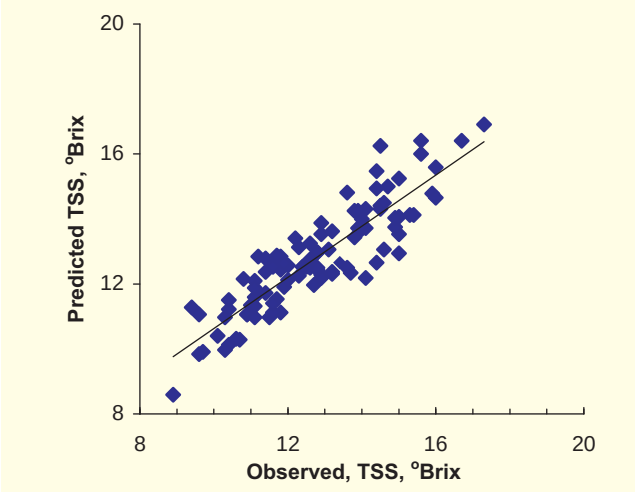


Fig. 2 Observed and predicted TSS of apple in wavelength range of 1136.25-1212.75 nm after MSC treatment of spectra of calibration set of samples

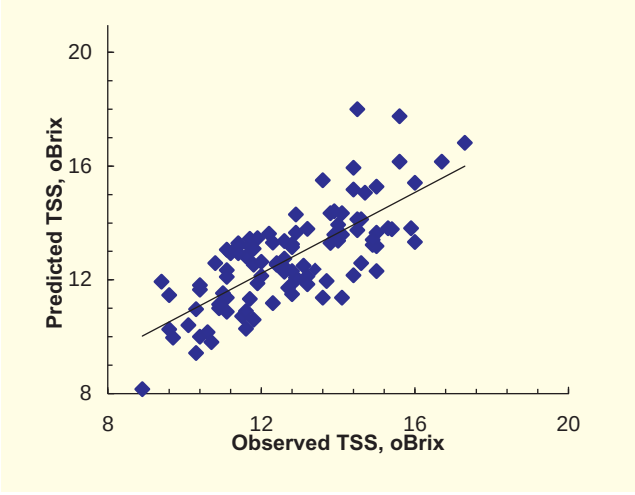


Fig. 3 Observed and predicted TSS in wavelength range of 1136.25-1212.75 nm after MSC treatment of validation set of samples

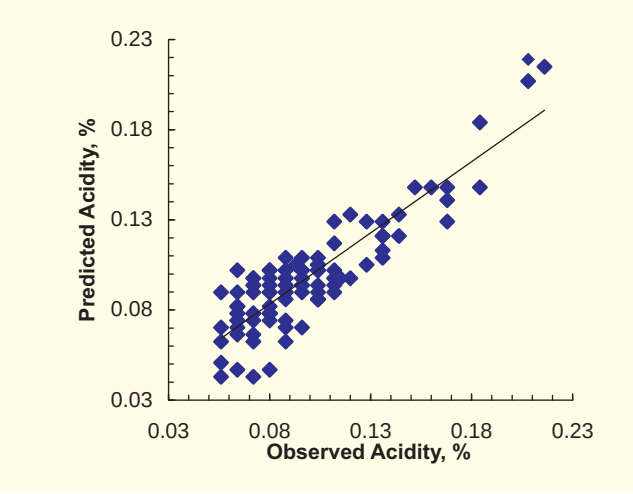


Fig. 4 Observed and predicted acidity in wavelength range 900-976.5 nm after MSC treatment of spectra of calibration set of samples

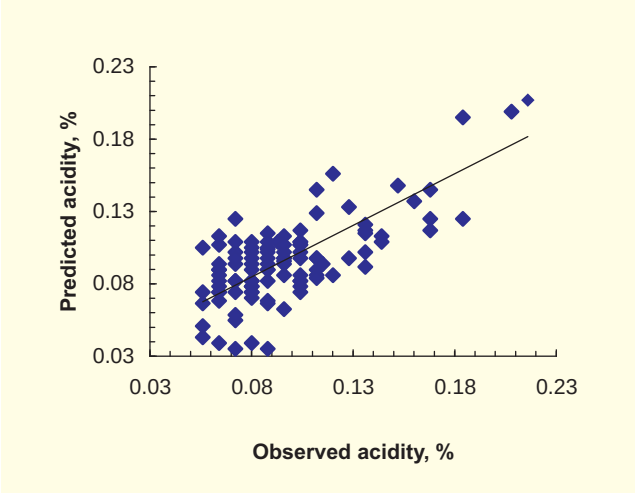


Fig. 5 Observed and predicted acidity of apple in wavelength range of 900-976.5 nm after MSC treatment of spectra of validation set of samples

Development of post-harvest processes and machinery for makhana processing and value addition

S. N. Jha, Janardanjee & B. K. Jha

A roasting and popping unit designed at CIPHET for processing of about 25-30 kg makhana guri (seeds) were got fabricated at M/s Nutan Engineering Works, Darbhanga in collaboration with RCM, Darbhanga. Two trial runs of the machine were conducted and found that machines were functioning as per assumption.

Fig. 6 Ready to Constitute *makhana kheer* mix

Various combinations of ingredients based on the results of experiments conducted last year for development of ready to constitute makhana kheer mix (Fig. 6) were tried to finalize the composition of its ingredients. Number of sensory evaluations and storage studies were conducted. It was found that *kheer* mix with moisture content of 13-14 % could be best before 3 month when stored in polyethylene pack and kept in refrigerator. If moisture content is brought down to about 5 % it could be stored for more than six months. Acceptance level during sensory evaluation was found to be more than 7. A patent has been filed for both the process and the product.

NAIP subproject on "Development of nondestructive systems for evaluation of microbial and physico-chemical quality parameters of mango"

S. N. Jha and K. Narsaiah

Approval of concept note of the project was received and full proposal was developed, presented in various committees. Based on comments and suggestions, project was approved with total budget of Rs. 630.2458 lakh. CIPHET, Ludhiana is the lead Centre and other consortium partners are CIAE, Bhopal, IARI, New Delhi and IMTECH, Chandigarh.

Followings are the objectives of the project:

(i) To conduct survey and profile the toxigenic and spoilage microorganisms on the major varieties

(ii) To develop a biosensing system to detect and quantify the predominant spoilage and /or toxigenic microbial loads

(iii) To develop a machine vision system using ultraviolet, visible and infrared imaging techniques for sorting based on size, colour and external defects and to investigate the potential of X-ray, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) for detecting the internal disorders

(iv) To develop Near Infrared (NIR) models and an instrument to estimate maturity and sweetness nondestructively.

Application of modified atmosphere packaging and storage to fresh vegetables

Deepak Raj Rai and S. N. Jha

Qualitative and textural changes in fresh okra pods (*Hibiscus esculentus* Linn.) under modified atmosphere packaging in perforated film packages

Fresh okra was grown at research farm of the institute; bright green and firm okra pods (length: 40-90 mm), free from blemishes, insect and the mechanical damage were harvested and placed inside the field crates for further handling and pre-cooling. Okra pods were first hydro-cooled and then air-cooled for 2 h inside a cold room maintained at 15°C. After pre-cooling, the okra pods were hand-picked from the pre-cooled lot and were used for subsequent experimentation. Okra pods (100, 200, 300 and 400 g) were packaged in perforated (2 perforations, perforation diameter: 0.3 mm) polypropylene (PP) film packages (bag area: 0.1 m^2, thickness: 35 m) and were stored at 15°C and 75% RH in an environmental chamber. Okra pods (100 g) kept at 15°C and 75% RH in the unsealed PP film bags were taken as control samples. Whereas, the okra pods wrapped in moistened jute bags and stored under prevalent outside environmental conditions (34-38°C) were taken as ambient samples. Three packages from each type of treatments were analysed on 1st, 2nd, 4th, 7th and 9th day of storage for analysis of in-pack headspace concentration of O_2 and CO_2 as well as the qualitative analysis of the okra pods by measuring weight loss, pigments (chlorophyll and -carotene), ascorbic acid content and texture. Also, the visual quality of okra pods was assessed on 1st, 2nd, 4th and 7th day by visual quality assessment techniques.

The in-pack atmospheric composition of O_2 and CO_2 is shown in Fig. 7. The gaseous composition changed rapidly till 24 h of storage, stabilised after 2nd day of storage and did not change thereafter. The different gaseous environments so attained had different effects on various subjectively and objectively evaluated parameters of okra. Among all the sealed film packages, the maximum weight loss was observed to be only 1.4 %. Whereas, the unsealed control samples kept at the same temperature lost 7.6 % at the end of 9th day of storage. As compared to this, the weight loss was largely influenced by the storage temperature in case of okra kept under ambient conditions, as they lost 30.2 % of their initial weight.

Chlorophyll is generally associated with the bright green colour of okra and is the one of the motivational factors for its purchase by the buyer. MAP resulted in maintenance of chlorophyll under the combined effect of low O_2 and high CO_2 conditions in 300 and 400 g samples. The okra samples kept under normal atmosphere at ambient temperature turned pale towards the end of storage indicating substantial loss of chlorophyll (Fig. 8). The ascorbic acid content of the okra seeds increased under MAP or it was preserved for air stored (control) okra samples (Fig. 9). Although, the okra seeds remained unexposed to the external gaseous environment, it was surmised that the observed increase in ascorbic acid content may be due to some kind of gaseous diffusion across the pericarp of okra which may have created a conducive environment

inside the hollow okra pods; under the low O_2 and high CO_2 atmospheres present in the polymeric film packages. Further, for okra pods kept under ambient conditions, the loss in the ascorbic acid was largely influenced by the combined influence of atmospheric level (21.16 %) of O_2 and the ambient storage temperature.

In this study, the increase in the maximum shear stress and toughness beyond a certain limit corresponding to difficulty in the snapping of the tip was considered unacceptable. As the storage under MAP in polymeric film packages led to a slight increase in the maximum shear stress and toughness of the okra pods, it indicated maintenance of the fresh like mechanical properties for film packaged okra. On the contrary, the observed decrease in the maximum shear stress and toughness of air stored okra was largely due to combined effect of continuous direct exposure to the surroundings, resulting in loss of moisture and turgidity as well as onset of flaccidity in the pericarp.

Table 3 depicts the visually assessed qualitative parameters for okra pods. Among the film packaged samples, the green colour was maintained better in 300 and 400 g samples. Generally, the modified atmosphere packaged samples were observed to be better from blackening point of view. Slight blackening was observed only in the apical portions of 100 and 200 g samples on 4th day which was later on observed to be non-uniformly distributed on 40-50 % length of ridges on 7th day. Further, the packaged okra could be snapped easily at the tip for 300 and 400 g samples. Also, no significant difference in the water accumulation severity was observed for okra under MAP. Till whole period of observations, no visible symptoms of disease and putrid off-odour were observed on opening the packages for okra in film packages. On the other hand, the control samples were considered unacceptable on 4th day on account of tremendous loss of green colour, blackening and loss of rigidity. As these samples were unsealed, so no water accumulation was observed in the control samples.

The okra samples kept under ambient conditions were too unacceptable after 2nd day due to loss of green colour, apparent weight loss and excessive toughness. Visually, okra pods (300 and 400 g) under an atmospheric gaseous concentration range for O_2 (6.3-8.4 %) and CO_2 (10.7-11.8 %) were observed to be more greener, very slightly blackened at the ridges, free from disease and off-odour, easily snapping at the tips and had the in-pack water accumulation with in acceptable limits till the 7th day of storage. On the other hand, the control and the ambient samples reached the limit of unacceptability after 4th and 2nd day, respectively.

In these experiments, the results revealed that the MAP stored okra (Fig. 10) in 300 and 400 g packages were much superior in terms of maintenance of chlorophyll (green colour) in the pericarp, -carotene and ascorbic acid in the seeds as well as other qualitative parameters. Further, the instrumental simulation of snapping at the tip as well as the other textural data obtained along the entire length of the okra pods showed that the MAP stored okra were easily snapping at the tips and had a very slight increase in the other mechanical properties which were considered to be with in acceptable limits.

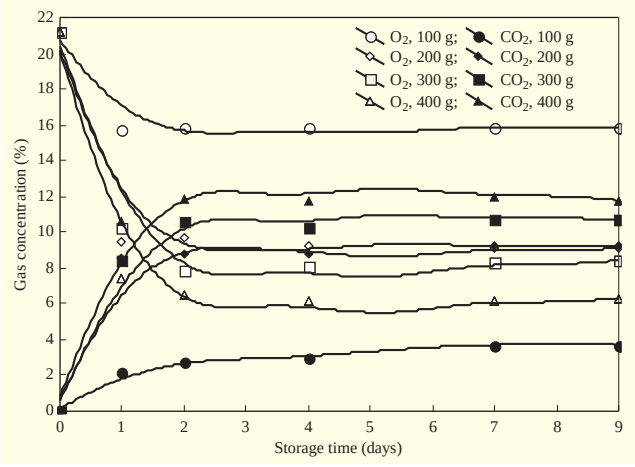


Fig. 7 Variation in gas concentration during storage under MAP

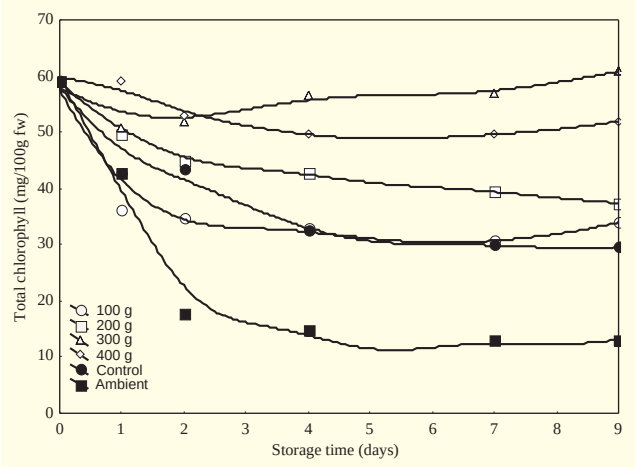


Fig. 8 Variation of total chlorophyll under MAP of okra

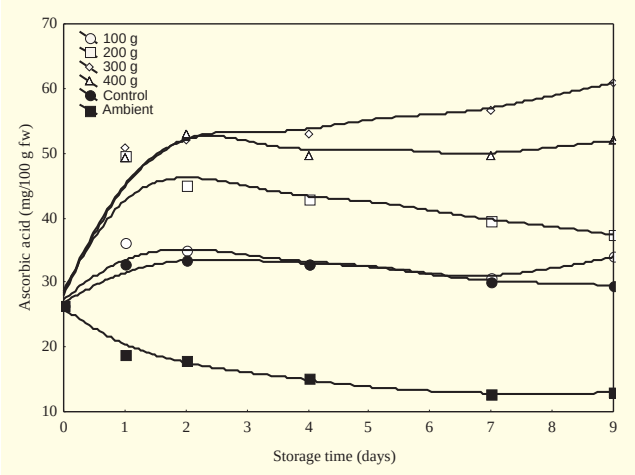


Fig. 9 Variation of ascorbic acid in okra under MAP

Fig. 10 Okra under modified atmosphere packaging in polymeric film packages

Effect of modified atmospheres on pigment and antioxidant retention of betel leaf (*Piper betel* Linn.)

Betel leaves (*Piper betel* L., cv Bangla) were procured from a local betel leaf wholesaler at Ludhiana. The betel leaves were first hydro-cooled, centrifuged by means of a basket centrifuge at 450 rpm for ten seconds to remove the surface moisture to the extent possible and were then air-cooled for 2 h, inside a cold room maintained at 20°C. Air-cooling prepared the betel leaves for subsequent storage temperature regime as well as helped in removing the remaining surface moisture. Betel leaves were packaged (250, 500 and 750 g; Samples A, B and C, respectively) in polypropylene (PP) film packages (0.18 m^2 bag area, 35 m thickness) having gas permeability coefficients of 1.49×10^{-6} and 5.24×10^{-6} $ml.m.m^{-2}.h^{-1}.kPa^{-1}$ for O_2 and CO_2, respectively. The packages containing betel leaves were then heat sealed for storage at 20 °C and 75 % relative humidity (RH) in an environmental control chamber.

Table 3 Visual[a] quality assessment score for okra pods for seven days during storage (A: 100 g; B: 200 g; C: 300 g; D: 400 g)

Sample	Days	Green	Blackening	Snapping	Off odour	Water[b] accumulation
A	1	4.0 ± 0.00	4.0 ± 0.00	4.0 ± 0.00	4.0 ± 0.00	9.0 ± 0.00
	2	3.3 ± 0.15	4.0 ± 0.00	3.3 ± 0.11	4.0 ± 0.00	8.5 ± 0.00
	4	2.8± 0.25	3.1 ± 0.18	2.8 ± 0.15	4.0 ± 0.00	7.5 ± 0.25
	7	2.5 ± 0.34	2.3 ± 0.25	2.1 ± 0.12	4.0 ± 0.00	6.5 ± 0.15
B	1	4.0 ± 0.00	4.0 ± 0.00	3.5 ± 0.00	4.0 ± 0.00	7.0 ± 0.00
	2	3.0 ± 0.00	3.5 ± 0.12	3.3 ± 0.30	4.0 ± 0.00	7.0 ± 0.00
	4	2.5 ± 0.00	3.0 ± 0.12	3.0 ± 0.25	4.0 ± 0.00	6.0 ± 0.25
	7	2.3 ± 0.25	2.7 ± 0.29	2.8 ± 0.25	3.2 ± 0.29	6.0 ± 0.25
C	1	4.0 ± 0.00	4.0 ± 0.00	4.0 ± 0.00	4.0 ± 0.00	8.0 ± 0.00
	2	4.0 ± 0.00	4.0 ± 0.00	4.0 ± 0.00	4.0 ± 0.00	7.8 ± 0.29
	4	3.3 ± 0.13	3.4 ± 0.14	3.4 ± 0.38	3.5 ± 0.00	7.1 ± 0.16
	7	3.2 ± 0.24	3.1 ± 0.15	3.1 ± 0.14	3.3 ± 0.16	7.0± 0.35
D	1	4.0 ± 0.00	4.0 ± 0.00	4.0 ± 0.00	4.0 ± 0.00	7.8 ± 0.35
	2	3.6 ± 0.18	3.8 ± 0.18	3.3 ± 0.35	3.5 ± 0.00	7.0 ± 0.71
	4	3.1 ± 0.19	3.4 ± 0.09	3.2 ± 0.29	3.5 ± 0.50	7.0 ± 0.18
	7	3.0 ± 0.50	3.2 ± 0.29	3.1 ± 0.17	3.3 ± 0.35	7.0 ± 0.50
Control	1	4.0 ± 0.00	3.5 ± 0.23	3.0 ± 0.26	-	9.0 ± 0.00
	2	3.1 ± 0.29	3.15 ± 0.36	2.2 ± 0.75	-	8.0 ± 0.15
	4	1.9 ± 0.45	2.25 ± 0.19	1.8 ± 0.16	-	8.0 ± 0.15
	7	1.7± 0.12	1.25 ± 0.21	1.0 ± 0.25	-	8.0 ± 0.15
Ambient	1	3.5 ± 0.35	4.0 ± 0.00	3.0. ± 0.15	-	-
	2	3.3 ± 0.14	3.7 ± 0.16	1.6 ± 0.26	-	-
	4	1.7 ± 0.36	2.5 ± 0.3	1.6 ± 0.26	-	-
	7	0.9 ± 0.19	2.5 ± 0.18	0.8 ± 0.24	-	-

[a]Scoring scale used for all parameters except water accumulation: 4- very good; 3- good; 2- acceptable; 1- unacceptable

[b]Scoring scale for water accumulation: 9- No water accumulation; 7- Vegetable slightly; 5- Vegetable and film slightly wet; 3- Vegetable moderately wet; 1- Vegetable and film moderately wet; 0- Vegetable completely wet and water accumulation

Three packages from each type of packaging treatments were taken out on 2nd, 5th, 6th, 7th, 9th and 10th day of storage for analysis of in-pack headspace concentration of O_2 and CO_2. The qualitative analysis of the stored packages (in triplicate) was carried on 2nd, 5th, 7th, 9th and 10th day of storage.

The in-pack atmospheric composition of O_2 and CO_2 is shown in Fig. 11. With the continued consumption of in-pack O_2 by packaged betel leaves, unsteady state O_2 and CO_2 levels continued to prevail in all the packages till 6th day of storage and fluctuated slightly, thereafter. The gradual build-up of CO_2 to the steady state levels was observed under all the treatments, which was largely due to fall in respiration and development of inter-leaf thin layer of water on the betel leaves. The different gaseous environments so attained had different effects on various pigments and phenolic content of betel leaves.

MAP resulted in a substantial maintenance of chlorophyll content of betel leaf during 10 days of storage under all the different packaging treatments (Fig. 12). However, the chlorophyll retention largely depended upon the transient and steady state in-pack gaseous environments attained under different modified atmospheres. As shown in Fig. 12, an initial decrease in the chlorophyll levels was observed under all the packaging treatments, when the in-pack O_2 was being consumed and a gradual increase in the CO_2 levels was taking place. Under these conditions, the decrease in chlorophyll content was largely influenced by higher levels of in-pack O_2 alone. As the storage period progressed and the CO_2 build-up took place inside the film packages, a stabilisation in the chlorophyll retention levels was observed for the film packages, which can be attributed to the progressing hyper-ambient levels of CO_2. At the end of storage, the chlorophyll retention levels increased slightly for the film packages containing 250, 500 and 750 g of betel leaves. The increase was observed to be more in 750 g samples which was again indicative of the fact that in-pack atmosphere of in these packages have been beneficial for chlorophyll retention, particularly the in-pack CO_2 may have played a predominant role in chlorophyll content retention. The -carotene content under all the modified atmospheres was more or less maintained under MAP conditions of low O_2 and high CO_2.

The effect of different modified atmospheres on the phenolic content was evaluated during the entire storage period involving the gradual consumption of O_2 and buildup of the CO_2 in the film packages containing betel leaves (Fig. 13). During the first two days of storage when the in-pack atmosphere under the different packaging treatments was dominated by high levels of O_2 (11-16 kPa), a larger increase in the phenol content was there under the higher in-pack levels of O_2 although the visual analysis showed no significant change in the betel leaves as compared to the initial (Fig. 14). The phenolic levels stabilized thereafter till 7th day of storage, but again with the gradual build up of CO_2 and reduction in O_2 levels further around 9th day of storage, a minor increase in the phenolic content was again observed for 500 and 750 g samples, largely due to the abnormal browning under low levels of O_2 prevailing in these packages. On the other hand, the equilibrated gaseous partial pressures of 8.9 kPa for O_2 and 4.8 kPa for CO_2 could increase the phenolic content only marginally in 250 g samples.

The results suggested that although the buildup of CO_2 is necessary for prevention of browning of

betel leaves in these film packages (Fig. 15), it should also be supplemented with sufficiently O_2 partial pressures around 9 kPa to avoid the abnormal browning in the betel leaves, during later part of the storage. Hence, attainment of suitable beneficial increase in the phenolic content of betel leaves under MAP demand either the application of the polymeric films of suitable gas permeability characteristics or alternatively optimization of in-package weight of betel leaves to achieve the desired partial pressures of 9 kPa for O_2 and 6.5-7.0 kPa for CO_2, respectively.

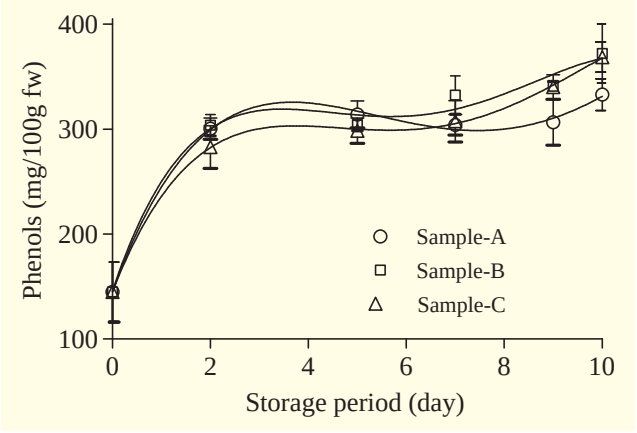


Fig. 13 Phenolic changes in betel leaf under MAP

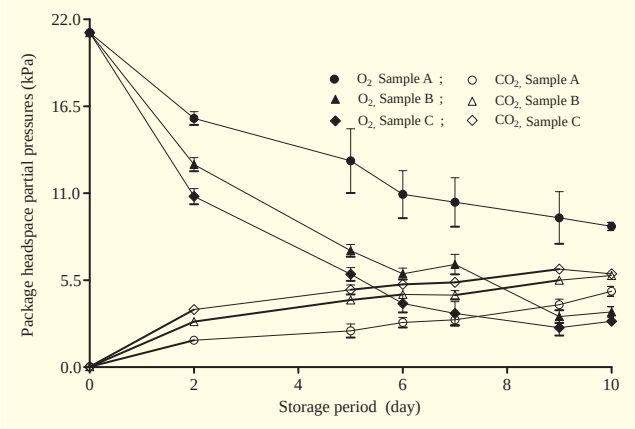


Fig. 11 Gas concentrations in different treatments under MAP

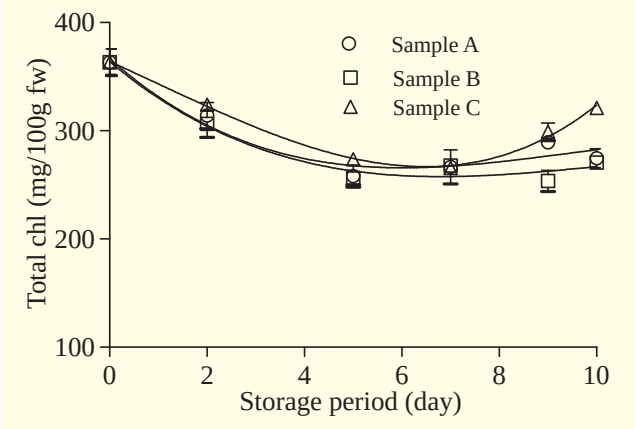


Fig. 12 Total chlorophyll in different treatments under MAP

Fig. 14 Modified atmosphere packaging of betel leaves

Fig. 15 Betel leaves after 13 days of storage under MAP

Identification & evaluation of appropriate packaging for minimal processing of selected fruits and vegetables

Deepak Raj Rai, K. Narsaiah and D.K. Bharti

Modified atmosphere packaging of minimally processed cabbage (*Brassica oleracea* Var. capitata)

Cabbage heads were minimally processed and the shredded cabbage was either washed with 0.5 % citric acid or was non-washed before storing under modified atmosphere packaging (MAP) in polypropylene (PP) film packages at 15°C and 75 % relative humidity (RH) in a cold room to study the effect of washing on pigments and antioxidant content of shredded cabbage. Results showed that during storage under MAP, the 0.5 % citric acid washed samples had a drastic reduction in the chlorophyll content (Fig. 16). However, for non-washed shredded cabbage, under the in-pack gaseous concentrations of 4.2-8.1 % for O_2 and 8.2-11.6 % CO_2, the chlorophyll content could be maintained to sufficiently reasonable levels. A combination of low in-pack O_2 (4.2 %) and high CO_2 (11.8 %) concentrations (Fig. 17) had a beneficial effect on -carotene content of non-washed samples, while it decreased drastically both under anaerobic as well as under the sustained higher levels of in-pack O_2. The ascorbic acid content could be retained significantly, both in non-washed and washed cabbage under the gaseous atmospheres of 2.4-4.2 % for O_2 and 11.8-13.5 % CO_2. However, under anaerobic levels of O_2, it decreased at a faster rate for all the packaging treatments (Fig. 18). The results of the study led to the conclusion that while washing of the shredded cabbage with 0.5 % citric acid led to a drastic reduction in its chlorophyll and -carotene content

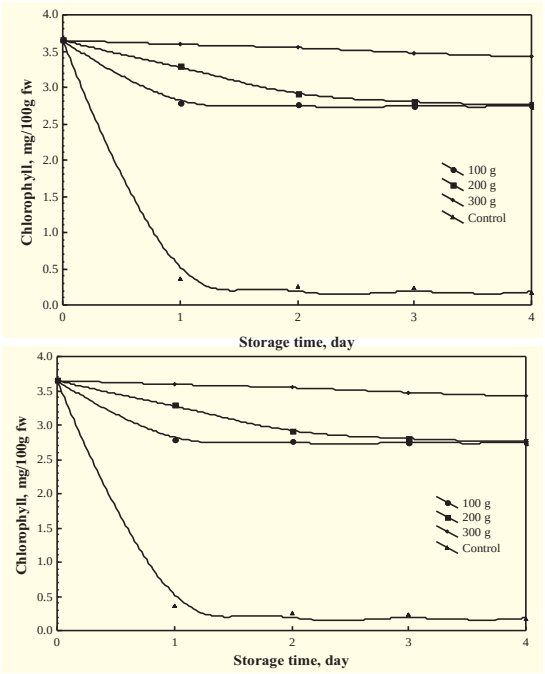


Fig. 16 Variation in the chlorophyll content of the shredded cabbage under modified atmosphere packaging in non-washed and washed samples, respectively

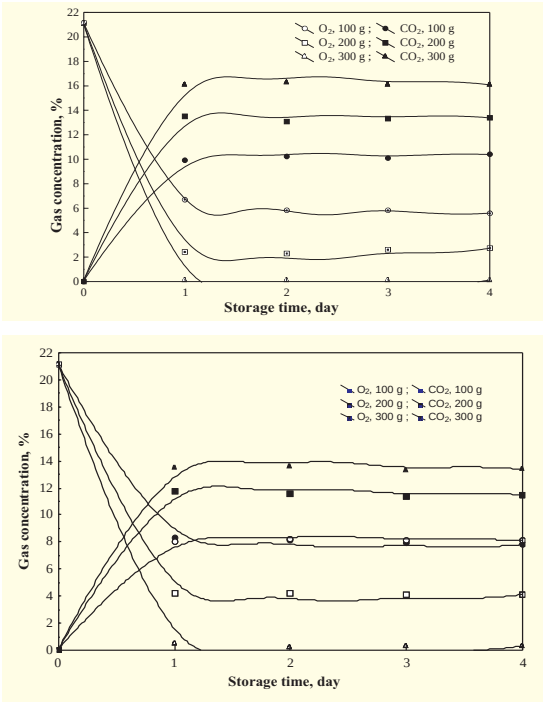
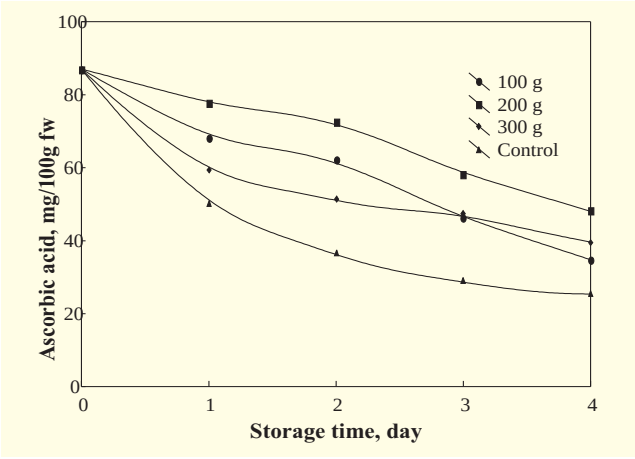


Fig. 17 Changes in concentrations of O_2 and CO_2 inside the polypropylene (PP) film packages containing shredded cabbage under modified atmosphere packaging in non-washed and washed samples, respectively



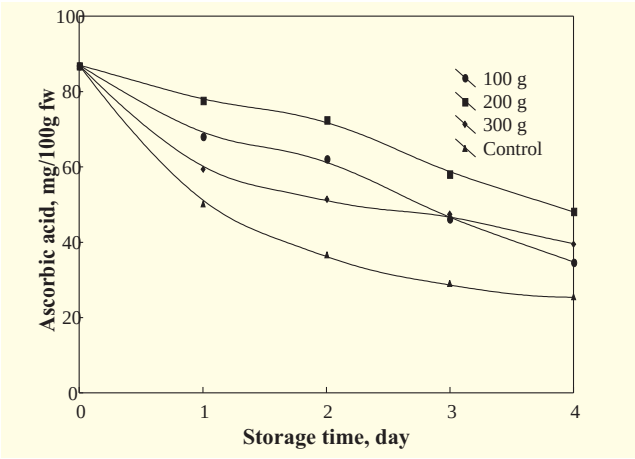
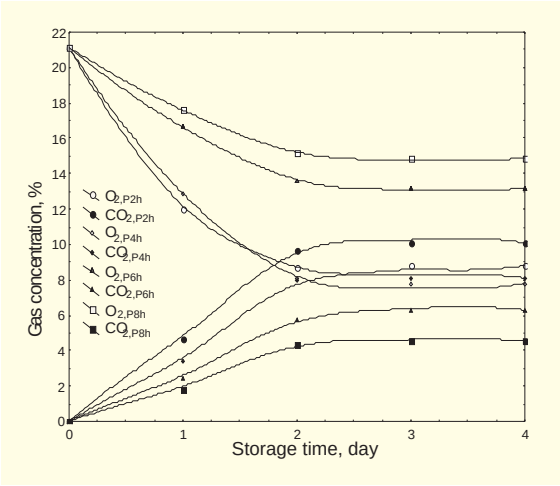


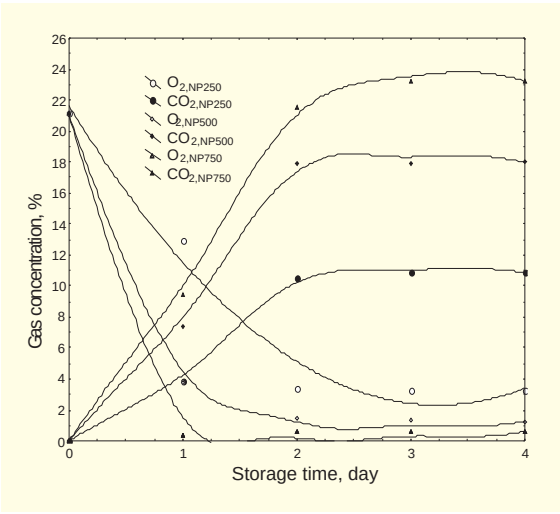
Fig. 18 Variation in the ascorbic acid content of the shredded cabbage under modified atmosphere packaging in non-washed and washed samples, respectively

during subsequent storage under modified atmosphere, the ascorbic acid content was affected insignificantly.

Effect of modified atmosphere packaging on physicochemical attributes of diced carrots

Minimally processed foods or ready to use convenience foods consist of raw fresh cut products, which have undergone peeling, slicing or shredding. However, as minimally processed foods have high rates of respiration, they need to be preserved by appropriate technologies. Carrots were peeled and diced to appropriate size and were stored under different modified atmospheres in perforated or non-perforated polypropylene (PP) film packages 5°C for 4 days of storage. The control samples were kept under ambient environment to assess the effect of modified atmospheres on weight loss, lycopene, â-carotene and in-pack water accumulation severity for diced carrots. Results showed that packaging treatments resulted in creation of modified atmospheres ranging from 0.57-15.2 % O_2 and 4.9-23 % CO_2 (Fig. 19). While the weight loss was found to be more for control samples under ambient (18-22 ^{0}C) environment, the in-pack water accumulation severity did not vary significantly among all the packaging treatments (Fig. 20). Lycopene content decreased slightly under all the packaging treatments, but was maintained under perforated 8 holes (0.3 mm diameter) treatment and 4 holes control samples kept under ambient conditions (Fig. 21). However, â- carotene content increased slightly under most of the packaging treatments at the end of 4th day.





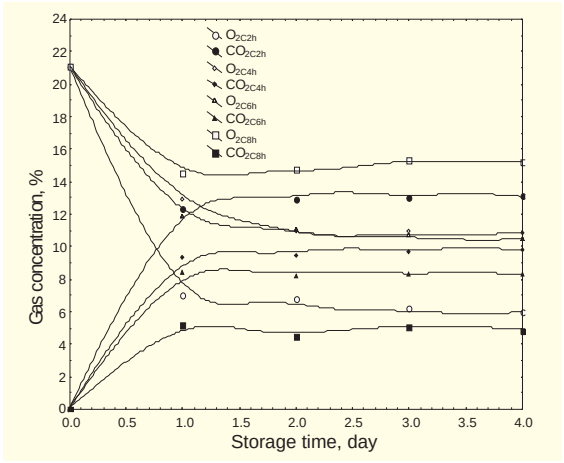
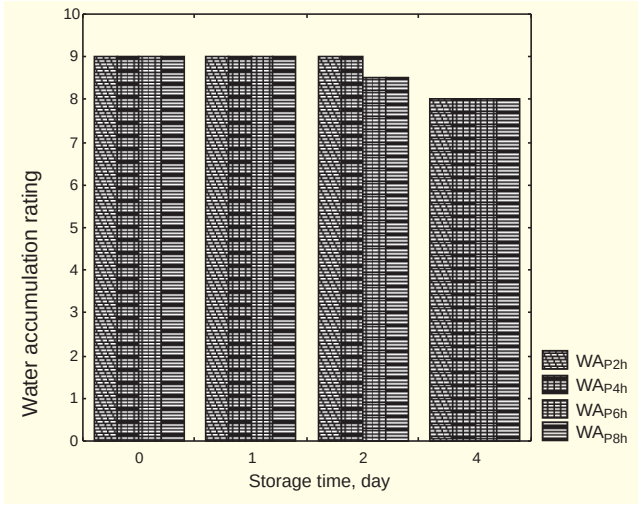
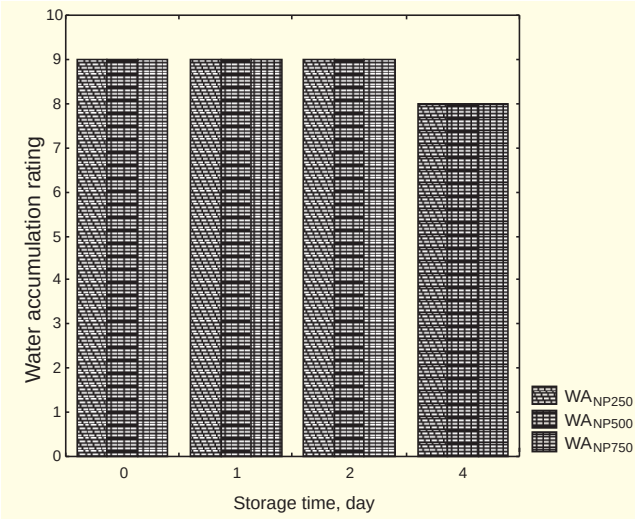


Fig. 19 Variation in the in-pack gaseous atmospheres in perforated, non-perforated and control packages of diced carrots, respectively





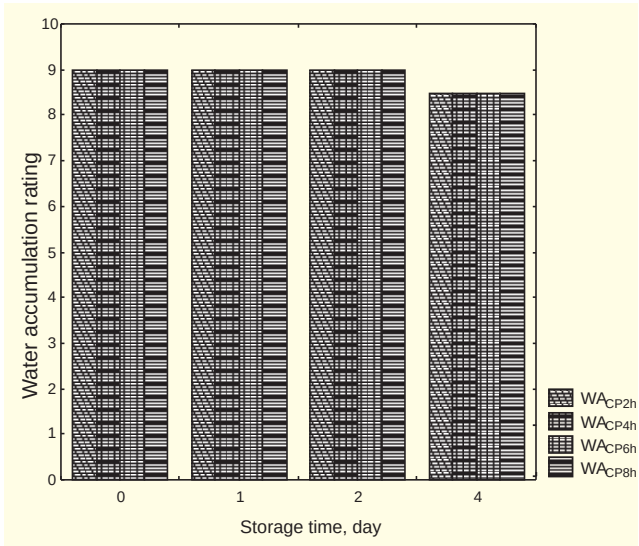
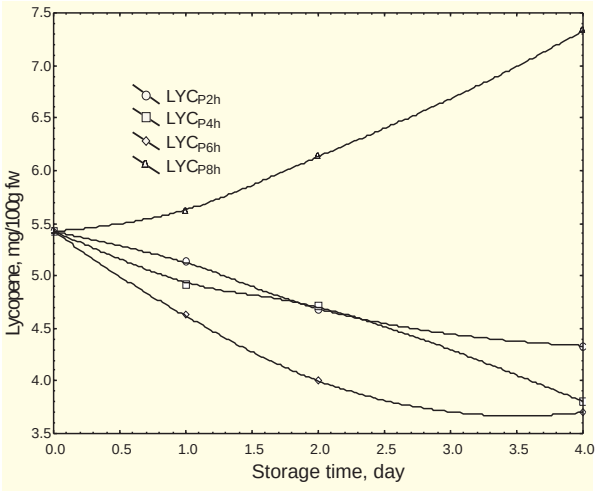
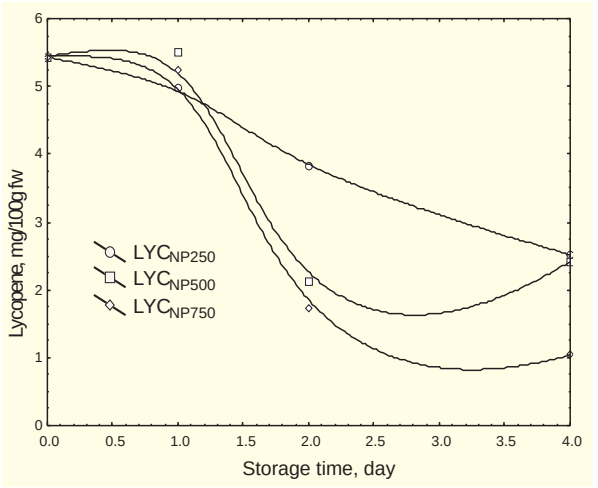


Fig. 20 Water accumulation in perforated, non-perforated and control packages of diced carrots, respectively





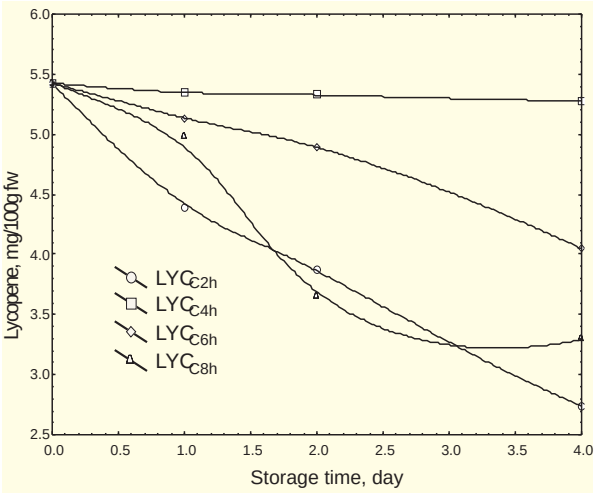


Fig. 21 Variation in the lycopene content in perforated, non-perforated and control packages of diced carrots, respectively

Chlorophyll retention in fresh-cut french beans (*Phaseolus vulgaris* Linn.) by modified atmospheres

French beans (*Phaseolus vulgaris* Linn.) were cut into 10-12 mm length size and were stored under different modified atmospheres in perforated (8 holes, 0.3 mm dia. each, bag area: 0.17 m^2) polypropylene (PP) film packages having gas permeability coefficients (4.14×10^{-14} ml. cm. cm^{-2}. s^{-1}. Pa^{-1} for O_2 and 1.45×10^{-13} ml. cm. cm^{-2}. s^{-1}. Pa^{-1} for CO_2, respectively) at 15°C for 3 days of storage. The modified atmospheres were created by packaging different weights (250, 500, 750 and 1000 g) of beans in polymeric film packages (Fig. 22). The effect of modified atmospheres on chlorophyll retention which is an indicative of green colour was analysed spectrophotometrically. Results showed that packaging treatments resulted in creation of modified atmospheres ranging from 2.6-12.7 % O_2 and 4.5-13.6 % CO_2, which affected the chlorophyll content of the french beans differently (Fig. 23). The chlorophyll was observed to be better maintained in 1000 g film packages in which the CO_2 concentration was observed to be highest and arrived at lowest retention levels in film packages containing 250 g of fresh-cut french beans indicating the predominant effect of high levels of CO_2 for retention of chlorophyll. Results of the study led to the conclusion that higher in-pack weight and so the high in-pack CO_2 levels can suitably maintain the green colour of french beans for 3 days of storage under modified atmosphere (Fig. 24).

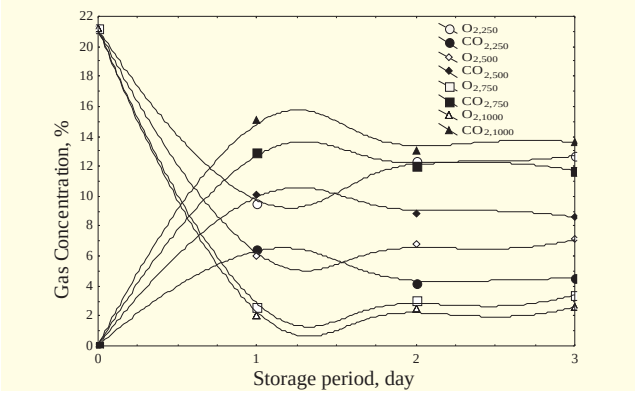


Fig. 22 Variation of headspace gas concentrations inside the film packages containing 250, 500, 750 and 1000 g of french beans, respectively kept for storage in PP film packages

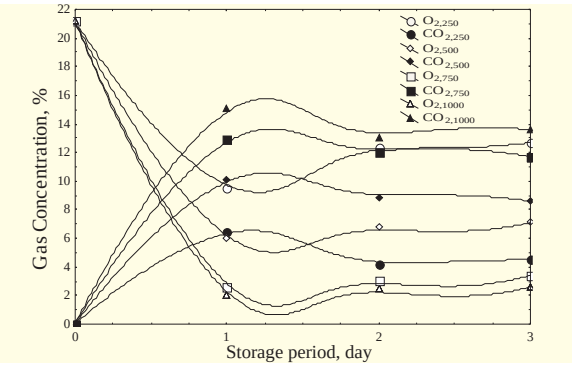


Fig. 23 Variation of chlorophyll content inside the film packages containing 250, 500, 750 and 1000 g of french beans, respectively kept for storage in PP film packages.

Fig. 24 Minimally processed cabbage, carrot and french beans respectively

Tenderization and instrumental quality evaluation of goat meat

K.Narsaiah, S.N. Jha, D.B. Singh and J. Sahoo

The goat meat was treated with pomegranate seed powder and pomegranate rind powder. The L,a,b values of uncooked and cooked samples rubbed with pomegranate seed powder (PSP) are given below in Table 4.

In uncooked samples, the increase in L values and decrease in 'a' values with increase in % PSP indicated that the meat becomes lighter and loses redness. The 'b' values are more or less unchanged. This means that the treatment makes the meat lighter in colour. In cooked samples, the samples treated with PSP were more darker compared to control sample and there was fall in redness and yellowness values. Thus the instrumental values correlate well with the sensory scores in terms of colour and appearance.

Solutions of pomegranate rind powder (PRP) were prepared and goat meat dipped for tenderization for 24 hours at refrigerated temperature and the results were similar. There was slight decrease in terms of peak shear force values compared to untreated sample (Fig. 25). The samples were cooked and sensory evaluation was carried out using cooked samples. Samples treated with PRP got less score for colour in sensory evaluation and there was adverse effect on taste of treated meat. There was no definite trend in sensory score of texture (Fig. 26). The L,a,b values of uncooked and cooked samples dipped in solution of pomegranate rind powder (PRP) are given below (Table 5).

Table 4 L, a, b values of meat samples rubbed with pomegranate seed powder (PSP)

Treatment (% PSP)	Uncooked			Cooked		
	L	a	b	L	a	b
0 (control)	35.84	8.79	7.47	31.35	3.94	8.71
2	40.36	7.05	7.45	24.00	3.265	5.53
4	40.31	6.41	7.72	25.56	2.31	5.22
6	41.59	6.51	7.83	23.99	3.13	4.77

Table 5 L, a, b values of meat samples dipped in solution of PRP

Treatment (% PSP)	Uncooked			Cooked		
	L	a	b	L	a	b
0 (control)	42.81	6.648	6.77	32.45	3.24	4.51
2	42.20	6.10	12.98	25.12	2.62	5.63
4	43.03	4.89	11.93	24.56	2.31	4.98
6	40.21	5.03	11.60	23.72	2.13	4.22

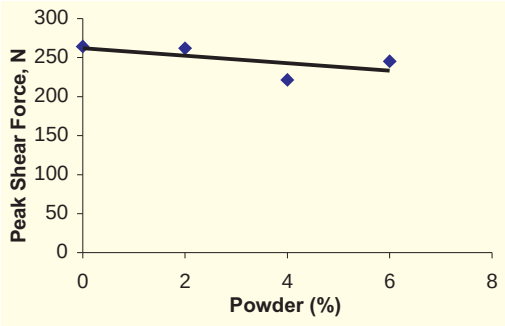


Fig. 25 Effect of pomegranate rind powder on goat meat tenderness

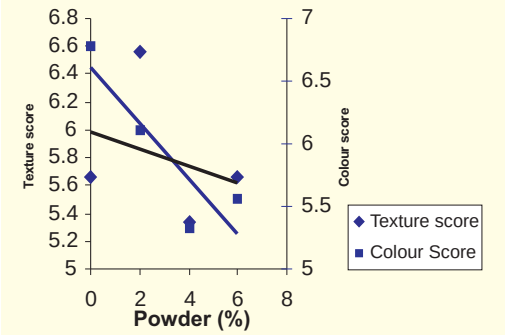


Fig. 26 Effect of pomegranate rind powder on sensory scores of goat meat

In uncooked samples, there was substantial change in b values (yellowness) with increase in % PRP. The 'L' and 'a' values were more or less unchanged. This means that the treatment imparts yellow color to meat. In cooked samples, the samples treated with PRP were more darker compared to control sample and there was drastic fall in redness and yellowness values.

Goat meat chunks tenderized by passing through gap between two rollers and the cooked samples of 8 passes and 12 passes through rollers scored better sensory scores and required lesser shear force for shearing compared to control and 16 passes.

Development of microencapsulator for immobilization of microorganisms and enzymes

K.Narsaiah and H.S. Oberoi

The two fluid nozzle system modified with projected tip on inner nozzle was tested. The

capsules were of size 0.6-1.5 mm with low nitrogen pressure of 0.2 bar and 0.1-0.6 mm with nitrogen pressure of 0.4 bar. Immobilized urease enzyme in alginate beads and tested its activity. Modified two nozzle system was integrated with pressurized bottle as pump for alginate solution. Produced Microcapsules were produced with this set up.

Produced microcapsules with syringe feeding and SS droplet generating system at two air pressures. The capsules were classified into three classes by settling in a glass column. At air pressure of 0.5 kg/sq.cm gauge, the capsules had larger diameter compared to capsules producued at 1.0 kg/sq.cm gauge air pressure. Stand for microencapsulator set up fabricated. A rotating plate assembly consisting of DC motor with speed regulation was fabricated and integrated with the system. Produced microcapsules with syringe feeding and SS droplet generating system using pressurized nitrogen. At air pressure of 0.5 kg/sq.cm g, the capsules had larger diameter compared to capsules producued at 1.0 kg/sq.cm g air pressure.

Produced microcapsules with syringe feeding and SS droplet generating system with needles as inner cylinder at two air pressures. When the distance from the nozzle outlet increasesd, diameter of capsule increased. With increase in needle diameter, there was increase in diameter of capsules. Produced microcapsules with syringe feeding and SS droplet generating system with two fluid nozzle droplet generator using air compressor. The capsules formed are of 0.6 mm diameter.

Encapsulated yeast in alginate and the encapsulation efficiency was about 41%. Produced microcapsules with syringe feeding and SS droplet generating system with two fluid nozzle droplet generator. Dehydration and rehydration of capsules was studied. Upon rehydration of dried capsules, the capsules gained 20 % of original water present.

Pelleting and singulating of selected seed spices

V. K. Bhargav

Seed pelleting is an essential component of seed technology and plays an important role in making the seed safer during handling and in field emergence. In pelleting, inert materials are added to change seed size and shape for improved plantability. Small and irregular shaped seed can now be treated as larger round seed. Singulating of seed in the field therefore becomes easier. A unit for pelleting the small seeds at farm scale was fabricated at CIPHET Ludhiana (Fig. 27). It consists of a used tyre having outer diameter of 68.5 cm and inner diameter of 40 cm. It is fixed on a structure in a way so that it can be revolved by a handle provided for the purpose. The cumin seed was used to coat the seed. The 250 g cumin was poured in the tyre. The inert materials used was clay. Then the tyre was revolved by handle and water was sprinkled with hand sprayer. Due to revolving action the inert material started sticking on to the surface of cumin. After that the material was sieved to get cumin separated and also to get uniform seed size as coating with this process was not uniform. The size of cumin coating with clay alone could be enhanced by 1.5 times. The seed treatment if required can also be done in this process. The pelleting with this equipment is to be compared with commercial pelletizers.

Fig 27 A view of seed pelletizers

Post harvest management and value addition in coriander and cumin seed spices

V. K. Bhargav, R. K. Vishwakarma and R. K. Goyal

A portable solar dryer was developed at CIPHET to dry the valuable harvested crop like seed spices Fig 28. It was made up with MS pipe of 1" square

section to give strength. The area covered was 7 sqm (3.5x2m). The structure was made movable using castor wheel. Fabrication of this unit was done in such a way so that height can be adjusted using telescopic arrangement of two rear legs. By this arrangement it is suitable for different places and through out the year. The structure is completely folding type and portable. The arrangement made for latitude 25, 30, 35, 40 degrees. It was covered with transparent UV-stabilized low-density polyethylene film (LDPE) of 350 micron. The ventilation was provided at the top with two 15" circular holes. At the bottom, there was a provision for clearance up to 12" to built a natural draft of air. This solar dryer was evaluated under no load condition and loaded with vegetable waste during the months June-July. The orientation of the greenhouse was from east-west direction. The inclination from south was 25 deg. (Lat. of Ludhiana). The temp was found to be 8 ^{0}C more than the ambient under no load conditions. The temperature inside the greenhouse was found to be 38.4 ^{0}C at 10 AM. Vegetable waste (cauliflower and pea pods) could be dried in 4 days from moisture content 86.6 % to 15 % (wb). The advantages of this structure are:

They require a small area of land in order to dry similar quantities of crop that would have been dried traditionally over large land areas in the open;

They yield a relatively high quantity and quality of dry crops because fungi, insects and rodents are unlikely to infest the crop during drying;

The drying period is shortened compared with open air drying, protection from sudden down pours of rain; and

Commercial viability, i.e. their relatively low capital and maintenance costs

The use of readily available materials for construction.

Fig. 28 A portable solar dryer

Optimization of parameters for utilization of paddy straw, kinnow pulp and pea pods for production of cellulases, ethanol and feed supplements

Harinder Singh Oberoi and Vinod Kumar Bhargav

Mild acid hydrolysis of paddy straw using different concentrations (1and 2 %, w/v) of acids such as HCl, H_2SO_4, oxalic acid and citric acid were carried out by using acids (w/v) at concentrations of 1 and 2 %. The hydrolysis was carried out in an autoclave at 15 psi at 121^{0}C for 15, 30 and 45 min. (Table 6) Prior to sterilization treatment, paddy straw was ground to a particular sieve size of 0.83 mm and was moistened with the required acid concentration in flasks and the flasks were vortexed and kept on a shaker for about 2 h prior to sterilization treatment.

In case of double acid hydrolysis treatment, the biomass was squeezed and the liquor was collected and the residual biomass was again subjected to acid hydrolysis using the same acid concentration which resulted in highest sugar concentration during primary hydrolysis step. The solid to liquid ratio in both the hydrolysis steps was maintained at 1:10.

Enzyme assays were carried out for analyzing FPase, CMCase and â- glucosidase (Table 7). Filter

Table 6 Effect of different acid concentrations and treatment time on sugar yields and extent of hydrolysis of paddy straw

Acid concentration	Total sugar yield (%)			Extent of Hydrolysis (%)		
	15 min	30 min	45 min	15 min	30 min	45 min
Water	0.1	0.57	1.0	0.16	0.95	1.66
Citric acid (1%)	0.9	2.0	1.8	1.50	3.33	3.0
Citric acid (2%)	2.6	4.8	4.5	4.33	8.0	7.5
Oxalic acid (1%)	1.9	4.7	4.5	3.16	7.8	7.5
Oxalic acid (2%)	5.9	11.1	10.2	9.83	18.5	17.0
Sulphuric acid (1%)	8.5	14.4	15.0	14.16	24	25.0
Sulphuric acid (2%)	10.4	15.0	14.5	17.33	25	24.16
Hydrochloric acid (1%)	8.7	14.7	12.1	14.50	24.50	20.16
Hydrochloric acid (2%)	9.5	16.4	13.3	15.83	27.33	22.16

Table 7 Cellulase production using different treatments

Treatments	FPase activity (IU/gds) at 96 h	CMCase activity (IU /gds) at 72 h	â-glucosidase activity (IU /gds) at 96 h
KP +W	13.0 ± 0.55	17.2 ±0.48	1.4 ± 0.12
KP + MW	11.0 ± 0.42	22.2 ± 0.60	2.8 ± 0.18
KP + WB(4:1) + W	13.4 ± 0.45	20.5 ± 0.60	8.2 ± 0.33
KP + WB(3:2) + W	13.2 ± 0.45	21.5 ± 0.64	12.8 ± 0.37
KP + WB(4:1)+ MW	11.5 ± 0.40	22.5 ± 0.63	15.2 ± 0.41
KP + WB(3:2) + MW	12.0 ± 0.50	25.2 ± 0.70	18.0 ± 0.47
CD (0.05)*	0.832	0.053	0.732

KP: Kinnow Pulp; W: Water; MW: Mandel Webber medium; WB: Wheat Bran Values are Mean ± SD
* CD value is calculated for mean values only and the values in superscripts with the same letter are not significantly different at P> 0.05

paper activity (FPase) was assayed by incubating the suitably diluted crude enzyme extract (0.5 ml) with 1.5 ml citrate buffer (50 mM, pH 4.8) containing ashless Whatman no.40 filter paper (50 mg 1x 6 cm) at 50^{0}C for 60 min. Endoglucanase (CMCase) activity was carried out by incubating the total reaction mixture containing 0.5 ml of suitably diluted enzyme and 0.5 ml of 1% (w/v) Carboxymethylcellulose (CMC) solution in citrate buffer (50 mM, pH 4.8) at 50 ^{0}C for 30 min. The reducing sugars liberated were quantified using the Dinitrosalicylic acid (DNS) method of Miller (1959). â- glucosidase activity was estimated using pNPG as substrate. The assay mixture containing 25 ì l substrate {5 mM, 4- Nitrophenyl â-D-glucopyranoside (pNPG)}, 25 ì l diluted enzyme, 50

ì l acetate buffer (50 mM, pH 5.0) was incubated at 50^{0}C for 30 min in an Elisa Reader (MULTISKAN ASCENT, Thermo Fisher Corporation) and p-nitrophenol liberated was measured at 405 nm by Elisa Reader. All the other colorimetric observations were recorded using microprocessor based double beam UV-VIS spectrophotometer (SL 164, Elico India). One International unit (IU) of enzyme activity was defined as the quantity of enzyme required to liberate 1 micromole of glucose or p-nitrophenol per ml of crude filterate per minute under standard assay conditions and was reported on the basis of gram dried substrate (gds).

Acid hydrolysate (Fig. 29) collected from mild acid hydrolysis of kinnow waste and the liquid collected was neutralized using alkali to bring the pH to about 5.0 and the same was supplemented with yeast extract, peptone and ammonium sulphate and was fermented using a combination of *Saccharomyces cerevisiae* and *Pachysolen tannophilus*. The operational conditions were (pH of 5.0, temperature 32^{0}C, agitation 120 rpm) for 48 h and ethanol was estimated using gas chromatograph (CIC, Baroda). The samples were centrifuged at 5,000 rpm for 10 min at 40^{0}C and the supernatant was analyzed for ethanol production and residual sugars. Ethanol was analysed using Gas Chromatograph, GC 2010 (CIC, Baroda, India). The injector and detector were maintained at 1200 ^{0}C and the oven was maintained at 1000 ^{0}C. Nitrogen was used as a carrier gas with linear velocity of 30 mL min^{-1}.

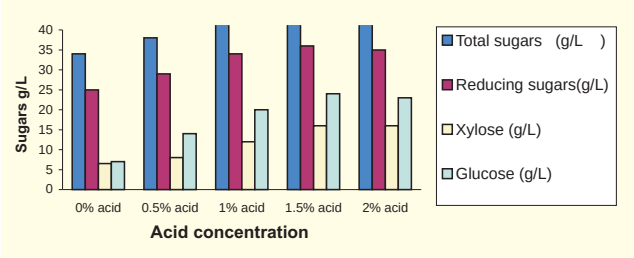


Fig. 29 Effect of different conc. of sulphuric acid on hydrolysis of kinnow waste

Primary hydrolysis using sulphuric acid treatment resulted in about 25 % hydrolysis of rice straw and the secondary hydrolysis resulted in further hydrolysis of about 13 %, thus about 38 % sugars were produced from the two stage hydrolysis of paddy straw.

The furfural, furan and phenolic compound concentration was relatively much less even at 4 % oxalic acid (w/v) concentration as compared to the production of furfural, furan and phenolic compound even at lower concentrations of strong acids such as HCl and H_2SO_4.

Supplementing kinnow pulp with wheat bran in 3:2 in simple distilled water resulted in FPase and â-glucosidase activity of 13.2 and 12.8 IU/gds and a ratio of nearly 1 :1 which is considered to be most appropriate for achieving ideal saccharification efficiency of pretreated lignocellulosic material.

Employing co-cultures of *Trichoderma reesei* RC-30 and *Aspergillus niger* BC-1 in the ratio 1:1 on paddy straw and wheat bran combination of 3:2 resulted in FPase, CMCase and â-glucosidase activity of 28 IU/gds, 46 IU/gds and 25 IU/ gds respectively.

Acid hydrolysate of kinnow waste using mild HCl without any detoxification treatment resulted in an ethanol concentration of 12g/l (Fig. 30) from total sugar concentration of 44g/l obtained by acid hydrolysis process with a fermentation efficiency of about 58 %.

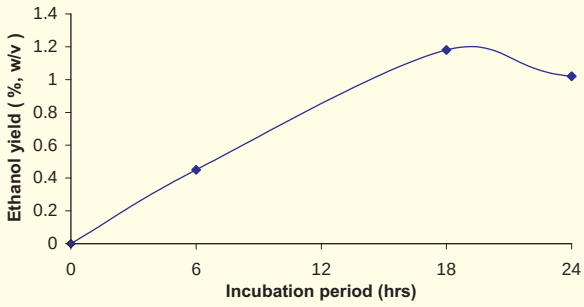


Fig. 30 Effect of fermentation period on ethanol production from kinnow waste

Development of design parameters of gasification of maize (*Zea mays* Linn.) cobs in throatless gasifier

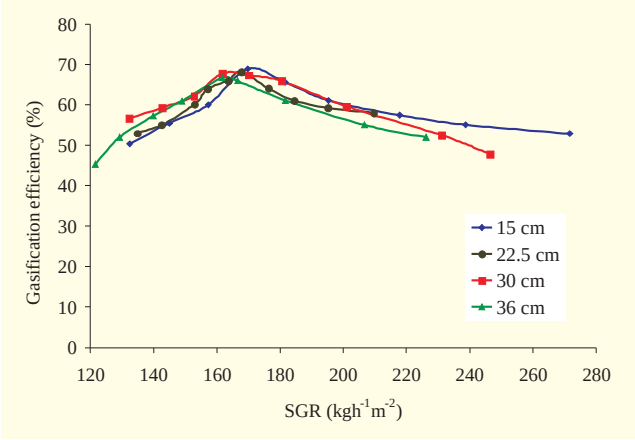


Fig. 32 Gasification efficiency and SGR for gasification of maize cobs in 15, 22.5, 30 and 36 cm reactors

Fig. 31 Gasification of maize cobs in throatless gasifier

Development of technology for health foods from legumes and millets using food extrusion systems

S. Balasubramanian and K. K. Singh

CIAE abrasive grain pearler was used to pearl red and white sorghum (jowar), and a pearling efficiency of 72 % and 83 % was observed for red and white sorghum, respectively. To manipulate the screw configuration, a single threaded screw with different die shapes has been fabricated. (Fig. 33) Experimentals on the production of expanded snack food were performed. The extruded (expanded) products were subjected to coarse grinding to produce instant porridge. Different extrudates were prepared using this food extruder keeping constant

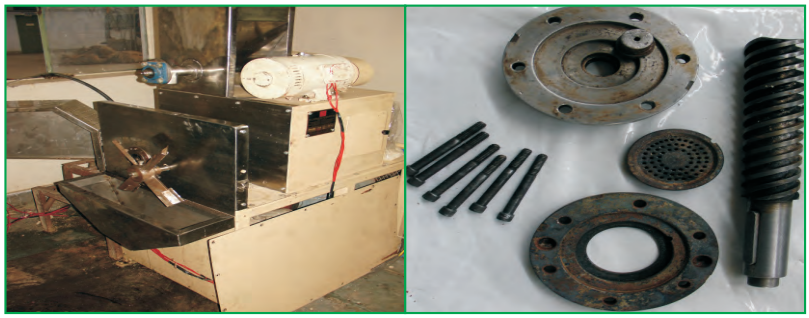


Fig. 33 Single screw food extruder with screw & dies

White sorghum (unpearled)

White sorgum grits (unpearled)

White sorghum (unpearled)

White sorghum grits (pearled)

Red sorghum grits (unpearled)

White sorghum (husk)

White sorghum extrudates

Red sorghum extrudate

Sorghum extrudates powder

Fig. 34 Sorghum based extruded products

feed rate (25 kg/h) and feed moisture (14% wb) at different legumes incorporation levels (0,5,10 and 15%) (Fig. 34). Effect of dehulled legumes on product characteristics was studied. Expansion ratio (ER), sectional expansion index (SEI), bulk density (BD), true solid density (TSD) of extrudates were found to be in the range of 4.0 to 3.3, and 16.0 to 10.0; 0.79 to 0.45, and 1.39 to 0.76. Expansion ratio and sectional expansion index showed a decreasing trend with bulk density and true density with increase in legumes incorporation level. The textural properties of extrudates were also evaluated using Texture Analyzer, TA-HD*i*. Hardness, puncture force and rupture energy were found to be in the range of 22.22 g to 68.22 g, and 5.95 g to 27.46 g, and 91.2 $x10^4$g-s to 377.7 $x10^4$g-s. Breaking strength (BS) and tensile stress (TS) of extrudates were calculated to be in the range of 0.05 to 0.26 g/mm^2, and 0.014 to 0.063 g/mm^2. Colour parameters of the extrudate powders were measured using Hunter colorimeter (NR-3000; 10^0/D65). L-value of extrudates made of rice and wheat were higher (80.63 to 74.51) in comparison to that of maize (74.81). a-values of rice and wheat were lower (1.82 and 2.51) than maize (7.88), and also b-value of extrudates made of rice, wheat showed lesser values (11.66 and 13.55) than that of maize (31.73). Water solubility indexes (WSI), water absorption index (WAI) and water absorption capacity (WAC) of extrudates were found to be in the range of 235.2 to 726.0 %, 206.0 to 769.2, and 1.06 to 6.69 %, respectively. Rheological properties of porridge made from extrudate powder were evaluated using Rapid ViscoAnalyser. The peak viscosity value was higher for maize (772 cp), followed by wheat and rice (542 and 476 cp). Second order polynomial equations for different extrudate were developed for these product quality attributes. Sensory evaluation (9 point hedonic scale) mean scores for the extrudates showed the mostly liking range (6 to 8) for all products. Among the legumes, black gram caused maximum change in the extrudate properties. In this study, an incorporation level (up to 15%) of dehulled legumes fetched good scores except black gram addition, because of its inherent characteristics. Thus, this study showed promising feature for the production of low cost legumes incorporated (protein enriched) RTEBCs using collet type extruder.

Design, Development and Evaluation of Banana-Comb Cutter

Dattatreya M. Kadam and D Dhingra

Development of Banana-Comb Cutter

At CIPHET efforts were made to develop a replacement for the traditionally used knife or sickle. The "CIPHET Banana-Comb Cutter" can be used instead of a sickle for separating banana-comb from banana bunch. This simple tool is suitable for all sizes of banana bunch stem and manually placing the tool and putting little pressure from top achieves cutting (Fig. 35) Banana - Comb Cutter maintains

Fig. 35 View of cutting location (banana-comb and stem)

smooth cutting curve of banana-comb, with no fruit damage during cutting (as in case of knife or sickle cutting, some banana-finger getting damaged). With this tool one person can perform the banana-comb/hand cutting activity with less stress as compared to the traditional method of cutting (Fig. 36) During our visits to traders' shops, where cutting is done, it was observed that 5 to 8 banana-fingers get damaged or injured during cutting of banana bunches. It works out to be about 2 to 6 % loss of banana fruits. This loss can be saved using "CIPHET Banana-comb cutter" (Fig. 37).

Fig. 36 Cutting of banana-comb

This hand tool was demonstrated to end users in Karnataka, Maharashtra and also in National Conference on Banana at NRC Banana, Trichy. After demonstration made at National Conference at NRC Banana, Trichy many farmers, industry persons, teachers, scientists from Tamil Nadu, Maharashtra, Kerala, Karnataka, Madhy Pradesh, Bihar, West Bengal and Andra Pradesh approached institute to purchase the developed "Banana-comb cutter". Hence CIPHET, Ludhiana is looking for mass production, multiplication, demonstration, distribution and sale of 'CIPHET Banana-comb / cutter' with the financial help from National Horticulture Board, Gurgaon. A Patent entitled "Manual Banana-Comb / Cutter" has been filed with Patent office, New Delhi.

Fig. 37 CIPHET banana-comb/ hand cutter

Optimisation of osmo-convective dehydration of banana and pineapple

D Dhingra, Dattatreya M. Kadam and D. B. Singh

Osmotic dehydration of banana slices was carried out in the sugar syrup solution having different concentrations (40, 50 and 60% w/w), banana slice thickness (4, 8 and 12 mm) and sample to sugar syrup solution ratio (1: 2, 1: 4 and 1: 6). Experiments 1-2-3, 4-2-5 and 6-2-7 were evaluated for weight loss and solid gain of banana slices due to the effect of sugar syrup concentration, banana slice thickness and banana sample to sugar syrup solution ratio, respectively (Table 8).

Table 8 Experimental design of osmotic dehydration of banana-slices

Experiment No	Sugar Syrup Concentration (w/w), %	Ratio (Sample: Sugar Syrup)	Banana Slice Thickness (mm)
1	40	1: 4	8
2	50	1: 4	8
3	60	1: 4	8
4	50	1: 4	4
5	50	1: 4	12
6	50	1: 2	8
7	50	1: 6	8

1) Effect of sugar syrup concentration on banana — Experiment No: 1-2-3
2) Effect of banana slice thickness — Experiment No: 4-2-5
3) Effect of banana sample to sugar syrup solution ratio — Experiment No: 6-2-7

Weight loss and solid gain were observed to increase with increase in sugar syrup concentration and banana slice sample to sugar syrup solution ratio and it increased with decrease in banana slice thickness. The experimental design of osmotic dehydration of banana-slices was prepared and the combinations of different parameters were studied. Two factor ANOVA of weight loss and solid gain of all experiments (Expt 1 to 7) indicated that osmosis time of banana and sugar syrup solution concentration, sample to sugar ratio and banana slice thickness were highly significant where as combination of osmosis time and sugar syrup solution concentration, sample to sugar ratio and banana slice thickness were non significant. The experiment on banana osmosis, the osmotic time of 5 to 6 hours was required to attain maximum weight loss and solid gain by banana slices. The optimum combination of banana osmosis for weight loss (water removed) and solid gain were found to be: 60% sugar syrup solution + 4 mm banana slice thickness + 1: 6 sample to sugar syrup solution ratio.

Design and development of foam mat dryer for selected liquid foods

Dattatreya M. Kadam, S. Balasubramanian and K. Narsaiah

Foam mat drying of tomato juice was carried out to determine the effect of drying temperature and concentration of egg albumen as foaming agent. Results showed that the hot crush method is better than cold crush method in term of yield, colour and quality. It was observed that increase in drying air temperature decreased the drying time and increase of foaming agent level enhances the drying process (up to 15% egg albumen) followed with a decreasing trend. The drying time of 510 and 450 min were observed for tomato juice dried at 60 and 70 ^{0}C drying air temperature, respectively. There is almost 30-minute reduction in drying time with 5^{0}C increase in drying air temperature. Thin layer mathematical drying models represented the drying behaviour of foamed juices. Drying rate was observed up to 360 minutes i.e. up to the weight loss value reaches constant. There was almost 30 minute reduction in drying time with an increase of 5^{0}C drying air temperature (Fig 38).

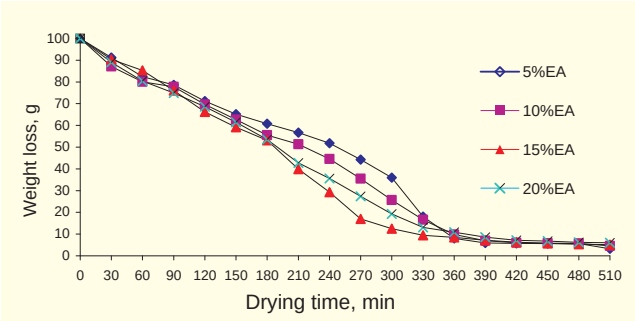


Fig. 38 Effect of egg albumen concentration level on foam mat drying rate of tomato juice at 60°C drying air temperature, (EA = Egg Albumen)

Effective moisture diffusivity of tomato juice ranged from 1.89 x 10^{-8} to 8.86 x 10^{-9} m^2/s (Table 9). The quality of foam mat dried tomato was found better then non-foamed tomato juice. Although non-foamed and foam mat dried tomato juice took almost same drying time, the foam mat dried tomato powder showed better quality, free flowing behaviour, reconstitutability and colour values. The optimum level of wet egg albumen was found to be 10 % with whipping for 5 minutes.

Table 9 Effective diffusivity (D_{eff}) of foam mat dried tomato juice with egg albumen

Egg Albumln, %	Drying Temperature, C 60	65	70
0		1.04E -08	1.72201E -08
5	1.82331E -08	9.37E -09	1.46878E -08
10	1.72201E -08	9.88E -09	1.62072E -08
15	1.88992E -08	1.16E -08	1.62072E -08
20	1.75297E -08	8.86E -09	1.57007E -08

An experiment was carried on drying of kinnow juice with different foaming agents. Five types of foaming agents with different concentration levels were tested for Kinnow juice. Physicochemical properties of foam mat dried Kinnow powder was tested (dehydration ratio, pH, colour of powder and rehydrated juice, TSS etc). It was observed that constant drying rate period was not noticed significantly in drying curves. The curves typically demonstrated smooth diffusion drying temperature on drying rate could be observed in these curves. Drying rate increased with the increase of drying air temperature and increased with increase in foaming agent was observed (Fig 39).

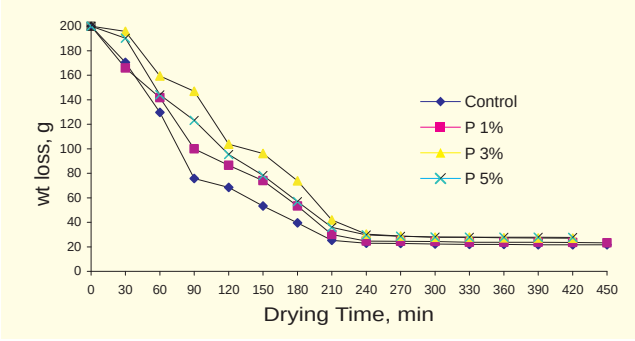


Fig. 39 Foam mat drying of kinnow juice at 75 ^{0}C treated with protein

Development of aonla processing plant

R K Goyal

Optimization of the process for storage of aonla fruits and its pulp

Aonla fruit rich in vitamin C arrives in the market in the month of November. The demand of aonla fruit and its products increase day per day in market but disadvantage is that it is available in market for few months (3-4 month). Hence, a study was undertaken for the storage of aonla fruit and its pulp. Experimentally it was found that the 5 min blanched aonla fruit treated with 0.3 % KMS (potassium meta bi sulphite) and packed in sterilized plastic tank or bucket, the shelf life of the fruit could be enhanced up to six months.

Similarly, Aonla pulp was prepared by heating the fruit for 12 to 15 min in hot water and extracted with pulper. Slow heating of this pulp at 40 ºC temperature for 15 min treated with 0.3 % KMS and packed after cooling in plastic bucket and other plastic bag resulted in pulp of good quality with minimum losses of nutrients up to six months. The over all acceptability of fruit and its pulp was found 8.0 out of 9.0.

Foam mat drying of aonla pulp

For the experimental work, aonla having uniform colour and maturity were selected. The percentage of peel, stone and pulp present in the aonla were determined. Aonla were pulped using a pulper with a capacity of 0.6 kg per minute (Kifco, India) for conducting foaming and drying studies. Biochemical analyses of the non-foamed aonla pulp namely acidity, total soluble solids, and ascorbic acid content were carried out to evaluate their relative loss during foam mat drying. Foaming and stabilizing agents were used with in the limits stipulated in the Prevention of Food Adulteration Act (1955) and also based on the preliminary foaming tests conducted. The food foaming and stabilizing agents such as egg albumen (5, 10 and 15%) with sucrose (25%) and 1% tri calcium phosphate were selected and used for the foaming experiment on wet pulp weight basis. The densities of the fresh and foamed pulps (5, 10 and 15 %) were 0.940, 0.60, 0.52 and 0.51 kg/m^3. For foaming and stabilizing the aonla pulp, egg albumen, and 20 % sucrose and 1 % tri calcium phosphate were incorporated subsequently during whipping.

Foaming properties

Foaming properties such as foam expansion and foam density were determined at different concentrations and based on the foaming properties, the optimum level was identified.

Foam expansion

Aonla pulp with foaming agent was foamed by operating a foaming unit attached with whipper/foaming blades at 1400 rpm to get maximum foam expansion with minimum density as described:

$$\text{Foam expansion} = \left[\frac{V_1 - V_0}{V_0}\right] \times 100 \quad ....(1)$$

Where,

V_1 = Final volume of foamed aonla pulp, cm^3

V_0 = Initial volume of aonla pulp, cm^3

During the foaming study, all the experiments were replicated thrice and the mean values were recorded. The whipping speed, which gives maximum foam volume with minimum density and the corresponding foaming time, was optimized for further foaming and drying study.

Foam density

The density of the foamed aonla pulp was determined in terms of mass by volume and represented as g/cm^3 :

$$\text{Foam density} = \frac{V_0}{V_1} \quad .....(2)$$

Where, ? is the density of the pulp.

Colour measurement

The colour of the non-foamed (control) and foamed aonla pulps was measured by using color meter (Hunter lab, USA) at 10^o observer and D65 illuminant. To measure the colour, the sample cup was filled with non-foamed and foamed aonla pulps separately without any void space at the bottom. Then the deviation in colour of the samples to standard were observed and recorded in the computer interface in terms of L, a & b values. Only the b (+) values, which represent the measure of yellowness of aonla pulp and powder were considered for the study.

Foam mat drying

The thin layer batch type dryer (Kilburn, India) was used for the study, which consists of heating coils, blower, drying chamber, air outlet openings and thermostat. The homogeneous foamed aonla pulps were evenly spread on the food grade non-

sticky Teflon lined trays of size (90 x 35 cm) at a foam thickness of 1, 2 and 3 mm. The foam thickness was arrived by multiplying the foam of known density (mass/volume) with drying area to get in terms of 'g/mm'. Similarly non-foamed aonla pulps thickness were also calculated. The lined trays were then placed on the tray stand in position for drying. The temperature inside the drying chamber was measured by using thermometer. The foamed and non-foamed aonla pulps were dried at a temperature of 60º C. At every 10 min interval, the trays were taken out of the drying chamber for mass loss determination. The drying was ceased when the mass of the samples recorded constant values. Thin layer drying equations were used to calculate the drying rate constant.

Drying rate constant '*k*' was determined by using the relationship as mentioned below

Moisture ratio

$$(MR) = \frac{M - M_e}{M_I - M_e} = ae^{-k} \quad .....(3)$$

Where,

$M_è$ = moisture content, dry basis (decimal) at è time

M_I = initial moisture content, dry basis (decimal)

M_e = equilibrium moisture content, dry basis (decimal)

a = constant

k = drying rate constant (min^{-1})

è = time, min

By linearising the equation (3)

$$In\ (MR) = In\left[\frac{M - M_e}{M_I - M_e}\right] = In\ a - k \quad .....(4)$$

The drying rate constant 'k' (minÏ¹) value was determined using the linearized equation (4) for each thickness of non-foam and foamed aonla pulp. Biochemical properties of aonla pulp viz., acidity, total soluble solids and ascorbic acid were also determined by following standard procedures for the foam mat dried aonla pulp after reconstituting the flakes to their original moisture content.

The physical property of the aonla such as percentage of pulp recovery was found to be 62.99 %. Various biochemical contents of non-foamed aonla pulps were determined as acidity (2.24), total soluble solids (11^0Brix) and ascorbic acid (291.1 mg/100g).

Foaming Properties of Aonla Pulp

Foam expansion

The effect of whipping duration on foam expansion in aonla pulp at different concentrations of egg albumin with 20 % sucrose and 1% tri calcium phosphate (TCP) is shown in the Table 10. From the table, it is seen that the percentage of foam expansion increased with increase in the level of foaming concentrations. It was also observed from the table that all the treatments recorded increased in foam expansion up to 20 min of whipping operation and after that it became almost constant. Hence, it was decided to conduct the foaming study with whipping duration of 20 min.

The characteristics of foamed aonla pulp are described in Table 11. From the table, it is seen that the density of aonla pulp mix varied between 0.96 and 0.94 g/cm^3. After whipping for 20 min, it

Table 10 Effects of whipper duration on foam expansion (FE)

Foaming agent	Foaming Agent levels,%	FE after 5 min., %	FE after 10 min., %	FE after 15min., %	FE after 20min., %	FE after25min. %
Egg albumen With 20% suc rose and 1% tri calcium phosphate	5.0+20+1 10.0+20+1 15.0+20+1	13.1 13.5 8.1	28.8 49.2 44.2	58.3 78.8 81.0	73.5 99.3 104.2	74.1 99.8 105.2

Table 11 Characteristics of foamed aonla pulp

Foaming agent	Concentrati--on level, %	Wt. of non-foamed pulp, g	Vol.of nonfoamed pulp, cm^3	Density of nonfoamed pulp, g/cm^3	Foam volume, cm^3	Foam expansion, %	Foam density, g/cm^3
Egg albumen With 20 % sucrose and 1% tri calcium phosphate	5.0+20+1 10.0+20+1 15.0+20+1	265.9 276.3 288.6	220.8 271.2 284.2	0.960 0.940 0.940	442.8 532.6 573.6	73.5 99.2 103.2	0.640 0.580 0.570

lowered between the values of 0.60 and 0.52 g/cm^3 due to foam formation. The foaming study conducted using egg albumen with 20 % sucrose and 1 % tri-calcium phosphate recorded increase in foam expansion by 25.7 and 4.0 per cent, when the egg albumen addition was increased from 5 to 10, and 10 to 15 per cent, respectively. In the case of foam density, egg albumen with 10 and 15 per cent recorded 0.58 and 0.57 g/cm^3, respectively. This increase in the egg albumen level from 10 to 15 per cent lowered the foam density only by 7.5 per cent. This might be due to the saturation point of egg albumen solubility under the given set of experimental conditions.

Colour values for the aonla pulps

The colour values (L, a & b) of the non-foamed aonla pulp was found to be 48.0, 9.08 and 32.54 and for the egg albumen (10 %) with 20 % sucrose and 1 % tri-calcium phosphate treated foamed pulp; it was 55.35, 10.89 and16.67, respectively. It is clear from the results that there was a little reduction in the colour of the pulp due to the incorporation of egg albumen sucrose and tri calcium phosphate as the 'b' value decreased when compared to the non-foamed pulp.

Drying characteristics of non-foamed and foamed aonla pulp

Foam-mat drying of foamed aonla pulps was carried out using the optimized level such as egg

albumin (10 %) with 20 % sucrose and 1 % tri calcium phosphate at three foam thicknesses viz. 1, 2 and 3 mm and three drying temperatures of 60, 65 and 70 ºC in a batch type thin layer dryer. The biochemical contents of the foam mat dried aonla were determined and statistically analysed. The biochemical results of the foamed and non-foamed aonla pulp dried at 60, 65 and 70 ºC are shown in Tables 12 and 13 for comparison.

From the biochemical analysis (Table 12), it was found that there was a significant reduction in total soluble solids (12.9 to12.50 ºBrix), and ascorbic acid (156.6 to 146.142.6 mg/100g) in the foam mat dried aonla due to heat sensitive nature of the aonla pulp during drying. Also, it was observed that the biochemical changes were comparatively higher in 2 and 3 mm thick foam dried at 65 and 70 ºC than in one mm thick foam dried at 60 ºC. But the variations in other biochemical contents such as acidity (0.98 to 1.0) were insignificant due to drying at higher temperatures with higher foam thickness.

The results of the non-foamed pulp (control) showed that there was a highly significant reduction in the biochemical contents during drying due to high viscous nature with longer drying time (Table 13). Between the foamed and non-foamed aonla pulp drying studies, it is observed that the biochemical changes were significantly lower in foamed aonla pulps due to shorter drying times at all selected temperatures. Based on the statistical analysis of foam mat dried aonla pulp, it was found that one mm thick foam mat dried flakes at 60ºC, retained significantly higher amount of biochemical / nutritional(ascorbic acid,mg/100g) qualities than the other treatments.

Effect of thickness on drying of foamed and non-foamed aonla pulp

The effect of foam thickness on the moisture content of foamed aonla pulp during drying at 60 ºC is shown in Fig. 40. From the figure, it is observed that the time taken for drying of foamed aonla pulp from 609.32 to 6.3 per cent moisture content (d.b.) was 50, 80 and 100 min for 1, 2 and 3 mm foam thickness, respectively. While the time taken for drying of non-foamed aonla pulp from 604.22 to 4.65 ± 2 per cent moisture content (d.b.) was 100, 120 and 200 min for 1, 2 and 3 mm thick pulp, respectively (Fig. 41).

Table 12 Biochemical composition of foam mat dried aonla pulp

Biochemical compositions	60ºC Foam thickness			65ºC Foam thickness			70ºC Foam thickness		
	1 mm	2 mm	3 mm	1 mm	2 mm	3 mm	1 mm	2 mm	3 mm
Acidity, %	0.98	0.97	0.97	0.99	0.99	1.0	0.99	0.99	0.98
TSS, ºBrix	12.9	12.9	12.9	12.8	12.6	12.7	12.50	12.50	12.50
Ascorbic acid, mg/100g	156.6	153.5	153.2	154.8	149.5	147.2	146.6	144.7	142.6

Table 13 Biochemical composition of control (non-foamed) dried aonla pulp

Biochemical compositions	60ºC Foam thickness			65ºC Foam thickness			70ºC Foam thickness		
	1 mm	2 mm	3 mm	1 mm	2 mm	3 mm	1 mm	2 mm	3 mm
Acidity, %	0.99	0.99	0.98	0.97	0.98	0.98	0.97	0.97	0.97
TSS, ºBrix	11.20	11.10	11.0	11.15	11.10	11.10	10.0	9.5	9.00
Ascorbic acid, mg/100g	153.2	149.1	145.6	147.9	146.8	142.3	142.5	139.5	136.9

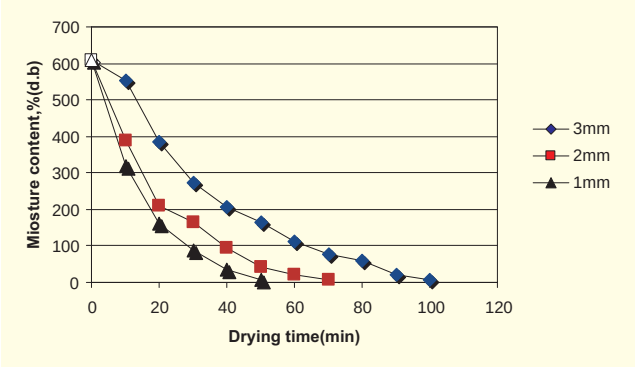


Fig. 40 Relationship between moisture content and drying time of foamed pulp

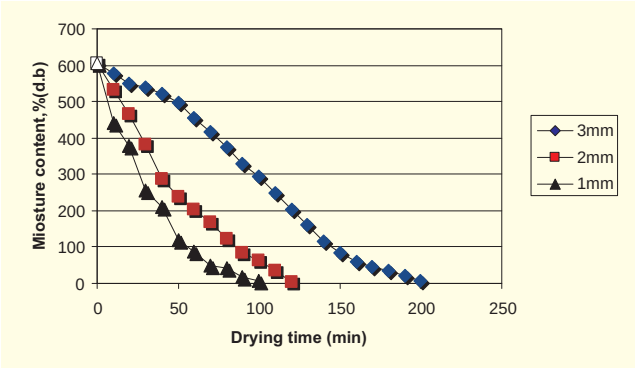


Fig. 41 Relationship between moisture content and drying time of non-foamed pulp

The drying curves clearly indicated that the aonla pulps dried with lower foam thickness dried at a faster rate as compared to the foamed aonla pulps dried with higher foam thickness. This might be due to the complete exposure of aonla pulps at lower foam thickness to the drying air. The data in the present study also indicates faster drying of aonla pulp in the presence of egg albumen thus portraying some similarity with the previous findings. It is also noted that the reduction in the moisture content of non-foamed aonla pulp at any point of time during drying was lower when compared to the foamed aonla pulps at all thickness studied. This might be due to high viscosity and bulk density of non-foamed pulp with less exposed surface area during drying.

Effect of thickness on drying rate of foamed and non-foamed aonla pulp

It was observed that the drying rate was 4.96,4.58,4.12 g/min at the beginning of drying and the same was reduced to 2.23, 2.4 and 2.04g/min at the end of the drying for 1, 2 and 3 mm thick foams, respectively.

It was observed that the drying of foamed aonla pulps at all thicknesses occurred at falling rate period because of the quick removal of moisture from thin surfaces of foams. The quantity of moisture removed is more in the three mm thick foam as compared to one mm thick foam due to the availability of higher moisture in higher thickness. But for the non-foamed pulp, the drying rate was 3.31, 2.89and 2.47g/min at the beginning of drying and the same was reduced to 1.36, 1.17 and 0.933 g/min at the end of the drying for 1, 2 and 3 mm thick pulps, respectively.

The drying rate of the non-foamed aonla pulps was lower than the drying rate of the foamed aonla pulp at all thickness ranges studied due to less surface area exposed during drying. Also the result showed that due to foaming there is a beneficial effect in increasing drying rate and in turn reducing drying time. The drying data at 65 and 70ºC are shown in Tables 14 and 15 for comparison of the results with 60 ºC.

Drying rate constant

Based on the equation 4, the drying rate constant '*k*' was determined at various pulp thicknesses. The result showed that the '*k*' value decreased with increase in the pulp thickness. Also the '*k*' value for foamed pulp (0.43, 0.28 and 0.19 /min) was higher than the non-foamed pulp (0.36, 0.24 and 0.16 /min) at 1, 2 and 3 mm thicknesses, respectively. It is obvious that the drying rate is higher in foamed pulps

Table 14 Drying characteristics of non-foamed and foamed aonla pulps at 65°C

Treatments	Foam thick ness,	Drying time, min	Initial moisture content, % (w.b.)	Final moisture content, % (w.b.)	Initial drying rate, g/min	Final drying rate, g/min
Egg albumen (10%) With 20% sucrose and 1% tri calcium phosphate	1 mm	40	71.87	5.7	4.53	0.45
	2 mm	60		5.7	4.38	0.45
	3 mm	80		5.7	4.20	0.5
Control (nonfoamed)	1 mm	80	71.86	4.04	2.21	0.24
	2 mm	110		4.03	2.52	0.19
	3 mm	170		4.03	2.32	0.20

Table 15 Drying characteristics of non-foamed and foamed aonla pulps at 70°C

Treatments	Foam thick ness,	Drying time, min	Initial moisture content, % (w.b.)	Final moisture content, % (w.b.)	Initial drying rate, g/min	Final drying rate, g/min
Egg albumen(10%) With 20% sucrose and 1% tri-calcium phosphate	1 mm	30	71.87	5.44	4.46	0.75
	2 mm	50		5.63	4.39	0.69
	3 mm	60		5.44	4.5	0.83
Control (nonfoamed)	1 mm	60	71.76	4.03	2.39	0.32
	2 mm	90		4.01	3.08	0.18
	3 mm	150		4.01	3.38	0.18

due to larger surface area exposed when compared to non-foamed (control) aonla pulps.

The optimum level of egg albumen was found to be 10% with the foaming time of 20 min for foam mat drying of aonla pulp. Based on the foam mat drying study, it was observed that the time taken for drying of foamed aonla pulp was 50, 70 and 100 min and for control samples (non-foamed), it was 100, 120 and 200 min at 1, 2 and 3 mm thick pulp thicknesses, respectively. The drying rate constant '*k*' value decreased with increase in pulp thickness. Based on the overall foam mat drying study, it was concluded that the foamed aonla pulp of one mm thick, dried at 60 ºC retained the maximum biochemical qualities when compared to all other treatments. The optimized drying study data can be used for the design of a continuous type foam mat dryer for drying aonla pulp.

Extrusion processing of fruits for development of novel value added products

R.K. Goyal, Mridula, D and D.B. Singh

Extrusion of dhal, wheat grit, rice broken and apple powder

Twenty kg apples of good variety were purchased from local market. Good quality apples were selected and stored in refrigerator until the experiments started. After 16 hours, apples were taken out, washed with tap water and hand peeled. Peeled apples were then dipped in citric acid to prevent browning reaction. Then these were shredded and again treated with citric acid solution. The treated shreds were steam blanched at a temperature of 60 ^{0}C for six minutes.

Dalia is a dehydrated product of wheat. It has high nutritional value. For each 50 g dried apple, 5 g Dalia was added and the mixture was ground. Another raw material used for the preparation of extruded product of apple was dhal. It was ground, sieved and mixed with apple powder in different proportions in different packets. Rice was also used for making extruded product of apple. This was also ground, sieved and mixed proportionately.

Response surface methodology with constraints mixture design was used to study the effect of different ingredients on textural and sensory qualities of extruded products. The equipment used for the extrusion process was single screw extruder. Apple powder, Dalia, dhal, and rice were taken in different proportions as per design and are fed into the extruder. The extruded product was collected into the paper bags. The experiment was repeated 3 times. Proximate analysis of different ingredients and extruded products is shown in Tables 16 and 17 respectively.

Table 16 Proximate composition of raw material

Ingredients	Moisture	Ash	Fat	Protein
Rice	11.81	0.45	0.73	7.54
Wheat dalia	10.60	1.27	1.20	11.39
Dal	11.90	2.42	0.90	22.79
Apple powder	12.35	1.31	0.27	2.74

Table 17 Proximate composition of extruded products (g/ 100 g, w.b.)

	Proportion Of Ap:Wd:Rice:Dal	Moisture	Ash	Fat	Protein
1	5:20:65:10	6.89	0.97	0.87	9.93
2	15:20:55:10	6.23	1.15	0.77	9.29
3	5:40:45:10	7.04	1.17	0.97	10.35
4	15:40:35:10	5.81	1.29	0.85	10.06
5	5:20:65:10	7.39	1.03	0.80	10.10
6	15:20:55:10	8.33	1.12	0.74	9.18
7	5:40:45:10	6.57	1.20	0.89	10.84
8	15:40:35:10	6.31	1.21	0.86	10.33
9	5:20:65:10	6.60	1.04	0.87	10.02
10	15:20:55:10	6.74	0.95	0.76	9.67
11	5:40:45:10	5.58	1.07	0.87	10.43
12	15:40:35:10	7.02	1.17	0.85	10.09
13c	10:30:50:10	6.57	1.03	0.83	10.92
14c	10:30:50:10	6.58	1.05	0.82	10.98
15c	10:30:50:10	6.62	1.08	0.83	10.41

13c-15c centroid

The developed extruded products were evaluated for sensory attributes (Table 18) and found that apple powder, wheat dalia, rice broken and dhal in the proportion of 5:40:45:10 showed 7.68 overall acceptability followed by apple powder, wheat dalia, rice broken and dhal in proportion of 15: 40:35:10 with 7.66. Colour values of extruded products were also measured using colorimeter and showed that 5:40:45:10 combination gave optimum scores (Table 19). Overall quality in terms of bulk density, expansion ratio and water absorption of the extruded products is shown in Table 20.

Table 18 Sensory evaluation of extruded product

Proportion Of Ap:Wd:Rice:Dal	Appearance/ colour	Aroma	Sensory Texture	Flavour & taste	Overall acceptability
5:20:65:10	7.52	7.32	7.91	7.23	7.63
15:20:55:10	7.68	7.66	7.04	8.25	7.63
5:40:45:10	7.41	7.49	7.70	7.57	7.68
15:40:3 5:10	7.48	7.76	7.29	7.87	7.66
10:30:50:10	7.45	7.43	7.69	7.43	7.59

Mean of 16 panelist

Table 19 Colour values measurement of extruded product (1-13)

	Proportion Of Ap:Wd:Rice: Dal	L*		a*		b*		h^0	C*
1	5:20:65:10	64.24	0.05	9.31	0.12	25.84	0.24	70.18	27.46
2	15:20:55:10	63.40	0.09	9.96	0.10	28.56	0.18	70.77	30.24
3	5:40:45:10	66.86	0.22	8.82	0.07	26.84	0.11	71.80	28.25
4	15:40:35:10	62.99	0.03	10.21	0.19	28.82	0.41	70.49	30.57
5	5:20:65:10	70.69	0.05	7.83	0.03	25.94	0.03	73.20	27.09
6	15:20:55:10	68.37	0.16	8.55	0.1	28.88	0.15	73.50	30.11
7	5:40:45:10	65.16	0.05	9.47	0.04	26.55	0.05	70.36	28.18
8	15:40:35:10	66.46	0.08	9.22	0.03	28.07	0.17	71.81	29.54
9	5:20:65:10	66.53	0.16	9.35	0.09	27.29	0.2	71.08	28.8
10	15:20:55:10	65.53	0.22	9.65	0.18	27.6	0.29	70.72	29.23
11	5:40:45:10	66.64	0.44	9.22	0.16	26.93	0.13	71.10	28.46
12	15:40:35:10	65.5	0.22	9.48	0.17	27.36	0.05	70.88	28.95
13c	10:30:50:10	70.34	0.42	7.61	0.18	27.68	0.23	74.62	28.70
14c	10:30:50:10	70.33	0.41	7.51	0.17	27.64	0.11	74.81	28.64
15c	10:30:50:10	70.19	0.63	7.54	0.11	27.51	0.12	74.66	28.52

13c-15c centroid

Table 20 Physical properties of extruded products

	Proportion Of Ap:Wd:Rice:Dal	Volume cm^3	Bulk Density g/cm^3	Exp. Ratio	Water Absorption (g/g) (FINAL)
1	5:20:65:10	4.53	0.25	3.12	4.209
2	15:20:55:10	1.57	0.59	2.03	4.098
3	5:40:45:10	2.88	0.26	2.6	4.846
4	15:40:35:10	6.74	0.54	2.10	4.513
5	5:20:65:10	6.64	0.19	3.19	4.58
6	15:20:55 :10	2.01	0.52	1.93	4.00
7	5:40:45:10	5.00	0.20	2.97	4.63
8	15:40:35:10	2.24	0.54	2.01	3.92
9	5:20:65:10	7.46	0.18	3.28	4.50
10	15:20:55:10	2.12	0.54	2.07	4.22
11	5:40:45:10	5.52	0.24	3.02	4.97
12	15:40:35:10	1.87	0.53	1.99	4.02
13c	10:30:50:10	3.75	0.35	2.56	4.49
14c	10:30:50:10	3.53	0.38	2.71	4.61
15c	10:30:50:10	3.52	0.49	2.76	4.54

Extrusion procedure for apple powder, wheat grit and dhal

The equipment used for the extrusion process was single screw extruder. Apple powder, Dalia, and Dal were taken in different proportions and fed into the extruder. The quality & proximate composition is shown in Table 21-24 of sensory score & colour values are

Table 21 Quality of extruded products (dal, dalia, AP)

Proportion Of AP:WD:Dal	CODE	Volume cm^3	Bulk Density g/cm^3	Exp. Ratio	Water Absorption (g/g) (FINAL)
0:90:10	0AP	7.82	0.15	3.49	4.87
2.5:87.5:10	A	6.19	0.15	3.38	4.78
5:85:10	B	5.30	0.16	3.34	4.67
7.5:82.5:10	BB	3.89	0.26	3.12	4.51
10:80:10	C	6.12	0.12	3.18	4.56
12.5:78.5:10	CC	5.55	0.18	3.11	4.47
15:75:10	D	6.13	0.15	2.82	4.45

Table 22 Proximate composition of extruded products (g/ 100 g, d.b.)

Proportion Of AP:WD:Dal	CODE	Moisture	Protein	Fat	Ash
0:90:10	0AP	5.92	12.40	1.15	1.38
2.5:87.5:10	A	6.63	12.36	1.15	1.33
5:85:10	B	5.51	12.14	1.10	1.38
7.5:82.5:10	BB	5.36	11.83	1.05	1.49
10:80:10	C	6.74	11.74	1.07	1.39
12.5:78.5:10	CC	5.89	11.76	1.02	1.40
15:75:10	D	6.59	11.42	0.98	1.39

13c-15c centroid, values are mean of two; AP:WD:Dal = Apple powder, wheat dalia: lentil dal

Table 23 Sensory evaluation of extruded product (dalia dal and apple powder)

Proportion Of AP:WD:Dal		Appearance/ colour	Aroma	Sensory Texture	Flavour & taste	Overall acceptability
0:90:10	0AP	7.53	7.57	8.07	7.68	7.79
2.5:87.5:10	A	7.63	7.63	8.02	7.57	7.84
5:85:10	B	7.77	7.36	7.89	7.71	7.79
7.5:82 .5:10	BB	7.29	7.55	7.87	8.13	7.75
10:80:10	C	7.64	7.35	8.1	7.63	7.88
12.5:78.5:10	CC	7.07	7.23	7.65	7.57	7.75
15:75:10	D	7.26	7.29	7.82	7.45	7.67

Mean of 15 panelist

Table 24 Colour values measurement of extruded product (A-D)

Proportion Of AP:WD:Dal	CODE	L*		a*		b*		h^0	C*
0:90:10	0AP	76.87	0.04	2.7	0.12	20.83	0.16	82.61	21.00
2.5:87.5:10	A	70.85	0.22	7.33	0.04	25.98	0.2	74.24	26.99
5:85:10	B	70.49	0.26	7.54	0.09	24.44	0.3	72.85	25.57
7.5:82.5:10	BB	66.28	0.19	8.33	0.07	25.06	0.05	71.61	26.40
10:80:10	C	65. 74	0.01	9.21	0.04	26.25	0.08	70.66	27.81
12.5:78.5:10	CC	67.77	0.28	8.69	0.14	24.98	0.31	70.81	26.44
15:75:10	D	65.68	0.21	9.2	0.08	26.92	0.25	71.13	28.44

Extruded products

The extruded product of apple powder was very tasty and had good appearance Fig. 42. The products obtained were very crispy. The product looked like kurkure. It did not have any sour and hot taste. Also it did not have any particular flavour, because the ingredients in the extruded product are only four that is apple powder, Dalia, dhal, and rice. Colouring agents and artificial flavors were not added in this product. So it is a pure one. Though it does not have high nutrient value, not even a single component is harmful to health.

All the products of different treatments were evaluated using texture analyzer for optimization of various ingredients. Sensory evaluations were also done to optimize the ingredients.

Fig. 42 Extruded product

Integrated dryer for some medicinal and aromatic plant leaves

R.K. Goyal, D.M. Kadam and O.D. Wanjari

Solar drying of henna leaves was studied. Dried henna leaves were packed for storage and colour data were noted using colorimeter. Experiments were carried out in the solar dryer and drying technology lab for drying henna leaves.

Physical dimensions of henna leaves

The physical dimensions of henna leaves are presented in Table 25. The average thickness was 0.39 mm, surface area 238 mm^2. The mean density of henna leaves was 0.11g/$cm^{3.}$ Moisture content of raw henna leaves is shown in Table 26.

Table 25 Physical dimensions of henna leaves (mm)

Sample	Thickness, mm	Width, mm	Length, mm
1	0.26	17.62	41.48
2	0.41	6.84	30.46
3	0.33	7.03	25.31
4	0.46	4.475	18.36
5	0.37	6.38	30.52
6	0.57	6.93	30.2
7	0.38	4.13	15.3
Avg	0.39	7.63	27.37

Drying of henna leaves

The moisture content data were plotted for different experiments (Fig. 43). It could be concluded from the figure that moisture depletion per hour was more in the initial stages, when initial weight loss was high, and then it started to decrease with increasing time. The henna was washed and thus had some moisture on surface due to which Fig. 43 shows higher moisture content then actual. Moisture loss and drying rate were found similar in all samples. In some cases drying rate was low initially and then it started to increase and remained constant for later part of the drying. The period for which drying rate increased, initially is known as heating period. A constant rate period was not observed because of the gap between two successive intervals of observation were one hour. A single falling rate period was observed during the drying of henna leaves.

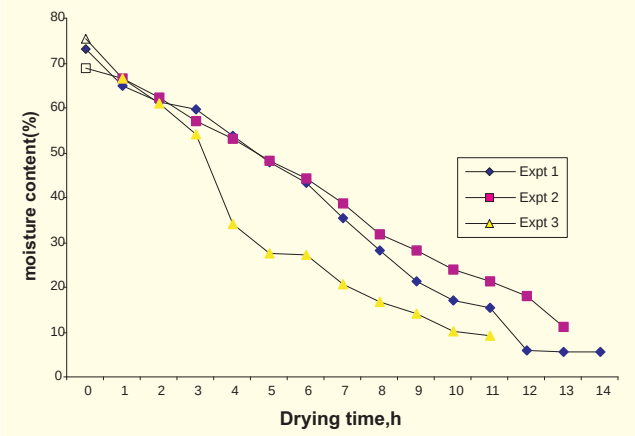


Fig 43 Drying curve of henna by solar drying

Table 26 Moisture content of henna leaves

Fresh Sample	M.C.,%wb	Dried Sample
1	68.0	10.18
2	69.6	7.09
3	69.3	6.75
Mean	68.96	5.64

MR of henna leaves

It was observed that the MR was falling with increasing the drying time (Fig. 44). Drying takes place, when the hot air is forced through the mass. The hot air, (a) evaporates the moisture from the henna leaves surface (b) increases the temperature of the henna leaves and (c) carries evaporated moisture from henna leaves. The increase in product temperature is further responsible for the rapid migration of moisture from the inside of the product towards the surface, due to moisture gradient developed in the drying process.

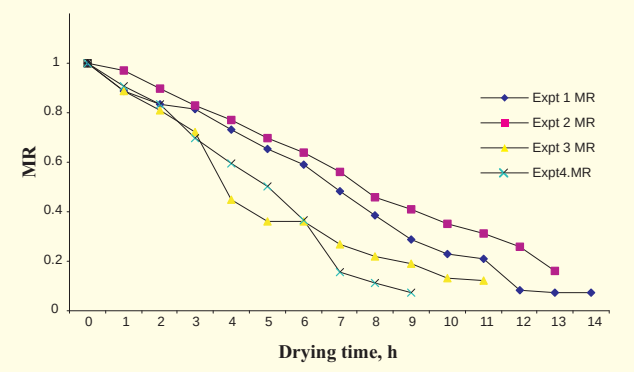


Fig 44 Effect of solar drying on MR of henna leaves

In all cases, the r^2 values for the mathematical models were greater than 0.80 at all temperatures, indicating a good fit. The results showed that highest values of r^2 and lowest values of ^{2}, MBE and RMSE were obtained with the logarithmic model. Thus the two term model with highest r^2 value of 0.998 may be assumed to represent the thin layer drying behaviour of henna leaves in solar dryer.

Moisture diffusivity

The effective moisture diffusivity, D_{eff} was calculated using method of slopes. Values of D_{eff} with coefficient of correlation, r^2 are given in Table 28. Effective moisture diffusivity of henna leaves ranged from 1.2325 x 10^{-10} to 2.6568 x 10^{-10} m^2/s. These values are within the general range 10^{-9} - 10^{-11} m^2/s for drying of food materials. The relationship between drying time and ln (MR) for determinations of moisture diffusivity is shown in Figs. 45-47 for three experiments.

Table 27 Name of the models given by various researchers in the literature

S.No.	Name of the model	Model equation
1	Newton	MR = Exp (-k*t)
2	Page	MR = Exp (-k * t ** n)
3	Modified Page 1	MR = Exp (-(k * t) ** n)
4	Henderson and Pabis	MR = a * Exp (- k * t)
5	Logarithmic	MR = a * Exp (- k * t) + c
6	Two -term	MR = a * Exp (-k * t) + b * Exp(-n * t)
7	Two -term exponential	MR = a * Exp (-k * t) + (1 -a) * Exp(-k *a* t)
8	Wang and Singh	MR = 1 + (a * t) + (b * (t ** 2))
9	Diffusion approach	MR = a * Exp (-k * t) + (1 -a) * Exp(-k *b* t)
10	Modified Henderson and Pabis	MR = a * Exp (-k * t) + b * Exp(-n * t) + c * Exp(-m * t)
11	Verma et al.	MR = a * Exp (-k * t) + (1 -a) * Exp(-m* t)
12	Midilli -Kucuk	MR = a * Exp(-k *(t ** n)) + b * t

Mathematical models for fitting drying curves

The moisture content data at the different drying air temperature were converted to the more useful moisture ratio and then curve fitting computations with the drying time were done by using the thin layer drying models in Table 27. The coefficient of correlation and results of statistical analyses are presented in Tables 28 and 29.

Table 28 Moisture diffusivity and its linear equation for henna leaves

No.	Equation	K0 values	R^2	Deff
Expt1	y= - 0.198.2x+0.3617	- 0.198	0.9116	- 1.3E - 08
Expt2	y= - 0.1281x+0.1878	- 0.1281	0.9448	- 8.3E - 09
Expt3	y= - 0.2026x+0.1062	- 0.2026	0.9852	6.14E - 24

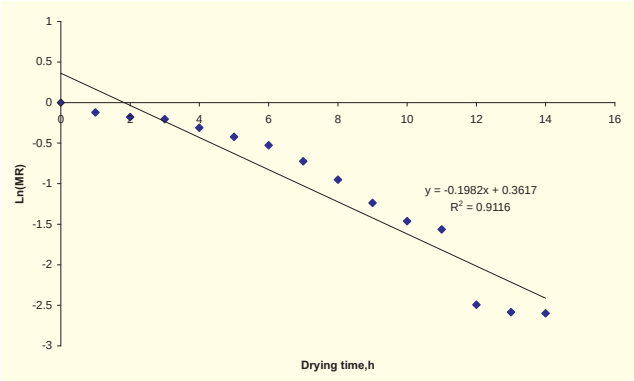


Fig. 45 Effect of solar drying on Ln(MR) of henna leaves

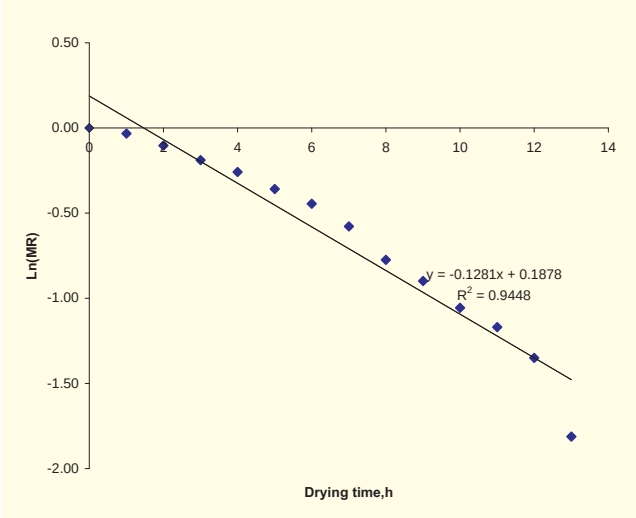


Fig. 46 Effect of solar drying on Ln(MR) of henna leaves

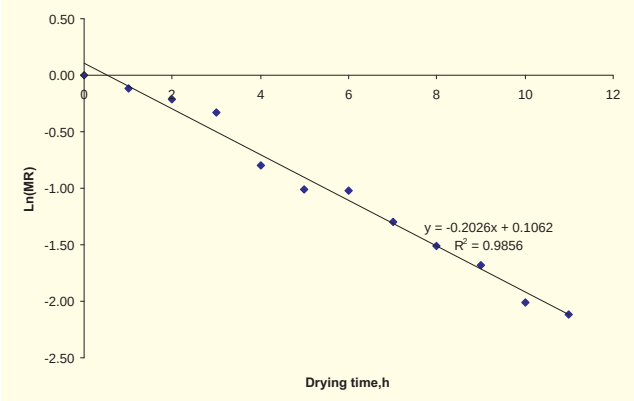


Fig. 47 Effect of solar drying on henna leaves

Table 29 Estimation of parameters of mathematical models for thin layer solar drying of henna leaves

Expt.1

NAME OF MODEL	Equation	R^2	Chi sq	MBE	RMSE
1.Newton	MR = Exp(-k*t)	0.928722	0.00328	-0.00932	0.014286
2.Henderson and Pabis	MR = a * E xp(- k * t)	0.964052	0.001781	0.0024	0.010145
3.Logarithmic	MR = a * Exp(- k * t) + c	0.985265	0.000791	0	0.006495
4.Two-term	MR = a * Exp(-k * t) + b * Exp(-n * t)	0.990024	0.000584	0.000746	0.005344
5.Two-term exponential	MR = a * Exp(-k * t) + (1-a) * Exp(-k *a* t)	0.973571	0.00131	-0.004646	0.008699
6.Wang and Singh	MR = 1 + (a * t) + (b * (t ** 2))	0.960956	0.001935	-0.010926	0.010573
7.Diffusion approach	MR = a * Exp(-k * t) + (1-a) * Exp(-k *b* t)	0.990024	0.000536	0.000746	0.005344
8.Modified Henderson and Pabis	MR = a * Exp(-k * t) + b * Exp(-n * t) + c * Exp(-m * t)	0.96405	0.002573	0.002416	0.010145
9.Verma et al.	MR = a * Exp(-k * t) + (1-a) * Exp(-m* t)	0.91258	0.004693	0.010132	0.015821
10.Modified Page 1	MR = Exp(-(k * t) ** n)	0.99043 2	0.000514	-0.000564	0.005234

Expt.2

NAME OF MODEL	Equation	R^2	Chi sq	MBE	RMSE
1.Newton	MR = Exp(-k*t)	0.984389	0.000704	-0.001714	0.006834
2.Henderson and Pabis	MR = a * Exp(- k * t)	0.985867	0.000691	0.001205	0.006502
3.Logarithmic	MR = a * Exp(- k * t) + c	0.997428	0.000116	0.0000000	0.002774
4.Two-term	MR = a * Exp(-k * t) + b * Exp(-n * t)	0.997871	0.000125	0.0000000	0.002523
5.Two-term exponential	MR = a * Exp(-k * t) + (1-a) * Exp(-k *a* t)	0.994602	0.000264	0.00184	0.004019
6.Wang and Singh	MR = 1 + (a * t) + (b * (t ** 2))	0.99726	0.000134	-0.596372	0.002863
7.Diffusion approach	MR = a * Exp(-k * t) + (1-a) * Exp(-k *b* t)	0.997371	0.00014	0.001507	0.002804
8.Modified Henderson and Pabis	MR = a * Exp(-k * t) + b * Exp(-n * t) + c * Exp(-m * t)	0.997871	0.000156	-4.94E -06	0.002523
9.Verma et al.	MR = a * Exp(-k * t) + (1-a) * Exp(-m* t)	0.96569	0.001829	0.02442	0.010131
10.Modified Page 1	MR = Exp(-(k * t) ** n)				

Expt.3

NAME OF MODEL	Equation	R^2	Chi sq	MBE	RMSE
1.Newton	MR = Exp(-k*t)	0.88569	0.006222	-0.002732	0.021802
2.Henderson and Pabis	MR = a * Exp(- k * t)	0.914556	0.005116	0.006697	0.018849
3.Logarithmic	MR = a * Exp(- k * t) + c	0.987107	0.000702	0	0.007322
4.Two-term	MR = a * Exp(-k * t) + b * Exp(-n * t)	0.987885	0.000907	0	0.007098
5.Two-term exponential	MR = a * Exp(-k * t) + (1-a) * Exp(-k *a* t)	0.942293	0.003455	-0.001223	0.01549
6.Wang and Singh	MR = 1 + (a * t) + (b * (t ** 2))	0.960148	0.002386	-0.467841	0.012873
7.Diffusion approach	MR = a * Exp(-k * t) + (1-a) * Exp(-k *b* t)	0.987804	0.000664	-0.000628	0.007121
8.Modified Henderson and Pabis	MR = a * Exp(-k * t) + b * Exp(-n * t) + c * Exp(-m * t)	0.914459	0.004656	0.007152	0.01886
9.Verma et al.	MR = a * Exp(-k * t) + (1-a) * Exp(-m* t)	0.652847	0.018896	-0.107693	0.032566
10.Modified Page 1	MR = Exp(-(k * t) ** n)	0.970836	0.001587	0.001896	0.009439

Colour of henna leaves

The colour of dry and fresh henna leaves was measured by using Hunter Lab MiniScan colorimeter (Model No-CO4-1005-631 Rev.E.) which gives reading in term of L, a, b and YI. The experiment was carried out for four times on individual samples. The details of colour analysis values and Standard Deviations (SD) are presented in Table 30.

Table 30 Colour analysis of henna leaves

Sample	L	a	b	YI
Fresh sample				
1	25.84	-7.81	20.75	57.88
2	29.13	-6.44	20.56	57.43
3	26.08	-5.66	18.75	57.09
4	27.84	5.02	16. 99	52.52
Mean	27.28	-6.2	16.19	56.18
SD	1.56	1.2	1.76	2.49
Dried sample				
Exp1				
1	27.76	-2.17	15.71	54.84
2	34.74	-1.82	18.12	55.82
3	36.98	3.9	19.83	54.39
4	33.98	-3.47	18.92	55.37
Mean	33.6	-2.29	18.26	55.1
SD	3.95	1	1.77	0.62
Exp2				
1	34.06	-3.2	18.34	54.29
2	31.51	-2.18	14.8	48.92
3	29.08	-1.2	13.57	49.16
4	29.59	-0.88	13.08	48.05
Mean	29.14	-1.93	15.06	50.39
SD	2.26	1.05	2.37	2.83
Exp3				
1	31.92	-3.59	17.9	54.22
2	28.26	-2.67	16.07	54.3
3	32.15	-2.24	15.73	50.48
4	26.8	-2.24	13.97	50.39
Mean	29.9	-2.75	15.96	52.38
SD	2.67	0.6	1.61	2.21

The drying studies on henna leaves using solar dryer was carried. Solar dryer took about 12 to14 hour to dry henna leaves samples. The thickness of henna leaves was about 0.399 mm and having moisture content of 68.9 % w.b. It was found that solar dried henna leaves retained good quality of green colour. Among the ten models fitted, Two-term model with highest R^2 value of 0.99 may be assumed to represent the thin layer drying behavior of henna leaves in solar dryer. Effective moisture diffusivity of mint leaves ranged from 8.27×10^{-10} to 1.278×10^{-8} m^2/s. The moisture diffusivity increased as drying air temperature was increased. The maximum R^2 value was 0.99 and minimum was 0.91 in solar dryer .The maximum temperature inside the solar dryer was observed to be 52^0C and minimum RH to be 9%.

Design, development and evaluation of multi-grade carborundum Dhal mill

R. K. Goyal, R. K. Vishwarkarma and Mridula D

The dhal milling machine developed by CIPHET is based on abrasive dehulling of pigeon pea. The machine consists of feed hopper, cylindrical emery, and concave of perforated mild steel. The external view of the machine is shown in Fig. 48.

Fig. 48 A view of CIPHET Dhal Mill

Feed Hopper: A trapezoidal feed hopper of capacity 15 kg is fitted at the top of the machine. A feed gate is provided at the outlet of the machine to control the feed rate of grain. The treated pigeon pea grain is filled in the hopper. After running the machine, the feed gate is opened to feed the material between emery roller and concave.

Emery Roller: The emery roller is fitted inside the machine. It is a mild steel cylinder of 75 cm length on which emery is pasted. The grades of emery pasted are 18, 24 and 32. First 25 cm of the roller is pasted with 18-grade emery, middle 25 cm with 24-grade emery and last 25 cm with 32-grade emery. The material is fed at the start of the roller where 18-grade emery is pasted. The diameter of the emery roller is 30 cm. Emery rotates at 900 rpm with a 3 hp three-phase motor. The power is transmitted from motor to roller through v-belt drive pulley.

Concave: Concave of the machine is made of mild steel perforated sheet. The diameter of the concave is 33 cm. The perforations of the concave are of 2mm round hole. Perforated concave is provided to facilitate the exit of hull, powder and broken formed during dehulling. The concave is fixed. The emery roller is placed at the center of the concave. Six rings of mild steel of 5x5 mm are placed at a distance of 10 cm inside the concave. These rings restrict the forward movement of the grain at the time of operation and hence more residence time is obtained. Besides these rings, five flat bars of 5x5 mm are also placed at a distance of 21 cm along the length of the concave (Fig. 49). An inlet and outlet is also provided. The inlet is at the top of feed end of the machine. Outlet is at the bottom of discharge end of the machine where the emery roller ends.

Fig. 49 View of ring and bars placed inside the concave

The cylinder and concave assembly is inclined at 7^0 from horizontal towards discharge end to facilitate the movement of dehulled grain towards discharge. The cylinder and concave assembly is covered with mild steel cage (Fig. 50) to avoid dust and broken coming out from the machine to the atmosphere. The hull, broken and powder coming out from the perforated concave is collected in the cage and a separate outlet is provided to collect them.

Fig. 50 View of cage of the dall mill

The cage is made in two parts. The upper part can be opened to check the machine's working even during the operation. The cylinder and concave system is fitted on a heavy mild steel frame to avoid any vibration to the machine. The emery roller is dynamically balanced to avoid uneven movement of the roller during operation and to reduce the load on bearings. The moving parts of the machine are covered with safety guards to avoid accidents. The machine is designed for 100 kg/h capacity based on pigeon pea grain.

Modifications in dall milling machine and their effect

Preparation of sample: Pigeon pea sample were cleaned and graded first and moisture content of the grain was determined. The sample was prepared according to the pretreatment optimised by CIPHET for dehulling pigeon pea. The optimised conditions for dehulling pigeonpea are: moisture content 10%, mustard oil pretreatment @0.3% (w/w) to the pitted grain, conditioning of pretreated grain for 24 hours, dehulling of grain in abrasive dehulling machine, residence time of grain inside the machine 12 seconds. The moisture content of the grain was adjusted to 10% (w.b.) and the grain was conditioned for 24 hours. Two samples of 5 kg grain were taken out from the prepared lot and the grain was pitted in CIAE dall mill. Thereafter the grain was treated with mustard oil. In this 0.3% mustard oil (weight/weight) was taken and the oil was applied on the surface of the pitted grain. The sample was mixed thoroughly for 30 minutes to facilitate the oil to be applied on all grains. The treated grain was packed into polyethylene bags and sealed. The bags were kept at room temperature for 24 hours. These treated samples were used for dehulling experiments.

Trial run without modification: Two trial runs were taken to test the dall mill and to observe the residence time of grain inside the machine. These runs were conducted when six rings of 5x5 mm were placed at 10 cm distance. The mustard oil pretreated grain was fed to the machine. The feed gate was opened and the residence time was observed. The pigeon pea grain was coming out from the outlet after 30 seconds. This showed that the observed residence time was very high than the optimised time of 12 sec. The dehulled grain coming out was analysed. Almost 99 % grains were found dehulled. Powder and broken formation was very high because of higher residence time.

First modification in the machine: In this modification, the number of rings fitted inside the concave were reduced to three and thickness of the ring was kept 5 mm (Fig. 51). The first ring was placed at 10 cm from the feed end of the emery. Second at 21 cm from first ring and third ring was at 21 cm from second ring. Rest of the machine was kept as such.

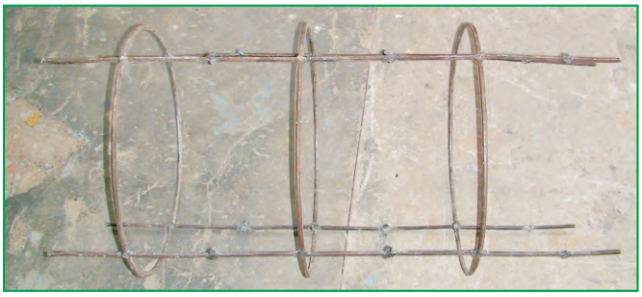


Fig. 51 Photo of three rings placed inside the concave (First modification)

Again the mustard oil pretreated grain was fed to the machine. The feed gate was opened and the residence time was observed. The pigeon pea grain was coming out from the outlet after 18 seconds. This showed that the observed residence time was higher than the optimised time of 12 sec. The dehulled grain coming out was analysed. Almost 89 % grains were found dehulled. Powder and broken formation was higher because of higher residence time. Samples were also taken out from different sections of the machine. The analysis of samples indicated that the optimum time of dehulling was achieved when the grain moved to a distance of 50 cm from feed end. This indicates that further modification in the machine is essential to reduce the residence time. Problems in fabrication of the machine were observed.

Second modification in the machine: In this modification, the number of rings fitted inside the concave were reduced to three and the thickness of the rings was changed to 3 mm round galvanized iron wire. The first ring was placed at 10 cm from the feed end of the emery. Second at 21 cm from first ring and third ring was at 21 cm from second ring. Rest of the machine was kept as such.

Again the mustard oil pretreated grain was fed to the machine. The feed gate was opened and the residence time was observed. The pigeon pea grain was coming out from the outlet after 16 seconds. This showed that the observed residence time was still higher than the optimized time of 12 sec. The dehulled grain coming out was analysed. Almost 89 % grains were found dehulled. Powder and broken formation was still higher because of higher residence time. Samples were also taken out from different sections of the machine. The analysis of samples indicated that the optimum time of dehulling was achieved when the grain moved to a distance of 60 cm from feed end. This indicated that further modification in the machine is essential to reduce the residence time. Problems in fabrication of the machine were observed. Then it was suggested to modify the machine again.

Third modification in the machine: In this modification, the number of rings fitted inside the concave were reduced to three and the thickness of the rings was changed to 3 mm round galvanized iron wire. The location of outlet of the machine was changed. In the trial run, some grains were observed to be going out of the machine due to improper fitting of the inlet opening. Hence, the feed end of the hopper was modified. Rest of the machine was kept as such.

Again the mustard oil pretreated grain was fed to the machine. The feed gate was opened and the residence time was observed. The pigeon pea grain was coming out from the outlet after 13 seconds. This showed that the required residence time was achieved though slightly higher than optimized residence time of 12 sec. The dehulled grain coming out was analyzed. About 86 % grains were found dehulled. Powder and broken formation was about 6 %. Samples were also taken out from different sections of the machine.

The dehulling unit was modified to adjust residence time to 12 second. The dehulling was 86 % and powder and broken formation was about 6 %. Conceptual designs of cleaner, grader and oil applicator have been prepared.

Evaluation of screw press mechanism for oil expelling as effect of process parameters

Dilip Jain, Rajesh Vishwakarma, S. Balasubramanian

Study the temperature profile along the length of screw press barrel

An oil expeller with multiple-screw shaft has been tested for increase in temperature during oil

extraction. The expeller has the multiple-screw shaft for obtaining the variable pressure and reduction of temperature. The configuration of screw-shaft is given in Fig. 52.

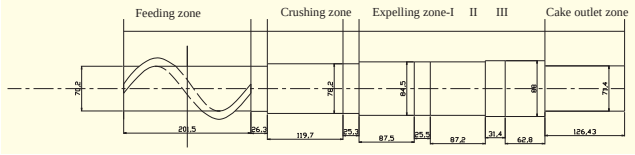


Fig. 52 Design of multiple-screw shaft of oil expeller

The digital temperature probes were fixed at the length of 7, 16.5, 25, 35.5, 45 and 55 cm from the feed point of oil expeller. The temperatures were recorded at the 10 minute interval from the start of operation for the 60 to 70 min. After that the steady state is achieved and temperature remains constant due to ambient cooling for 120-180 minute of operation. The oil and cake temperatures were also recorded during the expelling operation.

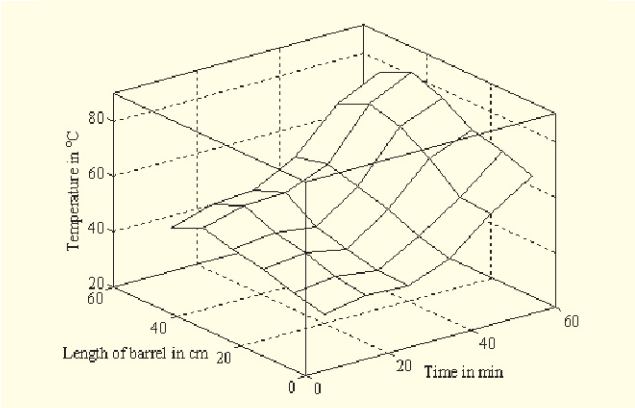


Fig. 53 Temperature profile along the length of screw expeller barrel with time of operation during sunflower oilseed expelling

Experiments were conducted with sunflower and mustard oilseeds. The temperature profile during the oil extraction from sunflower oilseed along with length of barrel is presented in Fig. 53. Temperature gradually increased along with length of barrel while it reduced at the end of barrel length. It is due to the reduction of size of screw-shaft, which resulted in pressure drop and then temperature drop. Similarly, the temperature of oil and oilcake increase during 60 minute of observations upto the 72 °C and 88 °C respectively (Fig. 54).

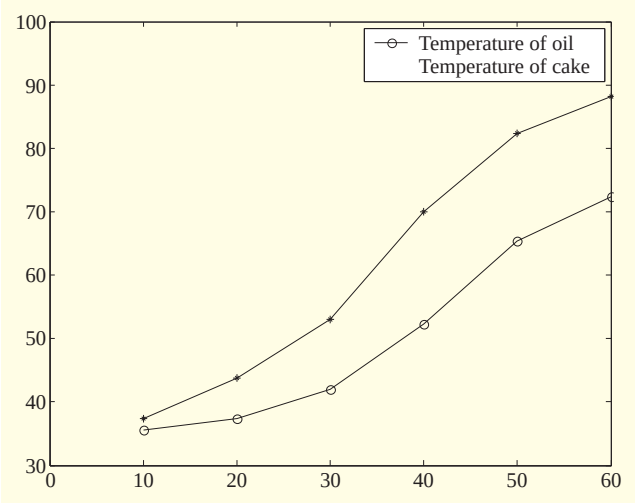


Fig. 54 Temperature of oil and cake during oil expelling of sunflower seed

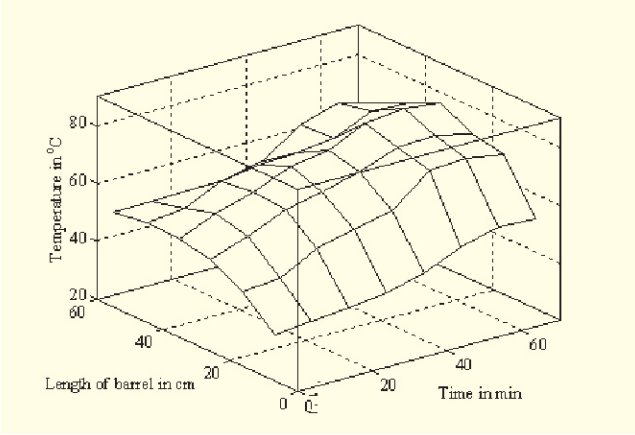


Fig. 55 Temperature profile along the length of screw expeller barrel with time of operation during mustard oilseed expelling

Temperature of barrel gradually increased along the length of barrel with time of operation, however it drops sometimes due to multiple screw shaft and space, which reduces the pressure and temperature Fig. 55. The temperature of mustard oil and oilcake gradually increased with time of operation and reached to 57 °C and 64 °C, respectively (Fig. 56).

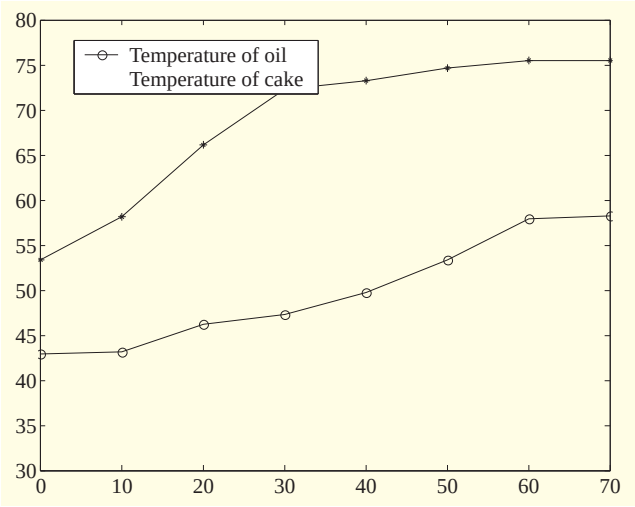


Fig. 56 Temperature of oil and cake during oil expelling of mustard seed

The digital temperature probes were fixed at the length of 7, 16.5, 25, 35.5, 45 and 55 cm from the feed point of oil expeller. The temperatures were recorded at the 10 minute interval from the start of operation for the 60 to 70 min. After that the steady state is achieved and temperature remains constant due to ambient cooling for 120-180 minutes of operation. The oil and cake temperatures were also recorded during the expelling operation.

Compaction of oilseed

Densifications of mustard seed were also observed during four passes of the oilseed. The initial mustard oilseed was at the density of 738 kg m^{-3}. During the four passes of operation, the density of cake was observed as 1202.8, 1224.5, 1325.6 and 1417.3 kg m^{-3} respectively, which showed that major compaction/ compression of oilseeds took place in first pass of operation, thereafter the oil expression occurred.

Development of green chilli based value added product

Dilip Jain, Mridula D., Ramesh Kumar and V.K. Bhargav

Effect of different pretreatment on colour while processing of green chilli for puree and dry powder

Effect of only blanching

The green chilli had more Vitamin C and antioxidant properties and finds a different place for preparation of Indian recipes. The processing of green chilli is important for maintaining the natural colour and its nutrition. Various pretreatment and thermal processes degrades the colour and affect the quality of product. Therefore, an attempt was made to study the color degradation while processing the green chilli for puree and powder.

A preliminary experiment was carried out with green chillies to observe the affect of various blanching methods. Fresh green chilli procured from local market was washed and destalked. The average length and diameter of the green chilli pod varied from 6 to 9 cm and 1.3 to 1.5 cm respectively. The total weight of pod was recorded between 3109.2 to 5148.6 milligram however, it comprises of stalk weight ranging from 251.6 to 362.6 milligram. The TSS (total soluble solid content) of green chilli was found to be 7 °Brix. The moisture content of the fresh green chilli was observed as 85-90 %. Brightness of green chilli varied from 41.0 to 44.5 (L value), whereas greenness (a value) and yellowness (b value) varied from -9.3 to -9.6 and 28 to 30, respectively.

Table 31 Changes in colour value as a result of blanching treatment

Blanching method	Colour value		
	L	a	b
Initial value	43.44	-9.29	29.50
Water blanched	35.55	-2.77	15.59
Lye blanched	30.96	-5.13	13.73
Steam blanched	33.73	-0.92	15.71

Three samples of green chilli (each 650 g) were blanched for six minutes in hot water, 2.0 % NaOH solution at 95°C and steam at 120 °C. The puree was obtained by grinding the blanched chilli and

straining the paste into screen. The colour of chilli puree was observed by hunter colour difference meter (D25 DP_9000 system, Hunter Associates Laboratory Inc., Reston, VA, USA). Different blanching treatment significantly influenced colour characteristic of green chilli puree (Table 31). Initial colour value of green chilli was recorded to be 43, 44 (L Value), -9.29 (a value), 29.5 (b value). The brightness of chilli puree decreased with blanching treatment. Similar trend was observed for green colour of chilli puree but maximum green colour retention was observed in case of lye blanched chilli puree (-5.13). Likewise yellowness of sample was reduced to its half value but the difference among the blanching treatment was not significant.

Colour degradation in thermal processing

About 200 g dried green chilli powder passed through 40 mesh screen, was tightly filled in standard optical cell having 6 cm diameter for the measurement. The instrument was calibrated with a fresh ground green chilli sample as standard (L=29.12, a=-4.91, b=14.75) under illuminated conditions. The information given by L, a and b generally represent the total chlorophyll of prepared paste.

For puree, approximately 300 gm sample was weighed and transferred into 500 ml glass beaker & covered. The beaker were then placed in water bath maintained at selected temperatures (65°C, 75°C, 85°C, 95°C) and periodically agitated to ensure uniform temperature throughout the bulk of sample. The temperature of sample at its geometric center was monitored using a thermometer. The beakers were heated for different duration after the puree at its geometric center has attained the desired temperature (Table 32). The samples were transferred to ice water bath immediately after the thermal treatment.

Table 32 Thermal processing treatments

Temperature(°C)	Thermal processing interval (minute)
65	0, 15, 30, 45, 60, 75, 90
75	0, 10, 20, 30, 40, 50, 60
85	0, 5, 10, 15, 20, 25, 30
95	0, 3, 6, 9, 12, 15, 18

The effect of thermal processing was studied at 65 °C, 75°C, 85°C & 95°C for different period of time (Fig. 57). A progressive loss in green colour was observed with increase in thermal processing time, irrespective of their blanching treatments. However, the drastic loss in green colour value was noticed during first 5 minutes under 85 °C and 95 °C there after it remained constant. Changes in yellow colour were found to be inconsistence for different thermal processing treatments with no significant effect.

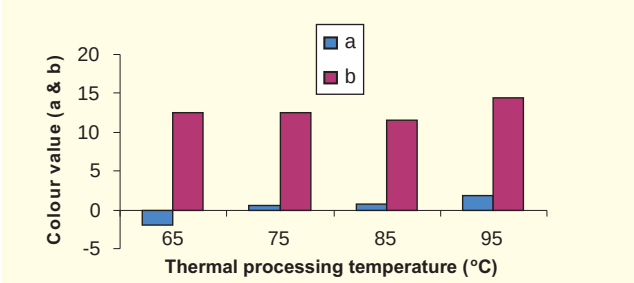


Fig. 57 Effect of thermal processing on colour degradation of green chilli puree

Effect of drying temperature regimes on colour and drying period

Colour and drying characteristics of green chilli were significantly influenced by different temperature regimes (Table 33). There was no significant change in lightness for 45°C Solar drying and sun drying. However, significant increase in lightness was observed for 65°C and 55°C with maximum value (28.97) recorded at 55 °C. The same trend was observed for yellow colour. Though there

was no significant variation in green colour value with different temperature regimes but the maximum value (3.25) for green colour was observed at 55°C temperature.

The time taken for dehydration of green chilli reduced as the temperature increased from 45°C to 65 °C in cabinet dryer. Earliest drying time 6.30 hrs was recorded at 65 °C and longest drying time 21.0 hrs was recorded in case of sun dried sample. This drying time was reduced to 15.30 hrs with solar drying. Moisture content reduced during drying but showed inconsistent trend among different treatments.

Table 33 Effect of different temperature regimes on drying period

Drying treatment	Colour value L	a	b	M C (%) on dry basis	Drying time (hrs)	Water activity (Aw)
45 °C	19.28	4.19	4.50	7.81	14.00	0.391
55 °C	28.97	3.25	15.90	4.28	11.30	0.407
65 °C	23.98	4.52	10.67	6.00	6.30	0.409
Solar drying	18.14	3.69	6.43	5.00	15.30	0.401
Sun drying	20.64	4.90	7.42	7.00	21.00	0.415

Effect of pretreatment on colour and drying period of green chilli

The data pertaining to different pretreatments on dried green chilies is presented in Table 34. The results show that brightness was slightly reduced with blanching treatments irrespective of their pricking, slitting and chopping treatment. Maximum value for brightness (29.14) was recorded in steam blanched chilli. It was also observed that values for green colour (a) changed from green to red and for yellow colour (b) from blue to yellow with the blanching treatments. Maximum green colour retention was observed in case of pricked chilli treated with lye and least was recorded in case of steam blanched chilli for same treatment. Similar trend was followed in case of slitting treatment. However, maximum green colour retention was recorded in steam blanched chilli (7.61). In case of chopping treatment, maximum colour retention was noticed in unblanched chilli (7.12). As far as yellowness is concerned, least yellowing was observed in case of lye blanched for pricking treatment and steam blanched for slitting and chopping treatment.

Longest drying time (14 hr) was taken by steam blanched sample with pricking treatment while minimum (8 hr) was recorded in case of lye blanched sample for same treatment. There was no difference in drying time for unblanched and lye-blanched sample in slitting treatment. Same trend was in chopping treatment and earliest drying (10 hrs) was observed in chopped sample with water blanch treatment. Moisture content did not show any definite trend among different treatment combinations. It varied from 9.52 to 14.95 % in pricked sample, 10.97 to 27.58 % in slitting sample and 2.39 to 14.62 % in chopped sample.

Table 34 Effect of pretreatment on colour and drying duration of green chilli

Pretreatment	Colour value			Drying time (hrs)	MC (%) on dry basis
	L	a	b		
Pricking					
Unblanched	27.07	5.54	1.50	12.3	14.95
WB	23.14	5.41	7.34	11.00	9.52
LB	27.03	7.13	9.93	8.00	16.0
SB	24.81	4.13	6.79	14	10.11
Silting					
Unblanched	27.53	6.03	11.96	9.15	20.75
WB	19.41	4.91	7.4	11.00	10.97
LB	22.1 5	5.29	7.68	9.30	27.44
SB	24.09	7.61	8.12	13.15	27.58
Chopping					
Unblanched	24.25	7.12	9.95	11.30	11.58
WB	27.18	6.95	9.37	10.00	2.39
LB	22.15	5.29	7.68	11.45	8.67
SB	29.14	4.42	13.22	13.35	14.62

Drying rate of green chilli as influenced by cabinet drying at 55 ^{O}C

Blanching in hot water at 95^{O}C for 3 minute followed by dipping the green chillies in 2% lye solution (NaOH) and drying in cabinet dryer at 55^{O}C resulted in maximum green colour retention of the final dried product. The initial moisture content of green chilli was recorded to be 85% and it was reduced to 10 % at the end of 8 hours of cabinet drying. The dried sample exhibited colour values of 28.23, 3.17 and 11.01 for brightness, greenness and yellowness respectively. Ahmed and Shivare (2001) also reported 7.5 % equilibrium moisture content while drying at 60 ^{O}C at 15 % relative humidity.

Convective heat and mass transfer coefficient of green chilli during drying

The solar drying of green chilli was studied for powder making. The convective heat and mass transfer coefficient is an important parameter, which governs the drying period and is useful in designing the drying equipment. The convective heat and mass transfer coefficients have been evaluated under natural and forced solar drying for different blanching treatment of green chilli. Convective heat and mass transfer coefficient has been determined based on linear relationship between Nusselt number and product of Grashof and Prandtl number for natural convection and Reynolds and Prandtl number for forced convection, respectively. Green chillies were treated with lye to protect greenness of colour. On the other hand treatment of common salt solution was used to eliminate the green colour (for colour-less chilli powder). The drying was performed under open sun, greenhouse dryer (Fig. 58) and tray dryer (mechanical dryer at 50 ^{o}C temperature).

The hourly convective heat and mass transfer coefficient as the function of mean moisture content with different treatments and drying method are presented in Fig. 59. The convective heat and mass transfer coefficient decreased with the reduction in moisture content with drying time. Higher convective heat and mass transfer coefficient was observed in greenhouse drying for the green chilli blanched in NaOH solution. It is because of the higher initial moisture content. The convective heat and mass transfer coefficient for chilli blanched in NaCl solution was observed to be lower. The variation in convective heat and mass transfer

coefficient was minimum during the drying period for tray drying method with both the treated green chilli.

Fig. 58 Experimental setup with drying the chilli in greenhouse

The concise results of three drying systems i.e. open sun, greenhouse and tray drying (mechanical dryer at 50 °C temperature) are presented in Table 35. The convective heat and mass transfer coefficients evaluated for NaOH treated green chilli were 3.1074 W m^{-2} C^{-1} under open sun drying, 3.4152 W m^{-2} C^{-1} under greenhouse drying and 1.6675 W m^{-2} C^{-1} under tray drying at 50 °C temperature. The convective heat and mass transfer coefficient was determined for common salt treated green chilli as 1.2685 W m^{-2} C^{-1} under open sun drying, 2.0543 W m^{-2} C^{-1} under greenhouse drying and 1.4099 W m^{-2} C^{-1} under tray drying at 50 °C temperature.

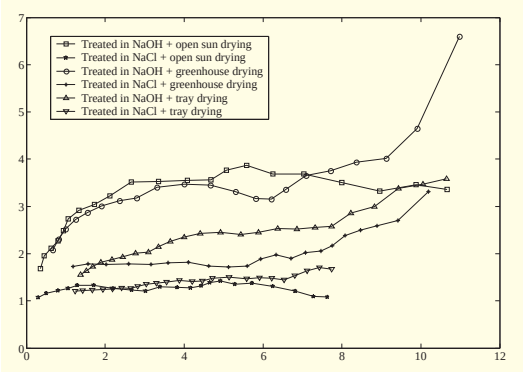


Fig. 59 Convective heat and mass transfer coefficient as function of moisture content under different blanching treatment and method of drying

Table 35 Average convective heat and mass transfer coefficient of green chilli drying with different mode

Treatments	Drying method	Initial moisture content [H_2O]/kg[DM]	Final moisture content [H_2O]/kg[DM]	Drying time, h	Average h_c, Wm $^{-2}C^{-1}$
Blanching in NaOH solution	Open sun	10.9955	0.3424	21	3.1074
	Greenhouse	11.6486	0.5928	21	3.4152
	Tray	10.9623	1.3100	24	1.6675
Blanching in NaCl solution	Open sun	7.7914	0.2432	21	1.2685
	Greenhouse	10.6623	1.0460	21	2.0543
	Tray	7.8981	1.1423	24	1.4099

Color of chilli powder

The completely dried green chilli was ground in the hammer mill and colour was observed (Table 36). It was observed that with NaOH + citric acid treated and tray dried treatment gave maximum greenness, indicated as value of 'a' 2.10 was least. This colour was obtained when the sample was treated with. This implies that for preserving the green colour the sample should be dried mechanically. It was also observed that the value of 'b' 23.03 was maximum i.e. the yellowness was maximum when the sample was treated with NaCl and dried in tray dryer. This showed that the tray drying was suitable for preserving and removing the colour.

Table. 36 Measurement of colour with hunter colour lab

No.	Treatment	L	a	b	YI
1	NaOH + citric acid treated chilli. (Open sun drying, initial weight=0.8085 kg)	59.76	5.25	20.56	54.81
2	NaOH + citric acid treated chilli (Greenhouse drying, initial weight=0.8099 kg,)	61.33	4.72	17.74	47.79
3	NaOH + citric acid treated chili (tray drying, initial weight= 0.0812kg)	54.86	2.10	21.32	54.87
4	NaCl treated chilli (Open sun drying, initial weight= 0.5767kg)	60.02	6.24	19.83	54.61
5	NaCl treated chilli. (Green house drying, initial weight=0.6103 kg)	59.63	5.77	19.02	52.63
6	NaCl treated chilli (tray drying, initial weight= 0.0812kg)	56.93	4.54	24.03	62.53
7	Unblanched chilli (Open sun drying, initial weight= 0.3151kg)	62.44	6.97	23.31	60.35
8	Unblanched chilli (Greenhouse drying, initial weight= 0.8085 kg)	63.55	6.54	21.38	55.73
9	Unblanched chilli (tray drying, initial weight= 0.1653 kg,)	57.67	3.67	22.49	57.36

Processing and utilization of beetroot and carrot for value addition in health foods

Mridula D, Dilip Jain, S.K. Tyagi, and D.R. Rai

Standardization of process parameters for making beetroot powder

In order to standardize the process parameters for making beetroot powder, beetroot was dried at different temperatures, ranging from 50 - 80 ^{0}C after blanching for standardized time period. The total time taken in drying of beetroot at different temperatures was in the range of 8-13 hours. The recovery of the completely dried beetroot at different temperatures was in the range of 13.9 to 14.6 %. These samples were analyzed for colour, solubility and proximate composition. Solubility of the different samples by boiling was in the range of 76.6 % to 80.9 %. In general different process parameters did not affect the solubility of beetroot samples. Different processing parameters affected the colour of beetroot powder. Due to higher sugar content in beetroot, grinding is somewhat difficult. Frequent choking may be observed during grinding, if sample is not properly dried. In order to find out the appropriate grinder for grinding of dried beetroot, hammer mill was tested for the purpose. About 60 % of the beetroot powder of 65 mesh size can be obtained from properly dried beetroot using the

hammer mill (Fig. 60). The effect of different particle size on solubility of beetroot powder on boiling was also studied but not much difference was observed in the solubility of beetroot powder of different particle size. The solubility of beetroot powder with different particle size was in the range of 77.3 to 79.9 %. The mean particle size of the beetroot powder, obtained from hammer mill was 0.215 mm.

Proximate composition: Average protein, fat, ash, fibre and total carbohydrates content in beetroot powder was 11.99, 2.17, 4.57, 7.40 and 79.87 %, respectively. Acid insoluble ash content in beetroot powder was 0.067 %.

Fig. 60 Beetroot powder

Utilization of beetroot powder for food purposes

Ready to serve drink was prepared from beetroot powder with different level of sugar, citric acid and water and evaluated by a panel of scientists for different sensory attributes. The mean sensory scores for different sensory characteristics are given in Table 37. The overall sensory acceptability of drink was maximum for the sample (A) with 2.6 g citric acid and 225 g sugar per liter of the ready drink. The minimum overall sensory acceptability of the drink was observed for the drink with lowest citric acid and sugar content.

Table 37 Organoleptic evaluation of beetroot powder based ready to serve drink

Samples	Mean sensory scores				
	Appearance/ colour	Aroma	Flavour	Taste	Overall acceptab-ility
A	7.83	7.41	7.21	7.25	7.39
A1	7.25	6.96	7.08	7.17	7.25
B	7.54	7.13	7.29	7.08	7.14
B1	7.20	6.88	7.08	7.17	6.95
C	7.33	6.92	7.38	7.50	7.14
C1	7.13	7.13	7.02	7.33	7.20

#9points hedonic scale; samples A-C1 were with different levels of citric acid, sugar and water

In order to utilize beetroot powder in the reconstituted drink form to get the benefits of beetroot, beetroot powder at 2.5, 3.5 and 4.5% with water was evaluated by a panel of scientists for different sensory attributes with reference to the fresh beetroot juice. The mean sensory scores for overall acceptability of reconstituted beetroot powder in the form of drink at 4.5% level was maximum as compared to fresh juice (Table 38).

Table 38 Organoleptic evaluation of reconstituted beetroot drink without flavouring agents

Beetroot powder in drink (%)	Mean sensory Scores			
	Appearance/ colour	Aroma	Flavour & taste	Overall acceptab-ility
Control	7.35	7.5	7.2	7.11
2.5	7.45	6.7	6.2	6.22
3.5	7.65	7.35	6.25	7.17
4.5	7.65	7.65	7.55	7.50

#9points hedonic scale

Standardization of process parameters for making carrot powder

In order to standardize the process parameters for making carrot powder, carrot was dried at

different temperatures, ranging from 50 - 80 ^{0}C after blanching for standardized period. The total time taken in drying of carrot at different temperatures was in the range of 8-13 hours. The recovery of the completely dried carrot at different temperatures was in the range of 8.4 to 9.4 %. The samples were analyzed for different quality parameters viz. colour, solubility, and carotene content and proximate composition (Fig. 61). Carrot powder samples, of two particle size viz. 65 mesh size and 100 mesh size were evaluated for solubility at different water temperature (30-90 ^{0}C) using the water bath.

Solubility of the carrot powder of 65 mesh size was in the range of 60.19 % to 69.65 %. The solubility of carrot powder of 100 mesh size at lower temperature (i.e. 30 ^{0}C) was slightly higher than the carrot powder of 65 mesh size. Solubility of the carrot powder of 100 mesh size was in the range of 64.25 to 69.8 %. In order to find out the appropriate grinder for grinding of dried carrot, hammer mill was tested for the purpose. Data presented in Table 39 shows that about 69 % of the carrot powder of 65 and 100 mesh size can be obtained from properly dried carrot using the hammer mill. The effect of different particle size on solubility of carrot powder on boiling was also studied but not much difference was observed in the solubility of beetroot powder with different particle size. The solubility of carrot powder with different particle size was in the range of 66.08 to 68.16 %. The mean particle size of the carrot powder, obtained from hammer mill was 0.197 mm.

Proximate composition of carrot powder

Average protein, fat, ash, and fibre content in carrot powder was 6.87, 2.77, 8.81, and 8.38 % (d.b.), respectively. Acid insoluble ash content in carrot powder was 0.36 %. The carotene content in the carrot powder samples, obtained from carrot dried at different temperatures was in the range of 60.47 to 70.82 mg/ 100g (d.b.).

Table 39 Effect of particle size on solubility of carrot powder

S. No.	Sieve* size no.	Carrot powder (%)	Solubility (%)
1	14	2.3	66.08
2	20	7.14	67.69
3	28	1.23	66.68
4	35	17.59	68.16
5	65	39.81	66.23
6	100	29.63	66.33

* ASTM standard

Fig. 61 Carrot powder

Evaluation of biodegradable plastic mulching on yield and quality of fruits and vegetables

Rajbir Singh, Satyendra Kumar and D.D. Nangare

Field experiments were conducted in okra to evaluate the efficiency of different biodegradable mulch films. The application of different biodegradable films had influenced the soil temperature and transparent film had higher soil temperature at 10 cm depth and the trend has been depicted in Fig. 62a. The degradation behaviour of biodegradable film (black and transparent) in the field has been depicted in Fig. 62b. It is evident that transparent film degraded in the field early compared to black biodegradable film where as

ordinary film could not degrade. Use of mulches had resulted in higher plant growth (plant height and no. of leaves) of okra. Highest plant height, number of leaves was found in black ordinary polymer mulch film compared to biodegradable film where as the transparent film failed to result in any remarkably higher plant growth over control. Fruit yield of okra was found highest in black ordinary film followed by black biodegradable film. The lowest fruit yield was observed in control (unmulched treatment), whereas the fruit yield was at par with transparent biodegradable film which showed poor performance in okra mainly due to poor weed control and higher soil temperature (2.7 to 5.8 ^{0}C higher temperature at 5cm depth compared to black mulch).

Different mulches were also used for solarization and subsequently used in okra for mulching and the results are presented in Table 40. Solarization influenced weed population and dry matter significantly and lowest weed population and dry matter was found in transparent polyethylene mulch closely followed by biodegradable mulch film. Solarization with black film had intermittent results on weed growth. However, the effect of biodegradable film was as effective as ordinary film (black and transparent). Subsequent mulching after solarization had better effect on weed population and weed dry weight and consequently higher green fruit yield. However, transparent mulching had resulted in poor fruit yield compared to black film (biodegradable and ordinary). Minimum weed growth was observed with solarization with black film and subsequent mulching (T_7) closely followed by biodegradable black mulch film (T_8). The degradability of the film was also observed and found that biodegradable film (both black and transparent) degraded with the time and film was degraded as last picking was over and film was mixed with the soil whereas ordinary plastic film was not degraded in the film.

Table 40 Effect of solarization and subsequent mulching with different biodegradable film on weed density and dry weight of weeds in okra

Treatments	Solarization	Mulching	Weed density (no./m^2)	Weed dry weight (g/m^2)
T_1	+	-	69.6	74.6
T_2	+	-	65.2	80.3
T_3	+	-	100.5	111.5
T_4	+	-	105.5	102.7
T_5	+	+	65.2	63.7
T_6	+	+	68.4	67.5
T_7	+	+	21.1	29.4
T_8	+	+	31.5	33.7
T_9	-	-	223.9	197.5

The experiment of evaluation of different mulches has been carried out in strawberry. The experiment was conducted during October 2007 to March, 2008. Strawberry runners were taken from YS Parmar University of Horticulture and Forestry, Solan. The runners were planted on raised beds at a spacing of 25x25 cm and irrigated with microsprinkler system at the early stage of plant development, which was later replaced by drip system. Mulching was done manually after 15 days after planting. The detail of mulching treatments are as follow: T1: Biodegradable black mulch film (25 µ) ; T2: Biodegradable black mulch film (40µ); T3: Biodegradable black mulch film (30µ); T4: Black ordinary polymer film (25µ). The whole experiment was laid out in Randomized Block Design (RBD) and replicated four times. The biodegradable film was evaluated by following the parameters like degradation, lesion and strength on a score ranging from 1-9 where 1: bare soil and 9: new film. Accordingly the film biodegradability was assessed and results are presented here (Fig. 62c). The effect of mulching with different plastic film affected the growth and development of strawberry. Plant growth in terms of plant spread and leaf area was affected with the use of different film. Maximum plant spread and leaf area was observed in ordinary plastic film followed by black biodegradable film (40 µ). The lowest leaf area and plant spread was observed with black biodegradable film (20 µ).

The degradation of biodegradable film is presented in Fig. 62d. In general, it was observed that thicker the film, the degradation is slow and thinner the film, the fast is degradation. It is evident from the figure that thinner film degraded in the field early compared to black biodegradable film which has higher thickness, where as ordinary film could not degrade. Similarly, the use of different film as mulching affected the fruit weight and yield. Maximum fruit yield was observed with the use of black plastic film followed by black biodegradable film (40µ). Least fruit yield was observed in black biodegradable film (20µ).

The effect of different coloured polyethylene mulches has also been evaluated and the use of different mulches in strawberry has influenced not only plant growth but fruit yield and the trend has been presented in Fig. 62e. Highest fruit yield was observed in red mulches followed by black film and the trend was in the order of red> silver>black>green>yellow >blue.

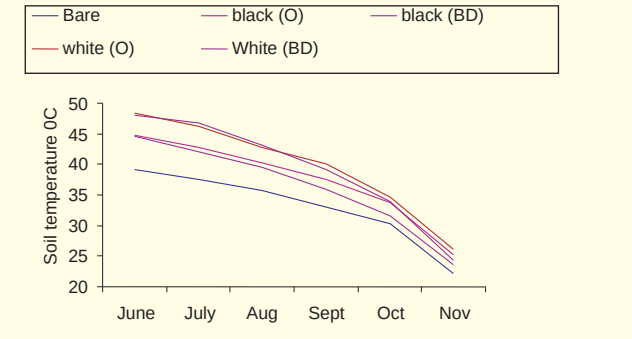


Fig. 62a Effect of biodegradable mulches on soil temperature in okra

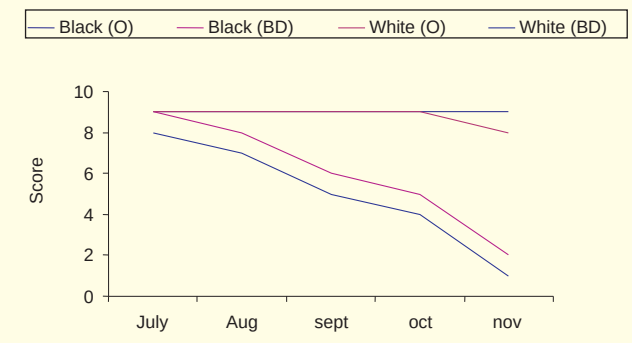


Fig. 62b Degradation of biodegradable mulch films in okra

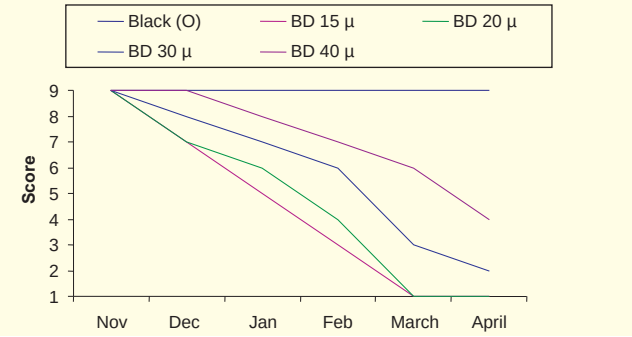


Fig. 62c Degradation of biodegradable mulch films in strawberry

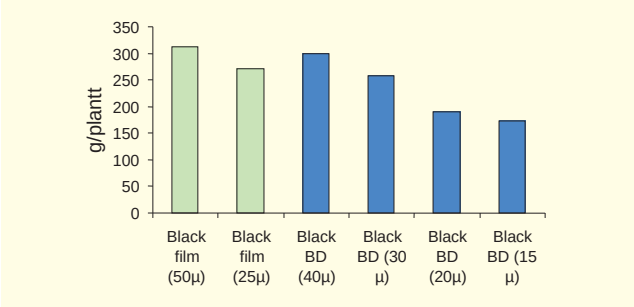


Fig. 62d Effect of biodegradable film mulching on fruit yield of strawberry

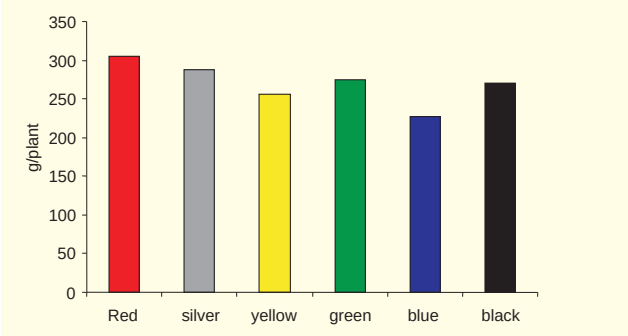


Fig. 62e Effect of coloured polyethylene mulch on fruit yield of strawberry

Organic production of vegetables in polyhouse

Rajbir Singh, Satyendra Kumar and D.D. Nangare

Vermicompost preparation from different manures

The C: N ratio is used as an index for maturity of organic wastes. The end product i.e. vermicompost obtained in this study had lower C: N ratio, as compared to the initial value. The C: N ratio reflects the spectra of changing of changing carbon and nitrogen concentration of the substrate material during vermicomposting process. C: N ratios of cow, goat and sheep wastes were in the range of 20.9 26.4 after 60 days of worm activity (Table 41). The TKN content in the vermicompost of cow and buffalo wastes was higher than vermicompost obtained from goat and sheep. Maximum increase in Phosphorus content was found in goat (39.3%) and sheep (38.6%) manure which were higher than cow and buffalo manure. Similarly, potassium content (TK) was higher in vermicomposts than in raw feeds and highest potassium concentration was observed in goat vermicompost (0.94 %) followed by sheep (0.86 %) which was higher compared to cow (0.40 %) and buffalo (0.68 %) *vermicast*. For the two-month vermicomposting, growth of the earthworms in cow manure was greater than other manures (Table 41). The quantity of *vermicast* produced was also higher in cow manure compared to buffalo, sheep and goat manures. Similarly vermicompost was also prepared from different plants like Parthenium, Water hyaeinth and leaf litter and were used in tomato, capsicum and strawberry and the results are presented in Fig. 63a .

Application of vermicomposts prepared from different animal manures influenced the number of fruits/plant and total fruit yield of tomato. Cow vermicompost produced about 15.1, 19.8 and 22.8 % higher fruit yield of tomato compared to buffalo, sheep and goat vermicompost respectively (Fig. 63b). Application of vermicompost prepared from cow and buffalo manures produced higher unmarketable fruit yield compared to sheep and goat vermicompost. Fruit harvested from plants receiving vermicompost prepared from sheep and goat manures were having better TSS, ascorbic acid and had lower pH and acidity than those harvested from plants receiving vermicompost prepared from cow and buffalo manures.

Influence of vermicompost levels on tomato and capsicum

Plant growth parameters like leaf area and dry weight of plant were influenced in plots substituted with vermicompost at higher levels (8 and 10 t ha^{-1}) than control. At lower substitution levels of vermicompost (2 and 4 t ha^{-1}), however, could not influence these parameters remarkably (Fig. 63c). However, with the increase in substitution of vermicompost from 6 to 10 t ha^{-1}, plant growth in terms of leaf area and dry matter accumulation had increasing trend. Further, leaf area and dry weight increased up to 20.1 % and 22.8 % with substitution of vermicompost @ 10 t ha^{-1} compared to control (Fig. 63d). Similarly, number of fruits/plant, average

Table 41 Growth of earthworm *Eisenia foetida* in different animal manures and quality of vermicompost

Parameters	Cow	Buffalo	Sheep	Goat
Biomass gain (g worm^{-1})	25.3	20.1	16.5	14.7
Quantity of vermicast (g)	648.5	594.8	527.2	519.5
C:N ratio	26.4	34.3	21.6	20.9
N content (%)	0.78	0.75	0.69	0.63
P content (%)	0.39	0.47	0.79	0.85
K content (%)	0.40	0.68	0.86	0.94

fruit weight, and total fruit yield were maximum when tomato plants received substitution of vermicompost @ 10 t ha^{-1}. Interestingly, tomato and capsicum grown in plots substituted with vermicompost had significantly influenced the occurrence of physiological disorders (rosette and blossom end rot incidence) and marketable fruit yield over control (Fig. 63d). Application of vermicompost had influenced fruit quality of tomato significantly over control. Fruit harvested from plants receiving vermicompost were having better TSS and ascorbic acid than those harvested from plants receiving inorganic fertilizers only. Similarly, vermicompost levels influenced the total and marketable fruit yield of capsicum. Highest marketable fruit yield was observed at application of vermicompost @10t/ha (Fig. 63e).

Effect of vermicompost on strawberry

Vermicompost significantly influenced yield attributing characters in strawberry. Strawberry plants received vermicompost @ 10 t ha^{-1} produced maximum fruit per plant (27.9), individual berry weight (14.2 g), and total fruit yield (396.2 g/plant) whereas those, which received inorganic fertilizers only, have produced minimum fruit/plant (25.5), had lowest berry weight (11.7 g) and total fruit yield (298.4 g/plant). Interestingly, strawberries grown in plots treated with inorganically amended vermicompost had influenced the occurrence of physiological disorders, like albinism and fruit malformation, and grey mould incidence and marketable fruit yield of 'Chandler' strawberry (Fig. 63f). On the other hand, plants receiving inorganic fertilizers only, produced higher proportion of albino (16.1 %) and malformed fruit (11.5 %) and, had higher incidence of grey mould (10.4 %), as a result, marketable fruit yield was lower (198.7 g/plant) than those receiving vermicompost. The lowest incidence of albinism (4.5 %), fruit malformation (4.0 %), grey mould (2.1 %), and highest marketable yield (315.1 g/plant) were observed when plants received vermicompost @ 10 t ha^{-1}. Fruit harvested from plants receiving vermicompost were firmer, had better colour, TSS, ascorbic acid, and had lower acidity than those harvested from plants receiving inorganic fertilizers only. The study revealed that substitution of vermicompost with chemical fertilizers is quite useful in field-grown strawberries for higher growth, reduction in physiological disorders, and it helps in getting higher marketable fruit yield of firmer fruit with attractive colour and

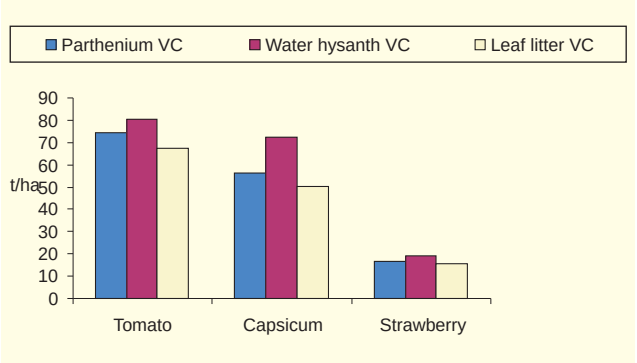


Fig. 63a Effect of vermicompost prepared from different waste plants on yield

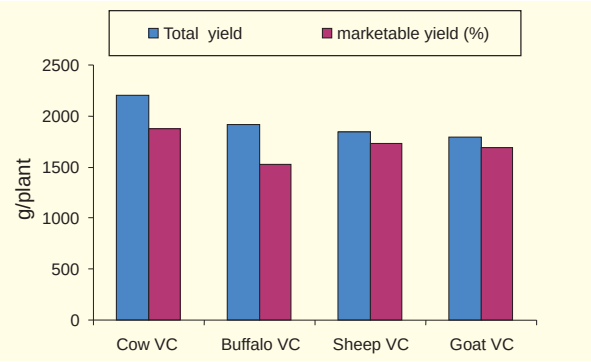


Fig. 63b Effect of different vermicompost on fruit yield of tomato

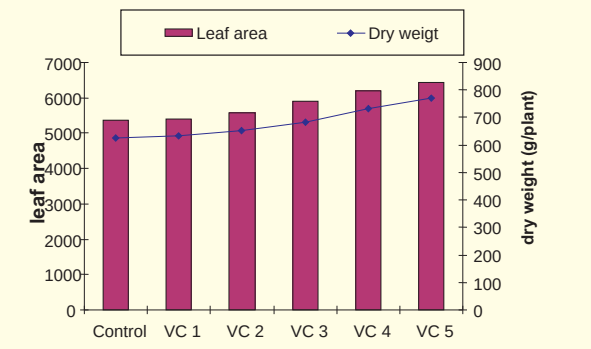


Fig. 63c Effect of vermicompost on growth of tomato

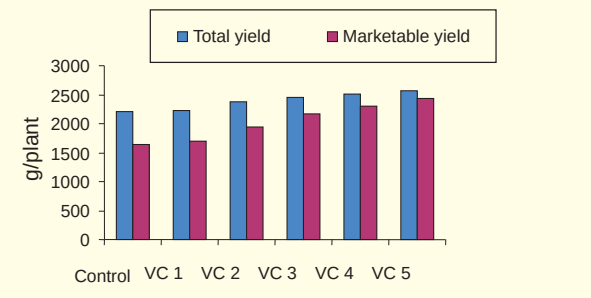


Fig. 63d Effect of vermicompost levels on fruit yield of tomato

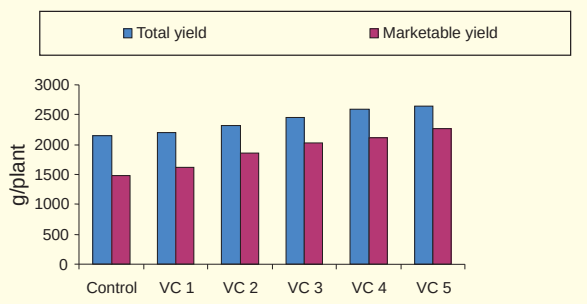


Fig. 63e Effect of vermicompost levels on total and marketable yield of capsicum

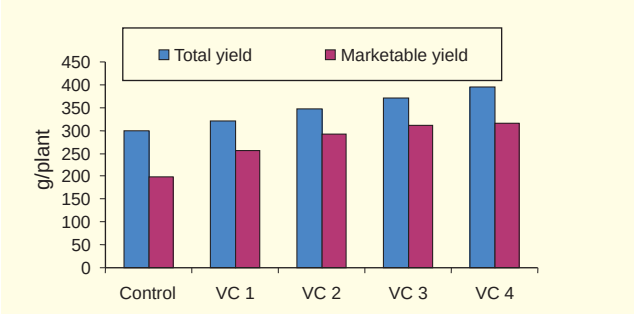


Fig. 63f Effect of different vermicompost on fruit yield of strawberry

Effect of irrigation, fertigation levels and mulching on growth and yield of Bt cotton in semi-arid region

Rajbir Singh, Satyendra Kumar, D.D. Nangare and V.K. Saharan

A field experiment was conducted in Bt-cotton with five treatments of mulching viz, T1: Biodegradable black mulch film; T2: Biodegradable transparent mulch film; T3: Black ordinary polymer film; T4: Straw mulch; T5: Control (without mulch). Bt-cotton variety Rashi-134 was sown on 2nd May, 2006 at a plant spacing of 1x1m in a plot size of 5x6m ($30m^2$). The biodegradable film was evaluated by following the parameters like degradation, lesion and strength on a score ranging from 1-9 where 1: bare soil and 9: new film. Accordingly the film biodegradability was assessed. Fig. 64 presents the biodegradability of the biodegradable film (both black and transparent). It clearly revealed that transparent biodegradable film degraded in the field early than black biodegradable film. The use of mulches influenced the weed growth in the cotton field and maximum weed population and weed dry matter was observed in control where the weed population and weed dry matter was least in black polymer film closely followed by black biodegradable film. The weed population and weed dry weight was higher in transparent biodegradable film compared to straw mulch. The result on weed management in cotton was clearly observed both in black film (ordinary and biodegradable) where as weed growth in transparent biodegradable film was less than straw mulch but better than control.

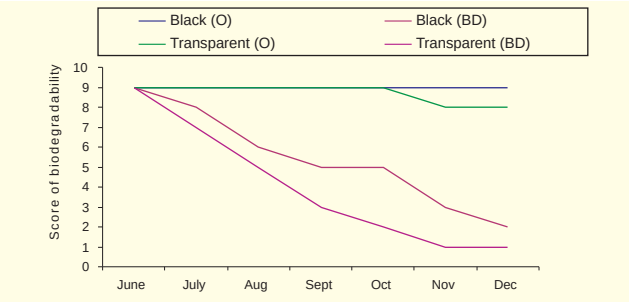


Fig. 64 Degradation of biodegradable mulch film mainly in cotton

Soil solarization for vegetable nursery and its demonstration at farmer's field

Rajbir Singh

The experiment was conducted at research station of CIPHET, Abohar. The details of treatments are as under: T_1: Control (without treatment); T_2: Solarization for 30 days, T_3:Nursery beds amended with FYM@ 10 T/ha and solarized for 30 days. The experiment was conducted in 9 naturally infested beds (3.0x1.0m). Temperature were recorded at 5,10 and 15 cm depth of soil during the period of solarization. Solarization resulted in an average increase of 10.6 ^{0}C temperature at different soil depth compared to non-solarized beds. Maximum temperature differences were observed in upper 5 cm soil depth, which decrease with increase in soil depth. There was not much difference in soil minimum temperature in different depths. There was not much difference in soil temperature at different depths with the addition of FYM in solarized plots. Temperature build up results in mortality of different disease spores and weed seeds. Solarization for 30 days resulted in 100 % mortality of sclerotia/spores of *Sclerotium*, *Pythium*, *Rhizoctonia* fungus, which are responsible for damping-off and other nursery diseases. Weed population/density decreased drastically mainly due to higher temperature build up in soil layers which might have been lethal to weed seeds. Solarization treatments significantly reduced the emergence of weed population compared to control. Solarization of nursery beds proved more effective and statistically superior with respect to higher germination, seedling survival and highest seed germination and survival was observed in capsicum followed by tomato and cauliflower. The higher germination and better seedling might be well correlated with the better and less competitive environment prevailed in the solarized beds compared to control mainly due to less weed and disease infestation in solarized plots. This clearly showed the beneficial effect of solarization for raising of nursery of different high value crops. Further, solarization resulted in better shoot length and root length of different vegetables.

Studies on packaging and storage of pomegranate fruits

D.B. Singh and R.K. Gupta

Pomegranate fruit have a low rate of respiration and ethylene production. They are susceptible to moisture loss and need to be stored at high humidity, low temperature and controlled atmosphere. After harvesting, fruits get spoiled during transit or before marketing due to rotting or development of black colour in the fruit. Under these conditions fruits become less attractive and have value reduction in the market. Since these fruits have got large area under cultivation in arid and semi arid areas where high temperature and low humidity prevails, storage and packaging becomes very important aspect as for its quality maintenance is concerned. During storage formation of black colour of the arils is one of the important factor for consideration. Under arid and semi arid conditions fruits need proper packing and suitable storage. Keeping these problems of storage and packaging of fruits efforts made to study the effect of different packaging and storage of pomegranate on shelf life and quality.

The fruits of pomegranate variety Mridula after washing and drying were treated with T1: Sodium bicarbonate 1.0 %, T2: Sodium bicarbonate 2.0%, T3: Sodium bicarbonate 3.0 %, T4: Calcium chloride 2.0 %, T5: Calcium chloride 4.0 %, T6: Calcium chloride 6.0 %, T7:Calcium carbonate 1.0 %, T8: Calcium carbonate 2.0 %, T9: Calcium

carbonate 3.0 %, T10: Carbendazim 0.05 %, Carbendazim T11: Carbendazim 0.1 %, T12: Carbendazim 0.15 %, T13: Control, and packed in CFB boxes and stored under ambient and cold conditions. There was sharp increase in physiological loss in weight of fruits stored at room temperature. Whereas, the increase in PLW was found to be very slow in fruits stored at low temperature. The fruits treated with calcium chloride 4.0 % and carbendazim 0.1 % showed very low increase in PLW. This was found to be more effective in high RH and relatively low temperature prevailing in cold chamber (LT) as compared to room temperature (RT). Juice contents of the fruits decreased significantly with increase in storage period under both the storage conditions. The fruits treated with calcium chloride 4.0 % and carbendazim 0.1 % showed low reduction in juice content as compared to control ones. This could be associated with the higher rates of respiration since acid forms the necessary respiratory substrate for the catabolic process in fruits.

The initial rise in TSS of fruits and fall after wards was observed under both the storage conditions regardless of post harvest treatments. But the rate of increase in TSS was faster at room temperature than at low temperature. It could be due to higher temperature and low relative humidity which, resulted in faster utilization of TSS and sugars at room temperature resulting in shorter shelf life of fruits. The changes in TSS were found to be slower in fruits stored at low temperature. Vitamin C (ascorbic acid) of juice decreased continuously with progress in storage period regardless of post harvest treatments. The decline in vitamin C was found to be at faster rate at ambient conditions (higher temperature) than in cool chamber. Comparatively calcium chloride 4.0 % and carbendazim 0.1 % were found to retain maximum vitamin C. It is evident from the data presented in Table 42 that shelf life of pomegranate fruits stored at low temperature was better than at room temperature stored fruits Fig. 65.

Fig. 65 Fruits treated with calcium chloride 4.0 %, packed in CFB Boxes (5 gauge) and stored at low temperature maintain quality up to 90 days of storage

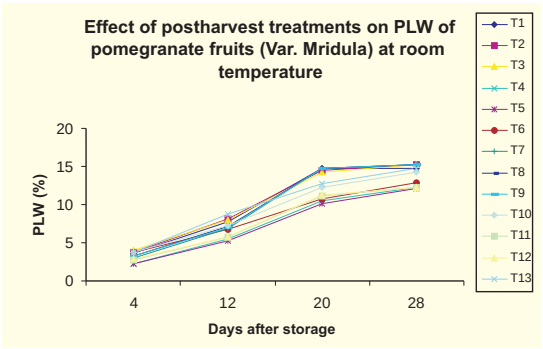


Fig. 66 Effect of post harvest treatments on PLW of Pomegranate Fruit (Var. Mridula) stored at room temperature

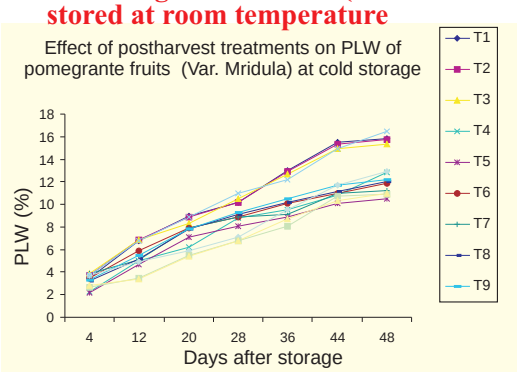


Fig. 67 Effect of post harvest treatments on PLW of pomegranate fruit (Var. Mridula) stored at Low temperature

Table 42 Effect of post harvest treatments and storage conditions on TSS, acidity and ascorbic acid of pomegranate fruits (Var. Mridula) at different storage periods.

Treatments	Storage	TSS (Brix)				Juice (%)				Acidity (%)				Ascorbic acid (mg/100g)			
		Days after storage				Days after storage				Days after storage				Days after storage			
		Ini	16	32	48	Ini	16	32	48	Ini	16	32	48	Ini	16	32	48
Sod.	RT	17.5	18.60	17.70	17.33	54.3	51.0	48.3	42.5	0.4	0.34	0.27	0.24	26.8	20.5	18.0	15.2
bicarbonate 1%	LT	-	18.22	17.97	17.36	-	51.5	49.0	43.7	-	0.40	0.38	0.33	-	21.0	19.7	16.7
Sod.	RT	17.5	18.68	17.72	17.41	54.3	51.2	48.5	42.7	0.4	0.37	0.29	0.25	26.8	20.7	18.3	15.0
bicarbonate 2%	LT	-	18.23	17.93	17.32	-	51.7	49.2	43.9	-	0.41	0.37	0.35	-	21.2	19.4	16.2
Sod.	RT	17.5	18.64	17.73	17.33	54.3	51.7	48.9	43.0	0.4	0.33	0.28	0.26	26.8	20.2	18.2	15.3
bicarbonate 3%	LT	-	18.24	17.95	17.44	-	51.9	49.7	44.1	-	0.40	0.35	0.32	-	21.0	19.2	16.4
Cal. Chloride	RT	17.5	18.32	17.81	17.33	54.3	52.2	50.0	45.3	0.4	0.33	0.29	0.27	26.8	20.3	19.3	16.1
2%	LT	-	18.05	17.93	17.43	-	53.1	51.2	47.9	-	0.41	0.34	0.33	-	21.5	19.4	16.7
Cal. Chloride	RT	17.5	18.35	17.84	17.34	54.3	52.1	50.1	45.9	0.4	0.37	0.30	0.29	26.8	23.2	22.5	18.5
4%	LT	-	18.09	17.92	17.48	-	53.2	51.7	48.5	-	0.42	0.40	0.35	-	24.1	23.7	20.2
Cal. Chloride	RT	17.5	18.31	17.81	17.39	54.3	52.0	50.0	45.6	0.4	0.33	0.27	0.26	26.8	20.2	19.7	16.0
6%	LT	-	18.00	17.91	17.43	-	53.2	51.6	48.3	-	0.40	0.39	0.33	-	21.4	19.7	16.8
Cal. Carbonate	RT	17.5	18.60	17.62	17.21	54.3	51.0	48.1	42.7	0.4	0.32	0.26	0.23	26.8	20.3	18.2	15.5
1%	LT	-	18.31	17.93	17.33	-	51.9	49.2	43.8	-	0.40	0.38	0.34	-	21.1	19.8	16.6
Cal. Carbonate	RT	17.5	18.61	17.61	17.22	54.3	51.1	48.0	42.2	0.4	0.33	0.27	0.24	26.8	20.2	18.4	15.3
2%	LT	-	18.33	17.92	17.39	-	51.8	49.0	43.2	-	0.41	0.37	0.34	-	21.3	19.9	16.7
Cal. Carbonate	RT	17.5	18.59	17.59	17.21	54.3	51.3	48.2	42.1	0.4	0.32	0.28	0.25	26.8	20.2	18.7	15.4
3%	LT	-	18.31	18.91	17.32	-	51.7	48.0	43.0	-	0.40	0.38	0.034	-	21.2	19.9	16.4
Carbendazim	RT	17.5	18.32	17.91	17.32	54.3	51.2	48.7	42.0	0.4	0.39	0.34	0.26	26.8	22.2	22.1	18.3
0.05%	LT	-	18.02	17.99	17.50	-	51.9	48.1	43.2	-	0.42	0.40	0.37	-	24.1	23.7	21.0
Carbendazim	RT	17.5	18.34	17.82	17.31	54.3	52.5	50.3	46.1	0.4	0.40	0.30	0.28	26.8	23.2	22.1	18.4
0.1%	LT	-	18.07	17.91	17.32	-	53.3	51.8	48.9	-	0.41	0.39	0.36	-	24.0	23.6	20.0
Carbendazim	RT	17.5	18.08	17.83	17.28	54.3	52.4	50.2	45.3	0.4	0.38	0.32	0.26	26.8	23.1	22.0	18.5
0.15%	LT	-	18.02	17.90	17.33	-	53.3	51.0	48.5	-	0.39	0.37	0.33	-	24.2	23.6	20.5
Control	RT	17.5	18.61	17.75	17.33	54.3	51.0	47.3	41.8	0.4	0.34	0.28	0.22	26.8	20.6	118.3	15.2
(untreared)	LT	-	18.21	17.99	17.39	-	51.2	48.2	42.9	-	0.40	0.37	0.32	-	21.0	19.3	16.2

Post harvest quality maintenance of strawberry by edible coatings

D.B.Singh, ARP Kingsly and Rajbir Singh

Strawberry (*Fragaria x ananass*a Duch.) is one of the most appreciated fruit for its excellent quality. The main quality indices are skin colour, which is related to fruit ripening and affected by anthocyanin concentration and sugar acid ratio at harvest. Both these parameters along with limited keeping quality determine consumer acceptance. Fruit firmness is also an important attribute and is directly related to enhancement of storability potential and induction of greater resistance to decay and mechanical damage. Strawberry fruit deteriorate rapidly after harvest and in some cases do not reach consumers at optimum quality after transport and marketing. The main causes of sweet cherry deterioration are weight loss, colour change, softening and loss of acidity.

Several pre and postharvest technologies have been used to control decay, but the post harvest use of chemicals as fungicide is restricted in most countries and consumers demand agricultural commodities without pesticide residues. Edible coatings are traditionally used to improve food appearance and conservation. They act as barriers during processing, handling and storage and do not solely retard food deterioration enhancing its quality but are safe due to natural biocide activity or to the incorporation of antimicrobial compounds.

Currently there is an increasing interest in use of edible coatings like *Aloe vera* gel, milk protein in the food industry, being used as a source of functional food in drinks, ice cream and beverages.

The aim of this work is to study the effect of different edible coatings on change in physico chemical parameters related to fruit quality during cold storage and shelf life in strawberry as well as its role in controlling microbial spoilage. It could be an innovative and interesting commercial product and an alternative to the use of synthetic post harvest fungicides and waxes.

Strawberry (*Fragaria x ananass*a Duch.) fruits var. Chandlier fruits were collected from local farmers/commercial farmer at Hissar. At the laboratory 50 kgs of homogenous colour and size, absence of injuries were selected. About 5 kg fruits were analyzed for initial properties. The experimental stock was treated with *Aloe Vera* gel (100%, pharmaceutical quality). Treatments were performed at 20 ºC by immersion for 5 minutes into solution of *Aloe vera* gel in ratio of 1:3, 1:2 and 1:1 in water. Equal portion was treated with water to be taken as control. Following the treatments, strawberries were air dried, randomly divided into 8 fruits lot (average weight of 120 g) and packed in punnets and stored at 5 ºC and 25 ºC. Three lots of both treated and control were taken out after 2,4,6,8,10,12,14 and 16 days of cold storage.

Weight loss increased during both cold storage and ambient condition i.e. room temperature but was significantly greater in control and whey treated/coated fruits compared to *Aloe Vera* treated fruits. At the end of cold storage fruits loss was 13.79 while loss of weight in Aloe treated strawberry fruits was 9.9 *%*. *Aloe vera* gel retarded the moisture loss and respiration rates. The mechanism & these positive effects is based on their hygroscopic properties, which enables formation of a barrier to water diffusion between fruits and environment, thus avoiding its external transference. The main colour changes were observed for 'L' & 'a' values which diminished during cold storage and subsequent room/ambient conditions. However, significant difference were found between control and Aloe treated fruits, since maintenance of 'L' and 'a' values was observed during first 16 days of cold storage in those strawberry fruits coated with *Aloe vera*, while a sharp reduction was observed in control. During

room temperature even greater differences were detected between control & *Aloe Vera* treated strawberries with value of respiration

TSS significantly increased with storage time in all coatings. However, increase was rapid in control and room temperature and thus increased metabolic activities.

TSS & TA at initial stage (after harvest) were 8.0 and 1.60 days and ratio was 5.1-0.9. This ratio slightly increased in both control & *Aloe Vera* gel coatings during cold storage reaching 7.85 & 10.10 respectively (Table 43). While TSS /TA ratio was 7.84 in case of control stored at room temperature. It is widely expected that most important parameters, which determined strawberry acceptance are colour and firmness, TSS/TA ratio. Titratable acidity decreased as function of storage time in all treatments. The rapid decrease in acidity demonstrates maturity and development, which also occurred in case of gel coatings.

Vitamin C decreased with storage period. Decrease in gel coatings was less and more effective to retain it in case of low temperature (5±1 ºC). Vitamin C increased with storage time. In case of coatings, fruit synthesized reducing sugar at lower rates than control (Table 44). Coatings of *Aloe vera* gel slows down metabolism for giving prolonged storage life. 'L' and 'a' colour diminished sharply in control fruit after cold storage & subsequently room temperature. *Aloe Vera* treated strawberry maintained typical red colour of recently harvested fruits even after 16 days of cold storage.

Table 43 Effect of edible coatings on TSS and acidity of fruits during storage

Treatment	Storage conditions	TSS° Brix Days after Storage								Acidity % Days after storage							
		2	4	6	8	10	12	14	16	2	4	6	8	10	12	14	16
Aloe	LT	8.0	8.0	8.0	8.2	8.2	8.8	8.4	8.4	1.60	1.58	1.42	1.40	1.35	1.33	1.19	1.07
***Vera* gel 1:3**	RT	9.0	9.1	9.2						1.53	1.46	1.37					
Aloe	LT	8.6	8.8	9.0	8.9	9.0	9.0	8.8	8.2	1.58	1.54	1.38	1.35	1.33	1.31	1.20	1.04
***Vera* gel 1:2**	RT	8.4	9.2	9.1						1.50	1.43	1.28					
Aloe	LT	8.0	8.8	9.0	9.0	8.9	8.6	8.4	8.7	1.69	1.59	1.43	1.42	1.36	1.29	1.21	1.08
***Vera* gel 1:1**	RT	9.0	9.6	9.0						1.52	1.47	1.31					
Control	LT	8.8	8.9	9.0	9.1	9.2	9.1	9.0	9.1	1.37	1.21	1.14	1.11	1.10	1.08	1.00	0.83
	RT	9.0	8.6	8.0						1.25	1.15	1.02					

LT = Low Temperature, RT = Room Temperature

Table 44 Effect of edible coatings on reducing sugar and vitamin C of fruits during storage

Treatment	Storage	Reducing Sugar % Days after Storage								Vitamin C (mg/100g) Days after storage							
		2	4	6	8	10	12	14	16	2	4	6	8	10	12	14	16
Aloe Vera	LT	3.74	3.78	3.97	4.10	4.17	4.25	4.92	5.56	55.6	53.5	50.1	50.0	49.2	48.1	4.1	45.0
gel 1:3	RT	3.76	3.88	4.70						54.9	50.1	49.5					
Aloe Ver	LT	3.76	3.80	4.00	4.11	4.19	4.22	4.97	5.55	55.2	50.2	50.0	49.0	48.2	47.3	47.0	44.9
***a*gel 1:2**	RT	3.82	3.95	4.10						54.2	50.8	48.2					
Aloe Vera	LT	3.77	3.81	3.99	4.10	4.17	4.21	4.96	5.53	55.6	54.0	50.5	51.0	49.5	48.9	47.5	45.6
gel 1:1	RT	3.88	3.97	4.07						50.1	50.3	49.2					
Control	LT	3.90	4.12	4.20	4.60	5.22	5.70	5.63	6.50	49.2	47.1	43.1	40.1	38.2	36.2	35.1	30.0
	RT	3.97	4.19	4.29						47.3	43.7	10.2					

LT = Low Temperature, RT = Room Temperature

Development of pomegranate aril extractor

A. K. Thakur, D. B. Singh and R. K. Gupta

Hand tool for easy separation of arils from Pomegranate

The basic method for extraction of juice from pomegranate involves cutting the fruit in pieces, aril separation and pressing of arils in screw press or basket press. Juice extracted by this method needs to be clarified by chemical methods because peel contributes high amount of tannins and other undesirable biochemicals. The hard peel of pomegranate fruits makes it difficult to release the arils, thus limiting its consumption as fresh fruit. At present in the country, there is no mechanical method or machine commercially available for safe separation of arils from the pomegranate. Since a pomegranate contains several hundreds of arils, manual processing of pomegranates consisting of cutting the fruit by knife into pieces and then separation of arils tends to be very inefficient and highly labour intensive, time consuming and irritating. To separate the intact arils from the fruit, there is no need to cut the fruit cross-sectionally; only needs to cut the outer peel so that the pomegranate can easily break into pieces by using the fingers. Arils are so firmly attached to each other and; with rind and peel that it makes difficult to separate by fingers.

CIPHET has developed a hand tool for breaking of pomegranate and consequently easy separation of arils from its peel (Fig. 68). The tool consists of fruit holders having knife arrangement in such a way that it only penetrates into the peel. Pomegranate fruit has to be held between the pair of holder, and the holders are turned by hand in opposite direction of each other. Due to rotating action of the holders, fruit is broken into two irregular halves as a simultaneous effect of tension with twist on the peel. During this action the whole fruit experiences a shearing effect; and due to this effect the inside arils become loose which provides an opportunity of easy separation. About 30-40 % arils are already separated in the process of irregular breaking due to shearing action on the inner sheath and outer peel. The hand tool is designed considering the medium size of the fruit because the maximum distribution of medium sized fruit as observed on pomegranate plant. The result of the hand tool was found encouraging; it makes the task of safe separation of arils from the peel and sheath effortless. To get the patent of the design of hand tool, an application has recently been filed.

Fig. 68 Working with hand tool for easy separation of arils from pomegranate

Mechanical pomegranate aril extractor

Prototype of a mechanical system for pomegranate aril extraction is under fabrication stage. Fabrications of the frustum cone-hopper with cutting/breaking blades were carried out with their

drive unit for inner and out cone-frustum. Preliminary testing of fruit breaking hopper with their drive units was undertaken for its functionality. About 40 kg pomegranate fruits of different sizes were used for testing of the breaking units in 4 batches of 10 kg each. The function of the breaking unit was found encouraging, and in the first hand evaluation, more than 90 % of arils were safely separated from the fruit peel during the process of breaking (Fig. 69). The fabrication of other unit like separation of arils from the broken fruits of pomegranate is in progress. The development of mechanical pomegranate arils extractor is being carried out with a view to process the pomegranate on large scale.

Fig. 69 Initial trial of mechanical pomegranate arils extractor

Process development for production of raisin like product from 'perlette' grape

A. K. Thakur and V. K. Saharan

'Perlette' grape is the only early ripening variety grown in North India mainly in south-west districts of Punjab (Table 45). Experiments were conducted to evaluate the suitability of this grape for raisin preparation with different physical treatments. The physical treatments consists whole berries, half cut berries into two pieces and berries having superficial abrasion of peel/waxy cuticle using an inert abrasive material. The effectiveness of these treatments on drying characteristics and quality of the prepared raisin were studied. The half cut berries took less time to dry as compared to scratch surface berries and whole berries. Physico-chemical characteristics of the grape berries were evaluated before and after drying. Drying of berries was carried out at 60°C in an air circulatory tray dryer with loading capacity of 6.0 kg/m^2 (Table 46). Initial moisture content of berries was 67.0 % (w.b.) with varying TSS of 15-18 % which was dried into raisin of moisture content around 15.0 % (w.b.). Empirical/semi-theoretical statistical/mathematical models, describing thin-layer drying of various biological materials have been investigated to illustrate the drying characteristics of the physically treated berries. A non-linear regression analysis using a standard statistical program was used to evaluate the constants of models to describe appropriately the drying behaviour. The experimental results provided an opportunity to conclude that the abrasion method is an effective pretreatment for faster drying against the chemical method; however this treatment gave comparatively darker raisins which were less attractive but, assumed to be safer than the chemically treated raisin.

Table 45 Physico-chemical characteristics of the Perlette grape

Sl. No.	Parameters	Value ± S.D.
1	Peel thickness, mm (n=20)	0.0227 ± 0.05
2	Average number of seeds (n=10)	2.9 ± 0.738 (Min. 2 and Max. 4)
3	Seed : Pulp : Peel ratio (n=10)	0.095 ± 0.035 : 1.879 ± 0.315 : 0.133 ± 0.044
4	Major axis diameter, mm (n=50)	16.41 ± 1.133
5	Minor axis diameter, mm (n=50)	15.59 ± 1.065
6	Average weight of single berry, g (n=50)	2.392 ± 0.547
7	Bulk density, kg/m^3	606
8	True density, kg/m^3	974
9	Moisture content of berry, % (w. b.)	67
10	Firmness, g (n=50)	295 ± 41.63
11	Total soluble solids (TSS), %	14-17
12	Acidity, %	1.075 (1^{st} week harvested) 0.760 (2^{nd} week harvested)
13	Viscosity of fresh juice, Kreb unit, Cp, g	42, 66, 38
14	Colour (n=10), L, a, b	47.773 ± 1.405, -6.186 ± 1.398, 13.879 ± 1.791
15	Acid (tartaric), mg/100 ml juice	10.51
16	Water activity of fresh berry at 41.58 ºC	0.923

Table 46 Overall drying rate of Perlette grape at 60 °C

Treatment	M_i % db	M_f % db	Drying time (t), h	dM/dt % / h	Dried weight (kg/kg)	DR	DY, %
T1	203	19.0	16.0	11.5	0.28	2.53	39.5
T2	203	18.2	14.0	13.2	0.25	2.55	39.2
T3	203	17.6	10.0	18.5	0.23	2.57	38.9

M_i and M_f Initial and final moisture content, DR Drying ratio, DY- Drying yield

Raisin like pills could be prepared by using the pulp of the grape with some additives as a test mix. Jam and squash were prepared by using the finished pulp of the grape whereas Jelly was prepared by pure juice extracted during the hot processing. The jelly prepared from this grape was of excellent quality with translucent light yellow in colour and with a good finish. In a single line processing of Perlette grape, juice was extracted by hot processing and pulps were prepared by using the remaining mass of the grape (Fig. 70).

Fig. 70 Value added products of Perlette grape

Mechanical device for detection of insects in stored grains

A. K. Thakur, V. R. Bhagwat and R. T. Patil

The "Mechanical Device for detection of insects in stored grains" is capable of instant detection, and a fair quantification, of insect infestation in stored food grains. The device facilitates the detection of live or dead insects in stored grain and it also allows to visualize the egg infestation in the grain sample; that further provide a fair quantification of insect infestation level. This device is simple in design and fabrication, portable and in-expensive (Fig. 71). As a result of the unique movement of clock-wise and anticlock-wise, the hiding insects get frightened, scared, wander and then screened out from the grain sample. The device can be suitably used to detect variety of different insects such as: grain borer, rice weevil, red flour beetle, rusty grain beetle, and saw-tooth grain beetle in different types of cereals, pulses and oilseeds and similar commodity that become infested during storage. This device is also capable to detect the carry over infestation from the field harvest. The mechanical device consists of two separate units: a set of insect detecting boxes and another is a mechanical system to provide the desirable motion to the set of insect detecting boxes. The insect detecting boxes has four major parts; upper container for grain samples, magnifying glass at the top lid, circular sieves of different sizes and insect collecting chamber at the bottom.

The desirable motion provided by mechanical unit is the clockwise and anticlockwise semi-circular motion to the detecting boxes. The peculiar and eccentric motion facilitates to agitate the grain samples. This particular motion and churning/agitating of grains samples create frightening experience to the hidden insects that are further trapped in insect collecting box. If there is any dead insect present in the sample, this will also sieve-out and get collected in the insect collecting box. The enclosed insect collecting box does not allow the insects to even fly out. Since the grain sample box & insect collecting box both are made of transparent HDPE material; one can easily see from outside the type and number of insects in order to further make an assessment of the infestation level. The device is tested for the stored chickpea grains and detected adults of *Callosobruchus* sp. However, immature and internal feeder could not be detected. Further it was tested for green gram, black gram, rice and wheat to detect insect pest like *Sitophilis oryae*, *Rhizopertha dominica* and *Tribolium castaneun.* The device is also suitably detects insects in flours by changing the size of the disk sieve. It is even more useful as sampling device in detecting storage pest at regular interval for Central Ware Housing Corporation (CWC), Food Corporation of India (FCI) and other private grain storage; research institutions involves in scientific storage of food grains like IGMRI, SAU, Agricultural Department of the State Governments etc. The device has been applied for patent recently and it is ready for commercial manufacturing through licensing.

Fig. 71 A view of mechanical device for delection of insects in stored grain

Development of value added health drinks from soybean milk whey

Matthew Prasad & D. Dhingra

Soybean milk whey was obtained from commercial sources and analysed for its physical and chemical characteristics. The solid content of whey, pH, specific gravity, colour (L*,a*, b*), turbidity and viscosity were observed to be 1.76 %, 5.10, 1.01, (L*=32, a*=4.55, b*=22.0), 71.7 93.0 NTU and 17-24 cP respectively. Titratable acidity, protein and total reducing sugar were observed to be 0.192, 0.3 and 0.4 % respectively.

Ready to serve beverage samples were prepared using soybean whey. Pineapple juice and guava pulp were used to make combinations with soybean whey (Fig. 72). The composition of the fifteen samples prepared from whey and pineapple juice and their chemical constituents and organoleptic quality are listed in Table 47. The soybean whey, pineapple juice and sugar were in the range of 40 - 60, 10 - 30 and 8 12 % (w/w) respectively.

Sample number 11 (whey 50 %, juice 10 %, sugar 12 %) was liked by most of the panelists. Flavour attribute got minimum score from each panelist. Soybean whey flavour was very strong and it masked flavour of juice. The maximum acceptable level of soybean whey and sugar was observed to be in the range of 30-35 and 18-20 %. The method of preparation of ready to serve beverage was explained through demonstration to the entrepreneurs' Sh B S Garcha, M/s B K Soya Products and Ms Gurpreet Kaur, M/s So-Fine for commercialization. After one month of storage pineapple soybean whey RTS had 1-2x10^4 / g fungal colonies and no bacterial contamination.

Table: 47 Composition, chemical characteristics and overall acceptability of soybean whey and pineapple beverages

Serial No.	Soy-whey (g)	Fruit juice (g)	Sugar (g)	pH	Tritable Acidity %	TSS (Brix)	Brix: Acidity	Overall acceptability
1	1200	600	200	3.80	0.37	13.3	35.9	6.12
2	1200	200	200	3.80	0.26	11.4	43.8	6
3	800	600	200	3.75	0.34	13.2	37.7	6.62
4	800	200	200	3.80	0.23	11.6	50.4	6
5	1200	400	240	3.85	0.31	14.3	46.1	6.5
6	1200	400	160	3.84	0.28	10.7	27.4	6
7	800	400	240	3.72	0.30	14.2	45.8	5.75
8	800	400	240	3.77	0.28	10.0	35.7	5.75
9	1000	600	240	3.72	0.37	14.7	39.7	6.75
10	1000	600	160	3.79	0.35	11.0	31.4	5.75
11	1000	200	240	3.81	0.24	14.0	56.0	7.12
12	1000	200	160	3.79	0.25	13.6	54.4	6
13	1000	400	200	3.78	0.30	12.1	39.0	6
14	1000	400	200	3.77	0.31	12.3	39.7	6.5
15	1000	400	200	3.79	0.30	12.2	39.4	6.5

(Total sample prepared in each case: 2000g, citric acid 2.4 g, Benzoic acid: 300 mg, colour (index no-15985): 0.15g were added in each sample)

Fig: 72 Samples of soybean whey-pineapple RTS beverage

Development of belt dryer for fruit slices

D Dhingra, D M Kadam and D K Bharti

Conceptual design and preliminary drawings of the belt dryer were prepared and fabrication of the belt dryer was completed. It consists of 4 belts mounted one above the other. The distance between

Fig. 73 Inside view of the belt dryer

rollers is 1 m and 1.2 m. The belts have been prepared from cotton cloth. Four heaters (0.5 kW) and an axial fan have been provided to heat the air and circulate the air. PID controller has been used to control the temperature. The inside views of the belt dryer are presented in Figs. 73 & 74.

Fig. 74 Side view of the belt dryer

AICRP on Post Harvest Technology

RESEARCH ACHIEVEMENTS

Minimal processing of fruits and vegetables (Akola centre)

Preliminary trials were conducted. The salad vegetables like carrot, radish, cucumber could be kept in acceptable condition under refrigeration up to 7 days . The spinach spoiled on 3rd day while capsicum could be stored safely up to 5th day under refrigeration.

Development of ethosorb technique for banana (Akola centre)

Four no. of ethylene absorbent pouches (each weighing 10 g) used for enhancing green shelf life of banana bunches (7.25 kg) packed in 250 µ polyethene were found to enhance shelf life upto 18 days, with better acceptability of ripened fruits.

Studies on bio-chemical changes of jaggery blocks/powder during and after cold storage (Anakapalli centre)

The jaggery samples of solid bricks as well as powder in different packaging materials kept for studying bio-chemical changes under normal and cold storage are being analysed for their quality characteristics. The study showed deterioration of jaggery that started after two months of its storage both during and after cold storage. Powder samples when packed in double layer with vacuum packing were affected with fungal growth; while such effect was not observed in mono layer packing of the same. In case of jaggery bricks (500 g), the deterioration started from the outer side of the brick sample immaterial of type of packaging (i.e. whether it is under monolayer or double layer packing). The physical changes are comparatively less when the jaggery brick samples are kept open without any packing. Also, the samples as long as they were under cold storage were found to be hard (Hardness = 0.2 cm), but readily became soft within one day when they were taken out from the cold storage (Hardness = 1.8 cm).

Performance Evaluation and improvement of walk in type poly house solar dryer for chillies (Bapatla centre)

A multipurpose poly house which can dry about two tons of ripe pods during January to April was designed. It can also be used to raise green coriander during May to June. Nursery raising can be taken up with a capacity of about 67,000 seedlings per batch. During July to August, at least two batches of nurseries could be raised.

Poly house drying experiments were conducted using BJ 304 hybrid chillies at Rajupalem. The drying could be completed from an initial value of 80% wb to 10% wb in 9 days compared to 13 days in open yard drying method. The colour of the pods was much better than that of dried in the open yard. Temperature of about 15-17 ^{0}C higher than the ambient temperature was observed. The operation of ventilator closing and openings are being observed for optimization.

Adoption of improved turmeric boiler for arecanut (Coimbatore Centre)

Trials were conducted with both the improved boiling and the traditional boiling arrangement for different boiling durations. Quality of the arecanut kernels was assessed with respect to the moisture content and the hardness, as indication of boiling. Change in the colour was significant in the improved method (using steam) as compared to the traditional method. The textural character of crushing strength for the boiled arecanut kernel was found to range between 287 to 800 N and 171 to 787 N, along the axial and longitudinal directions, respectively. The weight reduction after boiling was found to be 4 % in the steam boiling process as compared to 7.5 % in the traditional method of boiling. Fuel requirement was considerably less in the steam boiling process. Further experiments are under progress to assess the fuel requirement, drying characteristics boiled arecanut and the textural characteristics of dried kernels. The use of the arecanut boiling unit installed at Thondamuthur was monitored.

Development of green house type tunnel dryer for chillies (Coimbatore Centre)

Sun drying of fresh green pepper separated from the spikes was conducted by spreading uniformly in trays as single layer. The pepper dried from initial moisture content of 233.33 to 10 percent (d.b) in 22,

30 and 36 hours for single layer of 1 and 2 cm bed depths.

Mechanical drying of fresh pepper under similar conditions required 10, 12, and 14 hours. The drying rate of pepper decreased significantly in mechanical drying. The drying of pepper took 18, 20 and 22 hours when dried at heights of 120, 80 and 40 cm in solar tunnel dryer. The average drying air temperature was 15.5°C more than that of the ambient temperature thus enabling the drying of product faster in solar tunnel dryer than in sun drying. The average heat transfer efficiency during the trial was 65.12 % while the average overall efficiency of solar tunnel dryer was 28.7 %.

The drying time for pepper improved with 20 % perforated trays compared to that with 10 % perforated trays.

Developing technologies for processing and preservation of drumstick (Coimbatore Centre)

Preliminary experiments were conducted to calculate thermal process time for retort pouch packing of ready to use gravy with moringa pulp, onion and tomato with other seasoning spices. The thermal process time was found as 16.47 min.

Drumstick samples were cut into pieces and subjected to steam blanching at 80 ^{0}C for 5 minutes to inactivate the enzymes and the pulp was separated. Gravy was prepared with drumstick pulp, onion and tomato (2:1:1) along with other spices used for cooking; the product was packed in retortable pouches and retorted for 16.5 min. at 121 ^{0}C. The microbial qualities of processed samples are under further studies during storage.

Development of a pearler for minor millets and value addition of pearled millets (Coimbatore Centre)

The pearling efficiency of the minor millet pearler was found to be higher in fixed clearance casing compared to the variable clearance casing. The milling efficiency of the little millet was found to be 60%. The available laboratory model drum dryer was rectified for use as flaking mechanism. A mechanism to globulate pellets is under evaluation. Further work is in progress to extrude the dough using the hand operated domestic type extruder. Cyclone separator has been attached with the pearler to separate the husk from dust particles after pearling. Further refinement of the pearling unit is in progress.

Standardization of microbial consortia, fermentation conditions and packaging methods for enhancing nutritive value and shelf life of homemade/ commercial idli batter (Coimbatore Centre)

An experiment to study the effect of vacuum packaging, air tight packaging and normal packaging under refrigerated and room temperature storage on the shelf life and storage of idli batter was initiated. Periodical observations on pH, titratable acidity, volume, weight, bulk density, colour value, total, reducing and non-reducing sugars and microbial population are being recorded at 3 days interval. The experiment is in progress.

Mass multiplication of the bacterial isolates viz., *Lactobacillus delbruccii, Leuconostoc mesenteriodes* and *Enterococus faucalis* and the yeast isolate *Saccharomyus cerevisisa* was carried out in *Lactobacillus* MRS and Glucose Peptone Yeast Extract broth for preparation of a mixed culture inoculum for idli batter fermentation. After mass multiplication in the broth for a period of 5-7 days, the broths were centrifuged to collect the cell pellets. Then the cell pellets were frozen in the freezer of the refrigerator for overnight and freeze dried. The freeze dried cultures of the four different isolates mentioned above were mixed in equal proportion and filled in capsules under aseptic conditions @ 500 mg dried culture/capsule. This mixed culture inoculum is to be used @ 1 capsule for every 1 kg of idli batter to be fermented and to evaluate the fermentation rate and time for mixed culture inoculation vs. natural fermentation.

Development and evaluation of probiotic fruit juices/ fruit juice powder as a health drink (Coimbatore Centre)

The data on TSS of raw and pasteurized as well as probiotic enriched fruit juices indicated that grapes recorded the maximum TSS (º Brix) of 11.0, whereas the minimum TSS of 3.20 was noticed in tomato. There was not appreciable change in the TSS in all pasteurized fruit juices studied. However, the TSS of probiotic enriched fruit juices decreased with increase in incubation time from 24 to 72 hrs. The maximum and minimum TSS observed after 72 hrs of inoculation were 8.91 and 2.20 in probiotic fruit juices of grapes and tomato respectively.

The combined inoculation of *L. acidophilus* and *L. plantarum* in probiotic fruit juice recorded better survival than individual inoculation. However, production of undesirable odour was noticed in the fruit juice inoculated with both the cultures.

The data on total sugar content of raw, pasteurized and probiotic enriched fruit juices indicated that banana recorded the maximum total sugar content of 9.43 %, whereas the minimum of 3.37 % was noticed in tomato. The total sugar content of probiotic enriched fruit juices decreased with increase in incubation time from 24 to 72 hrs. The maximum and minimum total sugar content observed after 72 hrs of inoculation were 4.81 and 1.27 in probiotic fruit juices of grapes and tomato respectively.

Optimization of process parameters for shelf life enhancement of selected fresh cut fruits and vegetables (Coimbatore Centre)

Pineapple slices were packed in polypropylene pouches of 100, 200 and 300 gauge thickness with sodium benzoate and KMS as preservatives for pretreatment @ 1.0, 1.5 & 2.0 % and the samples were stored at RT and at refrigerated conditions. Samples with sodium benzoate (2%) and KMS (2%) treatment stored at refrigerated condition in 300 gauge polypropylene pouches were found to be good up to three days with physico chemical qualities.

Banana pseudo stem slices were pretreated with 1% citric acid and packed in HDPE & LDPE pouches and stored in RT and under refrigerated conditions. Samples stored in refrigerated condition were found to retain the physico-chemical properties for a period of 2 days, whereas the samples stored at RT were affected with fungal growth and browning within a day.

Drumstick leaves were pretreated with 1% chlorinated water as a disinfectant for 3 min and air dried to remove the surface moisture; then the sample was packed in LDPE & HDPE pouches and stored at RT and refrigerated conditions. Samples stored at refrigerated condition in HDPE pouches were found to retain the freshness of the greens for a period of 4 days, while the sample packed in LDPE pouches spoiled within two days.

Storage and processing of Custard apple (Junagadh centre)

Custard apple gritty pulp attached with peel posed difficulties in the automizer of spray drier, due to the coarser particles adhered with the inner side of custard apple peel. Slightly higher temperature of the pulp (50 ^{0}C) than room temperature facilitated smooth flow. The powder was very hygroscopic due to high sugar content so vacuum packaging was recommended.

Integrated pest management in coriander (Junagadh centre)

The well-dried good quality coriander seeds were obtained from local market and filled in clean and dry bags, weighing 1 kg each. Bags were properly packed and placed for experimentation in the laboratory and coriander seeds examined in laboratory at monthly intervals for population build up of cigarette beetle and damage of seed up to 10 months of storage. The infestation of cigarette beetle was not found during storage of coriander.

Development and evaluation of equipments and technologies in honey production and processing systems (PAU, Ludhiana centre)

Ten pieces of Electric-cum-battery heated wax uncapping knife were fabricated for further performance evaluation at different field locations.

Process development for improvement in rice milling through enzymatic pretreatment (PAU, Ludhiana centre)

The brown rice (Basmati 370) was treated with all the three enzymes (cellulase, xylanase and protease) produced in the laboratory under optimized conditions. For optimization of the enzymatic pretreatment conditions for brown rice, the pretreatment was given at three different temperatures with three different enzyme concentrations and for three different time durations. The optimized pretreatment conditions were an enzyme concentration of 85%, treatment time of two minutes, at a temperature of 42^{0}C.

Modified atmosphere packaging and storage of french beans and mushroom (PAU Ludhiana centre)

The gas and vapour permeability characteristics of some of the polymeric films available in the market were determined at different temperatures and relative humidity combinations. The trial experiments for selecting the most appropriate film have been carried out. The packaging and storage of vegetable was carried out as per the seasonal availability of the vegetables.

Respiratory behaviour studies were carried out for French beans and mushroom crops. For the highly respiring produce such as French beans, perforated polypropylene film packages containing 250, 500, 750 and 1000 g of cut beans were stored at 15 ^{o}C for three days. The film had eight holes of 0.3 mm dia each and the gas permeability coefficients of 4.14×10^{-14} and 1.45×10^{-13} ml cm cm^{-2} s^{-1} Pa^{-1} for O_2 and CO_2 respectively. The results showed that the packaging treatments resulted in the creation of modified atmosphere ranging from 2.6 - 12.7% O_2 and 4.51-3.6% CO_2. It was found that higher in-pack weight and so high in-pack CO_2 levels can suitably maintain the green colour of French beans for three days of storage under modified atmosphere.

Mushroom was packed and stored under modified atmosphere in LDPE and PP film packages having a thickness of 50 µm and 35 µm respectively. The bag area was 0.10 m^2 and 250 g material was stored. The water vapour permeability at 15^{o}C was observed to be 2.07×10^{-3} and 5.4×10^{-4} ml m. m^{-2} h^{-1} kPa^{-1} for LDPE and PP, respectively. The gas permeabilities for LDPE were 8.3×10^{-6} and 9.4×10.6^{-6} ml m-m^{-2} h^{-1} kPa^{-1} for O_2 and CO_2, respectively, and for PP, these were 1.65×10^{-5} and 1.92×10^{-5} ml m-m^{-2} h^{-1} kPa^{-1} for O_2 and CO_2, respectively. The surface colour of mushroom was judged by the lightness (L-value) of the bulb. The L-value was 90.9 for the initial sample, and 48.75 and 59.96 for LDPE and PP packages respectively, after 4 days of storage.

Development of protocol for post harvest management and processing of apple (Solan centre)

The modifications in the mechanical grader from PDKV, Akola were made and the dropping height of the fruits decreased in order to reduce injury during the drop of the apple in the collection chamber.

The method for standardization of packaging of apple for storage has been optimized. Shrink wrapping of individual apple fruit in PP shrink wrapping film was found better for retention of quality under room as well as refrigerated conditions. While fruits packed in trays experienced spoilage during storage period of 2 months. Further, the control fruits without wrapping experienced fruit shrinkage and higher physiological loss in weight.

conditions. While fruits packed in trays experienced spoilage during storage period of 2 months. Further, the control fruits without wrapping experienced fruit shrinkage and higher physiological loss in weight.

Development of protocol for post harvest management and processing of kiwi fruits for value addition (Solan centre)

The effect of ambient and refrigerated storage conditions on changes in total soluble solid of Kiwi

concentrate (50°B) was studied and no significant changes in total soluble solid, titratable acidity, increase in brix-acid ratio were observed under both storage conditions. However, significant decrease in ascorbic acid content was found under both the storage conditions.

The maximum mean absorbance in non-enzymatic browning was recorded in pure-Bruno concentrate (0.21) under refrigerated conditions which was statistically lower than that (0.24) under ambient storage conditions.

Utilization of sand pear (*Pyrus pyrifolia* Linn.) for value addition (Solan centre)

The method for preparation of sand pear candy has been optimized. Cutting of fruits into cubes after peeling , blanching (3min at 85-90°C) and osmotic dehydration in 70° Brix sugar syrup containing 2000 ppm KMS gave better dried candy with good colour and appeal. Further work on the refinement is under progress.

Development of value added products from Mahua flowers (Udaipur centre)

Drying kinetics and their effect on biochemical characteristics of mahua flower samples were studied through experimentation by different types of dryers. Value added products such as Halwa and Syrup were prepared.

Post harvest technology for Aloe-vera (Udaipur centre)

A prototype aloe gel extraction machine was fabricated. Study on convective drying of gel is being undertaken.

ASSESSMENTS OF POST HARVEST LOSSES

Data collected by Enquiry and by Observation is being computerized at all the centres under AICRP on PHT using the Data Entry software provided by IASRI. This job has been completed by Anakapalle, Bhubaneswar, Coimbatore, Pantnagar and Raichur centres during the period under report. Verification of Data sent on CD by the Centres (viz. Anakapalle, Bhubaneswar, Coimbatore, Pantnagar and Raichur) is being carried out at PC Unit in Ludhiana.

QRT OF AICRP ON PHT

The Quinquennial Review Team (QRT) of All India Coordinated Research Project on Post Harvest Technology had its first meeting on March 13, 2008 at CIAE, Bhopal to review the progress of different centers in the Central Region. The meeting was held under the chairmanship of Dr. Satish Bal, Professor Emeritus, IIT Kharagpur. The other members of QRT were Dr. RK Jain, Principal, ADIT, Vallabvidyanagar, Dr. US Shivhare, Professor, Panjab University, Chandigarh, Dr. Ashish M Paturkar, Professor, Bombay Veterinary College, Mumbai and Mr. Pawan Agrawal, Director, Khyati Foods Ltd. Dr. D. Dhingra, Sr. Scientist, CIPHET, Ludhiana acted as the Secretary of QRT. Dr. SK Nanda, Project Co-ordinator of AICRP on PHT was also present during the meeting. Principal Investigators and Research Engineers of altogether 7 centres (viz. CIAE Bhopal, AMU Aligarh, NDUAT Faizabad, JNKVV Jabalpur, RS&JRS Kolhapur, GBPUAT Pantnagar and YSPUH&F Solan) presented the progress, salient achievements and constraints of their centers during 2002-2007 to the members of QRT.

The second meeting of this QRT was held at MPUA&T, Udaipur on 17 March 2008. Principal investigators and Research Engineers of altogether 8 centres (viz. MPUAT Udaipur, PDKV Akola, HAU Hisar, RAU Jaipur, CAZRI Jodhpur, JAU Junagadh, SKUAS&T Srinagar and PAU Ludhiana) presented the progress, salient achievements and constraints of their centers during 2002-2007 to the members of QRT (Fig. 63).

Release of publications by QRT at Udaipur (MPUAT) centre

COMPLETED ADHOC PROJECTS

Post harvest sugarcane quality under mechanical and manual harvesting

Effect of mechanical and manual harvesting of the sugarcane variety (Co 86032) on loss during staling was carried out by Vasantdada Sugar Institute, Pune at different sugar factories located in Pune, and Kolhapur districts of Maharastra state. The harvested cane billets were brought to the laboratory and loss in weight was studied. The cane juice was also analysed for brix, pol, commercial cane sugar percentage (CCS), purity, reducing sugars and titrable acidity number (TAN) percentage from 2 hours up to 72 hours after harvesting. A gradual rise in reducing sugars and loss in cane weight due to the staling of cane was observed up to 72 hours after harvest. Loss in cane weight was more in the mechanically harvested cane (16.25±0.4%) as compared to manually harvested cane (6.08±1.7%). Pol, CCS and purity % decreased due to staling in whole cane as well as in billets. Purity decreased by 13-15% after 72 hours of staling in both manually and mechanically harvested cane, the decrease being more in billets as compared to whole cane. Delay in transport of harvested cane from field to factory is a major contributing factor to the loss of recoverable sugar resulting in a low recovery. The study confirms that the mechanical harvesting hastens the loss of sugar and ultimately affects the sugar recovery during summer months. It is recommended that during late crushing season, the cane should be crushed within 24 hrs of mechanical harvesting.

Performance evaluation of modern small scale production technology of jaggery and development, evaluation and shelf life studies of some jaggery and khandsari based value added ready-to-eat/ serve products

A jaggery manufacturing unit was established in Aligarh Muslim University, Aligarh. The unit consisted of three pan furnace of IISR, three roller vertical cane crusher and other equipment recommended by various centres of AICRP. Modern small scale production technology of jaggery was evaluated. Time taken to produce first batch of jaggery was 2:30 hours and that of subsequent batches were 1:30 hours. The storage study of jaggery cubes and liquid jaggery in LDPE and PP bags revealed that the products could be stored safely up to nine months. Bottled liquid jaggery had very good keeping quality under refrigerated conditions for nine months of storage.

Roasted groundnut, roasted and dehusked bengal gram and roasted peas coated with 25 % and 35 % jaggery were prepared and found to have good consumer acceptance. These products could be stored safely in LDPE bags for six months under ambient conditions.

Mango RTS, papaya candies, petha candies, petha preserves, and aonla preserves were developed using various combinations of jaggery and white sugar. In mango RTS, papaya candies, and aonla preserves, the white sugar can be replaced up to 50 % and could be stored safely up to six months under ambient conditions when packed in LDPE bags, sealed jars and PET jars. In case of petha candies and petha preserves, the sugar could be replaced up to 40 % and these products could be stored up to two months under ambient conditions.

Jaggery based hard caramelized toffees

Jaggery based soft cocoa toffee

Jaggery based hard caramelized and soft cocoa toffees were prepared and jaggery and milk powder ratio of 4:1 was found best on the basis of sensory evaluation. Toffees, individually wrapped in metalized PP sheets and packed in LDPE bags exhibited good storability up to three months. Jaggery based biscuits prepared with 1:1 wheat to jaggery ratio were rated best in sensory evaluation

Development of technology for the production of soymilk and its analogs free from antinutrients

Presence of trypsin inhibitors and phytate was observed in samples prepared from raw soybean and commercial samples of soymilk and tofu by IIT, Delhi. The Sofit and Staeta (brand names) soymilk , soya flour, tofu and other soybean products were quantitatively analysed for the inhibition of Trypsin activity. Efforts were made to remove Soybean Trypsin Inhibitors (STI) by sonication combined with heat treatment, which was not very effective

(only 33% of STI was removed in 5 min). However, enzymatic treatment was found to be quite effective. For this purpose, trypsin was immobilized in the form of cross-linked enzyme aggregates (CLEA). Since the trypsin aggregates are insoluble, these can be reused after treatment of soy food samples. More than 85.5% STI could be eliminated in 6 h when soymilk was treated with these aggregates.

Soy foods and soy formulas were found to contain high levels of phytate, which is most likely to reduce bioavailability of various metals and essential minerals. Attempts were made in this study to hydrolyse the phytic acid by treatment with phytase enzyme extracted from soybean seeds. Trypsin and phytase were co-immobilized and packed into a column for continuous removal of TI and phytate from soymilk stream. Both antinutrients could be reduced to traces in 24h without affecting the quality of treated soymilk.

Development of process for manufacture of carrot juice, concentrate and puree/paste

Effect of 0.05 N acetic acid and 0.2 % calcium chloride solution at 80-100^{0}C blanching temperature and 0.5-10 min blanching time on inactivation of catalase and peroxidase in carrot was studied at Panjab University, Chandigarh. Inactivation time for peroxidase was higher than that of catalase. Maximum -carotene was observed in the carrots blanched at 95^{0}C for 5 min. Yield of juice and vitamin C content decreased after blanching. The optimum blanching treatment for carrot was observed to be 95^{0}C for 5 min. During thermal concentration under vacuum, vitamin C and carotene content decreased with increase in temperature and also with decrease in vacuum.

AICRP on Application of Plastics in Agriculture

RESEARCH ACHIEVEMENTS

The All India Coordinated Research Project on Application of Plastics in Agriculture is operative at the nine centres with its coordinating unit located at Central Institute of Post Harvest Engineering and Technology, Ludhiana.

Research Achievements

- Portable FRP Carp hatchery developed at CIFA, Bhubaneshwar was commercialized and efforts were made to popularize through installation at 38 locations including research organization, state fishery departments, NGOs and farmer's field throughout the country as well as in neighboring countries. The center is also working on development of portable FRP silos for intensive fish culture along with the demand fish feeder
- Rainwater harvesting or storage of low discharge spring based LDPE film lined ponds have been constructed in the farmer's field conditions by VPKAS, Almora in hills of Uttarakhand along with gravity fed drip irrigation system. Vegetable and fruit orchards are being irrigated using the stored water in hilly terraces.
- Low cost bamboo greenhouses have been constructed in the hills of Uttarankhand and Meghalaya in the farmer's field conditions, which is being used for off-season vegetables cultivation. Bamboo frame rainshelters have been constructed in which strawberry cultivation has been done successfully with higher yield and good quality fruits.
- In Srinagar, strawberry cultivation wsa successfully undertaken in the greenhouse, which yielded 2.5 times with 45 day early harvesting as compared to outside condition.
- A schedule for operation of different type of climate control units (e.g. no ventilation, natural ventilation, fan and pad system, with and without shadings) has been developed to maintain the optimum climate inside the polyhouse in hot humid climate of Saurashtra region of Gujarat.
- A greenhouse type fish dryer has been designed at the Junagadh center which is under evaluation in collaboration with a commercial fish-drying unit in Veraval.
- Efforts have been made to develop and standardize the packaging techniques for regional fruits to enhance the shelf life at Srinagar, Abohar, and Junagadh.
- Trials on plastic mulching including bio-degradable plastic film were undertaken at different locations, which indicated encouraging results. However, further evaluations are required to confirm the results.

LIST OF ON-GOING RESEARCH PROJECTS

Sl. No.	Project Name	Name of Project Leader & Associates
1.	Improvement in CAP (cover and plinth) storage of wheat to minimize grain tempering and quality loss	**Dr. D.S. Uppal (PI)** Er. (Ms) S.K.Aleksha Kudos (Co-PI) Dr. V. K. Bhargav (Co-PI) Dr. V.R. Bhagwat (Co-PI) Dr. Dilip Jain (Co-PI)
2.	Energy efficient pulse milling technology	**Dr. R.K. Goyal (PI)** Dr. O. D. Wanjari (Co-PI) Er. R. K. Vishwakarma (Co-PI) Er. M. R. Manikantan (Co-PI) Dr. Mridula Devi (Co-PI)
3.	Location model for agro processing plants in view of diversification of agriculture in Punjab	**Dr. D.K. Bharti (PI)** Dr. D. Dhingra (Co-PI) Dr. M.S. Meena (Co-PI) Dr. Ashwani Kumar (Co-PI)
4.	Development of processing technology for guava leather, intermediate moisture fruits and nutrient rich beverages	**Dr. Ramesh Kumar (PI)** Sh. Gautam Mandal (Co-PI) Er. Satya Vir Singh (Co-PI) Sh. M. P. Singh (Co-PI)
5.	Study on packaging of selected fruits and vegetables	**Dr. Ramesh Kumar (PI)** Dr. Rajbir Singh (Co-PI) Er. D.D. Nangare (Co-PI)
6.	Organic production of vegetable inside polyhouse	**Dr. Rajbir Singh (PI)** Er. D.D. Nangare (Co-PI) Er. Satendra Kumar (Co-PI) Sh. V.K. Saharan (Co-PI)
7.	Integrated processing of sunflower seed for quality oil obtaining edible grade meal and diversified uses of by-products. (TMOP)	**Dr. R.K. Gupta (PI)** Dr. O.D. Wanjari (Co-PI) Dr. S.K. Tyagi (Co-PI) Er. R.K. Vishwakarma (Co-PI) Er. M.R. Manikantan

Sl. No.	Project Name	Name of Project Leader& Associates
8.	Study the effect of irrigation with marginal quality water on quality and shelf life of selected fruits.	**Er. Satyender Kumar (PI)** Dr. R.R. Sharma (Co-PI) Er. D.D. Nangare (Co-PI) Er. V.K. Garg (Co-PI)
9.	Evaluation on lac-based can coating for internal coating of cans used for packing and handling of edible oils and fats.	**Dr. R.K. Gupta (PI)** Dr. P.C. Sarkar (ILRI Co-PI) Dr. S.K. Tyagi (Co-PI) Dr. R.K. Vishwakarma (Co-PI) Dr. O.D. Wanjari (Co-PI)
10.	Development of aonla processing plant.	**Dr. R.K. Goyal (PI)** Er. A.R.P. Kingsley (Co-PI)
11.	Development of integrated dryer for some medicinal and aromatic plant leaves.	**Dr. R.K. Goyal (PI)** Er. M.R. Manikantan (Co-PI) Dr. D.M. Kadam (Co-PI) Dr. O.D. Wanjari (Co-PI)
12.	Shelf life studies of fortified sattu.	**Dr. Mridula Devi (PI)** Dr. (Mrs.) Reeta Jain (Co-PI) Dr. O.D. Wanjari (Co-PI)
13.	Studies on processing of guar (*Cyamopsis tetragonoloba*) for production of guar gum.	**Er. R.K. Vishwakarma (PI)** Dr. S.K. Nanda (Co-PI) Dr. U.S. Shivhare (Co-PI)
14.	Evaluation of evaporative cooled room (ECR) for cultivation of mushrooms and their shelf life assessment. **(Collaborative project between CIPHET Ludhiana and PAU)**	**Dr. H.S. Oberoi (PI)** Dr. M.R. Manikantan (Co-PI) Dr. D.S. Uppal (Co-PI) Dr. S. Kapoor (Co-PI) Dr. P.K. Khanna (Co-PI PAU, Ludhiana)
15.	Optimization of fermentation parameters for bioethanol production using whey and vegetable wastes through genetically engineered microbial strains in a pilot scale fermenter.	**Dr. H.S. Oberoi (PI)** Dr. V. K. Bhargav (Co-PI) Dr. D. Dhingra (Co-PI) Dr. B.S. Chadha (Co-PI)
16.	Studies on package and storage of pomegranate fruit arils.	**Dr. D.B. Singh (PI)** Dr. R.K. Gupta (Co-PI)
17.	Optimisation of osmo-convective dehydration of banana and pineapple.	**Dr. Devinder Dhingra (PI)** Dr. D.M. Kadam (Co-PI) Dr. D.B. Singh (Co-PI)

Sl. No.	Project Name	Name of Project Leader& Associates
18.	Design, development and evaluation of banana hand cutter.	**Dr. D.M. Kadam (PI)** Dr. Davinder Dhingra (Co-PI)
19.	Effect of irrigations, fertigation levels and mulching on growth and yield of Bt cotton in semiarid region.	**Dr. Rajbir Singh (PI)** Dr. Satyendra Kumar (Co-PI)
20.	Evaluation of biodegradable plastic mulching on yield and quality of vegetables.	**Dr. Rajbir Singh (PI)** Er. D.D. Nangare (Co-PI) Dr. Satyendra Kumar (Co-PI)
21.	Studying the effects of coloured plastic mulches and shade nets on production & quality of pomegranate.	**Dr. D.B. Singh (PI)** Dr. Rajbir Singh (Co-PI)
22.	Vegetable production in naturally ventilated polyhouse.	**Dr. Rajbir Singh (PI)** Dr. Satyendra Kumar (Co-PI)
23.	Soil solarization for vegetable nursery production and its on-farm demonstration.	**Dr. Rajbir Singh (PI)**
24.	Dehydration of fruit slices in a tunnel dryer.	**Dr. R.K. Goyal (PI)** Er. A.R.P. Kingsly (Co-PI) Er. M.R. Manikantan (Co-PI) Dr. D.B. Singh (Co-PI)
25.	Optimization of parameters for production of cellulases, ethanol and feed supplements using paddy straw and kinnow pulp. **(Project funded under AMASS with NBAIM being co-ordinating centre)**	**Dr. H.S. Oberoi (PI)** Dr. V.K. Bhargav (Co-PI)
26.	Extrusion processing of fruits for development of novel value added products.	**Dr. R.K. Goyal (PI)** Dr. Mridula Devi (Co-PI) Dr. D.B. Singh (Co-PI)
26.	Production of Potato flour and starch and it's use for product diversification and value addition.	**Dr. Sanjeev Kumar Tyagi (PI)** Dr. Mridula Devi (Co-PI) Dr. Davinder Dhingra (Co-PI) Dr. Rajbir Singh (Co-PI)
28.	Powdering Technology for preservation and value addition of selected agricultural commodities	**Dr. S.K. Tyagi (PI)** Dr. Deepak Raj Rai (Co-PI) Dr. Rajbir Singh (Co-PI)

Sl. No.	Project Name	Name of Project Leader& Associates
29.	Evaluation of screw press mechanism for oil expelling as effect of process parameters for high value crops.	**Dr. Dilip Jain (PI)** Dr. S. Balasubramanian (Co-PI) Er. R. K. Vishwakarma (Co-PI) Prof. (PAU) (Co-PI)
30	Development of green chilli based value added product.	**Dr. Dilip Jain (PI)** Dr. Mridula Devi (Co-PI) Dr. R.K. Jangra (Co-PI) Dr. V.K. Bhargav
31.	Processing and utilization of beetroot and carrot for value addition in health foods.	**Dr. Mridula Devi (PI)** Dr. S.K. Tyagi (Co-PI) Dr. Dilip Jain (Co-PI) Dr. D.R. Rai (Co-PI)
32.	Design, development and evaluation of composite dhall mill.	**Dr. R.K.Goyal (PI)** Er. R.K. Vishwakarma (Co-PI) Dr. (Mrs) Mridula Devi (Co-PI)
33.	Evaluation of polymeric-film packaging for enhancing quality and shelf-life of apple	**Dr. A. K. Thakur (PI)** Dr. Ramesh Kumar (Co-PI) Mr. V.K. Saharan (Co-PI)
34.	Development of technology for health foods from legumes and millets using food extrusion system	**Dr. S. Balasubramanian (PI)** Dr. K.K. Singh (Co-PI)
35.	Development of post-harvest processing and machinery for makhana processing & value addition. *(Collaborative research project between CIPHET, Ludhiana & Research Centre for Makhana, Darbhanga {ICAR - RCER})*	**Dr. S.N. Jha (PI)** Dr. Janardan Jee (Co-PI) Dr. B.K. Jha (Co-PI)
36.	Development of a nondestructive technique for evaluation of quality of apple.	**Dr. S.N. Jha (PI)** Dr. D.R. Rai (Co-PI)
37.	Tenderization and instrumental quality evaluation of goat meat	**Dr. K. Narsaiah (PI)** Dr. S.N. Jha (Co-PI) Dr. D.B. Singh (Co-PI)
38.	Development of microencapsulator for immobilization of microorganisms and enzymes.	**Dr. K. Narsaiah (PI)** Dr. H.S. Oberoi (Co-PI)

Sl. No.	Project Name	Name of Project Leader& Associates
39.	Application of modified atmosphere packaging and storage of fresh vegetables	**Dr. Deepak Raj Rai (PI)** Dr. Shyam Narayan Jha (Co-PI)
40.	Identification and evaluation of appropriate packaging for minimal processing of selected fruits and vegetables	**Dr. Deepak Raj Rai (PI)** Dr. K. Narsaiah (Co-PI) Dr. D.K. Bharti (Co-PI)
41.	Production of amylases, proteases and pectinases using agricultural and horticultural residues as supplements.	**Dr. Harinder Singh Oberoi (PI)** Dr. K. Narsaiah (Co-PI) Dr. D. Dhingra (Co-PI) Dr. Jatinder Singh. (Co-PI)
42.	Post harvest management and value addition in coriander and cumin seed spices.	**Dr. V.K. Bhargav (PI)** Dr. R.K. Vishwakarma (Co-PI)
43.	Pelleting and singulating of selected seed spices.	**Dr. V.K. Bhargav (PI)**
44.	Post harvest quality maintenance of strawberry by *aloe vera* treatments.	**Dr. D.B. Singh (PI)** Dr. Rajbir Singh (Co-PI)
45.	Development of pomegranate aril extractor.	**Dr. A.K. Thakur (PI)** Dr. D.B. Singh (Co-PI) Dr. R.K.Gupta (Co-PI)
46.	Process development for production of quality raisin from Perlette grape	**Dr. A.K. Thakur (PI)** Sh.Vinod Saharan (Co-PI)
47.	Market access and constraints in marketing of R & D oriented new value added products in northern India. market intelligence study for new food processing technology and value added products **(The RPF- I was merged with earlier project and advised that the technical programme of this project should be merged with earlier project.)**	**Dr. D.K. Bharti (PI)** Dr. D. Dhingra (Co-PI) Dr. M.S. Meena (Co-PI) Dr. D.M. Kadam (Co-PI) **Dr. D.K. Bharti (PI)** Dr. D. Dhingra (Co-PI) Dr. D.R.Rai (Co-PI) Dr. D.M. Kadam (Co-PI)
48.	Video preparation on training opportunities at CIPHET, Ludhiana.	**Dr. M.S. Meena (PI)** Dr. D.S. Uppal (Co-PI)

Sl. No.	Project Name	Name of Project Leader& Associates
49.	Establishment of linkages and transfer of post-harvest technology through video conferencing.	**Dr. M.S. Meena (PI)** Dr. D.S. Uppal (Co-PI) Dr. Rajbir Singh (Co-PI) Sh. M.P. Singh (Co-PI)
50	Impact assessment of self-help groups.	**Dr. M.S. Meena (PI)** Sh. Vinod Saharan (Co-PI) Sh. M.P. Singh (Co-PI)
51.	Development of belt dryer for fruit slices.	**Dr. Davinder Dhingra (PI)** Dr. D. M. Kadam (Co-PI) Dr. D K Bharti (Co-PI)
52.	Development of value added health drink from soybean milk whey	**Dr. D. Dhingra (PI)** Dr. Mathew Prasad
53.	Design and development of foam mat dryer for selected liquid foods (tomato, mango, kinnow and pineapple).	**Dr. D.M. Kadam (PI)** Dr. Balasubramanian (Co-PI) Dr. K. Narsaiah (Co-PI)
54.	Development of millet mill to produce refined flour.	**Er. R.K. Vishwakarma (PI)** Dr. S.K. Nanda (Co-PI)

PAPER PUBLISHED IN JOURNALS

A K Thakur and A R P Kingsly (2007) Biosensor and electronic nose: Complement of human perception towards food-quality. *Indian Food Industry*, 26(2): 50-54

A K Thakur and Dinesh Singh (2007) Kinnow prasanskaran ke liye laghoo Udyog ki sampbhawnaien. *Krishi Prasanskaran Darpna* No. 2, 06-08.

A K Thakur and Sayavir Singh (2007) Gulab ke katein pushpin ka rakh-rakhav, bhandaran evam parivahan. *Prasaar Doot,* 11(2):41-43.

Archana Kushwaha and Dattatreya M. Kadam (2008). What all one needs to bake bread? *Processed Food Industry.*

Balasubramanian S (2007) Effect of extrusion process variables and legumes on corn extrudates behaviour. *Journal of Food Science and Technology* 44(3): 330-333

Balasubramanian S and Viswanathan R (2007) Properties of *idli* batter during its fermentation time. *Journal of Food Processing and Preservation,* 31: 32-40

Balasubramanian S and Viswanathan R (2007) Texture profile analysis of *idli* made from parboiled rice and decorticated black gram. *Journal of Food Science and Technology,* 44(5): 548-550

Balasubramanian S (2007) Studies on textural properties of selected fruit pulps and retexturised fruit bars. *Beverage and Food World.* India. 34(2): 67-69

Bansal S, Oberoi HS, Dhillon GS and Patil RT (2007) Production of galactosidase by luyveromyces marxianus MTCC 1388 using whey and effect of four different methods of enzyme extraction on galactosidase activity. Accepted (in press) with the *Indian Journal of Microbiology*.

Bargale PC and Patil RT (2007) Effect of oil recovery and oil point pressure of soybean under uniaxial pressing. *J of Food Sci Technol*, 44(5): 478-482

Bharti D.K. and Patil R.T. (2007) 'Performance of Food Processing Industry in Punjab : Opportunities and Challenges' in the referred Journal "Effective Management" of Ludhiana Management Association, Vol.24, No.1, Pp. 37-45, 2007.

Chopra S and Jain A (2007) "A Review of Fixed Bed Gasification Systems for Biomass". Agricultural *Engineering International: the CIGR journal*. Invited Overview No. 5. Vol. IX. April, 2007.

Dattatreya M Kadam, D V K Samuel, Pitam Chandra and H S Sikarwar (2008) Impact of processing treatments and packaging materials on some properties of stored dehydrated cauliflower. *International Journal of Food Science and Technology.* 43; 114doi:10.1111/j.1365-2621.2006.01372.x

Dhingra Devinder, Jasjit Singh, Patil RT Uppal DS (2008) Osmotic dehydration of fruits and vegetables: A review, *J Food Sci Technol* 43 (3): 209-217.

D Mridula, Goyal R K and Manikantan M R (2008) Effect of Roasting on Texture, Colour and Acceptability of Pearl Millet (Pennisetum glaucum) for Making Sattu. *International Journal of Agricultural Research,* 3(1):61-68.

D Mridula, Gupta R K and Manikantan M R (2007) Effect of incorporation of sorghum flour to wheat flour on quality of biscuits fortified with defatted soy flour. *American Journal of Food Technology* 2(5): 428-434.

Garg V K, Goyal R K, Kingsly A R P and Kumar Satyendra (2007) Design and development of castor depodder and decorticator. *J. of Agricultural Engineering* (under review)

Gangwar L S, Dinesh Singh and D B Singh (2007) Estimation of post harvest losses in kinnow mandarin in Punjab using modified formula. *Agricultural Economics Research Review*. July to September 2007: 315-331.

Goyal R K, Mujeeb O and Bhargava V K (2007) Mathematical modeling of thin layer drying kinetics of apple in tunnel dryer. *International Journal of Food Engineering* (under review).

Goyal R K and Kadam D M (2007) Drying Kinetics of Convective Thin Layer Drying of Basil Leaves. *International Journal of Food Engineering* (under review).

Goyal R K, Patil R T, Kingsly A R P, Walia H and Kumar P (2008) Status of Post harvest Technology of Aonla in India- A review. *American Journal of Food Technology* 3(1): 13-23.

Goyal R K, Vishwakarma R K and Wanjari O D (2007) Optimization of process parameters for dehulling of pigeonpea. *Biosystems Engineering*, 99 (2008): 56-61.

Goyal R K, Vishwakarma R K and O D Wanjari (2007) Effect of moisture content on pitting and milling outturn of pigeonpea grain. *Food and Bioprocess Technology* (under review).

Goyal R K, Kingsly A R P, Kumar P and Walia Himanshu (2008) Some physical and mechanical properties of aonla fruits. *Journal of Food Engineering* 82(4): 595-599.

Goyal R K and Vishwakarma R K (2007) Nami ki matra ka arhar dhal ki satah par khurchan (pitting) prabhav. *Krishi Prasanskaran Darpan,* January-June (2): 3-5.

Gupta R K, Alaka Sharma and Rajiv Sharma (2007) Textural profile analysis of sunflowersesame kernel confection (Chikki) *Journal of Texture Studies* 38 (1): 153-165.

Gupta R K, Alka Sharma and R Sharma (2007) Instrumental Texture Profile Analysis (TPA) of shelled sunflower seed caramel snack using Response Surface Methodology. *Food Science Technology International* 13(6): 455-460.

Jha S N (2007) Nondestructive determination of sweetness of orange juice using portable near infrared spectroscopy. *Journal of Agricultural Engineering*, 44(3): 10 -14.

Jha S N (2008) Development of a pilot scale evaporative cooled storage structure for fruits and vegetables in hot and dry region. *Journal of Food Science and Technology* 45(2): 148- 151.

Jha S N, Chopra S and Kingsly A R P (2005) On-farm nondestructive determination of maturity of intact mango. *Indian Journal of Horticulture* in press.

Kingsly A R P, Rajbir Singh, R K Goyal and D B Singh (2007) Thin Layer Drying Behaviour of Organically Produced Tomato. *American Journal of Food Technology*, 2 (2): 71-78.

Kumar Satyendra, Kumar A and Singh Rajbir (2007) Microirrigation for onion cultivation in a canal command area. *Journal of Agricultural Engineering*. 44(1):33-37.

Mandal G Kumar, S Kumar, R and Rajbir Singh (2007) Effect of drip irrigation and plant spacing on yield, quality and economic returns of guava (Psidium guajava L.) grown in saline soils. *Acta Horticulturae*. 735: 427-432.

Meena M S and Goyal R K (2007) Sanchar sadhano ka krishak samaj ke utthan mein yogdan. *Krishi Prasanskaran Darpan*, January-June (2): 10-12.

Mridula D and Goyal R K Manikantan M R (2008) Effect of Roasting on Texture, Colour and Acceptability of Pearl Millet For Making Sattu. *International Journal of Agricultural Research*, 3 (1): 61-68.

Mridula D and Gupta R K (2008) Effect of *Bajra flour on quality of biscuits fortified with defatted soy flour*. *The Indian Journal of Nutrition and Dietetics* 45(1): 17-25.

Mridula D, R K Gupta, and R K Vishwakarma (2008) Effect of method of preparation and storage on quality of microwave heated sunflower snack food. *Processed Food Industry* 11(5): 31-40.

Mridula D, R K Gupta and M R Manikanthan (2007) Effect of incorporation of sorghum flour to wheat flour on quality of biscuits fortified with defatted soy flour. *American Journal of Food Technology*: 2(5):428-434.

Mridula D and R K Gupta (2008) Effect of bajara flour on quality of biscuits fortified with defatted soy flour, *Indian Journal of Nutrition and Dietetics* 45(1):17-25.

Narsaiah K and Agarwal G P (2007) Transmission analysis in ultrafiltration of ternary protein mixture through a hydrophilic membrane. *Journal of Membrane Science*, 287: 9-18

Narsaiah K (2007) Environmental management in dairy processing plant. Indian Dairyman 59 (5): 43-46.

Patil R T and Jha S N (2007) Post-harvest Infrastructure -A key to post-harvest management and value addition an invited lead paper presented in 2nd Horticulture Congress held at ICAR Research Complex, Barapani, Meghalaya during 18-21 April.

Rai D R, Tyagi S K, Jha S N, Mohan S Qualitative changes in the broccoli (*Brassica oleracea italica)* under modified atmosphere packaging in perforated polymeric films. J Food Sci Technol, 45(3) (*in press*).

Rai D R, Masuda R, Saito M Effect of modified atmosphere packaging on amino acid content of oyster mushroom (*Pleurotus ostreatus*). *J Food Sci Technol*, 45(3) (*in press*).

Rai D R, Paul S (2007) Transient State In-pack Respiration Rates of Mushroom under Modified Atmosphere Packaging based on Enzyme Kinetics. *Biosystems Engg*, 98(3): 319-326.

Rai D R, Paul S Water vapour and headspace temperature predictions for button mushrooms (*Agaricus bisporus*) under modified atmosphere packaging. *J Food Sci Technol*, 45(3) (*in press*).

Rai D R, S Paul An empirical approach for assessment of safe storage period for button mushroom (Agaricus bisporus) based upon colour changes under modified atmosphere packaging. Paper no. 26-117, *J Food Process Preserv* (*in press*).

Rajbir Singh and Ram Asrey (2007) Cultivating strawberry the plasticulture way. *Indian Horticulture*. (2): 6-7.

S. Mangaraj and Dattatreya M. Kadam (2007). Design and Scale up of Food Extruder: Single Screw. *Processed Food Industry.* 10 (11): 32-41.

Rajbir Singh, Kumar S and Sharma R R (2007) Jal Shrankshan aaj ki jarorat (In Hindi). Kheti (July issue).

Rajvinder K Kang, Jain Rita and Mridula D (2008) Impact of indigenous fibre rich premix supplementation on blood glucose levels in diabetics. *American Journal of Food Technology* 3(1): 50-55.

Satyendra Kumar and Rajbir Singh (2007) Microirrigation produces bumper onion. SAIC Newsletter 17(1): 3-4.

Rajbir Singh, R R Sharma, S Kumar, R K Gupta and R T Patil (2008) Vermi-compost substitution influences growth, physiological disorder, fruit yield and quality of strawberry. Bioresourse Technology 99(4)(doi:10.1016/j.biortech.2008.03.034)

Rai D R, Brar S S, Paul S, Wanjari O D (2008) Effect of modified atmosphere packaging on physicochemical attributes of diced carrots. Paper presented at ICFOST , 2007 held at IIT, Kharagpur from 31st December 2007-2nd January,2008.

Rai D R, Brar S S, Paul S (2008) Chlorophyll retention in fresh-cut french beans (*Phaseolus vulgaris* L) by modified atmospheres. Paper presented at 42nd Annual convention and Symposium of Indian Society of Agricultural Engineers , held at Central Institute of Agricultural Engineering, Bhopal from 1-3 February, 2008.

Rai D R (2007) Mathematical modeling of modified atmosphere packaging of fruits and vegetables. Paper presented at National seminar on Application of Engineering Principles and Mathematical Modelling in Food Processing at CIPHET, Ludhiana on 7th August, 2007.

Rai D R (2008) Modified atmosphere packaging for vegetables. Paper presented at National seminar on "Environmental control for plants, animals and fisheries" held at Central Institute of Post Harvest Engineering and Technology, Ludhiana during 15-16 March, 2008.

Rai D R (2007) Atee sheegarha kharab hone wale khadaya padarathon ka parivartit vatavaran dwara sangrahan. *Krishi Prasanskaran Darpan*, July-Dec, 2007, (3): 6-8.

Rajbir Singh and R R Sharma (2007) Pre-harvest foliar application of calcium and boron influences physiological disorders, fruit yield and quality of strawberry. *Scientia Horticulturae*.112: 215-220.

Rajbir Singh and Ram Asrey (2007) Cultivating strawberry the plasticulture way. *Indian Horticulture*. (2): 6-7

Rajbir Singh and Ram Asrey (2007) Cultivating strawberry the plasticulture way. *Indian Horticulture* (2): 6-7.

Ram Asrey, Rajbir Singh, R.K. Jain and Anil Kumar (2008) Fruit maturity, transportation and storage study in strawberry. *Journal of Food Science and Technology* (In press)

R R Sharma, Rajbir Singh, D Singh and R K Gupta (2008) Interactive influence of row covers and mulching on leaf physiology, fruit yield and albinism incidence in Sweet Charlie Strawberry (Fragariaxananassa Duch), *Fruits* 63(2):103-110.

R R Sharma, Rajbir Singh, D Singh, R K Gupta (2008) Interactive influence of row covers and mulching on leaf physiology, fruit yield and albinism incidence in 'Sweet Charlie' strawberry (Fragaria x ananassa Duch.). *Fruits* 63(2): 103-110.

R. T. Patil, J. De J. Berrios, J. Tang, B. G. Swanson (2007) Evaluation of methods for expansion properties of legume extrudates, *Applied Engineering in Agriculture*, Vol. 23(6): 777-783

Satyendra Kumar, Imtiyaz M, Kumar A and Rajbir Singh (2007) Response of onion (Allium cepa L.) to different levels of irrigation water. *Agricultural Water Management* 89:161-166

Satyendra Kumar, Rajbir Singh, D D Nangare and M S Meena (2007) Economic feasibility of drip irrigation system for potato-onion cropping system in semi-arid region. *Journal of Farming Systems Research and Development* 14(2) 142-145.

Satyendra Kumar and Rajbir Singh (2007) Microirrigation produces bumper onion. *SAIC Newletter* 17(1): 3-4.

Sharma Rajiv, Alka and R K Gupta (2007) Ohmic Heating: A novel technique for Food Processing. *Beverage and Food World* 34(4): 22-24.

Singh D B and A R P Kingsly (2007) Regulation of bahar in pomegranate to control fruit cracking and improve the quality. *Indian Journal Agric. Sciences.* 77(10): 692-694.

Singh D B and R S Singh (2006) Diversity of Wild Pomegranate in Himachal Pradesh. *Progressive Horticulture.* 38(1): 49-52.

Singh D B, A R P Kingsly, H R Meena and Nirmaljit Kaur (2007) Studies on physico-chemical and nutritional properties of pomegranate rind powder. Indian *J. Hort. Sciences,* 64(2): 155-158.

Singh D B, A R P Kingsly and R T Patil (2007) Anardana- A Promising Spice. *Spice India* 20(3): 21-22.

Singh Dinesh and Thakur A K (2007) Tudai Uprant Kinnow ke Phalon ka Upchar evam Rakh Rakhav. *Krishi Darpan*, 2(6): 30-31.

Singh DB, Kingsly ARP and Patil, R. T. (2007) Anardana- a promising spice, Spice India, Vol XX No. 3 :21-22

Thakur A K and Gupta A K (2007) Fluidized bed drying of high moisture paddy in two stages, *Journal of Agricultural Engg.*, 44(3): 1-9

Thakur A K (2008) Studies on drying characteristics and physical quality evaluation of green peas. *J Food Sci Technol*, 45(2): 117-122.

संगीता चोपड़ा (2007) "सूक्ष्मरंध्र गुणवत्ता युक्त ईटों का विकास" कृषि प्रसंस्करण दर्पण अंक 3, पुष्ठः 8 – 9.

PAPER PRESENTED AND PUBLISHED IN PROCEEDING OF SEMINARS/CONFERENCES/WORKSHOP/SYMPOSIUM/SOUVENIR

Anandakumar S, Arumuganathan T, Balasubramanian S and S Shanmugasundaram (2007) 'Effects of pretreatments and drying methods of oyster mushroom (*pleurotus* spp.). National Conference on 'Prospects and Challenges in Food Processing. January 24-25, 2007, SRM University, Chennai.

Balasubramanian S and Singh N (2007) ' Protein enriched ready-to-eat corn balls'. 8th Agricultural Science Congress. National Academy of Agricultural Sciences (NARS) New Delhi and conducted at TamilNadu Agricultural University, Coimbatore-3. p:123-124.

Balasubramanian S (2007) Presented a lead paper on 'Recent trends in cereal based food products'. National Conference on 'Prospects and Challenges in Food Processing. SRM University. Chennai.

Bhargav Vinod K (2008) Development of portable poly house dryer for drying crops. A paper presented during National Seminar on Environmental control for plants, animals and fisheries 15-16 March 2008 at CIPHET Ludhiana.

Bhargav Vinod K, Wanjari O D and Patil R T (2008) Quality improvements in seed spices through post harvest management: A lead paper presented in National workshop on "spices and aromatic plants" from Feb 6-7 at ARS Mandor Jodhpur.

Bharti, D.K., Patil R.T., Dhingra, D. and Meena, M.S. (2007) 'Prospects and Performance of Food Processing Industry in Punjab' in the National Conference on Food and Nutritional Security : Food and Biotechnologies Interventions' SLIET, Longowal during 22-23 March, 2007 (Abstract).

Chatli MK, Siva Kumar S, Balasubramanian S and J Sahoo (2007) Comparative evaluation of texture and colour profile of high-fat and low-fat paneer incorporated with soy protein isolate as fat replacer-objective method' International conference on traditional dairy foods, 14-17 November, 2007. National Dairy Research Institute, Karnal. Haryana.

Chopra S, Wanjari O D, and Jha S N (2008) Theoretical considerations for improved structures for dairy cattle. Presented in National Seminar on Environmental Control for Plants, Animals and Fisheries during 15-16 March.

Chopra S, Wanjari O D, Jha S N and Vinya V S (2008) Theoretical considerations for improved structures for poultry. Presented in National Seminar on Environmental Control for Plants, Animals and Fisheries during 15 - 16 March.

Dattatreya M. Kadam, Scientist attended 11th Punjab Science Congress-2008 held at Thapar University, Patiala and presented a research paper entitled "Production of Dehydrated Onion (Allium cepa L) Using Low Cost Greenhouse Technology" in the Section A: Agriculture, Bioscience etc for "Young Scientist Award" between 7- 9 February 2008. Theme was "Science and Technology: Opportunity and Challenges".

Dattatreya M. Kadam, R T Patil and D Dhingra (2007) Design, Development and Evaluation of manually operated Banana-Hand Cutter" (poster presented). National Conference on "Food and Nutrition Security: Food and Biotechnological Interventions" Dept. of Food Technology, SLIET, Longowal on 22nd and 23rd March 2007.

Dattatreya M. Kadam, D. Dhingra and R. T. Patil (2007) Development, Evaluation and Demonstration of Manual Banana-comb/Hand Cutter" (poster presented) during National Conference on Banana held at NRC Banana, Trichy during 25 to 29 October, 2007.

Dattatreya M. Kadam, Devinder Dhingra, Mathew Prasad, R. T. Patil (2007) Studies on osmotic dehydration of banana slices" (paper presented) during National Conference on Banana held at NRC Banana, Trichy during 25 to 29 October, 2007.

Goyal R K and Kadam D M (2008) Thin layer drying of henna leaves. Presented during 42nd ISAE Annual convention held at CIAE Bhopal during February 2-4, 2008.

Goyal R K, Kingsly A R P, Kumar P and Walia H (2008) Foam mat drying of aonla pulp. Presented in 42nd ISAE Annual convention held at CIAE Bhopal during February 2-4, 2008.

Goyal R K, Kingsly A R P, Kumar P and Walia H (2008) Osmotic dehydration of aonla. Presented in 42nd ISAE Annual convention held at CIAE Bhopal during February 2-4, 2008.

Goyal R K and Kingsly A R P (2007) Osmotic dehydration of aonla (*Emblica offinalis* Gaertn). In Proceedings of 5th Asia-Pacific Drying Conference held at Hong Kong, China during august 13-15, 2007, 1048-1057.

Gupta RK and Singh DB (2007) Minor fruits and vegetables of Arid Region and their exploitation for Value added Products. Paper presented during National Workshop on Identification of Appropriate Primary Processing Technologies for Value Addition of Minor Forest Produce in Tribal Areas: A step in rural Development 5-6th Oct. 2007, organized by CIPHET, Ludhiana/Abohar & DST, N Delhi. Pp.35-38.

Jha S N (2007) Spectroscopic data modeling for food quality evaluation (Lead Paper). Presented in National Seminar on Application of Engineering Principles and Mathematical modeling in Food Processing held on 7th August, 2007 at CIPHET, Ludhiana.

Jha S N (2008) Modern pilot scale evaporative cooled storage structure for fruits and vegetables. Presented in National Seminar on Environmental Control for Plants, Animals and Fisheries during 15-16 March.

Jha S N and Rai D R (2008) Nondestructive prediction of sweetness of apple using colour modeling. Presented in 42nd ISAE convention held at CIAE, Bhopal during 1-3 February, 2008.

Kumar S, Singh D B, Patel V B, Singh Rajbir and Gupta R K (2008) Economic feasibility study of drip irrigation in canal irrigated arid eco-system for pomegranate. Paper presented during XLII ISAE Annual Convention and Symposium organised by ISAE at CIAE, Bhopal.

Kumar S, Singh D B, Singh Rajbir and Gupta R K (2008) An assessment of the impact of secondary reservior and drip irrigation technology in canal irrigated areas. Paper presented in 10th Indian Agricultural Scientists and Farmers Congress, 16-17 February, 2008 organised by Bioved Research and Communication Centre, Allahabad.

Mattos L M, Piffer E, Moretti C L and Singh Rajbir (2007) Physiological behaviour and quality attributes of fresh cut cucumber and onion salad mix. Paper presented in Latin American Symposium on Food Science at Sao Paulo, Brazil.

Mridula D, Rita Jain, K K Singh and O D Wanjari (2007) Effect of storage on physico-chemical quality and acceptability of bengal gram sattu. Paper presented in 39th National Conference of Nutrition Society of India, at National Institute of Nutrition, Hyderabad, 15-16 November 2007.

Narsaiah K (2008) Jet based systems for food processing and environmental control. In proceedings of National Seminar on "Environmental Control for Plants, Animals and Fisheries" CIPHET, Ludhiana, 15-16 March 2008.

Narsaiah K (2008) Microencapsulation of probiotic bacteria. In proceedings of National Seminar on "Food Biotechnology- Present Scenario", MCM DAV College for Women, Chandigarh, 30 January, 2008.

Narsaiah K and Oberoi H S (2007) Microencapsulation of probiotic microorganisms and food ingredients for functional foods. In proceedings of International Conference on Tradition Dairy Foods, NDRI, Karnal, 14-17 November, 2007.

Narsaiah K, Jha S N, Singh D B and Sahoo J (2008) Tenderization of goat meat using pomegranate seed powder and pomegranate rind powder. Presented in 42nd ISAE convention held at CIAE, Bhopal during 1-3 February, 2008.

Narsaiah K, Jha S N, Singh D B and Sahoo J (2008) Tenderization of goat meat using pomegranate seed powder and pomegranate rind powder. In proceedings of XLII Annual Convention and Symposium of Indian Society of Agricultural Engineers, CIAE, Bhopal, 01-03 February 2008.

Narsaiah K, SN Jha, DB Singh and J Sahoo (2008)Tenderization of goat meat using pomegranate seed powder and pomegranate rind powder. Paper presented during XLII ISAE Annual Convention and Symposium, organized by Indian Society of Agricultural Engineers, from 1-3 Feb. 2008 at CIAE, Bhopal.

Oberoi HS, Bansal S ,Dhillon GS and Patil RT (2007) Evaluating the potential of rice straw for production of cellulase and ethanol. Poster presented at International Conference on New Horizons in Biotechnology (NHBT 2007) at NIST, Trivandrum, India. November 26-29, 2007.

Patil R. T. and Chopra S (2008) 'Impact of Scientifically Designed and Controlled Environment Structures on Animal Comfort and Productivity' in the National Seminar on 'Environmental control for Plants, Animals and Fisheries' CIPHET, Ludhiana, 15-16 March 2008.

Patil RT and S Balasubramanian (2007) 'Modern processing technologies for sorghum products' 37th Annual Group meeting of AICRP. Maharana Pratap University of Agriculture and Technology, Udaipur.

Patil RT, Singh DB and Gupta RK (2008) Processing of Arid Horticultural Crops- Present Status and future Prospects. Lead Paper presented during Nat. Seminar on Opportunities and Challenges of Arid Horticulture for Nutrition and Livelihood. From 8-9 March, 2008 at CIAH, Bikaner.

Patil R. T. 2007 Soybean Growth and Sustainability through Food Uses, Proceedings of brain storming session on soy utilization, Soy Update Vol IV Issue VI: 22-24

Patil R. T. 2007 Status of Food Quality and Safety, in Course Manual of winter school on Non destructive and biosensing methods for food safety and quality assurance, Sept 6-26, 2007:3-6

Patil R. T. (2007) Changing trends in Food Processing "Role of engineering principles and mathematical modeling" Inaugural keynote lecture delivered during the National seminar on Application of Engineering Principles and Mathematical Modeling in Food Processing held at CIPHET on August 7, 2007.

Patil R.T. and S. Chopra (2008). Impact of Scientifically Designed and Controlled Environment Structures on Animal Comfort and Productivity, A Paper presented in National Seminar on Environmental Control for Plants, Animals and Fisheries during 15-16 March 2008 at CIPHET Ludhiana.

Patil RT and S Balasubramanian. (2007) 'Modern processing technologies for sorghum products' 37th Annual Group meeting of AICSIP. Maharana Pratap University of Agriculture and Technology, Udaipur.

Patil R. T. and Jha SN (2007). Post harvest infrastructure- a key to post harvest management and value addition- an invited paper presented in 2nd horticultural congress held at ICAR Research Complex Barapani, Meghalaya during April 18-21, 2007.

Ramesh Kumar, DD Nangare and RK Gupta (2008) Individual shrink wrap packaging for extending shelf life of Capsicum. Paper presented during National seminar on opportunities and changes of Arid Horticulture for Nutrition and Livelihood was held during 8-9 March 2008 at CIAH, Bikaner.

Rajbir Singh, Sharma R R, Kumar S and Gupta R K (2008) Foliar application of calcium and boron influence physiological disorders, fruit yield and quality of strawberry. Paper accepted for presentation in 6th International Symposium on Strawberry to be held at Hueleu in France.

Rita Jain, Amandeep Kaur and Mridula D (2007) Nutritional profile and energy balance of heavy workers engaged in moulding of bricks in brick kiln industry. Paper presented in 39th National Conference of Nutrition Society of India, at National Institute of Nutrition, Hyderabad, 15-16 November 2007.

R.K. Vishwakarma, S.K. Nanda, U.S. Shivhare and R.T. Patil. (2007) Processing of guar (*Cyamopsis tetragonoloba*) in India and its applications. Paper presented in National Seminar on "Value added products of Commercial Importance from Natural Resins and Gums" held at Indian Institute of Natural Resins and Gums, Namkum, Ranchi during September 20-21, 2007.

RT Patil and HS Oberoi 2007. Bioprocessing technologies for crop residue management in winter school compendium on "Bioprocessing technologies in utilization of crop residues for production of enzymes and bio-fuels" organized at CIPHET from October 16- Nov 5, 2007.

RT Patil (2008) Role of post harvest engineering and technology in meeting the food and nutritional security of the nation a key note lecture in ICFOST 2007 at IIT Kharagpur on Jan 1, 2008.

Satyendra Kumar, D.B. Singh, VB Patel, R Singh and RK Gupta (2008) Economic feasibility study of drip irrigation in canal irrigated arid eco-system for pomegranate. Paper presented during XLII ISAE Annual Convention and Syposium organized by ISAE during 1-3Feb 2008 at CIAE, Bhopal

Satyendra Kumar, DB Singh, RK Gupta and R Singh (2008) An assessment of the impact of secondary reservoir and drip irrigation technique in the canal irrigation area. Paper presented in 10th Agricultural Scientists and Farmers Congress was held during 16-17th February, 2008 at BRCC, Allahabad.

Satyendra Kumar, D B Singh, VB Patel, R Singh RK Gupta (2008) Economic feasibility study of drip irrigation in canal irrigated arid eco-system for pomegranate. Paper presented during XLII ISAE Annual Convention and Symposium, organized by Indian Society of Agricultural Engineers, from 1-3 Feb. 2008 at CIAE, Bhopal.

Satyendra Kumar, DB Singh, RK Gupta and R Singh (2008) An assessment of the impact of secondary reservoir and drip irrigation technique in the canal irrigation area. Paper presented in 10th Indian Agricultural Scientists and Farmers congress, 6-17th Feb. 2008. Organized by Bioved Research and communication center Allahabad. Pp 3.

S Balasubramanaian, Kuldeep Kumar , KK Singh and RT Patil (2008) Extrusion Cooking Characteristics of Selected Cereals-Legumes Blends to Produce RTEBCs A paper presented in the seminar on recent Advances in Bioengineering at SRM University, Kattankulathur, Tamil Nadu Feb 7-9, 2008.

Singh DB and RK Gupta (2008) Post harvest technology management in pomegranate. Paper presented during State Level Seminar on prospects of quality pomegranate production and marketing in Karnataka during 26-28th February was held at UAS, Dharwad.

Singh DB, ARP Kingsly, HR Meena and RK Gupta (2008) Screening of Ber cultivars for processing and value added products. Paper presented during National seminar on opportunities and changes of Arid Horticulture for Nutrition and Livelihood was held during 8-9 March 2008 at CIAH, Bikaner

Singh DB and ARP Kingsly (2007) Effect of Convective Drying on Quality of Anardana. Paper presented during "Indian Horticulture Congress 2007" from 18-21st April. 2007, organized by The Horticultural Society of India held at ICAR, Research Complex Barapani, Shillong. p: 287.

Singh DB (2007) Suitable Indian Crop Products for High Pressure Processing. Paper presented during Workshop on "Application of High Pressure in Food Processing" on 21st June 2007, at CIPHET, Abohar.

Singh DB and BL Attri (2007) Studies on Nutritional Potential and Value Addition of Untapped wild fruits of Andaman Nicobar Islands. Paper presented during National Workshop on Identification of Appropriate Primary Processing Technologies for Value Addition of Minor Forest Produce in Tribal Areas: A step in rural Development 5-6th Oct. 2007, organized by CIPHET, Ludhiana/Abohar & DST, N Delhi. Pp.35-38. pp 29-33.

Singh DB, ARP Kingsly, HR Meena and RK Gupta (2008) Screening of Ber Cultivars for Processing and Value Added Products. Paper presented during Nat. Seminar on "Opportunities and Challenges of Arid Horticulture for Nutrition and Livelihood. From 8-9 March, 2008 at CIAH, Bikaner.

Singh DB and RK Gupta (2008) Post Harvest Technology Management in Pomegranate. Paper presented during State Level Seminar on "Prospects of Quality Pomegranate Production and Marketing in Karnataka, from 26-28 th Feb. 2008. held at UAS, Dharwad.

Thakur AK and RK Gupta (2008) Drying characteristics of perlette grapes under different physical treatment for raisin making. Paper presented in 42nd ISAE annual convention and symposium held at CIAE, Bhopal during 1-3 February 2008.

Thakur AK, Saharan VK and RK Gupta (2008) Value added processed products from Perlette grapes. Paper presented during National seminar on opportunities and changes of Arid Horticulture for Nutrition and Livelihood was held during 8-9 March 2008 at CIAH, Bikaner

Thakur A K and Gupta R K (2008) Drying characteristics of 'Perlette' grape under different physical treatment for raisin making. Presented at the 42nd ISAE annual convention and symposium, Central Institute of Agricultural Engineering, Bhopal, 1-3 February, 2008.

Thakur A K, Saharan V K and Gupta R K (2008) Value added processed products from 'Perlette' grape. Presented at National seminar on Opportunities and Challenges of Arid Horticulture for Nutrition and Livelihood, Central Institute of Arid Horticulture, Bikaner, 8-9 March, 2008.

Tyagi SK, Oberoi HS and Patil RT (2007) Effect of enzymatic treatment in enhancing oil recovery from mustard seeds (Brassica juncea L), Paper presented at a National Conference on Food and Nutritional Security (FNS 2007) held at SLIET, Longowal, India

Viswanathan R, Shinoj Subramanian, Satish Kumar TA, Wilson S and Balasubramanian S (2008) 'Value addition of minor millets' in the Grain Tech 2008-National seminar on empowering grain processing sector through recent technological interventions' 25-26 January 2008, organized by Ministry of Food Processing industries, GOI, New Delhi and Paddy Processing Research Centre (PPRC), Thanjavur.

TECHNICAL BULLETIN/BOOK CHAPTER

Chopra Sangeeta, AK Jain, PK Gupta, AK Singh, P Singh, RK Jindal (2008) 'Liquid fuel production from biomass'. Training manual on Non Conventional Energy technologies. Training Unit. COAE, PAU, Ludhiana, pp 66-73.

D Mridula and OD Wanjari. Value Addition in Bakery Products. Technical Bulletin No. CIPHET / Pub./ 05/ 2006. Central Institute of Post harvest Engineering and Technology (ICAR), Ludhiana. Satyendra Kumar, Rajbir Singh, P.R. Bhatanagar R.K. Gupta and DD Nangare. 2008. Micro-irrigation in conjunction with service reservoir in canal command. Technical Bulletin (3/2008 AICRP on APA, CIPHET, Abohar)

Goyal RK and Vishwakarma RK (2007) Nami ki matra ka arhar dhal ki satah par khurchan (pitting) prabhav. Krishi Prasanskaran Darpan, January-June (2): 3-5.

Jha S N, Kudos SKA, Jain D and Chopra S (2007) Construction, operation and maintenance of CIPHET Evaporative Cooled Storage Structure. CIPHET, Ludhiana. Technical bulletin no. CIPHET/pub/01/2007.

Jha SN and Rai D R (2008) Colour and spectroscopy methods for nondestructive evaluation of quality of apple. CIPHET Technical bulletin no. CIPHET/pub/01/2008.

Jha S N and Narsaiah K (2007) Winter school manual on Nondestructive and biosensing methods for food safety and quality assurance. Central Institute of Post-harvest Engineering and Technology (CIPHET), Ludhiana.

Kumar S, Singh Rajbir, Bhatnagar PR, Gupta RK and Nangare DD (2008) Microirrigation in Conjunction with Service Reservoir in Canal Command. Technical bulletin (APA/Pub/03/2008), CIPHET, Abohar

Processing Technologies for Value Addition of Minor Forest Produce in Tribal Areas: A Step in Rural Development (Edited by R K Gupta and RT Patil)-In press

Rai D R, Jha S N and Wanjari O D (2007) Post-harvest handling and packaging of Okra. CIPHET Technical bulletin no. CIPHET/pub/02/2007.

Rai DR (2008) Minimal processing and packaging of horticultural crops. In: Post Harvest management of Horticultural Crops. Delhi Agri-Horticultural Society, New Delhi. p 74-78.

Meena MS and Goyal RK (2007) Sanchar sadhano ka krishak samaj ke utthan mein yogdan. Krishi Prasanskaran Darpan, January-June (2): 10-12.

Rajbir Singh, Kumar S and Sharma RR (2007) Jal Shrankshan aaj ki jarorat (In Hindi). Kheti (July issue).

Singh Rajbir, Kumar S and Wanjari OD (2007) Bemausmi sabjiyon ke liye kam lagat ka polyhouse. Technical bulletin (03/07APA), CIPHET, Abohar.

Satyendra Kumar and Rajbir Singh (2007) Microirrigation produces bumper onion. SAIC Newletter 17(1): 3-4.

Singh DB, ARP Kingsly, RK Gupta and RT Patil (2008) Value added products of pomegranate, CIPHET, Abohar (In press)

PARTICIPATION IN CONFERENCES/SEMINARS/WORKSHOPS AND TRAINING

Sr. No.	Name	Participation	Duration
Scientific Staff			
1.	Dr. R.T. Patil, Dr. S.K. Nanda, Dr. D.B. Singh, Dr. Ramesh Kumar	Participated in Second Indian Horticulture Congress held at ICAR Research Complex for NEH Region, Barapani (Meghalaya)	18.04.2007 to 21.04.2008
2.	Dr. H.S. Oberoi	Participated in a Training/ Workshop on Biosafety issues and web Research in GMOs at NRCPB, New Delhi.	23.04.2007 to 25.04.2007
3.	Dr. Matthew Parsad	Participated in a Workshop on "Intellectual Property Management and Technology Transfer" held at Goa.	19.05.2007 to 22.05.2007
4.	Dr. R.T. Patil	International Conference on Agribusiness and Food Industries in Developing Countries: Opportunities & Challenges at IIM, Lucknow.	10.08.2007 to 12.08.2007
5.	Dr. K.K. Singh	Management Development Programme in Agricultural Research at NAARM, Hyderabad.	24.08.2007 to 30.08.2007
6.	Dr. (Mrs.) Mridula	Participated in National Residential Functional Workshop on Official Languages Organized by Institute of Public Administration, Mysore.	31.08.2007 to 01.09.2007
7.	Dr. S. Balasubramanian	Winter School Entitled "Nondestructive and Biosensing Methods for Food Safety and Quality Assurance" at CIPHET, Ludhiana.	06.09.2007 to 26.09.2007
8.	Dr. R.T.Patil	Executive Development Programme in Agricultural Research Management at NAARM, Hyderabad.	18.09.2007 to 21.09.2007
9.	Dr. V.K. Bhargav	Networking Essentials for Information Management in Agriculture at NAARM, Hyderabad.	16.10.2007 to 25.10.2007
10.	Dr. D.M. Kadam	National Conference on Banana-2007 at NRC for Banana, Trichy.	25.10.2007 to 28.10.2007

Sr. No.	Name	Participation	Duration
11.	Dr. K. Narsaiah	International Conference on Tradition Dairy Foods at NDRI, Karnal.	14.11.2007 to 17.11.2007
12.	Dr. (Mrs.) Mridula Devi	XXXIX National Conference of NSI at National Institute of Nutrition, Hyderabad.	15.11.2007 to 16.11.2007
13.	Dr. D.M. Kadam	Short Course on Food Laws and Standards : Changing Scenario & safety of Consumers at PAU, Ludhiana.	10.12.2007 to 19.12.2007
14.	Dr. H.S. Oberoi	International Conference on New Horizons in Biotechnology (NHBT-2007) at NIST, Trivandrum	26.11.2007 to 29.11.2007
15.	Dr. D.M. Kadam	Participation In Bhartia Vigyan Samelan-2007 organized by MP Council of Science & Technology, Bhopal.	23.11.2007 to 25.11.2007
16	Dr. Dilip Jain	Attended XXI National Convention of Agricultural Engineers (NCAE2008) at Udiapur.	18.01.2008 to 20.01.2008
17.	Dr. H.S. Oberoi	Participated in National Symposium-cum-Exhibition on Bio-Venture 2007.	28.01.2008 to 29.01.2008
18.	Dr. R.T. Patil Dr. R.K. Goyal Dr. S.N. Jha Dr. Dilip Jain Dr. K.Narsaiah Dr. D.R. Rai Dr. Satyendra Kumar	Participated in 42nd ISAE Annual convention at CIAE, Bhopal.	01.02.2008 to 03.02.2008
19.	Dr. V.K Bhargav	Attended National Workshop an Spices and Aromatic Plants, at Agricultural Research Station, Mandor, Jodhpur	06.02.2008 to 07.02.2008

Sr. No.	Name	Participation	Duration
20.	Dr. S.Balasubramanian	Attended National Conference on Recent Advances in Bioengineering at SRM University, Chennai.	07.02.2008 to 09.02.2008
21.	Dr. D.M. Kadam	Participated in 11th Punjab Science Congress at Thapar University, Patiala.	07.02.2008 to 09.02.2008
22.	Dr. R.T. Patil Dr.R.K. Gupta Dr. (Mrs.) Mridula Devi Dr. Satyendra Kumar	Attended the 10th Indian Agricultural Scientists and Farmers' Congress held at	16.02.2008 to 17.02.2008
23.	Dr. A.K. Thakur	Participated in Short Course training on "Mechanization of Cultivation of Horticultural Crops" held at IIHR, Bangalore.	18.02.2008 to 27.02.2008
24	Dr. R.T. Patil Dr. D.B. Singh Dr. Ramesh Kumar Dr. A.K. Thakur	Participated in National Seminar on opportunity and challenges in Arid Horticulture for Nutrition and Livehood held at CIAH, Bikaner, Rajasthan.	07.03.2008 to 08.03.2008
25.	Dr. S.N. Jha	Attended Workshop on Policy and Prioritization, Monitoring and Evaluation (PME) Support to National Agricultural Innovation Project at NAARM, Hyderabad.	11.03.2008 to 17.03.2008
26.	Dr. R.T. Patil Dr. Dilip Jain Dr. D.R. Rai Dr. D. Dhingra Dr.K.Narsaiah Dr. (Mrs) Sangeeta Chopra Dr. (Mrs.) Mridula Devi Dr. S.Balasubramanium Dr. H.S. Oberoi Dr. V.K Bhargav	National Seminar on "Environmental Control for Plants, Animals and Fisheries" at CIPHET, Ludhiana	15.03.2008 to 16.03.2008

Sr. No.	Name	Participation	Duration
27.	S Balasubramanian	Participated in the winter school entitled 'Nondestructive and biosensing methods for food safety and quality assurance' at Central Institute of Post Harvest Engineering and Technology, Ludhiana, India.	06.09.2007 to 26.09.2007
27.	S Balasubramanian	Participated in a one day seminar on 'Texture Analysis and viscosity measurement of food and agricultural products' Chandigarh, organized by Scientific Digital Systems, New Delhi and Punjab Biotechnology Incubator, Chandigarh.	28.02.2008
28.	SK Nanda & Matthew Prasad	Participated in Graduate Course and workshop on "Intellectual Property Management and Technology Transfer" orgainzed at Goa by STEM	19-05-2007 to 22-05-2007
29.	Matthew Prasad	Participated in two days Training program on Warehousing (Development and Regulation) Bill 2007 organized by Central Warehousing Corporation.	21-08-2007 to 22-08-2007
30.	Matthew Prasad	Participated in the National Workshop on Identification of Appropriate Primary Processing Technologies for Value Addition of Minor Forest Produces in Tribal Areas : A Step in Rural Development, at Central Institute of Post Harvest Technology, Ludhiana.	05-10-2007 to 06-10-2007
31.	Matthew Prasad	Participated as Expert in a State Level Seminar on "Cold Chain Development and Post-harvest Management in Horticultural Crops" at Patna organized by Directorate of Horticulture, Govt. of Bihar	24-11-2007
32.	Matthew Prasad & M P Singh	Participated in one day seminar on "Sorting, Storage & Preservation of Fruits & Vegetables organized by Food & Nutrition Board CF & NE unit	30-11-2007
33.	Matthew Prasad	Participated in National Seminar on Environmental Control for Plants, Animals and Fisheries held at CIPHET Ludhiana	15-03-2008 to 16-03-2008
34.	Matthew Prasad RT Patil SK Nanda	Participated in one day Workshop on Entrepreneurship Development in Modern Food Processing Technology organized by CIPHET in collaboration with MSME (GoI) and Thapar University at Patiala	25-03-2008

Sr. No.	Name	Participation	Duration
Training Abroad			
1.	Dr. Rajbir Singh	Study/Training of Indian Scientists to Brazil under the Work Plan between ICAR and EMBRAPA, Brazil (2007-2008)	16.07.2007 to 20.07.2007
Administrative Staff			
1.	Sh. B.C. Katoch, Asstt.	गहन हिन्दी प्रशिक्षण एवं कार्यशाला, नार्म, हैदराबाद में भाग लिया।	17.07.2007 to 21.07.2007
2.	Sh. Gurdial Singh, UDC	गहन हिन्दी प्रशिक्षण एवं कार्यशाला, नार्म, हैदराबाद में भाग लिया।	17.07.2007 to 21.07.2007
3.	Sh. Harbhupinder Singh, UDC	गहन हिन्दी प्रशिक्षण एवं कार्यशाला, नार्म, हैदराबाद में भाग लिया।	17.07.2007 to 21.07.2007
4.	Sh. Tej Ram, AO	One day Seminar on Records Management held at Govt. Museum and Art Gallery, Chandigarh	03.08.2007
5.	Sh. Ajay Kumar Tandon, LDC	Attended 26th Annual meeting of CJSC at NAARM, Hyderabad.	13.09.2007 to 16.09.2007
6.	Sh. J.S. Paul, AAO	Participated in Training for Nodal Officer/Data Enterer of Intelligent Reporting System at IASRI, New Delhi.	10.09.2007 to 11.09.2007
7.	Sh. J.S. Paul, AAO	राजभाषा कार्यान्वयन में राजभाषा अधिकारियों की समस्याओं पर कार्याशाला, नार्म हैदराबाद में भाग लिया।	04.12.2007 to 06.12.2007
8.	Sh. Avtar Singh, UDC	राजभाषा कार्यान्वयन में राजभाषा अधिकारियों की समस्याओं पर कार्याशाला, नार्म हैदराबाद में भाग लिया।	04.12.2007 to 06.12.2007
9.	Sh. Ashwani Kumar, LDC	Training to learn Pay Roll package/software for ICAR Research Institutes at NAARM, Hyderabad.	04.12.2007 to 06.12.2007
10.	i) Sh. Vijay Kumar, AF&AO ii) Sh. Kunwar Singh, UDC	Training/ Workshop for Consortia Partners entitled" To familiarize with procurement procedures of the World Bank at NASC Complex, New Delhi.	12.03.2008 to 13.03.2008
Technical Staff			
1.	Sh. Vishal Kumar, T-2	Participated in Training for Nodal Officer/Data Enterer of Intelligent Reporting System at IASRI, New Delhi.	10.09.2007 to 11.09.2007

INSTITUTE ACTIVITIES

Institute Research Council Meeting

The Institute Research Council (IRC) Meeting was held on August 03 - 05, 2007 at CIPHET, Ludhiana. The completed projects (RPF-III), ongoing projects (RPF-II) and new research project proposals (RPF-I) were discussed under the Chairmanship of the Director. All the scientists, technical officers and research associates participated:

The IRC meeting began with welcome address of Dr. R.K. Goyal Principal Scientist and Member Secretary, IRC. He welcomed the Chairman, IRC mentioning that the vast experience of Chairman in the Post Harvest Sector would benefit the scientists of the Institute in sharpening their research projects. He further added that the new initiative taken by him would definitely increase visibility of the institute. He also welcomed Dr. Oladiram Fasina, Associate Professor, Food Engineering, Aubum University Aubum, USA who was in the Institute as consultant under AKI program.

Dr. Fasina presented a talk on How to prepare winning research proposal for research funding. He discussed various characteristics of winning proposal and stressed that objective should be clear and there should be not any typographical errors as these errors decrease the quality of research proposal. So researchers should always keep in mind the format of funding agency and stick to number of word, style, font, size, etc under different needs. This helps in evaluating the proposal using single yardstick objectively.

Dr. R.T. Patil, Director and Chairman, IRC welcomed all scientists, technical officers and Dr. Fasina before making his remarks. He informed the house that such meetings refine the research programme and provide an opportunity for midway corrections in technical program if any, hence the technical programme should be very clear. He said that scientists should identify clients for adoption of results in their area of work right from the beginning. At present the market intelligence is an important tool to assess the scope of particular technology in the market hence, it should become integral part of each research project. He added that the authorship in any publication should be maintained as per the work. There are large number of scientists working in the field of applied research in PHT and publishing their work in various journals, we should make use of these publication and make a regular habit of visiting library. He advised that scientist should discuss their work at divisional level atleast once in a month. He further reiterated that institute has been publishing e newsletter regularly and receiving appreciation from all corners of the globe. Hence, all the scientists should submit salient information related to their project work, event conducted, participation in seminar/ workshop etc to RCMU so that its timely publication is ensured. He added that while presenting the RPF I, scientists should come forwarded with quality research proposals with comprehensive review of work & focused technical

CIPHET Management Committee Meeting

The meeting of the IMC of this Institute was held on 23.06.2007 under the Chairmanship of Dr. R.T. Patil, Director, CIPHET, Ludhiana. At the outset, the Director & Chairman warmly welcomed the members in his chamber and from there took them to the Institute facilities.

The Director & Chairman, IMC before presentation introduced all PCs and HODs recently joined this Institute to the members of the IMC. The Director & Chairman, IMC presented the progress of activities undertaken during the last financial year 2006-2007 and apprised the members about ongoing projects and the salient achievements made by the institute at CIPHET, Ludhiana & Abohar. The Director informed the IMC members that the Institute has FG&OP, AS&EC and TOT Divisions at Ludhiana. The Director has also informed the IMC members regarding MOU signed with different SAUs and Research Institutes in the Country. He also presented the topics of the on going projects - 2006-2007 achievements such as low cast extruder, lotus seed decorticator developed at CIPHET, Abohar, low cost seed spices crop dryer, single feed multi abrasion dhal mill, 30 ltrs. fermentation, Pilot Plant at CIPHET, Ludhiana, Modern rice mill, banana comb cutter, awarded model of kinnow processing, anola beverage toffee multi grain biscuits, Novel technology for refined sorghum, dehulling guar gum seeds, dehulling of millets & coarse grains, value added products from green chili, soybean milk powder, pomegranate value added products, solution to pomegranate cracking is semi-arid regions and ber value added products. He further informed regarding letter of intents, awareness camp conducted by CIPHET and cyber connectivity promotion details. He also presented the information on budget utilization, trainings undertaken as well as imparted by institute staff, participation in different meetings and publications. Members appreciated the efforts made and actions undertaken by the institute.

The following members of IMC participated in the meeting:-

1. Dr. R. T. Patil, Director, CIPHET, Ludhiana - Chairman
2. Dr. Pitam Chandra, ADG(PE) - Member
3. Dr. D. V. K. Samuel, Head & Professor - Member
4. Dr. D. Nag, Principal Scientist - Member
5. Dr. B. S. Modi, Principal Scientist (AS&PE)- Member
6. Sh. Tej Ram, Administrative Officer, CIPHET, Ludhiana - Member Secretary

Special Invitees:

1. Dr. S. K. Nanda, PC (PHT), CIPHET, Ludhiana
2. Dr. R. K. Gupta, Head, HCP, CIPHET, Abohar.
3. Dr. O.D. Wanjari, Head, AS&EC, CIPHET, Ludhiana
4. Dr. K. K. Singh, Head, FG&OP, CIPHET, Ludhiana
5. Dr. Matthew Prasad, Head, TOT, CIPHET, Ludhiana
6. Dr. P. R. Bhatnagar, PC(APA), CIPHET, Ludhiana
7. Sh. Vijay Kumar, AF&AO, CIPHET, Ludhiana

The review of ongoing activities including R&D of CIPHET was conducted in this meeting along with important decisions related to infrastructure and facilities development at the institute as felt fit collectively by the honorable members of the management committee.

Enttreprencurship Development Programmes

An entrepreneurship development programme on modified atmosphere packaging (MAP) of fresh and minimally processed vegetables was held at CIPHET, Ludhiana during July 24-30, 2007. Two participants from the KVKs of Tamilnadu Agricultural University, Coimbatore and one from farmer's organisation at Nasik, Maharashtra attended the programme. The participants were exposed to the MAP technology through lectures on harvesting, pre-cooling, on-farm storage, assessment of respiration rates of fresh and minimally processed vegetables, assessment of gas permeability of packaging films, instrumentation, qualitative analysis, design of MAP, minimal processing, hands-on practicals and visit to the commercial users of this technology.

Entrepreneurship Development Programme on packaging and storage of vegetables at CIPHET, Ludhiana

Entrepreneurship Development Programme on "Vermicompost Technology" was conducted at CIPHET, Abohar from 4-10 February 2008. Dr. Rajbir Singh Senior Scientist was the Coordinator and Dr. R.K. Gupta, Head, Horticultural Crop Processing Division was Co-coordinator for this programme. A physically challenged young man Sh. Kamljit Singh from Ludhiana attended the programme. He was exposed to different methods of compost preparation, methods of vermiculture and different ways of vermicompost preparation. He was also trained to develop small vermicompost unit with earning of Rs. 7000/- per month which can be strengthened further.

Production and processing of pomegranate for value addition during 5-11 September 2007, at CIPHET, Abohar (Dr. D.B. Singh was Training Coordinator)

Processing of guava for manufacturing of value added products during December 10-16, 2007 (Dr. Ramesh Kumar was Training Coordinator)

Grading and shrink packaging of fruits and vegetables for urban market during December 12-18, 2007 (Dr. R.K. Gupta was Training Coordinator and Dr. Ramesh Kumar was Co-Coordinator).

EDP on Food Processing was organized during 24 July to 21 August 2007 in collaboration with North India Technical Consultancy Organization Limited (NITCON), Chandigarh and CIPHET, Abohar.

EDP on Food Processing for Women organized during 19 November to 15 December 2007 in collaboration with North India Technical Consultancy Organization Limited (NITCON), Chandigarh and CIPHET, Abohar.

Technology based EDP on Food Products for Science and Technology Persons during 19 February to 31 March 2008 in collaboration with collaboration with North India Technical Consultancy Organization Limited (NITCON), Chandigarh and CIPHET, Abohar.

EDP on Processing of Onion, Ginger and Garlic into Value Added Products

The annual production of onion, ginger & garlic in India during the year 2005 was 5.5, 0.23 and 0.5 million metric tonnes respectively. These crops are invariably added in most of our traditional cuisines. Apart from their aroma and taste, these crops are also known for their medicinal properties. These crops undergo qualitative and quantitative losses during storage. For want of knowledge about the commercial level processing these crops are sold in the raw form after prolonged storage and hence there

are losses. The dehydration is the best option both for their value addition and safe storage. The processing of these crops into value added products through dehydration route such as flakes, slices, powder, pickle, pastes etc. adds convenience and also results in reduction of post harvest losses. To promote the processing of these crops a one-week entrepreneurship development programme was organized at CIPHET during 17th May 2007 to 23rd May 2007. Six participants belonging to Punjab, Haryana and Rajasthan attended the programme. The faculty drawn from CIPHET conducted the theory and practicals. The following topics were covered during the programme:

- Chemistry of onion, ginger & garlic
- Varieties and processing characteristics of onion, ginger & garlic
- Dehydration of onion, ginger & garlic-methods & machines
- Operation and maintenance of processing equipment
- Quality standards of dehydrated onion, ginger & garlic
- Methods of pickling
- Extraction of essential oils of ginger and garlic
- Preparation of project profiles
- F.P.O (Fruit Product Order)- Terms & conditions for licensing
- Project planning, launching and management

The participants were given hands on training on preparation of processed products, such as onion flakes, ginger powder, garlic powder, ginger pickle, extraction of essential oils etc. and operation and maintenance of the machines.

Dehydration of Fruits and Vegetables for Preservation and Value Added Products

A one-week entrepreneurship development program on dehydration of fruits and vegetables was conducted at CIPHET during 4 10 July 2007. Eleven participants attended the EDP. The topics such as chemical composition structure and maturity; theory of dehydration (psychrometrics, mechanism of drying, calculation of drying rate, principle of freeze drying); process of dehydration with emphasis on suitability and pre-treatments; principles, constructional features & operation of drying equipment; osmotic dehydration and practicals on selected fruits and vegetables were covered. The processing of fruits and vegetables into value added products (processes, methods, equipment, quality / safety standards, and packaging); preparation of project profiles and F.P.O. (Fruit Product Order) - terms and conditions of licensing were explained to the participants. Important products covered under this course were ginger powder, garlic slices and powder, onion flakes and powder, osmo-dehydration of banana and pineapple.

Faculty and participants of EDP programme on dehydration of fruits and vegetables for preservation and value addition

Entrepreneurship development program on Post Harvest Technology.

A one-week entrepreneurship development program on Post Harvest Technology was organized for fifteen farmers from Assam during 16th July to 21st July 2007. This program was sponsored by SIRD, Assam. The training programme on post-harvest technology of foodgrain, oilseeds, spices, pulses, fruits and vegetables was organised at the Central Institute of Post-Harvest Engineering and Technology (CIPHET) for 15 participants from

Chirang in Assam. Dr. R.T.Patill, Director, Dr. Mathew Prasad, Head, Technology Transfer Division, and Dr. S.K. Nanda of CIPHET appealed the farmers to take up processing and value addition of the local produce for higher income and more employment. The training programme was coordinated by Dr. D. Dhingra and faculty members drawn from CIPHET conducted lectures and practical. The trainees learnt cleaning, grading and de-stoning of foodgrains, milling of foodgrains, pulses and oilseeds and processing of fruits and vegetables. The training concluded with a visit to Markfed canneries, Jalandhar, and Nijjer Agro Foods Ltd. Amritsar.

Valedictory session of one-week entrepreneurship development program on Post Harvest Technology was organized for fifteen farmers from Assam during 16th July to 21st July 2007.

Entrepreneurship development program on "Dehydration of Fruits and Vegetables for Preservation and Value Added Products"

Dr. D. Dhingra and Dr. D. M. Kadam organized the Entrepreneurship Development Programme on Dehydration of fruits and vegetables for preservation and value added products during 27 August 01 September 2007. Three participants from Mumbai attended the program. Topics such as chemical composition structure and maturity of fruits and vegetables, theory of dehydration of fruits and vegetables, principle of operation of dehydration equipment, osmotic dehydration, processing of fruits and vegetables into value added products, preparation of project profiles, F.P.O., quality evaluation of dehydrated and processed products, MAP, dehydration of ginger/ garlic/ onion, marketing of products etc along with practicals were covered.

International Training Programme

An International Training Programme on "Post Harvest Management of Horticultural Crops (Pomegranate and Date Palm)" from 20-28th December 2007 was organised at CIPHET, Abohar, under ICAR Egypt Work Plan.

Dr. Fatma Esimat Ibrahim, Head, Fruits Handling, Department of PHT, ARC, Giza, Egypt and Dr. Hossaim Ali Ali Metwally, Researcher, Central Lab. For Research and Development for Date palm, ARC, Giza, Egypt attended the training.

During the training following topics/visits were covered :

i. Training on Post Harvest Management of Pomegranate and dates and its processing for value addition.

ii. Visit to Pomegranate and date growers.

iii. Visit to Date Palm Research Station Bikaner, Rajasthan and Regional Research Station, PAU, Abohar and interaction with scientists and research workers.

iv. Visit to Deptt. of Food Technology, GNDU, Amritsar.

National Trainings and Other Programmes

One week training programme was organized on **Post Harvest Management and Value Addition of Horticultural Produce** w.e.f. **19-25 November, 2007** at CIPHET, Abohar. 14 participants from Uttrakhand participated in the training programme. The training included various lectures including post harvest management of fruits and vegetables, role of cold chain in post harvest management of perishables, MAP including minimal processing of fruits and vegetables, palsticulture techniques for better productivity of fruits and vegetables, scope and uses of shrink packaging of fruits and vegetables and development of various value added products of fruits and vegetables. The training also included the practical classes on novel products from aonla, ber, guava, pomegranate etc. including demonstration of waxing plant. The participants were also exposed to different laboratory and field experiments on different aspects of post harvest management of fruits and vegetables. The participants also visited multi-fruit juice plant, waxing and packaging unit of kinnow, hi-tech nursery and farmers orchards. The participants were awarded successful completion certificate by the chief guest Dr. N. S. Brar, SDM, Abohar, in the valediction function. He urged the participants to disseminate the techniques learned during the training to the farmers level so that the purpose of the training can be fulfilled in the larger interest of farmers and entrepreneurs.

Training and visit on Food Processing for Rural Women during 27 February to 31 March 2008 in collaboration with IFFCO and CIPHET, Abohar.

Sensitization program on Scheme for Development of Agricultural Marketing Infrastructure on 8th June 2008 was organized in collaboration with Cotton Testing Laboratory (Directorate of Marketing and Inspection, Min. of Agriculture, GOI), Abohar and CIPHET, Abohar.

Farmers Awareness Program on Warehousing (Development and Regulation) Bill-2007.

A training cum awareness program for farmers on warehousing (Development and Regulation) Bill 2007 was organized by Central Warehousing Corporation (CWC) at CIPHET on 21-22 August 2007 in collaboration with Division of Transfer of Technology. Dr. Nawab Ali, Deputy Director General (Engineering), ICAR New Delhi inaugurated the programme. Twenty-five farmers from Punjab attended the programme. Drs. D. Dhingra, V.K.Bhargav and D.M. Kadam participated in the programme as Resource Person. Field visit to a local registered warehouse was organized on the second day. Scientists from CIPHET and Officials of CWC interacted with the farmers.

Awareness programme on Warehousing (Development and Regulation) Bill 2007

Institute Technology Management Unit (ITMU)

Patents filed during the period under report

Date	Application Number allotted by the Patent office.	Title	Name of the Scientists
7.6.2007	1238/DEL/2007	Process for dehulling guar seed for refined guar split production.	Er. R. K. Vishwakarma, Dr. S. K. Nanda Dr. U. S. Shivhare
14.02.2008	480/DEL/2008	Mechanical Device For Detection of Insects in Stored Grains.	Dr. A. K. Thakur, Dr. V . R. Bhagwat, Dr. R. T. Patil
14.02.2008	479/DEL/2008	Hand Tool For Easy Separation of Arils From Pomegranate.	Dr. A. K. Thakur, Dr. R. T. Patil, Dr. Deshbeer Singh, Dr. R. K. Gupta
29.02.2008	515/DEL/2008	Process technology for preparation of blended guava leather/bar.	Dr. R. K.Jangra, Er. Gautam Mandal, Dr. Satyavir Singh
14.03.2008	683/DEL/2008	Manual Banana Comb/Hand Cutter.	Dr. D. M. Kadam Dr. Devinder Dhingra
21.03.2008	746/DEL/2008	Process of Manufacturing Mix for Ready to Constitute *Makhana Kheer*	Dr. S. N. Jha

Following entrepreneurs were registered during the period under report for advisory consultancy:

Name of the entrepreneurs	Address	Registration Date	Field of work
Dr. Karam Singh Nandpuri	103 G, BRS Nagar, Ludhiana	10 .04. 2007	Guava Processing
RACSUN Foods	B-II/1607, Tractor Street, Ludhiana	17.05.2007	Soya Milk
Shriram Gadhave, President	Vegetable growers Asso. of India, Pune	18.05.2007	All vegetables
Manmohan Jha	Bhikajee cama place	30.06.2007	Pulse processing industry to be set up.
ASAKA Foods Specialites	Geeta Vihar Colony, village Threeke, Ludhiana	12.07.07	Spices, Pickles, James & Jelly
Sh. Pankaj Mahajan	Laxmi Sales Corporation, Pathankot	16.08.2007	Mustard oil & other edible
Indico High Tech Agro Rural , D.W.W.S.	Bharat Nagar Chowk, Bus Stand Road, Ludhiana	18.10.2007	Stevia, Contract Farming Agency for Organic Stevia Cultivation
Chempharm Industries India	B-50, Sector - 64, Noida	31.10.2007	Post Harvest Technology
Gurdev Kaur	Deol Dairy Farm, Dashmesh Nagar, Ayali Khurd, Ludhiana	05.04.2008	Food Preservation

National Seminars

1. On day National Seminar on "Application of Engineering Principle and Mathematical Modeling in Food Processing" was organized on the 7th August 2007.

2. Two days National Seminar was organized on 'Environmental Control for plants, animals and fisheries' during 15-16 March 2008. It was sponsored by ICAR and private companies.

Winter Schools

A winter school on "Nondestructive and biosensing methods for food safety and quality assurance" was organized during 5-26 September 2007. The participants from ICAR institutes, State Agricultural and general Universities participated.

Another winter school on "Bioprocessing technologies in utilizations of crop residues for production of enzymes and bio-fuels", was organized during October 16-November 5, 2007.

Launch workshop of NAIP

The Launching Workshop of NAIP subproject on, “Development of nondestructive systems for evaluation of microbial and physicochemical quality parameters of mango” was held at consortium lead centre, CIPHET, Ludhiana on 29.03.2008. The workshop was attended by scientists from CIPHET, PAU, Ludhiana, IMTECH, Chandigarh and stakeholders, Reliance and Field Fresh (corporate fruits and vegetables retailers) and farmers. Prof. Suresh Parsad, Emeritus Professor IIT Kharagpur and Chairman of the CAC was the chief guest and Professor E. S. Raja Gopal, IISc, Bangalore, Dr. D. C. Joshi, Anand Agricultural University, Anand, and Dr. A. Bandyopadhyay, National Coordinator, NAIP, ICAR, were the guests of honour. Dr. R. T. Patil, Director, CIPHET, presided and the CPI, the CCPIs and the Co-PIs were the official participants in the workshop.

Dr S. N. Jha, Consortium PI, welcomed the delegates and other guests. Thereafter Dr. R. T. Patil presented the brief overview of CIPHET and its achievements. Dr. A. Bandyopadhyay, NC, briefed the gathering about the NAIP as a whole and objectives of Component 4 in particular. The CCPIs made brief presentations on their respective institutions and their major achievements. Dr. S. N. Jha, Consortium Principal Investigator (CPI) presented an overview of the project. Dr. Suresh Prasad the chief guest launched the project by releasing the information brochure of the subproject. This was followed by a very useful discussion with the stakeholders on their needs with respect to PHT for fruits in general and their expectations from the subproject in particular. All the experts stressed on the need for knowledge sharing between the stakeholders and the scientists in the sub-project. Dr D.C. Joshi stressed the need for scientific solution to non-destructive detection of fruit fly infestation in mango. Dr. R. T. Patil advised the stakeholders to be in regular contact with the scientists of CIPHET for their problems related to post harvest handling and value addition of the agriculture produce. The session ended with a vote of thanks by Dr. K. Narsaiah. A poster session was also organized on history, maturity, harvest, diseases and disorder development in mango in the afternoon.

L to R: Dr. Raj Gopal, Dr. RT Patil, Dr. Suresh Prasad Chairman CAC and Chief Guest, Dr. Bandopadhyay, Dr. DC Joshi and Dr. OD Wanajri

Hindi *Pakhwara* at CIPHET, Abohar

Hindi Pakhwara w.e.f. 14-28 September 2007 was organised at CIPHET, Abohar and all the staff participated in the various competitions during the programme. The participants who stood 1st, 2nd and 3rd were honoured by cash and other prizes.

QRT of APA at cooperating centre, CIPHET, Abohar

Quinnquenial Review Team of AICRP on APA comprised of Dr. A. Alam, ViceChancellor, SKUAS&T, Srinagar as the Chairman and Dr. Brahm Singh, Ex-Director, FRL, Leh; Dr. K.N. Tiwari, Professor, Dept of Agricultural and Food Engineering, IIT, Kharagpur; Dr. K.G. Varshney, Ex-Professor, ANGRAU, Hyderabad; and Dr. U. K. Swaroop, General Manager (Business Development), Reliance Industries Limited, Mumbai as members. The team visited cooperating centre of CIPHET, Abohar on **16 March 2008**.

The team visited the experimental field and showed their satisfaction on the on-going projects. The team was also exposed to outreach activities of the centre and interacted with farmers who adopted the technologies. The team visited Billa Patti, Kala Tibba, Khubban where microirrigation and use of low plastic tunnels are being adopted in different fruits and vegetable crops. The team also visited hi-tech nursery at Maujgarh and were impressed with the use of plasticultural techniques and suggested to prepare a video of the nursery and need to popularize and highlight such type of activities for scientific management of planting material for supply to the farmers. At many places Dr. Anwar Alam were honoured by the farmers and thanked him for his visit and guiding the scientists, entrepreneurs and farmers. The team was also exposed to Multi-Juice Extraction Plant at Alamgarh. The team appreciated the work done at the centre and encouraged the team of scientists to keep it up.

Coordination Committee Meeting (CCM) of APA

Coordination Committee Meeting (CCM) of AICRP on Application of Plastics in Agriculture (APA) was conducted at CIPHET, Abohar during **22-23 February 2008** at CIPHET, Abohar. The project leaders from all the nine centers participated in the meeting and finalized the technical programme for next two years. The chief guest of the program Dr. Pitam Chandra, ADG (PE), in his inaugural address highlighted the prospects of plasticultural techniques and cited many examples of enormous benefits from these technologies in the field of water conservation, surface covered cultivation and post harvest management. He urged the project leader to develop the technologies which can be replicated at the farmers field for higher productivity and profitability. Dr. R. T. Patil, Director and chairman of the inaugural session narrated the usefulness of man made plastics in agriculture and elaborated that plasticultural technologies can play impetus role in enhancing productivity, improving shelf life and quality of the produce. He exhorted cooperating centres to work with a clear mind to make plasticultural techniques relevant for the farming community. Dr. P. R. Bhatnagar, Project Coordinator (APA) urged the scientists to develop full package of plasticultural techniques and emphasis should be given to demonstrate the proven technologies at farmer's field. He urged the researchers to develop the technical programme in such way that some technologies can be come out of the project. Dr. S. K. Nanda, PC (PHTS) also asked the researchers that environmental issues should be well addressed while dissemination of the technologies and stakeholders should be made aware about the judicious use of plasticultural techniques. Dr. R. K. Gupta, Head (HCP) thanked all the participants coming from far away places to Abohar and elaborated the usefulness of plastics based technologies for end users as these technologies have successfully been practiced in many advanced countries for higher productivity and reducing post harvest losses. One technical bulletin was also released by chief guest and chairman during the inaugural session. All the project leaders presented their technical programme and after discussion the technical programme was finalized for each center. The participants were also exposed to field visit of progressive farmers who are making use of plasticultural technologies. Dr. Rajbir Singh, Project Leader of cooperating centre of APA presented formal vote of thanks to all the dignitaries and participants attended the meeting.

RESEARCH ADVISORY COMMITTEE

1. Dr. Satish Bal — Chairman
   Professor Agricultural Engineering
   Indian Institute of Technology,
   Kharagpur- 721 302 (W.B)

2. Dr. N.C. Patel — Member
   Dean,
   Agril. Engg. Technology,
   Junagarh Agricultural University,
   Junagarh- 362 001 (Gujart)

3. Dr. G. R. More — Member
   Director Research
   Marathwada Agricultural University,
   Parbhani - 431 038

4. Dr.(Mrs.) Kanta K. Sharma — Member
   B- XI/8025, Vasant Kunj,
   New Delhi - 110 070

5. Dr. P.K. Chattopadhyay — Member
   Professor
   Indian Institute of Technology
   Kharagpur 721 302

6. Dr. R.P. Kachru — Member
   303, D.K. Rainbow
   Chuna Bhatti
   Kular Road
   Bhopal

7. Dr. Pitam Chandra — Member
   Asstt. Director General (PE),
   Indian Council of Agricultural Research,
   KAB-II, Pusa
   New Delhi - 110 012

8. Dr. R. T. Patil — Member
   Director
   CIPHET, Ludhiana

9. Dr. S.K. Nanda — Member
   PC, (AICRP on PHT) — Secretary
   CIPHET, Ludhiana

INSTITUTE MANAGEMENT COMMITTEE

1. Dr. R.T. Patil — Chairman
   Director
   CIPHET, Ludhiana

2. Dr. D.V.K. Samuel — Member
   Principal Scientist (AS&PE)
   Division of Post Harvest Technology
   IARI, PUSA, New Delhi 110 012

3. Dr. D. Nag — Member
   Head, TOT Division
   National Institute of Research
   on Jute & Allied Fibre Technology
   12 Regent Park
   Kolkata 700 040 (W.B)

4. Dr. S.P. Aggarwala — Member
   Head, Division of Dairy Engg.
   National Dairy Research Institute
   Karnal 132 001 (Haryana)

5. Dr. Pitam Chandra — Member
   ADG (PE)
   Indian Council of Agricultural Research
   Krishi Anusandhan Bhavan-II
   PUSA, New Delhi - 110 012

6. Dr. B.S. Modi — Member
   Principal Scientist (AS&PE)
   IARI, Regional Research Station
   Karnal 132 001 (Haryana)

7. Sh. Tej Ram — Member
   Administrative Officer — Secretary
   CIPHET, Ludhiana

PERSONALIA

JOINING

Dr. R. K. Gupta joined as Head, HCP, CIPHET, Abohar on 11.04.2007 (AN)

Dr. O. D. Wanjari joined as Head, AS&EC on 12.04.2007

Dr. K. K. Singh joined as Head FG&OP on 16.04.2007.

Dr. Matthew Prasad joined as Head, TOT on 09.05.2007.

Dr. P. R. Bhatnagar joined as PC (APA) on 14.06.2007.

Dr. D.S. Uppal joined as Emeritus Scientist on 6th June 2007.

Dr. Sangeeta Chopra, Scientist (S.G.) joined CIPHET after completing her Ph.D. on "Development of design parameters of gasification of maize (*Zea Mays* L.) cobs in throatless gasifier" from Energy Science and Technology Dept. PAU, Ludhiana in January 2008.

Sh. O. P. Moondan, T-5, CSSRI, Karnal joined CIPHET, Ludhiana on 15.06.2007 on mutual transfer basis.

PROMOTION

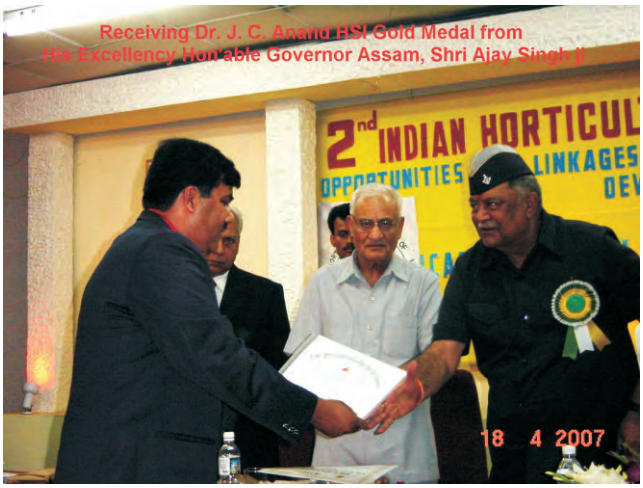
Er. (Mrs.) S.K. Aleksha Kudos, Scientist has been promoted to the post of Scientist (SS) w.e.f. 01.12.2006.

Dr. Vinod Kumar Bhargav Scientist has been promoted to the post of Scientist (SS) w.e.f. 27.12.2006.

Dr. (Mrs.) Sangeeta Chopra, Scientist (SS) has been promoted to the post of Scientist (SG) w.e.f. 22.03.2007.

AWARD/ HONOUR

Dr. S.N. Jha Sr. Scientist received Dr. J. C. Anand Gold Medal of Horticulture Society of India for outstanding contribution and displaying leadership in Post-harvest Management of Fruits. A gold medal and a citation was presented by his Excellency Governer of Assam, Mr. Ajay Singh during 2nd Horticulture Congress on 18 April 2007 held in Barapani, Meghalaya



Dr. Mridula D. received 'Young Scientist Award' 2008. It is conferred by the executive committee of Bioved Research Society, Allahabad in the 10th Indian Agricultural Scientists and Farmers' Congress, 16-17th February 2008 at Allahabad, for her outstanding contribution in the field of bengal gram *sattu* making technology.

TRANSFERS

Sh. Rajinder Singh, T-2 (Turner) transferred to CSSRI, Karnal on 13.06.2007 (AN) on mutual transfer basis.

Dr. M.S. Meena, Scientist (SS) has been transferred to ICAR Research Complex for Eastern Region, Patna on Promotion to the Post of Sr. Scientist and relived from CIPHET, Ludhiana in the afternoon of 27.08.2007.

PERSONNEL

Name	Designation
Dr. R.T. Patil	Director
Dr. S.K. Nanda	Project Coordinator (AICRP on Post Harvest Technology)
Dr. O.D. Wanjari	Head, Division of Agril. Structures & Environmental Control
Dr. K.K. Singh	Head, Division of Food Grains & Oilseeds Processing
Dr. Matthew Prasad	Head, Division of Transfer of Technology
Dr. R.K. Gupta	Head, Division of Horticultural Crops Processing
Dr. P. R. Bhatnagar	Project Coordinator (AICRP on Application of Plastics in Agriculture)
Dr. R.K. Goyal	Principal Scientist (Agril. Structures and Process Engineering)
Dr. S.N. Jha	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Dilip Jain	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Devinder Dhingra	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Deepak Raj Rai	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. K. Narsaiah	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Desh Beer Singh	Sr. Scientist (Horticulture)
Dr. Rajbir Singh	Sr. Scientist (Agronomy)
Dr. Abhay Kumar Thakur	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Dinesh Kumar Bharti	Sr. Scientist (Agril. Economics)
Dr. Sanjeev Kumar Tyagi	Sr. Scientist (Chem. Engg.)
Dr. (Mrs.) Sangeeta Chopra	Scientist (SG) (Electrical Engineering)
Dr. (Mrs.) Mridula Devi	Scientist (SS) (Food & Nutrition)
Dr. Harinder Singh Oberoi	Scientist (SS) (Microbiology)
Dr. S. Balasubramanian	Scientist (SS) (Agril. Structures and Process Engineering)
Er. Rajesh Kumar Vishwakarma	Scientist (SS) (Agril. Structures and Process Engineering)
Er. M.R. Manikantan	Scientist (SS) (Agril. Structures and Process Engineering)
Dr. Satyendra Kumar	Scientist (SS) (Soil and Water Conservation Engineering)
Sh. Goutam Mandal	Scientist (SS) (Horticulture)

Er. Pradyuman Barnwal	Scientist (Mech. Engineering)
Er. (Mrs.) S.K. Aleksha Kudos	Scientist (Agril. Structures and Process Engineering)
Dr. Vinod Kumar Bhargav	Scientist (Farm Machinery and Power)
Dr. Dattatrya M. Kadam	Scientist (Agril. Structures and Process Engineering)
Dr. Ramesh Kumar	Scientist (Horticulture)
Er. D.D. Nangare	Scientist (Soil and Water Conservation Engineering)

Technical

Sh. V.K. Garg	T-9 (Training Assoc.)
Sh. Mahipal Singh	T-6 (Technical Officer)
Smt. Satnam Kaur	T-6 (Home Science)
Sh. V.K. Saharan	T-6 (Technical Officer)
Sh. Rajinder Singh	T-5 (Technical Officer)
Sh. O. P. Moondan	T-5 (Technical Officer)
Smt. Promila Rani	T-4 (Library Assistant)
Sh. Mukund Narayan	T-4 (Technical Asstt.)
Sh. Prithvi Raj	T-4 (Technical Asstt.)
Sh. Rajesh Kumar	T-4 (Technical Asstt.)
Smt. Davinder Bhan Chadda	T-I-3 (Data Entry Operator)
Sh. Chaman Lal	T-2 (Lab. Asstt.)
Sh. Hardev Singh	T-3 (Driver)
Sh. Gurdip Singh	T-I-3 (Lab. Asstt.)
Sh. Lakhwinder Singh	T-2 (Fitter)
Sh. Bhajan Singh	T-2 (Fitter)
Sh. Jaswant Singh	T-2 (Welder)
Smt. Sonia Rani	T-2 (Data Entry Operator)
Sh. Hardeep Singh	T-2 (Turner)
Sh. Beant Singh	T-2 (Driver)
Sh. Jaswinder Singh	T-2 (Machinist)
Sh. Jagtar Singh	T-2 (Electrician)
Sh. Pawan Kumar	T-2 (Electrician)
Sh. Vishal Kumar	T-2 (Data Entry Operator)
Sh. Ganpat Ram	T-2 (Driver)
Sh. Devinder Kumar	T-2 (Fitter)
Sh. Dalu Ram	T-2 (Fitter)
Sh. Pradip Kumar	T-1 (Field Asstt.)
Sh. Yashpal Singh	T-1 (Field Asstt.)
Sh. Satwinder Singh	T-1 (Lab. Technician)

Administrative

Sh. Tej Ram	AO
Sh. Vijay Kumar	AF&AO
Sh. J.S. Paul	AAO
Sh. Manni Lal	JAO
Smt. Jasvindar Kaur	Stenographer
Sh. B.C. Katoch	Assistant
Sh. Pawan Kumar	Assistant
Sh. Kunwar Singh	UDC
Sh. Avtar Singh	UDC
Sh. Tarsem Singh	UDC
Sh. Gurdial Singh	UDC
Sh. Harbhupinder Singh	UDC
Sh. Mohan Lal	UDC
Smt. Jasvir Kaur	LDC
Sh. Ashwani Kumar	LDC
Smt. Sunita Rana	LDC
Sh. Ajay Kumar Tandon	LDC
Sh. Ram Khelawan Yadav	LDC
Sh. Sohan Lal	LDC
Sh. Sanjay Kumar Gaur	LDC
Sh. Rajinder Kumar	LDC
Sh. Iqbal Singh	LDC

Supporting

Sh. Sukhbir	SSG-II
Smt. Viran Vali	SSG-II
Sh. Surinder Kumar	SSG-II
Sh. Sarup Singh	SSG-I
Sh. Shalikgarm Dwivedi	SSG-I