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लुधियाना-141004 (पंजाब)

ICAR-CENTRAL INSTITUTE OF POST-HARVEST ENGINEERING & TECHNOLOGY
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PREFACE

The Agriculture had two equally important aspects i.e. production and post production management. No country can achieve food and nutritional security to its people without proper management of produced commodities. The post-harvest management is a multi disciplinary task involving combined effort of process engineers, food technologist, biochemist, nutritionist etc. I feel privileged for being associated with ICAR-Central Institute of Post-harvest Engineering and Technology, which is actively engaged in post-harvest management and processing of agricultural produce since last 26 years.

It's my honour to place before you the Annual Report (2015-16) of the Institute. During the reported year, the institute has advanced in the post-harvest engineering and processing sector by developing various machines, storage structures, process technologies and value added products to reduce the post-harvest losses. It's a matter of great honour and pride that the institute has been authorized for testing of all types of Post-Harvest Equipment and Machinery by Mechanization & Technology Division, Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India to ensure supply of quality post-harvest equipment & machinery by manufactures. The institute has achieved another milestone in the area of by-product utilization by designing and commissioning of pilot plant for the production of protein isolates from de-oiled cakes. In future, this achievement may be proved a revolutionary step towards the commercial production of protein isolates in the country. To address the increasing demand of live fish and limitations associated with its transportation, a battery operated transportation vehicle is modified for local transport of live fishes. In the area of horticultural produce processing, institute has developed a semi-automatic peeler for *kinnow* and sweet orange; pneumatic assisted coring device for oblong fruits such as *ber* and fresh date palm. Concerns about food safety and regulations have ensured the development of various techniques for detection of adulterant in food. Our continuous effort in this direction has laid the development of attenuated total reflectance fourier transform infrared spectroscopy based methods for the detection of fungal toxins in fruit juices and milk. Process protocols for detection of safflower adulteration in saffron by SCAR markers and DNA barcodes were also developed during the year. We are also engaged in human resource development by organizing different programmes such as entrepreneurship development program (EDP) on "*Aonla* and *Kinnow* processing and value addition, winter/summer schools in the area of post-harvest management, hands on training on process for onion drying and chilli and powder etc. We joined hands with MOFPI-NIFTEM for collaborative research work in the area of post-harvest engineering and technology as well as food quality and safety by signing a MOU on June 18, 2015. I feel pleasure to share that AICRP on PET has added 4 new centres in its umbrella and AICRP on PHET has established 22 new agro-processing centres (APCs) during the year. Besides, two mega Consortium Research Projects on Secondary Agriculture and Health Foods have also been approved by ICAR at ICAR-CIPHET, Ludhiana. With these additional assignments, we feel a great sense of responsibility to achieve our set goals. In our continuing efforts to create awareness about post-harvest management of agricultural commodities, we showcased and demonstrated our technologies in various exhibitions i.e. IASOWA exhibition at New Delhi, 5th Global Economic Expo Summit 2015 at WTC Mumbai; "*Krishi Unnati Mela*" at IARI, New Delhi; Agri-Intex 2015, Coimbatore; India International Trade Fare-2015 at New Delhi etc. A series of radio talks under "*Do Duni Chaar*" programme was broadcasted through All India Radio, Jalandhar.

I take this opportunity to place on record my sincere thanks and gratitude to Hon'ble Director General, ICAR and Secretary, DARE; Chairman, ASRB; Additional Secretary, DARE; DDG (Agril Engg); ADG (PE) and ADG (Farm Engg) for their continued guidance, encouragement and support in executing the mandate of the Institute. I thank all the Head of Divisions, Project Coordinators, Section/Unit in-charges, scientists, technical, administrative, audit and supporting staff of the institute for their constant support, teamwork and dedication towards research as well as other assigned activities. The untiring efforts of Dr Deep Narayan Yadav, Dr Sangita Bansal, Er Arun Kumar TV and Dr Arvind Jaiswal in bringing out this report in its present form are duly acknowledged.

R. K. Gupta
Director

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कार्यकारी सारांश

वर्ष 2015–16 में संस्थान ने कुछ महत्वपूर्ण उपलब्धियाँ प्राप्त कर कटाई उपरान्त अभियांत्रिकी एंव प्रौद्योगिकी के क्षेत्र में अपने योगदान की निरन्तरता को बनाए रखा है। संस्थान में चल रही शोध परियोजनाओं में तेल निस्काशित केक व खल का उपयोग, फल प्रसंस्करण उद्योगों से प्राप्त होने वाले सहउत्पादों का उपयोग, जैव सक्रीय यौगिकों का लघुकैप्सूलीकरण, किन्नू, बेर एवं नाशपाती प्रसंस्करण, खाद्यों की गुणवत्ता को बढ़ाना, खाद्यों में मिलावट की पहचान एवं उनका मात्रात्मक निर्धारण, जीवित मछली परिवहन, बिमार पशुओं के आराम को ध्यान में रखते हुए बनायी गयी संरचनाएं इत्यादि शामिल हैं। इसके अलावा संस्थान दो अखिल भारतीय समन्वित अनुसंधान परियोजनाओं–कटाई उपरान्त अभियांत्रिकी और प्रौद्योगिकी एवं प्लास्टीकल्चर अभियांत्रिकी एवं प्रौद्योगिकी का प्रधान केन्द्र भी है। प्रत्येक वर्श की भांति वर्श 2015–16 में भी कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी की अखिल भारतीय समन्वित अनुसंधान परियोजना में कई यंत्र, जैसे भण्डारण सरंचनाएं, प्रक्रिया प्रौद्योगिकी और मूल्य वर्धित उत्पाद विकसित किए गये। इसी प्रकार प्लास्टीकल्चर अभियांत्रिकी एवं प्रौद्योगिकी परियोजना के अंर्तगत संरक्षित खेती के लिए पालीहाउस संरचना की डिजाइन पर कई कार्य किये गये। संस्थान द्वारा वर्ष 2015–16 में अनुसंधान, प्रसार तथा अन्य सम्बन्धित क्षेत्रों में प्राप्त की गई उपलब्धियों का विवरण निम्नवत है:

तेल निष्काषित केक व खली का उपयोग:

संस्थान द्वारा तेल निष्काषित मूंगफली की खली से प्रोटीन आईसोलेट का उत्पादन करने के लिए एक स्वदेशी प्रायोगिक संयंत्र डिजाइन एवं स्थापित किया गया है। इस संयंत्र द्वारा अन्य तिलहनों से प्राप्त होने वाले तेल निष्काषित केक/खल से भी प्रोटीन आइसोलट का उत्पादन किया जा सकता है। इस संयंत्र के प्रमुख घटक निष्कर्षण टैंक, अपकेन्द्रण संयंत्र व अवक्षेपण टैंक हैं। इस संयंत्र से प्राप्त होने वाले आईसोलेट में 90 प्रतिशत से अधिक शुद्ध प्रोटीन उपस्थित रहती है। इस संयंत्र द्वारा प्रतिदिन लगभग 40 किलोग्राम तेल निस्काषित केक/खल को प्रसंस्कृत किया जा सकता है। संयत्र की अनुमानित लगभग रू 10 लाख है।

फल प्रसंस्करण उद्योगों द्वारा प्राप्त होने वाले सहउत्पादों का उपयोग:

संस्थान में सूक्ष्म तरंगो (microwave) की ऊर्जा का उपयोग कर किन्नू के छिलके से पेक्टिन निकालने की प्रक्रिया का विकास किया गया। इस प्रक्रिया में निष्कर्षण के बाद प्राप्त मिश्रण से पेक्टिन को इथेनॉल डालकर अवक्षेपित करा लेते हैं। अवक्षेप को निथारकर सुखा लिया जाता है। सर्वप्रथम किन्नू के छिलके के पाउडर को जल में भिगोया जाता है फिर मिश्रण को 900 वाट की माईक्रोवेव पर विभिन्न अंतरालों पर उपचारित किया जाता है। प्राप्त मिश्रण को ठंडा करने के पश्चात इथेनॉल से पेक्टिन को अवक्षेपित करते हैं। विकसित प्रक्रिया द्वारा मिश्रण में हाइड्रोजन आयन की सान्द्रता 2 पर सिट्रिक अम्ल और एंजाइम के मिश्रित उपचार द्वारा 60 मिनट के माइक्रोवेव ऊश्मीयन द्वारा पेक्टिन की 10.5 प्रतिशत की अधिकतम प्राप्ति की जा सकती है। समान उपचार देने पर नियंत्रण नमूनों से प्रेक्टिन प्राप्ति की अधिकतम मात्रा, विकसित विधि से प्राप्त पेक्टिन की आधी या इससे भी कम प्राप्त होती है।

जूस निष्काषित नाशपाती के गूदे द्वारा नरम टॉफी बनाने की प्रक्रिया और मिश्रण में घटकों की मात्रा का इश्टतमीकरण किया गया। नरम टॉफी को बनाने के लिए भिन्न घटकों की इश्टतम मात्रा (जूस निश्कासित नाशपाती के गूदे के आधार पर) निम्नवत थीः शर्करा 30 प्रतिशत, पेक्टिन 0.25 प्रतिशत एवं पोटैशियम मेटा बाइसल्फाइट 1000 पीपीएम। प्रक्रिया में सर्वप्रथम जूस निश्कासित नाशपाती के गूदे को धीमी आंच पर प्रारम्भिक मात्रा की आधी मात्रा हो जाने तक पकाया जाता है और फिर लगातार मिश्रण को हिलाते/मिलाते हुए शर्करा और पेक्टिन मिलाया जाता है।

माइक्रोइनकैप्सूलेशन

सोया लेसीथीन (lecithin) को पायसीकारक (emulsifier) और व्हे प्रोटीन कन्सन्ट्रेट को स्थिरीकारक की तरह उपयोग करके अलसी तेल, लहसुन तेल एवं इन तेलों को संयुग्मन में इस्तेमाल कर जल में तेल (oil-in-water) प्रकार का पायस (emulsion) बनाया गया। समरुप मिश्रण प्राप्त करने के लिए बने पायस को सोडियम एल्जिनेट के साथ मिलाया गया। सोडियम एल्जिनेट पायस पर परत बनाने का काम करता है। अलसी के तेल, लहसुन के तेल एवं अलसी लहसुन के तेल से बने लघुकैप्सूलों की कैप्सूलीकरण दक्षता क्रमशः 85, 69 एवं 92 प्रतिशत थी। स्कैनिंग इलेक्ट्रान माइक्रोस्कोपी अध्यनों से यह पाया गया कि लघुकैप्सूल लगभग गोलाकार, सतत् और सोडियम एल्जिनेट की परत से पूरी तरह से आच्छादित थे।

किन्नू, बेर और नाशपाती प्रसंस्करण

संतरे एवं किन्नू जैसे फलों की छिलाई के लिए एक अर्द्ध–स्वचालित प्रकार की प्रोटोटाइप मशीन को बनाया गया है। इसमें फलों को फल धारकों के बीच हाथ से रखा जाता है। फलों के व्यास के अनुसार ब्लेड के समायोजन के लिए लगभग 1 इंच की जगह प्रदान करने के लिए एक स्प्रिंग की व्यवस्था है। मशीन को अधिकतम् 1440 घेरे प्रति मिनट की रफ्तार से 0.5 एच.पी. की मोटर से घुमाया जा सकता है। प्रारम्भिक परीक्षणों द्वारा यह पाया गया कि इस मशीन द्वारा रस के न्यूनतम नुकसान के साथ 8 से 10 सेकेन्ड में एक किन्नू को छीला जा सकता है।

बेर एवं खजूर फलों से केन्द्रीय कोर एवं बीज को निकालने के लिए वायुवीय सहायता से चलने वाला एक यंत्र विकसित किया गया है। इस यत्रं में फलों को डालने के लिए कम्पन्न करने वाले तंत्र के साथ हापर एवं लकड़ी से बना रोलर, फल ड्रापर, लकड़ी से बने चार ढांचे (प्रत्येक 470.50 मिमी.) 6 छेदों के साथ (25.4 मिमी. व्यास), फल कोरिंग यंत्र (6 संख्या में), कोर निर्गम और कोर निकाले फलों के लिए निर्गम की व्यवस्था है। विकसित मशीन की बेर एवं खजूर के लिए कोरिंग क्षमता क्रमशः 28 किग्रा/प्रति घंटा एवं 16 किग्रा./ प्रति घंटा है। इस यंत्र की कोरिंग दक्षता बेर के लिए 78 प्रतिशत एवं खजूर के लिए 65 प्रतिशत है।

नवीन खाद्य उत्पाद विकास एवं खाद्य प्रबलीकरण

पादप आधारित वसा विस्थापकों (fat replacer) का उपयोग कर कम वसा वाले मांस उत्पादों को विकसित किया गया। पादप आधारित वसा विस्थापकों के प्रयोग से सामान्यतः सम्पूर्ण वसा वाले मांस पायस की तुलना में लगभग 30–35 प्रतिशत तक वसा की मात्रा को घटाया जा सकता है। अतः पादप जेल को कम वसा वाले मांस पायस उत्पादों को बनाने के लिए एक महत्वपूर्ण वसा विस्थापक की तरह उपयोग किया जा सकता है।

फल एवं फल आधारित पेय के पोषक घटकों में प्रोटीन नहीं के बराबर पायी जाती है। फल आधारित पेयों के अम्लीय एवं आयनिक स्वभाव के कारण इन पेयों में प्रोटीन मिलाना एवं इसका स्थिरीकरण एक बड़ी चुनौती है। आमतौर पर फल आधारित पेयों का पीएच 3 से 4 के बीच होता है जो कि प्रोटीन के आईसोइलेक्ट्रिक पीएच के समतुल्य होता है जिसके कारण प्रोटीन आपस में चिपककर अवक्षेप बना लेती है और पेयों को खराब कर देती है। इस चुनौती को स्वीकार करते हुए संस्थान ने इस वर्श 3 प्रतिशत व्हे प्रोटीन और आम के जूस के मिश्रण पर आधारित उपभोग के लिए तैयार पेय बनाने की प्रक्रिया विकसित की। विकसित पेय संवेदी रुप से स्वीकार्य एवं ऊश्मीय प्रसंस्करण और भण्डारण के समय पूरी तरह से स्थिर रहता है।

आक्टेनिल सक्सीनिक एनहाइड्राइड (ओ एस ए) संशोधित बाजरा स्टार्च का उपयोग कर कम वसा दही एवं आईसक्रीम विकसित किये गये। ओ .एस .ए–संशोधित बाजरा स्टार्च को 2 प्रतिशत स्तर तक डबल टोंड (1.5% वसा) एवं टोंड (3.0% वसा) दूध में कम वसा वाला दही बनाने के लिए मूल्यांकन किया गया। संशोधित स्टार्च की 1.5% स्तर पर डबल टोंड एवं टोंड दूध से बने दही के नमूने का कुल संवेदी स्कोर 95.8 और 95.2 था जोकि मानकीकृत दूध (वसा 4.5%) से तैयार दही (86.7) की तुलना में अधिक था। बेहतर उत्पाद दृढ़ता, स्थिरता, प्रवाही गुण (संरचनात्मक शक्ति), संकुचन और समग्र संवेदी स्वीकार्यता के आधार पर ओ एस ए संशोधित स्टार्च की 1.5% मात्रा कम वसा वाले दही को बनाने के लिए ईश्टतम पायी गयी। इस प्रकार बनाए गये दही की गुणवत्ता मानकीकृत दूध से बनाए गए दही के समतुल्य थी। इसी प्रकार ओ एस ए संशोधित बाजरा स्टार्च का स्तर आईसक्रीम मिश्रण के लिए भी अनुकूलित किया गया और पाया गया कि 10% वसा वाली आईसक्रीम के समतुल्य स्वीकार्यता वाली आईसक्रीम जिसमें 7.5% और 5% वसा है को बनाने के लिए क्रमशः 1% और 2% के स्तर पर ओएसए संशोधित स्टार्च मिलाया जा सकता है। इस प्रकार ओएसए संशोधित बाजरा स्टार्च 1.5% के स्तर पर दही में 75% वसा की मात्रा कम कर सकता है एवं संशोधित बाजरा स्टार्च की 1% मात्रा आईसक्रीम में 25% वसा एवं 2% के स्तर पर 50% वसा की मात्रा को कम कर सकता है।

गुणवत्ता प्रोटीन मक्का आंटा (QPM) उपयोग कर विभिन्न स्रोतों की प्रोटीन के साथ ग्लूटन रहित मफिन विकसित किये गये। प्रोटिन स्रोत के रूप में समग्र दूध पाउडर, अण्डे की प्रोटीन, केसीन, सोया प्रोटीन आइसोलेट एवं व्हे प्रोटीन आइसोलेट का अध्ययन किया गया। नियंत्रण नमूनों की तुलना में अण्डे की प्रोटीन से प्रबलित कर बनाए गए गुणवत्ता प्रोटीन मक्का वाले मफिन की कठोरता एवं चवर्णता कम थी एवं इसकी स्वीकार्यता काफी अधिक थी। समग्र दूध और व्हे प्रोटीन मिलाकर बनाए गए मफिन भी स्वीकार्य थे।

5 प्रतिशत तिल के बीज, 6% पालक पाउडर, 15% वसा निष्काषित सोया आटा एवं 74% मक्का के आटें को मिलाकर प्रोटीन एवं खनिज प्रचुर बर्हिवर्धित (extruded) उत्पाद बनाए गये। इष्टतम मापदंडों में फीड नमी 14%, डाई का तापमान 115 डिग्री सेलिसयम और पेंचगति 335 आरपीएम थे। अनुकूलित नमूने में 18.2% प्रोटीन, 3.0% कुल खनिज, 24.6% प्रतिआक्सीकारक क्षमता, 7.66 मिग्रा/100 ग्राम फ्लैवोनाइडस थे। हेडोनिक पैमाने (अधिकतम अंक 9 के आधार पर) पर उत्पाद की समग्र स्वीकार्यता 8.1 थी।

प्रोटीन एवं खनिज में प्रचुर पालक युक्त पास्ता तैयार किया गया। अनुकूलित सयोंजन में शामिल की गयी खाद्य सामग्रीयों में क्रमश : 80.8% गेहूँ सूजी, 10.9% वसा निष्काषित सोया आटा, 5. 9% पालक पाउडर, 3.9% तिल के बीज और 24 मिलीलीटर प्रति 100 ग्राम गाजर का जूस इश्टतम पाए गए। बनाए गए पास्ता में 17.3% प्रोटीन, 2.4% समग्र खनिज, 23.4% प्रतिआक्सीकारक क्षमता, 10 मिलीग्राम प्रति 100 ग्राम फ्लैवोनाइड थे। विकसित पास्ता की हेडोनिक पैमाने पर समग्र स्वीकार्यता 7.4 थी। इस उत्पाद का पुर्नजलीकरण अनुपात एवं पकाने में लगने वाला समय क्रमशः 2.38 एवं 6 मिनट था।

परासरणीय विधि से सुखाए गए नाशपाती के फांक तैयार किये गए। उत्पाद में भूरापन रोकने के लिए विभिन्न लवणों की सान्द्रता को अनुकूलित किया गया। यह पाया गया कि कैल्शियम लैक्टेट का लवण जल क्रियात्मक्ता (Water activity) को रोकने में कैल्सियम क्लोराइड की तुलना में अधिक प्रभावी है। 2% से अधिक सान्द्रता के स्तर पर कैल्शियम क्लोराइड शुश्क नाशपाती की फांकों में कड़वाहट प्रदान करता है जबकि कैल्शियम लैक्टेट के इस्तेमाल से ऐसा नही पाया गया। कैल्शियम के उपचार

से शुश्क किये गये नाशपती के फांकों की बनावट एवं रंग में भी काफी सुधार पाया गया। परासरणीय विधि से फलों को सुखाने एवं इनकी गुणवत्ता में सुधार के लिए कैल्शियम लैक्टेट द्वारा पूर्व उपचार को कैल्शियम क्लोराइड के विकल्प के तौर पर उपयोग किया जा सकता है।

छिड़काव तकनीक, टेम्परिंग और संस्तुतीत जैव बहुलकों को परत बनाने वाले पदार्थों की तरह इस्तेमाल करते हुए लौह प्रबलीकृत गेहूं दलिया प्रीमिश्रण बनाया गया। इसे बनाने के लिए वांछित लौह की मात्रा के अनुसार (लौह मात्रा–16 मिग्रा/मिलीलीटर), लौह विलयन का छिड़काव दलिया में करके, 30 मिनट की टेम्परिंग के लिए रखते हैं। इसके बाद प्रीमिश्रण को सुखा लेते हैं। इस प्रकार बनाए गये गेहूं दलिया प्रीमिश्रण में लौह की मात्रा 4.27 मिग्रा/100 ग्राम थी। इसी प्रकार कैल्शियम प्रबलीकृत गेहूं दलिया प्रीमिश्रण बनाने के लिए कैल्शियम लवण के घोल का गेहूं दलिया पर छिड़काव किया जाता है तत्पश्चात 90 मिनट की टेम्परिग कर सुखा लिया जाता है। प्रबलीकृत गेहूं दलिया के प्रीमिश्रण में कैल्शियम की मात्रा 28.8 मिग्रा/ग्राम थी।

खाद्यों में मिलावट की पहचान एवं उनका मात्रात्मक निर्धारण

दूध में अफलाटाक्सिन एम–1 का पता लगाने के लिए एवं शीघ्र गुणवत्ता निगरानी वाले तरीके के रुप में फोरियर ट्रांसफार्म इन्फ्रारेड स्पेक्ट्रोस्कोपी की कीमोमेट्रिक्स के साथ क्षमता का ऑकलन किया गया। इसके लिए अफलाटाक्सिन एम–1 को दूध में मिलाकर (20–100 पी पी टी) वर्णक्रम लिए गए। शुद्ध दूध एवं अफलाटाक्सिन मिश्रित दूध के वर्णक्रमों में स्पश्ट रूप से अंतर पाया गया। दूध में अफलाटाक्सिन बी–1 का पता लगाने एवं उसकी मात्रा निर्धारण करने में भी फोरियर ट्रांसफार्म इन्फ्रारेड स्पेक्ट्रोस्कोपी तकनीक की क्षमता का आंकलन किया गया। शुद्ध दूध में माइकोटाक्सिन की अलग–अलग मात्रा (10,20,30,40 और 50 पी .पी बी) मिलाकर वर्णक्रम लिए गये। मिलावटी एवं गैरमिलावटी दूध से प्राप्त होने वाले वर्णक्रमों में स्पष्ट अन्तर पाया गया।

केसर मसाले के रूप में एवं खाद्यों को रंगने के लिए इस्तेमाल किया जाता है। इसके अलावा कम पैमाने पर कपड़ों को रंगने वाली डाई एवं इत्र के रुप में भी इस्तेमाल किया जाता है। केसर एक बहुमुल्य मसाला है जिसमे प्रायः कुसुम के फूलों की मिलावट की जाती है। इस प्रकार की मिलावट का पता लगाने के लिए संस्थान द्वारा पी सी आर आधारित पद्धति विकसित कर उसे केसर मे कुसुम की मिलावट का पता लगाने के लिए अनुकूलित एवं मान्य किया गया। इस पद्धति द्वारा प्राइमर सेट एस ए एफ एल–40 का उपयोग कर केसर में कुसुम की 1% मात्रा तक का भी निर्धारण किया जा सकता है।

जीवित मछली परिवहन वाहन

जीवित मछलियों को कम दूरी तक परिवहन के लिए संस्थान द्वारा बैट्री चालित स्वनिहित एरिएटिंग वाहन बनाया गया। यह वाहन 12 वोल्ट एवं 100 एम्पियर की रिचार्जेबल लेड अम्ल बैट्रीयों द्वारा संचालित होता है इसके साथ ही यह स्वतः एरिएटिंग प्रणाली युक्त है। इस वाहन की 500 किलोग्राम (मछली 200 किलोग्राम + पानी 200 किलोग्राम एवं वाहन चालक का भार) तक भार वहन की क्षमता है। यह एक बार चार्ज करने पर 60–80 कि.मी. की दूरी तक चल सकता है। इसमें स्वतः एरिएटिंग पात्रों को एक के ऊपर एक करके रखा जा सकता है एवं आसानी से उतारा भी जा सकता है। इन पात्रों में लगभग 10 से 20 कि.ग्रा. मछली प्रति पात्र ले जायी जा सकती हैं। यह एरिएटर, फिल्टर एवं मेटाबोलाइट अवशोशक से सुसज्जित है जो कि मछलियों के परिवहन के दौरान पानी की आदर्श गुणवत्ता को बनाए रखने में मदद करता है।

पशु आराम प्रणालियां

बीमार पशुओं को खड़ा रखने एवं उठाने के लिए एक पशु लिफ्टर विकसित किया गया है। इस लिफ्टर द्वारा 1000 कि.ग्रा. भार तक के छोटे एवं बड़े पशुओं (गाय, भैंस, ऊँट और घोड़े) को उठाया जा सकता है। इसको आसानी से इधर–उधर ले जाया जा सकता है और इसके पूर्जों को आसानी से अलग किया एवं जोड़ा जा सकता है। यह अत्यधिक टिकाऊ गैल्वेनाइज्ड लोहे से बना हुआ है। पशु गोफन (स्लिंग) को अत्यधिक टिकाऊ कपडे से समर्थित पॉलिस्टर से बने पट्टों से बनाया गया है। यह बीमार पशुओं को पर्याप्त समर्थन और आराम एवं सुविधा प्रदान करता है। इसमें दो पट्टियो को क्रास (cross) व्यव्स्था में सिला गया है। पट्टियों की लम्बाई को समायोज्य शाफ्ट और जानवर के आकार के अनुसार स्वयं ताला बकसुआ के साथ समायोजित किया जा सकता है। गोफन की लम्बाई (जानवर की परिधि का प्रमुख हिस्सा लपेटकर रखने के लिए) एवं चौड़ाई क्रमशः 1.58 और 9.83 मीटर है।

पशु कल्याण एवं आसान पशु चिकित्सा निरीक्षण तथा अन्य उपचार प्रक्रियाओं को ध्यान में रखते हुए पशु को नियंत्रित करने के लिए एक प्रोटोटाइप विकसित किया गया। इस प्रोटोटाइप के मुख्य फ्रेम की ऊँचाई 1.07, चौड़ाई 0.71 एवं लम्बाई 1.22 मीटर है। इसमें पशुओं के सिर को स्थिर रखने की व्यवस्था के साथ बाहर निकलने के लिए खुलने वाले गेट की भी व्यवस्था प्रदान की गयी है। जानवर को नियंत्रित करने के लिए समायोज्य पार्श्व पैनल भी लगाया गए हैं।

ए आई सी आर पी–पी एच ई टी (AICRP on PHET) ने खाद्यान्न, बागवानी उत्पादों एवं पशुधन उत्पाद प्रसंस्करण के क्षेत्र में विभिन्न मशीनों, उत्पादों और प्रक्रिया प्रोटोकाल को विकसित किया है। पीएचईटी की 2015–16 वर्ष की प्रमुख उपलब्धियों में चने की हरी फलियों से दाने को अलग करने की मशीन, चौलाई पॉपिंग इकाई, मक्का से छिलका एवं दाने अलग करने की मशीन, पेक्टिन निकालने के लिए प्रायोगिक संयंत्र, अनानास फसल काटने की मशीन, हल्दी की धुलाई के लिए

मशीन, प्याज की क्यूरिंग एवं भंडारण के लिए संरचना, भारत के दक्षिण–पूर्व राज्यों के लिए उपयुक्त अदरक को सुखाने की मशीन, चीकू को सतत् धोने की मशीन (sapota cleaner), बहु मोड सौर शुष्कक एवं समुद्री खाद्य उद्योगों से प्राप्त होने वाले अपशिष्ट का उपयोग कर पोल्ट्री फीड का उत्पादन करने की प्रौद्योगिक शामिल है। अन्य विभिन्न प्रौद्योगिकियां जैसे कि मधु हीटिंग–सह निस्पंदन, महुआ से बीज निकालना, मछली से पैटीज़ एंव चिकुआ बनाने की विधि, प्रोटीन प्रचुर कसावा पास्ता एवं तले हुए उत्पाद इत्यादि को विभिन्न उद्यमियों को स्थानान्तारित किया गया। इसके अलावा दो सफलता की कहानियां **"एग्रो प्रोसेसिंग सेन्टर फार टर्निंग फार्मर इनटू इन्ट्रीप्रनोयोरस"** और "मॉडल रिटेल आउटलेट फार प्रोडक्सन आफ हाइजीनिक चिकन मीट" को भी प्रकाशित किया गया। इसके साथ ही 7 पेटेंट दाखिल किए गए और 22 कृशि प्रसंस्करण केन्द्रों को विभिन्न स्थानों में स्थापित किया गया। कई प्रशिक्षण सह–प्रदर्शन कार्यक्रम, कार्यशालाओं और उद्यमिता विकास कार्यक्रमों का आयोजन भी किया गया।

इस वर्ष ए आई सी आर पी–पी ई टी (AICRP on PET) के चार नये केन्द्रों–बी.एस.के.के.वी., डापोली, यूएएस, रायचुर, आईसीएआर–सी.आइ.जी.आर, मखदूम और एन.आर.सी.वाई, दीरांग की शुरूआत की गयी एवं सी.एस.के.एच.पी.के.वी, पालमपुर केन्द्र को बन्द किया गया। एआइसीआरपी–पीईट की इस वर्श की मुख्य उपलब्धियों में ग्रीनहाउस से संयुग्मित धरती नलिका ऊश्मा एक्सचेंजर का डिजाइन एवं मूल्यांकन, स्वच्छ मछली विपणन के लिए प्लासटिक के उपकरण, संरक्षित फसल प्रणाली के तहत सब्जियों द्वारा ऊर्जा उपयोग की दक्षता बढाने की प्रौद्योगिकी, मध्य पहाड़ी क्षेत्रों के लिए संशोधित जल कृषि प्रणाली का विकास, मूंगफली फसल के लिए मल्चिंग प्रौद्योगिकी, वर्षा जल संचयन और बेहतर जल दक्षता के लिए प्लास्टिक का उपयोग, पहाडी क्षेत्रों में प्लास्टिक का उपयोग कर बनाए गए तालाबों के लिए गुरूत्वाकर्शण संचालित ड्रिप सिंचित प्रणाली की डिजाइन और कम गुरूत्वाकर्शण वाली ड्रिप सिंचाई प्रणाली इत्यादि है।

शोध सम्बंधी क्रिया कलापों के अलावा संस्थान अन्य कई कार्यक्रमों जैसे कि किसानों, विद्यार्थियों, कृशि अधिकारियों और उद्यमियों को कटाई उपरान्त प्रबन्धन से सम्बधित कई प्रशिक्षण कार्यक्रमों का भी आयोजन करता है। इस वर्श संस्थान द्वारा 3 आईसीएआर प्रायोजित ग्रीश्म/शीत स्कूलों का आयोजन किया गया। इसके अलावा संस्थान द्वारा कृशि अधिकारियों के लिए 2 एवं किसानों के लिए 3 प्रशिक्षण कार्यक्रमों का आयोजन भी किया गया।

प्रत्येक वर्ष की भांति इस वर्ष भी संस्थान ने विभिन्न कृषि प्रदर्शनियों में भाग लिया और संस्थान द्वारा विकसित प्रौद्योगिकियों एवं मशीनों का प्रदर्शन किया। प्रमुख प्रदर्शनियों में पंजाब कृषि विश्वविद्यालय, लुधियाना में आयोजित किसान मेला; भारतीय कृषि अनुसंधान संस्थान, नई दिल्ली में आयोजित कृशि उन्नति मेला; कोयम्बटूर, तमिलनाडु में आयोजित एग्री इंटेक्स 2015; मोतीहारी बिहार में आयोजित कृषि प्रदर्शनियां; विश्व मतस्य दिवस–2015 के अवसर पर दिल्ली के प्रगति मैदान में आयोजित आइ.आइ.टी.ई–2015; नई दिल्ली में आयोजित इंडिया इटरनेशनल ट्रेड मेला–2015 इत्यादि शामिल हैं। संस्थान द्वारा हाल ही में प्राप्त की गयी उपलबधियों पर प्रकाश डालते हुए एक नई वीडियो फिल्म भी बनायी गयी। साथ ही संस्थान की आधिकारिक वेबसाइट को भी उन्नत किया गया। कृषि उत्पादों के कटाई उपरान्त प्रबंधन के बारे में जागरूकता पैदा करने के लिए 13 रेडियो वार्ता युक्त कार्यक्रमों की एक ऋंखला "दो दुनी चार" कार्यक्रम के अन्तर्गत आकाशवाणी जालंधर द्वारा प्रसारित किया गया। संस्थान में "साम्प्रदायिक सद्भावना सप्ताह", "सतर्कता जागरूकता सप्ताह" "जय किसान जय विज्ञान सप्ताह" का आयोजन किया गया। संस्थान का 26वां स्थापना दिवस पूरे हर्श और उल्लास के साथ मनाया गया। इस वर्श संस्थान में "मेरा गॉव मेरा गौरव" योजना को पूर्ण उत्साह के साथ शुरू किया गया। इस योजना के तहत संस्थान द्वारा लुधियाना और अबोहर की परिधि में 38 गांवों को अपनाया गया है।

इस वर्ष संस्थान को मशीनीकरण और प्रौद्योगिकी प्रभाग, कृषि एवं सहकारिता विभाग, कृषि मंत्रालय, भारत सरकार द्वारा कटाई–उपरान्त उपयोग आने वाले सभी उपकरणों एवं मशीनों के सभी प्रकार के परीक्षण के लिए अधिकृत किया गया है। इस पहल के द्वारा संस्थान को कटाई उपरान्त उपयोग में आने वाले सभी उपकरणों एवं मशीनों की उच्च गुणवत्ता को बनाए रखने में मदद मिलेगी। इसके अलावा द्वितियक कृषि (secondary agriculture) और स्वास्थवर्धक खाद्य (health food) पर दो मेगा अनुसंधान परियोजनाओं को भी संस्थान के लिए भारतीय कृशि अनुसंधान परिषद द्वारा अनुमोदित किया गया है। खाद्य गुणवत्ता और सुरक्षा के साथ–साथ कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी के क्षेत्र में सहयोगात्मक अनुसंधान कार्य के लिए संस्थान ने खाद्य प्रसंस्करण उद्योग मंत्रालय के अग्रणी संस्थान राष्ट्रीय खाद्य प्रौद्योगिकी उद्यमिता एवं प्रबंधन के साथ समझौता ज्ञापन पर हस्ताक्षर भी किए।

कई विशिष्ट हस्तियां जैसे कि कृषि वैज्ञानिक भर्ती बोर्ड के अध्यक्ष; अपर सचिव डेयर; उपमहानिदेशक (कृषि अभियांत्रिकी); भारतीय कृषि अनुसंधान परिषद, नई दिल्ली; सहायक महानिदेशक (प्रक्रिया अभियांत्रिकी), भारतीय कृषि अनुसंधान परिषद, नई दिल्ली; निदेशक, सी.एस.आई.आर–केन्द्रीय वैज्ञानिक उपकरण संगठन (सी.एस.आइ.ओ), चंडीगढ; कुलपति, बागवानी एवं वानिकी विश्वविद्यालय, भरसार आदि ने संस्थान का दौरा किया। इसके अलावा इलिनोइस विश्वविद्यालय के वैज्ञानिकों एवं छात्रों का एक समूह एवं अमेरीका–भारत–अफ्रीका त्रिकोणीय अंतराष्ट्रीय प्रशिक्षण कार्यक्रम के तहत केन्या, लाईबेरिया और मालावी के अधिकारियों ने संस्थान का दौरा किया और कटाई उपरान्त प्रबन्धन के कई मुद्दों पर गहन चर्चा की।

EXECUTIVE SUMMARY

During the reported year (2015-16), the institute has achieved several milestones towards its continuous contribution in the area of post-harvest engineering and technology. The research projects of the institute covered the area of de-oiled cake/meal utilization; by-products utilization of fruit processing industries; micro-encapsulation; *kinnow*; *ber* and pear processing; product development; food fortification; identification and quantification of food adulterants; live fish transportation; animal comfort systems etc. The AICRP on PHET developed various machines, storage structures, process technologies and value added products. AICRP on PET was basically involved in designing of structures (polyhouses) for protected cultivation.

The highlights of the research, extension and other accomplishments of the year 2015-16 are as follows:

De-oiled cake/meal utilization:

Indigenous pilot plant has been designed and commissioned for production of protein isolate from groundnut de-oiled cake. The other de-oiled cakes i.e. soy meal, sunflower cake, mustard cake etc. can also be processed for the purpose. The pilot plant comprises of the extraction tank, centrifuge and precipitation tank as major component. Isolates produced from this plant has more than 90% of protein. This plant can process 40 kg of raw materials/day.

By-products utilization of fruit processing industries

A process was developed for pectin extraction from *kinnow* peel using microwave energy. *Kinnow* peel powder was soaked in water, microwaved at 900 W for different durations, cooled and precipitated with ethyl alcohol, decanted and dried. Pectin yield of 10.5% was obtained with 60 min of microwave incubation and combinatorial treatment of citric acid and degradative enzymes at pH 2.0. Yield of pectin without microwave treatment of *kinnow* peel was 5-6% only.

Process technology and ingredients level were optimized for the preparation of pear pomace based soft toffee. Soft pear toffee was prepared by mixing 30% sugar, 0.25% pectin and 1000 ppm KMS (based on pear pomace). The process comprised: boiling of pear pomace at low flame till its volume reduced to half, addition of sugar with continuous stirring followed by addition of pectin.

Microencapsulation

Oil in water emulsion of flaxseed oil, garlic oil and in combination (both) was prepared using soy lecithin as emulsifier and whey protein concentrate as a stabilizer. The emulsion is mixed with the alginate as a coating material to obtain a homogenous mixture. The encapsulation efficiency determined for flaxseed oil, garlic oil and flaxseed oil-garlic oil microcapsule was 85, 69 and 92% respectively. Scanning electron microscopy revealed that the microcapsules were almost spherical, discrete and completely covered with sodium alginate as coating material.

***Kinnow*, *ber* and pear processing**

A prototype of semi-automatic peeler was designed and developed for the peeling of sweet orange and *kinnow*. The fruit is placed manually between the fruit holders. There is an arrangement of spring which provides the clearance for the movement of blade according to diameter of *kinnow*. The machine can be operated with 0.5 HP motor (maximum speed of 1440 rpm). Preliminary trials showed that this semi-automatic peeler takes approximately 8-10 s for peeling of single *kinnow* fruit with minimum loss of pulp/juice.

❖ A pneumatic assisted coring device was developed for removal of central core/stone from oblong fruits like *ber* and *date palm*. It comprises of a hopper with vibrating feeding mechanism, movable wooden roller, extended fruit dropper, four wooden frames (470×50 mm, with 6 openings of 25.4 mm diameter each), fruit coring tools (6 No.), core outlet and cored fruit outlet. The coring capacity of the

developed prototype for *ber* (cv. Umran) fruits is 28 kg/h, and for date palm (cv. Hillawi) 16 kg/h. Coring efficiency is 78 and 65% for *ber* (cv. Umran) and date palm (cv. Hillawi), respectively.

Product development / Food fortification

Low-fat meat products have been developed with the use of plant based fat replacers. A substantial fat reduction up to 30-35% as compared to full-fat control meat emulsion was achieved. Thus, plant gel is a potent fat replacer for manufacturing of low-fat meat emulsion.

Fruits/fruit drinks lack the protein as a nutritional component. The major challenge to the protein fortification of fruit drinks is to stabilize the protein in the acidic and ionic environment. The most fruit drinks are formulated to pH range of 3.0 to 4.0, where the iso-electric pH of the most of food proteins lies, due to which the protein gets precipitated and leads to unacceptable beverage. The mango RTS beverage with 3.0% protein was successfully developed, which had good sensory appeal and stability during thermal processing as well storage in glass bottles.

Low fat yoghurt & Ice-cream: OSA-modified pearl millet starch was evaluated in double toned (1.5% fat) and toned milk (3.0% fat) up to 2.0% level in order to develop low fat yoghurt. The total sensory scores (95.8 and 95.2) for the double toned and toned milk yoghurt samples containing 1.5% modified starch was higher than that of the yoghurt prepared from standardized milk (86.7). On the basis of improved product firmness, consistency, rheological (structural strength, G'), syneresis and overall sensory acceptability over control, the addition of 1.5% OSA-modified pearl millet starch was found optimum to prepare low fat (1.5%) yoghurt with equivalent quality of standardized milk yoghurt (fat 4.5%). Similarly, the level of OSA-modified pearl millet starch was also optimized in ice-cream mix and found that it can be added at 1 and 2% level in order to prepare ice-cream with 7.5 and 5% fat, respectively, with similar acceptability of ice-cream having 10% fat. Thus OSA modified pearl millet starch can reduce 75% fat in yoghurt at 1.5% level; 25 and 50% in ice-cream at 1 and 2% respectively.

Gluten free muffins were developed from quality protein maize (QPM) flour with different proteins (whole milk, egg proteins, casein, soy protein isolate and whey protein isolate). The hardness and chewiness of egg fortified muffins were 49 and 16.6 N against 68.2 and 28.7 N for control samples, respectively. The muffins prepared from QPM with whole milk and whey protein were also found acceptable.

Protein and minerals rich expanded snack food was developed utilizing maize (74%), defatted soy flour (15%), spinach powder (6%) and sesame seed (5%). Optimized parameters for extursion were as: feed moisture 14%, die head temperature 115°C and screw speed 335 rpm. The optimized sample had 18.2% protein, 3.0% total minerals, 24.6% antioxidant activity, 7.66 mg/100 g flavonoids. Its overall sensory acceptability on 9 point headonic scale was 8.1.

Protein and minerals rich pasta containing spinach powder was developed. Optimized combinations of different raw materials for spinach incorporated pasta were: 80.8% wheat semolina, 10.9% defatted soy flour, 5.9% spinach powder, 3.9% sesame seeds and 24 ml/100 g carrot juice. It contained 17.3% protein, 2.4% total minerals, 23.4% antioxidant activity, 10.0 mg/ 100 g flavonoids and had 7.4 overall sensory acceptability score. The rehydration ratio and cooking time was 2.38 and 6 min respectively.

In order to develop osmotically dried pear slices pre-treatments were optimized with different salts to prevent the browning. The salt of calcium lactate (Ca-L) was more effective in lowering the water activity (a_w) than $CaCl_2$. Beyond 2.0% $CaCl_2$ concentration undesirable bitter taste to the dried pear was observed while Ca-L at same concentrations did not imparted bitter taste. Calcium treatment improved the colour and texture of the dried pear. Calcium lactate could be used as an alternative of $CaCl_2$ for pre-treatment of pear slices in order to improve the quality prior to drying.

Iron fortified wheat *dalia* premix was developed using spraying technique followed by tempering and coating with recommended biopolymers. In view of desired iron content in the premix, spraying of iron containing solution (Iron content-16 mg/ml), 30 min

tempering time followed by drying was found optimum. Iron content in the fortified wheat *dalia* was 4.27 mg/100 g. Similarly, calcium fortified wheat *dalia* premix was also developed by addition of calcium salt i.e. calcium chloride solution (calcium 90 mg/ ml), tempering for 90 min followed by drying. Calcium content in the fortified wheat *dalia* premix was 28.8 mg/g.

Identification and quantification of food adulterants

The potential of Fourier Transform Infrared (FTIR) spectroscopy together with chemometrics was investigated as a rapid quality monitoring method for detection of Aflatoxin M1 in milk. Spectral signatures of Aflatoxin M1 spiked (20-200 ppt) milk samples were acquired. Spectra revealed clear differences in the absorbance values of milk with and without Aflatoxin M1 (AFM1). The potential of Attenuated Total Reflectance (ATR) - FTIR was also evaluated as a rapid method for detection and quantification of Aflatoxin B1 (AFB1) in milk. Spectra (4000–500 cm^{-1}) of milk adulterated with known concentrations of mycotoxin (viz. 10, 20, 30, 40 and 50 ppb) were analyzed. The adulterated and non-adulterated milk showed clear differences in absorption values.

Saffron (*Crocus sativus*) is used as spice and food colorant and, less extensively, as a textile dye or perfume. It is one of the most common spices that is adulterated with safflower. A PCR based method for detection of safflower adulteration in saffron is optimized and validated. Safflower concentration of as low as 1% could be detected by using primer set SAFL-40 which resulted in single amplification product of expected size 414 bp.

Live fish transportation

A battery operated self-contained aerating vehicle for short distance transportation of live fish was developed. It is operated by rechargeable 4 Lead Acid batteries of 12 Volt 100A each, equipped with self-aerating system with a total carrying capacity of 500 kg (200 kg fish + 200 kg water). In a single charge it can run about 60-80 km. It has two major components, Self-Aerating Containers (SAC) and Battery Operated Vehicle (BOV). SAC are stackable and easy to unload with approximate capacity of 10-20 kg fish/container. It is equipped with aerators, filters and metabolite absorbent to maintain ideal water quality for fish during transportation.

Animal comfort systems

An animal lifter along with animal sling is developed for lifting sick animals (downers cow/ accident hurt animals) and providing support till recovery. It can lift up to1000 kg body weight of animals including small to large (cow, buffalo, camel and horse). It is portable, easy to dismantle and made of heavy duty GI pipes. The animal sling is made up of polyester web straps supported with heavy duty fabric which provides adequate support and comfort to sick animals. Two straps are stitched crosswise. The length of straps can be adjusted with adjustable ratchet and self- locking buckle according to the size of the animal. Length (for wrapping major part of girth of animal) and width of animal sling are 1.58 and 0.83 m.

A prototype of animal squeeze chute was developed to restrain the animal keeping in view of animal welfare considerations for easy veterinary inspection and other treatment procedures with following dimensions and features: main frame: height- 1.07 m; width 0.71 m and length 1.22 m; head locking arrangement with openable gate for exit; movable side panels to restrain animal.

The AICRP on PHET developed various machines, products and process protocols in the area of food grains, horticultural commodities and livestock produce processing. The major achievements includes green chickpea pod stripping machine, amaranthus popping unit, improved maize dehusker-cum-sheller, pilot plant for pectin extraction, pineapple harvester, turmeric washing machine, curing and storage structure for onions, drying system for ginger suitable to North Eastern states, power operated continuous sapota cleaner, multi-mode solar dryer (5 tonnes capacity) and technology for the production of poultry feed using seafood industry waste. Various technologies such as honey-heating-cum filtration system, *mahua* seed decorticator, fish patties and fish chikuwa, protein rich cassava pasta and fried products etc. were transferred to various entrepreneurs. Two success stories entitled "Agro-Processing Centre for Turning

Farmers into Entrepreneurs", "Model Retail Outlet for Production of Hygienic Chicken Meat" were published. Seven patents were filed and 22 APCs were also established across the India. Besides, many training cum demonstration programmes, workshops and EDPs were organized.

AICRP on PET has started four new centres at BSKKV Dapoli, UAS Raichur, ICAR-CIGR Makhdoom and NRCY Dirang and closed one centre at CSKHPKV, Palampur. Major achievements of AICRP on PET includes design and evaluation of earth tube heat exchanger (ETHE) coupled greenhouse, plastic gadgets for hygienic fish marketing, enhancing the energy use efficiency of vegetable based cropping system under protected condition, development of improved aquaculture system in mid hills, mulching technology for bunch type groundnut crop, rain water harvesting and its utilization for better water efficiency, design of gravity-fed drip irrigation system for hilly areas, plastics lined ponds and low head gravity drip irrigation system.

Apart from contribution in research activities, institute has organized trainings for farmers, officers, entrepreneurs and students on post-harvest management. Three ICAR sponsored summer/winter schools i. e. "Recent advances in development of automatic systems/machines for secondary agriculture", "Advances in processing, value addition and by product utilization of livestock and fish produce" and "Novel approaches and technologies for processing and value addition of agricultural produce"; two agricultural officers training, three farmers training were organized at the Institute.

Institute showcased and demonstrated its technologies in 9 agricultural exhibitions viz. "*Kisan Mela*" at PAU, Ludhiana; "*Krishi Unnati Mela*" at IARI, New Delhi; Agri-Intex 2015, Coimbatore, Tamil Nadu; Agricultural Exhibitions 2015, Motihari, Bihar; IITE-2015 on World Fisheries Day 2015 at Pragati Maidan, New Delhi; IASOWA exhibition at New Delhi; 5th Global Economic Expo Summit 2015 at WTC Mumbai and in India International Trade Fare-2015 at New Delhi.

A new video film, highlighting the recent achievements of the institute was prepared. The institute website was also upgraded. To create awareness about post-harvest management of agricultural commodities, 13 radio talks on post-harvest management of different agricultural commodities under the programme "*Do Duni Chaar*" was broadcasted through All india Radio, Jalandhar.

Institute celebrated "Communal Harmony Week", "Vigilance Awareness Week", "*Jai Kisan Jai Vigyan* Week" and 26th foundation day of the institute. "*Mera Gaon Mera Gaurav*" scheme was started with full enthusiasm. Under this scheme, institute has adopted 38 villages in the periphery of Ludhiana and Abohar.

During the year, the institute has been authorized for testing of all types of Post-Harvest Equipment and Machinery by Mechanization & Technology Division, Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India to ensure supply of quality post-harvest equipment & machinery by manufactures. Two mega consortium research projects on Secondary Agriculture and Health Foods have also been approved by ICAR for the institute. Memorandum of understanding was signed with MOFPI-NIFTEM for collaborative research work in the area of post-harvest engineering and technology as well as food quality and safety.

Many distinguished personalities viz. Chairman, ASRB; Additional Secretary, DARE; Deputy Director General (Agri. Engineering), ICAR, New Delhi; ADG (Process Engineering), ICAR, New Delhi; Director, CSIR-Central Scientific Instruments Organisation (CSIO), Chandigarh; Vice-Chancellor, University of Horticulture & Forestry, Bharsar etc. visited the institute. Besides, a group of scientists and students from University of Illinois, USA, group of officers from Kenya, Liberia and Malawi under US-INDIA-AFRICA Triangular International Training Programme also visited and discussed the post-harvest issues.

ICAR-CIPHET - AN OVERVIEW

The ICAR-Central Institute of Post-Harvest Engineering and Technology (ICAR-CIPHET) was established on 29th December 1989 at Ludhiana, Punjab (India); as a nodal institute to undertake lead researches in the area of post-harvest engineering and technology appropriate to agricultural production catchments and agro-industries. The institute's second campus was established on 19th March 1993 at Abohar, Punjab and is primarily responsible for conducting research and development activities on fruits and vegetables. ICAR-CIPHET is also headquartering two All India Coordinated Research Projects (AICRPs) *viz.* AICRP on Post-Harvest Engineering and Technology (PHET) with 34 centres and AICRP on Plasticulture Engineering and Technology (PET) with 14 centres spread over the country.

Vision

Higher profitability of agricultural production systems ensuring better income to farmers and increased employment opportunities in rural sector through efficient post harvest engineering and technological interventions for loss reduction and value addition to agricultural produce and by-products resulting in high quality and safe food and feed at competitive prices for domestic and export markets.

Mandate

- Research for solving problems and identifying technologies related to post-harvest loss assessment and prevention, processing, value addition and storage of agricultural, horticultural, livestock, and aquaculture produce targeted to achieve food safety and quality assurance
- Human resource and entrepreneurship development in post-harvest engineering and technology.

Research Divisions

Ludhiana Campus

1. Agricultural Structures and Environment Control
2. Food Grains and Oilseeds Processing
3. Transfer of Technology

Abohar Campus

4. Horticultural Crops Processing

Consortium Research Platforms (CRPs)

1. CRP on Secondary Agriculture
2. CRP on Health Food

Infrastructure

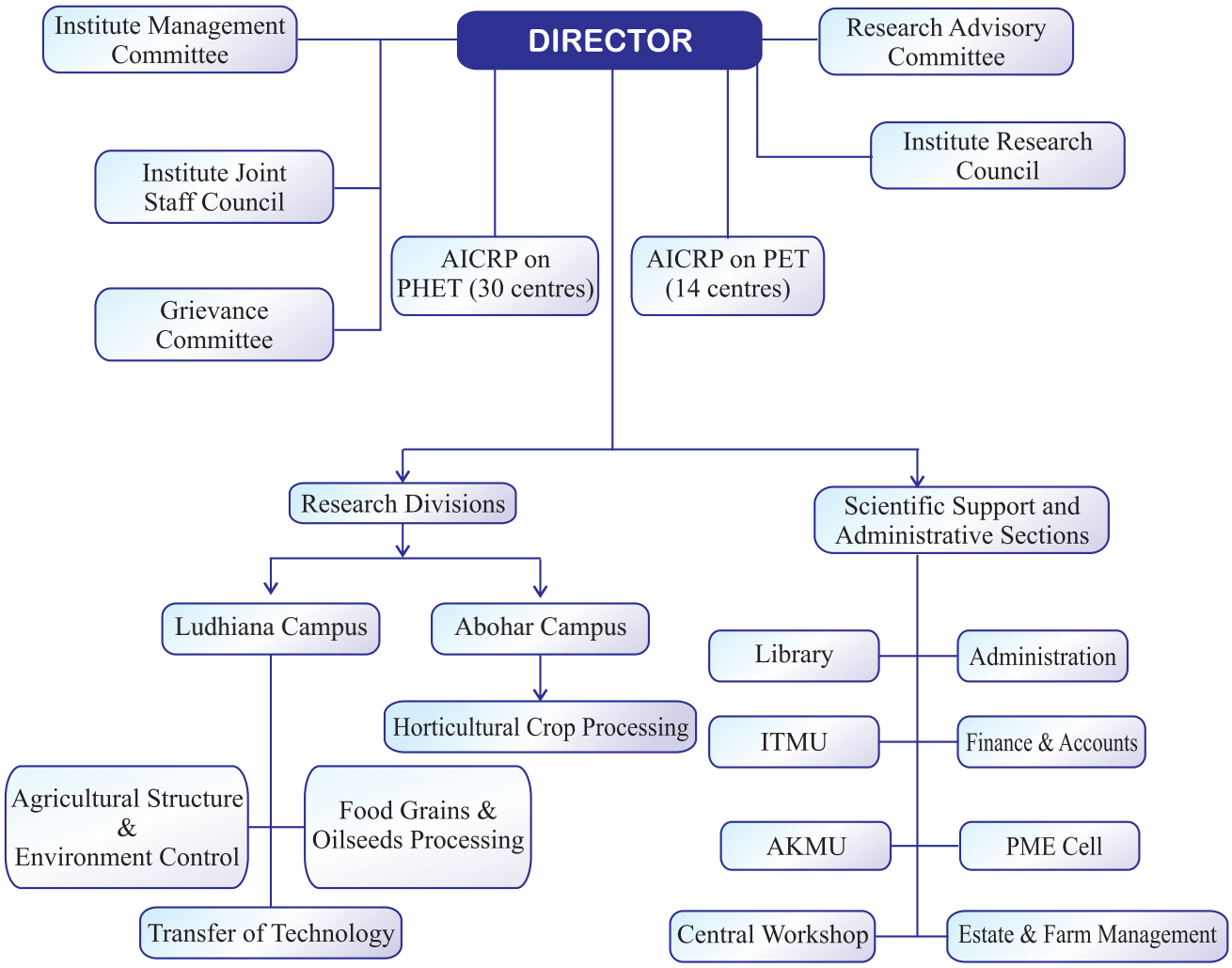
Workshop

The workshops at ICAR-CIPHET, Ludhiana and Abohar manage fabrication and modification of post-harvest machinery, which are designed and developed under different research projects. Workshops also extend service support to repair and maintenance of institute facilities/ work etc. from time to time. It is equipped with drilling machine, gas welding set, arc welding set, sheet bending machine etc. to deliver its services. Besides, various measuring instruments are also available in the workshops, which are useful in day to day research work.

Agro Processing Centre (APC)

Agro-processing centre is designed to process the agricultural produce in production catchment with a view to enhance employment and income opportunities in rural areas. At ICAR-CIPHET, modest agro-processing centre has been established for processing of bengal gram, green gram, pigeon pea, maize, black pepper, turmeric, coriander etc. The processed products are being regularly sold to customers in and around ICAR-CIPHET. During the reported period, the total purchase value of raw materials was Rs 1,73,588/-. The net profit amount was Rs 9,299/- against the sale of processed products like *dal*, *besan*, ground spices etc. Besides, the APC

ORGANIZATIONAL STRUCTURE



STAFF POSITION

Category	Sanctioned	Filled		Total Filled	Vacant
		Ludhiana	Abohar		
Scientific	76*	31	08	39	37
Administrative	21#	16	03	19	03
Technical	29	16	08	24	05
Supporting	05	03	01	04	01
Total	**131**	**66**	**20**	**86**	**46**

* Excluding Director # Including SAO

Discipline wise distribution of scientific strength

Discipline	Pr Scientist	Sr Scientist	Scientist	Total
Agricultural Process Engineering	3*	2	8	13
Agricultural Structures & Environmental	1	-	3	4
Agricultural Economics	1	-	-	1
Agricultural Microbiology	-	-	2	2
Biotechnology (Plant Science)	-	1	-	1
Biochemistry (Plant Science)	-	2	1	3
Chemical Engineering	1	-	-	1
Electronics & Instrumentation	-	-	1	1
Food & Nutrition	1	-	-	1
Food Technology	-	1	5	6
Fish Processing Technology	-	1	-	1
Horticulture	-	2	-	2
Livestock Product Technology	-	-	2	2
Management				
Microbiology-Plant Science	-	1	-	1
Total	**7**	**10**	**23**	**39**

*Excluding Director

facilities are also used to impart training to potential small rural entrepreneurs.

Food Testing Laboratory

The well equipped Food Testing Laboratory funded by Ministry of Food Processing Industries (MoFPI) has been established. The laboratory houses basic and some of the semi-advanced equipment for food analysis and evaluating the safety aspects of food products. This laboratory will cater to the food testing and quality analysis requirements of different stake holders, entrepreneurs in getting their samples tested. Testing protocols for certain parameters like water quality testing, fat, protein and fibre analysis, mineral contents etc. have been validated. This facility will enable the institute to answer the need based test requirement of processers, entrepreneurs, small and medium enterprises and industry at reasonable testing charges.

Testing Centre for Post-Harvest Equipment & Machinery

The institute is authorized for testing of all types of Post-Harvest Equipment and Machinery by Mechanization & Technology Division, Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India to ensure supply of quality post-harvest equipment & machinery by processing equipment & machinery manufactures to the end users. This is a unique facility in the country available at ICAR-CIPHET for testing of post-harvest technology equipment & machinery.

Agri-Business Incubation (ABI) Centre

Agri-Business Incubation (ABI) facility is also available at the Institute. The centre is established with financial help of ICAR, New Delhi under "National Agricultural Innovation Fund". The ABI centre is providing necessary support for validation and up-scaling of technologies to encourage its reach to the user as an attractive business venture. The centre is also expected to facilitate innovator and researchers to turn their ideas into commercial venture. The centre will focus on incubation and business development programme including entrepreneurship skill development and Grassroots Innovators activities.

The centre had following set objectives:

- Skill and Entrepreneurship Development in Food Processing and Value Addition.
- Skill and Entrepreneurship Development in Food Processing Machinery Manufacturing based on institute technology and / or entrepreneurs innovation.
- Assist Skilled/Trained Entrepreneurs in Establishing Food Processing and Value Addition Industries in Production Catchment.

Library

ICAR- CIPHET library plays an important role and act as a centre for knowledge and information related to the Institute's mandate. It has good collection of books and journals in the area of post-harvest engineering, food processing, food engineering, food microbiology and biotechnology that attracts many researchers / visitors from all over the nation to review the literature. During the reported year, 154 new publications were added to its collection. This brings the total number of books & standards in the library to 5068. The library subscribed 12 journals, out of which 1 is foreign scientific journal (in print) and 11 are Indian scientific journals/ magazines (in print). In addition of these, a number of National and International serial publications, Annual reports, Newsletters and Research Bulletins were received on gratis. Wi-Fi facility is made available in the library, so that library users may use their own laptop and other electronic gadgets to access internet. The library as a member of Consortium for e-Resources in Agriculture (CeRA) is getting access to more than 2000 online full text journals. The library also provides Internet, E-mail, information retrieval and Xerox services to the scientists and students. Current content service of journals and list of new arrivals is also being circulated among the CIPHET staff.

Guest House

Both Ludhiana and Abohar campus has guesthouse facilities for providing accommodation to ICAR/SAUs/Government employees and farmers. One International Training Centre with 08 AC-rooms and dining hall with kitchen is also available at Ludhiana campus.

Units

Prioritization, Monitoring and Evaluation (PME) Cell

Prioritization, Monitoring and Evaluation concept is the key management tool in R&D system to enhance scientific productivity. It helps in setting a unified priority and monitoring of externally funded and in house projects. PME cell of the institute conducts Institute Research Council meeting and maintains the record of research projects. The monthly and quarterly reports of individual scientist are collected and compiled into progress reports, results framework document, quarterly and half yearly performance review reports. It also acts as link between various regional committee meetings, directors' conferences etc. and the institute scientists. The exchange of information takes place through PME cell. The database of parliament questions and their answers, action taken reports and issues related to scientific activities of the institute are dealt by PME cell. The research information related to ongoing and completed research projects is uploaded through Project Information and Management System (PIMS) software to avoid duplication in research.

Institute Technology Management Unit (ITMU)

The Institute Technology Management Unit is responsible for IP protection, Management and Transfer/Commercialization of technologies developed by the Institute. ITMU plays a crucial role in management of technologies. The role of ITMU is to encourage and accelerate the efforts towards development of technologies in the field of post-harvest management and to facilitate the transformation of ideas, inventions and technologies developed by the Institute into commercial ventures to serve the society. ITMU since its inception has been involved in protection, management and commercialization of Intellectual property generated by the Institute. A total of 47 patent applications have been filed through ITMU out of which six patents have been granted. Vigorous efforts of ITMU lead to commercialization of 45 technologies developed by the institute.

Agricultural Knowledge Management Unit (AKMU)

The Institute has an Agricultural Knowledge Management Unit (AKMU) for the scientists and staff for data analysis and electronic communication. The unit has latest eighteen desktop computers including three servers. More than 100 desktop computers of the institute are well connected through Local Area Network (LAN). Wi-Fi connectivity is available through 100 mbps line provided by National Knowledge Network (NKN). All the computers are protected by the server based Symantec Anti Virus. Internet is provided to different nodes through proxy server Nebero. The Nebero facility provides the information of internet bandwidth; user details, firewall security and stability on the network. Besides, AKMU houses a number of analysis and design software such as Front Page 2003, Corel draw graphics Suite, Adobe Professional, SAS, Design Expert Software, Leap Office 2000 (Hindi Software). The Institute's website *www.ciphet.in* is also being maintained by AKMU.

At present following services are provided by AKMU:

- Electronic communication to all institute staff and trainees
- Data analysis facility
- Assistance in software application in different research works
- Internet browsing
- Software and computer hardware support
- Assistance in online patent search through various databases

AICRP on Post-Harvest Engineering and Technology (PHET)

The All India Coordinated Research Project on Post-harvest Engineering and Technology was launched by the Indian Council of Agricultural Research in September 1972. The Project is currently operating from 30 centres covering almost all the states and agro-climatic zones of the country. The aim is to develop location and crop specific post-harvest technologies and equipment to minimize quantitative and qualitative post-harvest losses and to produce value added products from agricultural crops including livestock and their by-products. The major activities are: (i) Adoption/development of equipment/technologies for reduction in post-harvest losses in critical stages/operations, as well as crop/commodity-wise, (ii) Development of need based agro-processing centres (APCs) in different production catchments for income augmentation and employment generation, (iii) Value added products from agricultural crops/commodities, (iv) Prototype production and process refinement with a view to develop appropriate complete packages for post-harvest utilization of crops/commodities and their by-products, (v) Multi-locational trial and demonstration of the post-harvest technologies.

AICRP on Plasticulture Engineering and Technology (PET)

The AICRP on Plasticulture Engineering and Technology has fourteen cooperative centres. In approved 12th Plan EFC, 4 new centres (NRCY, Dirang, Arunachal Pradesh, CIRG, Makhdoom, Mathura, UP, UAS, Raichur, Karnataka and DBSKKV, Dapoli, Maharashtra) were started and one centre (CSKHPKV, Palampur, HP) was closed. The project has contributed in the development or modification of technologies related to Plasticulture in horticulture, irrigation, intensive fish culture and animal housing as per the mandated area of the co-operating centres.

Statement of Budget Estimates and Expenditure (2015-2016)

A. PLAN

(Rs. in Lakhs)

S.No.	Account Head	Budget	Expenditure
1.	Institute	415.00	414.00
2.	AICRP on PHET	2010.00	2010.00
3.	AICRP on PET	270.00	270.00
4.	CRP on Secondary Agriculture	213.13	208.20
5.	CRP on Health Food	74.07	63.76
	Total	**2982.2**	**2965.96**

B. NON - PLAN

(Rs. in Lakhs)

S.No.	Account Head	Budget	Expenditure
1.	Institute	872.00	749.73
2.	AICRP on PHET	37.00	28.60
3.	AICRP on PET	11.00	9.08
	Total	**920.00**	**787.41**

Revenue generation

During the year 2015-16, the institute generated Rs. 37.69 lakhs revenue against target of Rs. 47.11 lakhs.

RESEARCH ACHIEVEMENTS

Post-Harvest Equipment and Machinery

Pneumatic assisted coring device for oblong fruits: *ber* and fresh date palm

A pneumatic assisted coring device was developed for removal of central core/stone from oblong fruits like *ber* and date palm. The cored fruits can be further utilized for canning, drying and other food processing operations. The prototype (Fig 1) operates with five pneumatic air cylinders having maximum working pressure of 10 bar each. It comprises of a hopper with vibrating feeding mechanism, movable wooden roller, extended fruit dropper, four wooden frames (470×50 mm, with 6 openings of 25.4 mm diameter each), fruit coring tools (6 Nos.), core outlet and cored fruit outlet. The wooden frames are mounted on individual mild steel sheets at equidistance on a circular movable unit which rotates in clockwise direction. The whole unit is assembled on a supporting mild steel frame work (1020×1020 mm). The fruits are loaded on the hopper having vibrating mechanism and then they move to the roller. The roller carries six fruits at a time and drops them longitudinally on to the wooden frame having fruit openings. The loaded frame move clockwise direction for coring. Coring of fruit takes place in third frame *via* coring panel from which the stone is separated through an outlet. Further, the cored fruit are collected in fourth base *via* opening of wooden base through plunger.

Fig 1-Pneumatic assisted coring device

(a) (b)

Fig 2(a)-Cored *Ber* (cv. Umran) fruits
(b)-Cored Date palm (cv. Hillawi)

To complete single coring round (6×4 frames = 24 fruits), approx. 1.30 min is sufficient. The coring capacity of the developed prototype for *ber* (cv.*Umran)* fruits is 28 kg/h (Fig 2a), and for date palm (cv. *Hillawi)* 16 kg/h (Fig 2b). Coring efficiency of the pneumatic assisted device is 78% and 65% for *ber* (cv. *Umran)* and date palm (cv. *Hillawi)*, respectively. The coring device would be instrumental for removal of stone/core from the fruits which is a prerequisite for canning and drying of destoned fruits.

Dried chillies destalking machine (under testing)

A prototype for destalking of dried chillies based on cutting mechanism was designed and developed. It consists of following components:

(1) Hopper fitted with vibrator for continuous feeding

(2) A set of 20 rollers act as an extended feeding system and for width wise alignment of chillies

(3) Rexin belt (4 inch width and 10 feet length) fitted with triangular rubber slots (100 no.) moving on two pulleys (10 inch dia) for movement of chillies till cutting mechanism

(4) Two rollers (9.5 inch dia, thickness 1.85 mm) were fitted at the end of belt to provide cutting to the chillies

(5) Vacuum assembly (Blower :4 inch dia, 21inch length, 36 fins fixed at around 30-35°) was fixed and being rotated at 2800 rpm (approx.) for creation of proper suction

Fig 3. Prototype of Chilli destalking machine

(6) These components were fixed on a frame (80×36×36 inch) to make an integrated unit

(7) Separate outlets for stalk and destalked chillies

Fig 4(a)

The role of vacuum system is to suck the chilli towards its stalk on either side of the moving belt. This movement of stalk portion outside the belt will allow for effective cutting of stalk. The working model of the chilli destalking prototype is shown in Fig 3.

Mechanical peeler for sweet orange and *kinnow* (under testing)

A prototype of semi-automatic peeler was designed and developed for peeling of sweet orangeand *kinnow* (Fig 4a&b). Machine components include:

Frame (length × width × height): 24×18×30 inches

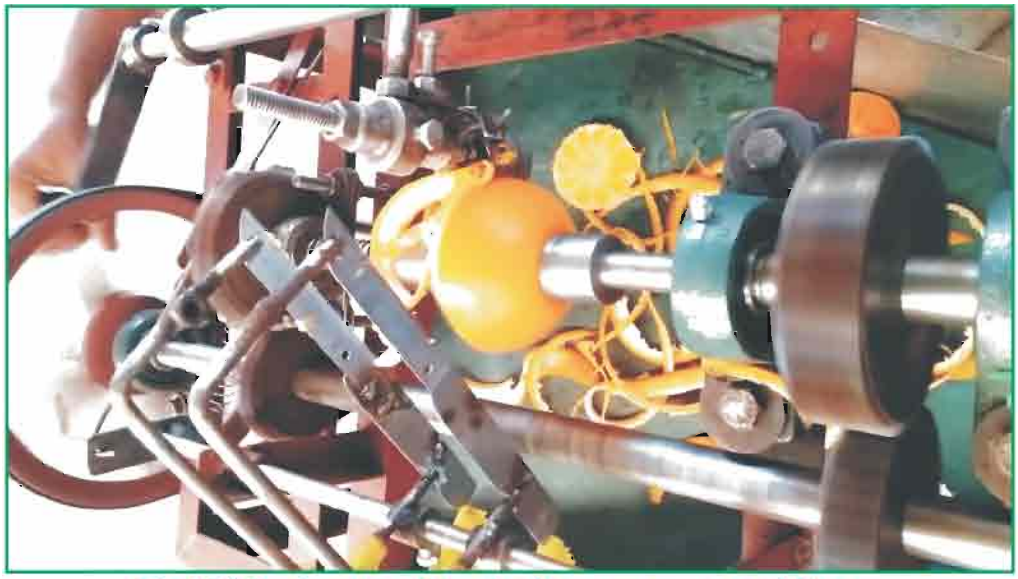


Fig 4(b) Semi-automatic peeler for sweet orange and *kinnow*

Diameter of larger gear: 4 inches

Diameter of smaller gear: 3 inches

Diameter of each fruit holder: 1.2 inches

Length of the revolving shaft: 22.5 inches

Clearance of the tool for peeling: 1 inch

Length of the each cutting knife: 3.2 inches

The machine can be operated with 0.5 HP motor (maximum speed of 1440 rpm). Optimum speed of the fruit rotation was 200-220 rpm. The fruit is placed manually between the fruit holders. The shaft connected with the tool movement can be operated manually. There is an arrangement for automatic spring which provides the clearance of about 1 inch for movement of blade according to diameter of *kinnow*. There exists some portion/percentage of the fruit which doesn't comes in contact with peeling blade and that can be removed easily using the arrangement of two cutting knives assembly. Fruits with variation in size (medium to large) can be placed easily with a handle provided for adjustment. Preliminary trials showed that this semi-automatic peeler takes approximately 8-10 s for peeling of single *kinnow* fruit with minimum loss of pulp/juice.

Hand operated *wadi* dropping machine

Wadi is generally prepared manually by women. This not only leads to unhygienic way of manufacturing but also takes more time, labour as well as causes drudgery. The hand operated *wadi* dropping machine (Fig 5) provides a simple way of producing uniform size *wadis*. The developed machine has two grooved rollers of length 53.5 cm and diameter 28 mm. The rollers rotate through a set of gears attached to a handle. These have been specially designed to draw the *wadi* batter through it and discharge the uniform size *wadi* through the holes below the rollers. There are 7 holes (round) designed on the plate through which the *wadi* batter passes. Manually operated stainless steel blades are provided for cutting *wadi* batter. Capacity of the machine is 13 – 15 kg of *wadi* dropping per hour. The holes in the plate under the rollers can be changed in order to produce different shapes of *wadi*.

Fig 5. Hand operated *wadi* dropping machine

Pilot plant for protein isolation

Protein isolates contain over 90% protein on a moisture free basis and are the most concentrated form of protein products. Being almost pure protein, these can be made practically free of objectionable odour, flavour, colour, anti-nutritional factors and flatulence. Furthermore, the high protein concentration provides maximum formulation flexibility for incorporation into food products. The protein isolates had several applications such as in meat analogues, texturized vegetable proteins, protein supplements, bakery, infant foods, imitation dairy products etc. The availability of protein can be increased by utilizing the proteins from de-oiled cake. The de-oiled cake left after oil extraction from major oilseeds *viz.* soybean, groundnut, mustard and sunflower is about 10 million tonnes (soy meal: 4.0 mt, groundnut cake: 3 mt, mustard: 2 mt, sunflower cake: 1.0 mt). At present, these cakes are either utilized as animal feed or being exported to other countries like China and Malasia. In 2014-15, India imported 11.02 million kg soy protein isolate worth 38.9 million USD. There is need to shift this pattern by developing suitable processing technologies and indigenous machines/equipment so that these cakes can be utilized in our country as a result we may get protein at cheaper cost to fortify our products.

In India presently no indigenous machinery is available for the commercial production of protein isolate from de-oiled cakes. The ICAR-CIPHET, Ludhiana has designed and commissioned the first (to the best of our knowledge) indigenous pilot plant for production of protein isolate from groundnut

Purified commercial groundnut cake flour

↓

Soaked in water (Cake: water, 1:10)

↓

Adjusted pH (10.0 using 1.0 N NaOH)

↓

Mixing for 2 h

↓

Centrifuge

↓

Supernatant taken

↓

Adjusted pH to 4.5 using 1.0 N HCL

↓

Supernatant discarded after 25-30 min

↓

Neutralized the precipitate using 1.0 N NaOH

↓

Spray drying, packaging and storage

Fig 6. Process flow diagram for the production of protein isolate from groundnut de-oiled cakes.

DOCs, having capacity of 40 kg of raw material/day (Fig 6). The pilot plant (Fig 7) comprises of the following major components *viz.* 1) Extraction tank 2) Centrifuge 3) Precipitation tank along with a control panel for automated operation. Isolates produced from this plant has more than 90% of protein. The other de-oiled cakes *i.e.* soy meal, sunflower cake, mustard cake etc. can also be used for the purpose.

Fig 7. Protein Isolate Pilot Plant

Agricultural Structures, Material Handling and Transportation

Animal lifter

Animal lifter is required for providing support to sick animals (downers cow/ accident hurt animals). The most likely reason for a cow to go down is trauma. This could be post-calving, a metabolic issue (such as milk fever) or a disease such as mastitis or metritis. Even after the initial cause of the downer cow is resolved, the animal may not able to stand up. This failure is usually observed within 24 h of the cow going down as a result of muscle and nerve damage. This damage occurs because a cow going off its feet results in heavy pressure on its muscles and nerves. The cow may unable to shift position to prevent continuous bearing of weight. If, it is not supported the animal may not recover.

The chances of recovery increase dramatically by the use of animal lifter for rehabilitation. It aids in getting the animal up on its feet, regaining proper circulation, eating and drinking habits, and the restoring of normal bodily functions. The sling supports the animal for over extended periods of time, while allowing the repair of torn muscle and nerve damage.

An animal lifter along with animal sling is developed (Fig 8) for lifting sick animals (downers cow/ accident hurt animals) and providing support till recovery. It can lift up to1000 kg body weight of animals including small to large (cow, buffalo, camel and horse).

Features of animal lifter frame:

- Made of heavy duty GI pipes.
- Portable and easy to dismantle.

Features of animal sling:

- The animal sling is made up of polyester web straps supported with heavy duty fabric which provides adequate support and comfort to sick animals. Two straps are stitched crosswise. The length of straps can be adjusted with adjustable ratchet and self- locking buckle according to the size of the animal.
- With support spread over large body area of animal, the pressure points are reduced.
- Length (for wrapping major part of girth of animal) and width of animal sling are 1.58 and 0.83 m.
- The animal lifter is made in such a way that sling legs will be almost vertical so that the stress in webbing straps is minimum.
- Low cost

Fig 8. Animal lifter along with sling

Animal squeeze chute

A prototype of animal squeeze chute (scaled down)

Fig 9. Prototype of animal squeeze chute

was developed to restrain the animal keeping in view of animal welfare considerations for easy veterinary inspection and other treatment procedures with following dimensions and features (Fig 9).

- Main frame: height- 1.07 m; width 0.71 m and length 1.22 m
- Head locking arrangement with openable gate for exit
- Movable side panels to restrain animal

Extraction of cellulose fibres for preparation of nano-bio-composite based materials for silos construction

Currently wide range of silo construction materials - including mild steel, stainless steel, galvanised steel, and dual metallic alloys are used. These materials are dense, heavy and costlier, which limits the farmers to go ahead with construction of such silos in their farm production areas. Light weight and low-cost silo construction materials need to be developed using carbon fibres/cellulose that could replace the currently used metals in silos manufacturing instead of using expensive petroleum-based carbon fibre.

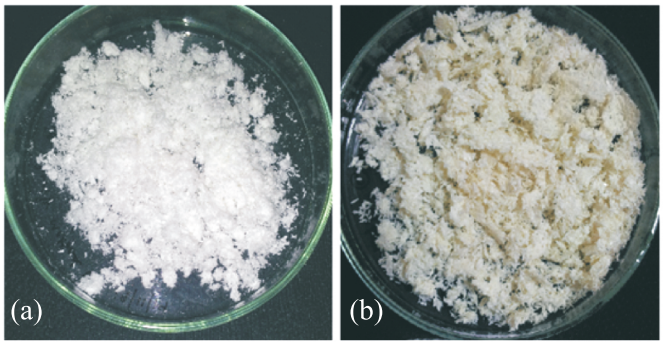


Fig 10. Cellulose extract (a) method 1 and (b) method 2

Extraction of cellulose and cellulosic lignin

For the extraction of cellulose fibres, two methods were used to optimize the extraction conditions The yield and lignin obtained from different agricultural waste using standardized methods are presented in Table 1 and 2.

Method 1

After crushing, defatting, ethanot and water extraction dried samples were digested in 4% sodium hydroxide solution for 4 h 80 °C. This removed the major portion of lignin and hemi cellulose. Because of persistent discoloration the product was subsequently bleached with sodium chlorite/glacial acetic acid mixture to remove residual lignin and hemi cellulose. The bleached cellulose fibres were washed repeatedly, initially with 5% aqueous sodium hydroxide and subsequently with deionized water in order to attain neutral pH (Fig 10a).

Method 2

The pre-treated samples were bleached with hydrogen peroxide, followed by alkali wash(1N NaOH), drying in air-circulated oven at 60°C for 6 h and storage in air tight polybags (Fig 10b).

Process flow diagram for extraction of cellulose is shown in Fig 11.

Table 1: Cellulose and lignin content as well as their purity extracted through method-1 and method-2

S.No	Parameters (%)	Method 1	Method 2
1.	Cellulose Content	41.569	53.298
2.	Lignin Content Yield	10.091	5.722
3.	Purity	90	85

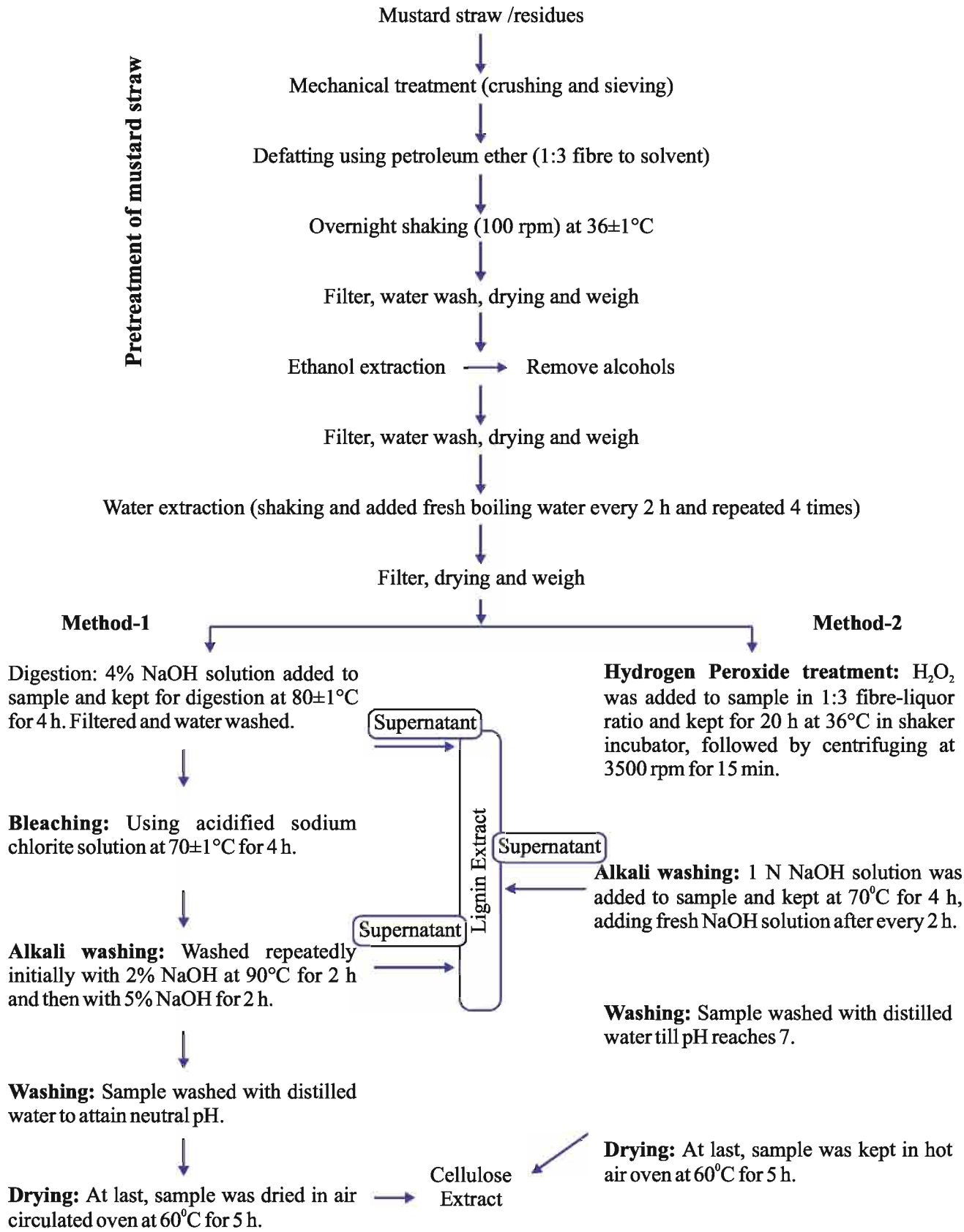


Fig 11. Process flow diagram for extraction of cellulose and cellulosic-lignin using optimized methods

Table 2: Cellulose and lignin obtained from different sources of agricultural waste using standardized cellulose extraction method.

S.No.	Source material	Cellulose (%)	Lignin (%)
1	Mustard straw	41.57±2.00	10.09±1.75
2	Cotton stalk	46.75±1.50	15.83±1.00
3	Dry cotton flower	33.67±0.50	15.10±1.00
4	Wheat straw	30.58±2.50	24.95±1.00

Semi-permanent shade-net house to reduce the sun burn and cracking of pomegranate fruits in hot and arid region of Punjab

Sun burn of pomegranate fruits is a major concern in hot and arid regions where, maximum temperature reaches about 48-50°C and relative humidity drops up to 20-25%. About 20-30% pomegranate fruits are lost due to sun burn and sun burn induced fruit cracking. Therefore, a suitable approach is required to reduce such heavy losses caused by the sun burn. In this context, an attempt is being carried out at ICAR-CIPHET, Abohar to develop a semi-permanent shade net house appropriate for pomegranate orchards in hot and arid regions. Temporary shade net houses were constructed from photo selective green, black, red and white shade nets having shading intensity of 35 and 50% and their performance in reducing the sun burn after *ambay bahar* flowering was observed.

Borax spray (0.4%), kaolin spray (4%) and plants without any treatment were considered as control. Fogger and micro sprinkler were installed over plants at the height of 2.5 m alone as well as in combination with shade nets for reduction of sunburn of pomegranate fruits.

Results revealed that black shade net with 50% shading intensity in combination with foggers was the most effective treatment in reducing the sun burn (Fig 12 to 14). This combination allowed only 4-5% sun burn in comparison to 17-19% in case of pomegranate without any shade.

Fruits produced under different treatments were evaluated for their quality. Juice yield (%) was found

Fig 12. Fruit produced under black shade net

to be the highest (72%) in case of fruits under black shade net coupled with fogger (treatment T_7). Highest average fruit weight (302 g) was recorded in case of fruits produced under micro sprinkler (treatment T_1) as compared to control (213.3 g). No significant difference was observed in TSS, acidity and ascorbic acid content of fruits produced under different treatments. Lower amount of anthocyanin pigment (5-9 mg/100 g) was observed in case of fruits produced under shade nets as compared to open field (15-16 mg/100 g).

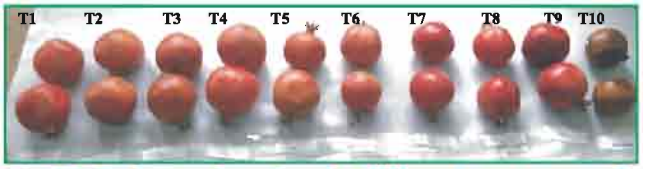


Fig 13: Fruits produced under different treatments of shadenet and fogger

Aril and fruit juice colour was affected significantly with the application of black shade net treatment coupled with fogger (T_7), resulted in deep red aril and deep red juice color (22.45, 45.25 and 0.12 L, a, b value compared to control 46.20, 39.25 and 8.34 respectively. Because black colour seems bad radiation reflector compared to other shade net colour. Minimum (4%) sunburn were recorded under black shade net coupled with fogger as compare to control (15%).

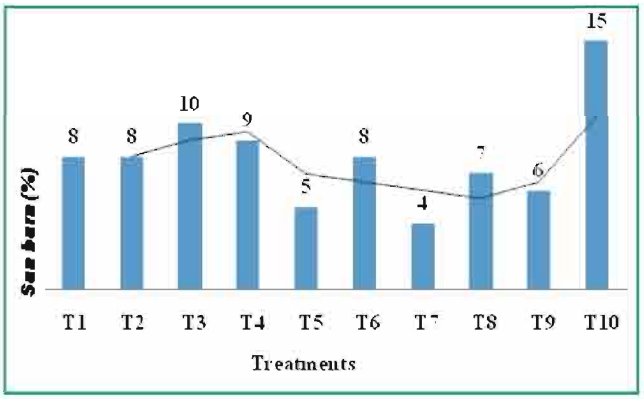


Fig 14. Effect of different coloured shade nets and fogging on sun burn

Polyhouse structure for mushroom cultivation suitable for hot and arid region of Punjab

Cultivation of button mushroom is difficult in hot and arid regions. Cultivation season in such regions is only 2 months as compared to 4-5 months in case of temperate regions. However, increased demand for crop diversity as well as health benefits of mushroom has forced farmers to cultivate the mushroom in hot and arid regions also. In this context, efforts are being made at ICAR-CIPHET, Abohar to develop a polyhouse structure which can assist to increase the cultivation season of button mushroom and also be useful for cultivation of *Dhingri* mushroom during summer months.

A polyhouse structure was constructed at ICAR-CIPHET, Abohar (Fig 15) for mushroom cultivation with following specifications:

Foundation walls

- Height - 1.22 m, width – 0.2 m

Roof

- Ridge height from the floor - 4.27 m
- Roof : eve height from the floor - 2.13 m
- Multilayered roof composed of iron net (half inch mesh), polythene (25 micron), jute (2-3 mm), EPF thermocol (8 mm), UV stabilized polythene (300 gsm)

Walls

- Front wall: centre height - 4.27 m
- Front wall is equipped with arrangement for two 18 inch exhaust fans
- Rear wall: centre height - 4.27 m

Floor

- Floor level: 3 ft below ground level
- Floor material: single layer vertical brick

Door

- Double door frame

Button mushroom was cultivated in the structure during December, 2015 - February, 2016. Observations on quality parameters of produced button mushroom were recorded. It was found that mushroom contained 88% moisture, 0.2% acidity, 11.13 mg/100 g ascorbic acid with the pH as 6.6.

Fig 15. Polyhouse constructed for mushroom cultivation at ICAR-CIPHET, Abohar

Live fish carrier system

A battery operated self-contained aerating system (BOSCAS) for short distance transportation of live fish was developed (Fig 16). The system was developed under the funding by National Fisheries Development Board (NFDB), Hyderabad. It is useful for carrying live fish from farmers' pond to the auction centres and further to the retail market with least mortality. BOSCAS is operated by rechargeable 4 lead acid batteries of 12 Volt, 100 A each, equipped with self-aerating system with a total carrying capacity of 500 kg (200 kg fish + 200 kg water). In a single charge it can run about 60-80 km. BOSCAS has two major components, Self-Aerating Containers (SAC) (Fig 17) and Battery Operated Vehicle (BOV). SAC are stackable and easy to unload with approximate capacity of 10-20 kg fish/container. It is equipped with aerators, filters and metabolite absorbent to maintain ideal water quality for fish during transportation.

Fig 16. Battery operated self-contained aerating system

Easy to unload aerating fish carrier system

The system has an opening at the bottom and an inner liner of LDPE (300 gsm). The dimensions (l x b x h) of the system are 66x47.5x49.7 cm. The aeration is provided with dry cell based DC aerator. The testing was done with inner liner LDPE, water + headspace (20 cm +15 cm), fish loading capacity 0.2-0.3 kg/L, water 40-50 L , fish density 15-25 no./container for a continuous test duration of 28 h. The weight of loaded fish (15-25 nos) was 8-12 kg. Indian major carps (*rohu, catla, mrigal*) and two Chinese carps (*bighead carp and silver carp*) of mean size (length) 25-40 cm and weight 0.36-0.78 kg (individual weight) were used for the study. The dissolved oxygen (DO) level of the water was kept 3.0-5.3 mg/L by continuous aeration with 25% water renewal at every 6 h. Other water quality parameters such as dissolved free ammonia was 0.8-1.3 ppm, pH 6.4-7.1 and water temperature was 18.6-25 °C. An overall mean survivality of 95.7% was achieved in above mentioned conditions. This system may be used in the truck to transport live fish.

Fig 17. Self-aerating container

Aerating fish conditioning cum storage tank trolley

The PVC tank with MS angle base along with provisions of aeration, filtration, metabolite absorption and easy mobility has been designed for conditioning live fish before transportation as well as storage of live fish in the market premises (Fig 18). The system dimensions are: length 4 m, width 1.04 m and height 1.27 m. It also had four wheels of 6 inches (dia) and 2 inches thickness for easy move. The capacity of the tank is 300-600 L and can accommodate 200-300 kg fish. It can be towed by a motor bike.

The testing of the system was done with fish load capacity 2-3 kg/L and water 200 L. Dissolved oxygen (DO) was kept 3.0-6.0 mg/L and dissolved free ammonia <1.3 ppm by continuous aeration and 25% water renewal at every 12 h.The pH of the water was about 7.0 and temperature 18.6-25°C (ambient). With total fish load of 100 kg/container of Indian major carps (*rohu, catla, mrigal*) and two Chinese carps (*bighead and silver*) of mean size (length) 25-40 cm and individual weight 0.36-0.78 kg; 95 % fish survived after 48 h of storage. The machine needs further improvements in water filtration, cooling of water and in unloading mechanisms.

Fig 18. Institute IMC members visiting aerating fish conditioning-cum-storage tank trolley

Development of nano-particle embedded biodegradable food packaging biopolymers

Development of a new type of packaging materials to replace petroleum-based non-biodegradable plastics has become a growing field of interest since synthetic plastics lead to serious environmental concerns as a result of their non-biodegradability and depletion of natural resources. An adequate selection of packaging materials can prevent food quality loss by providing barrier, or otherwise protective features, and enhancing food quality and shelf-life.

Synthesis of silver nano-particles

Nanoparticles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecular structures. 50 ml of 0.01 M tri-sodium citrate (reducing agent) was dissolved in distilled water followed by stirring. Thereafter, 50 ml of 0.003 M silver nitrate was dissolved in distilled water with stirring for 15 min. After this, tri-sodium citrate solution was added to the silver nitrate solution drop wise and stirring was continued for 45 min at at 80^{0}C and 550 rpm. As, the colour of the solution turned yellow, it confirmed the synthesis of the silver nanoparticles (1-100 nm).

Characterization of silver nano-particles

Synthesized silver nano-particles were characterized by Zeta Sizer (Malvern Zetasizer Nano ZSP, Melvern Instruments, UK). Size of the silver nanoparticles was in the range of 40 to 100 nm. The confirmation of the synthesis of silver nano-particles was done by UV-Vis spectroscopy which usually gives absorption peak of silver nano-particles in the range of 420-440 nm.

Antibacterial activity of silver nano-particles

Nano-particles synthesized herewith were also tested *in-vitro* for the antimicrobial analysis (Fig 19). Antibacterial analysis was performed against *E.coli* bacteria using disk diffusion method. Another quantitative method was optimized for in which nutrient agar was incorporated with synthesized silver nano-particles in 1:10 ratio and was counted for CFU/ml. A respective blank of same *E.coli* dilution was also spread on nutrient agar plate in which silver nano-particles were not incorporated.

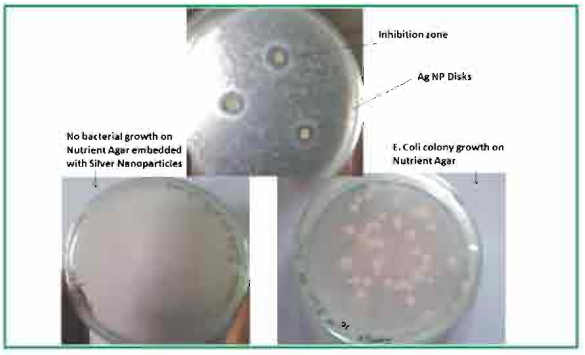


Fig 19. *In-vitro* antimicrobial analysis

Products and Process Protocols

Products

Low-fat high fibre functional meat product

Low-fat meat products have been developed with the use of plant based fat replacers. The low-fat meat emulsions with added plant gel (PG) and vegetable oil (VO) in different proportions were compared with full-fat meat emulsion. A substantial fat reduction ($p < 0.05$) up to 30-35% as compared to full-fat control meat emulsion was recorded without compromising other sensory attributes of meat emulsion. Rheological analysis showed that plant gel added samples had viscoelastic behaviour and weak gel properties. The samples had good matrix structure which provided more stability to the emulsion. Thus, plant gel is a potent fat replacer for manufacturing of low-fat meat emulsion. Microstructural properties (scanning electron microscopy) showed more homogenous regular protein matrix with less cracks in PG added samples than the control samples (Fig 20).

(a)

(b)

Fig 20. Scanning electron microscopic images of low-fat meat emulsion (a) with 50% plant gel, (b) without plant gel

Whey protein fortified mango ready-to-serve beverage

Fruit juices are the nature's perfect fast food for modern lifestyle and consumed as refreshing and thirst quenching drink. However, fruit drinks lack the protein as a nutritional component. The major challenge to the protein fortification of fruit drinks is to stabilize the protein in the acidic and ionic environment. Most of the fruit drinks are formulated to pH range of 3.0 - 4.0, where the iso-electric pH of food proteins lies, due to which the protein gets precipitated and leads to unacceptable beverage. The whey protein was hydrolysed with papain in order to improve its stability in acidic medium. The water holding capacity of whey protein increased about two times (3.14 - 6.69 g water/g protein) after hydrolysis. Hydrolysed and native whey protein was used at 2, 3 and 4% levels for fortification of mango based ready-to-serve (RTS) beverage (Fig 21). Addition of hydrolysed whey protein at all the three levels did not significantly ($p > 0.05$) change the flow behaviour of the beverage (Fig 22&23). Native whey protein fortification resulted in precipitation;

Fig 21. Mango RTS beverage containing whey protein hydrolysate

however, addition of hydrolysed whey protein led to stable beverage formulation at all the three levels. Hydrolysed whey protein imparted slight bitter taste to the RTS beverage, which was masked by incorporating suitable bitterness masking agent. The mango RTS beverage with 3.0% hydrolysed whey protein was found acceptable with good sensory appeal and stability during thermal processing as well storage in glass bottles.

in reduced fat yoghurt prepared form double toned milk (1.5% fat). The NCDC-144 culture procured from NDRI, Karnal was used @ 2% for preparation of yoghurt. Lactic acid bacteria count increased significantly ($p<0.05$) from 5.83±0.06 to 7.50±0.20 log_{10}cfu/ml with increasing OSA starch concentration. The firmness, storage and loss modulus increased from 43.8 (control) to 83.7 N, 58.9 to 72.7 and 22.2 to 32.3 Pa, respectively with

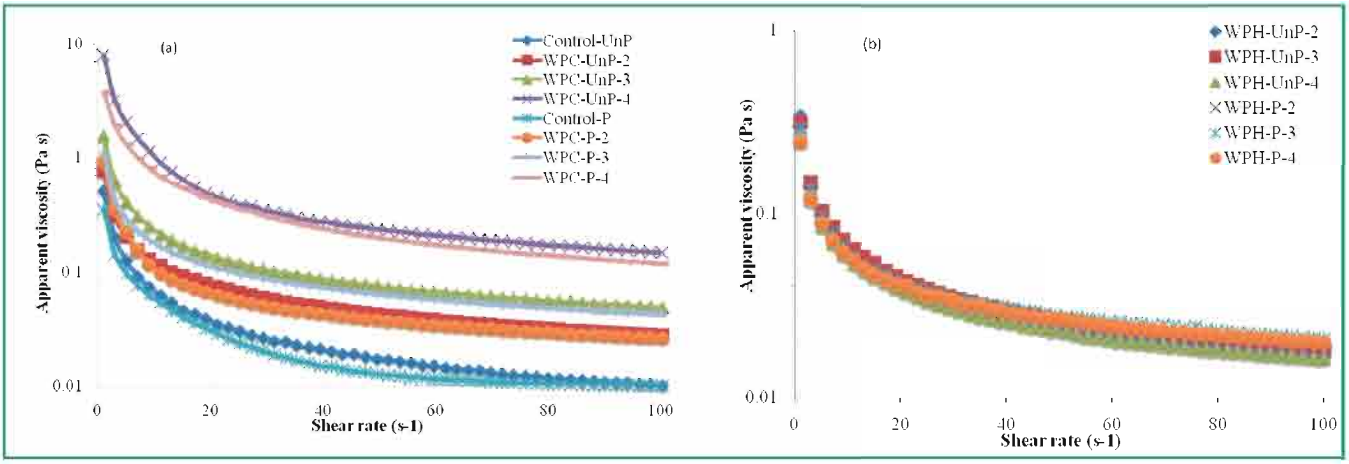


Fig 22. Changes in apparent viscosity of pasteurized (P) and un-pasteurized (UnP) mango RTS beverages fortified with different levels (2, 3 and 4%) of: (a) WPC and (b) WPH with respect to shear rate

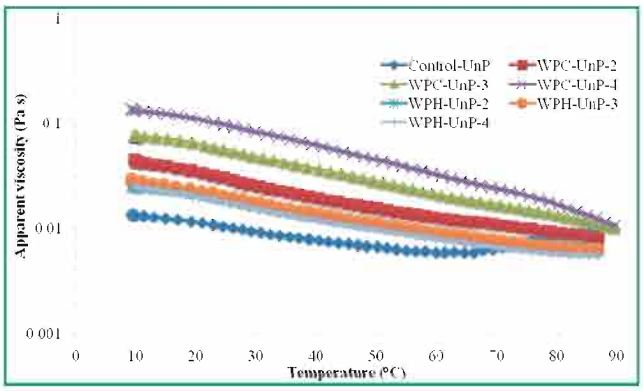


Fig 23 Variations in apparent viscosity of un-pasteurized (UnP) mango RTS beverages fortified with different levels (2, 3 and 4%) of WPC/WPH during temperature sweep test

Fig 24. Reduced fat yoghurt containing (a) 1.5% OSA-St and (b) control made with double toned milk

Reduced fat yoghurt

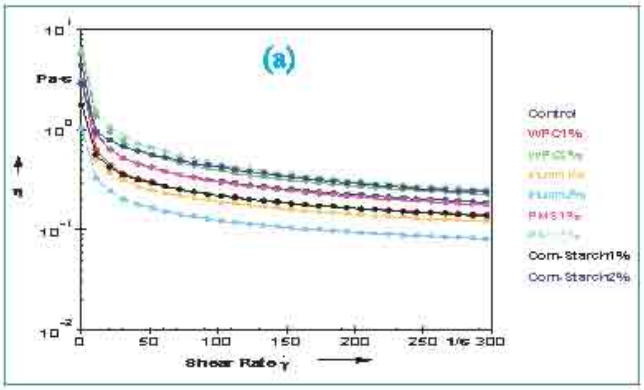
The influence of octenyl succinic anhydride esterified pearl millet (*Pennisetum typhoides*) starch (degree of substitution= 0.0208) as a fat replacer at four levels *viz.* 0.5, 1.0, 1.5 and 2.0%, was evaluated

increasing OSA starch content. Syneresis significantly ($p<0.05$) decreased as the level of modified starch increased in the yoghurt samples. The sample containing 1.5% OSA-starch had 26.34% syneresis, while control double toned milk (DTM) and standardized milk yoghurt (4.5% fat) had

27.5 and 48.1%, respectively (Fig 24). The total descriptive sensory score of yoghurt samples (double toned milk) containing OSA starch ranged from 85.3 to 95.0, while that for control yoghurt (double toned milk), it was 81.1. On the basis of improved product firmness, consistency, rheological (structural strength, G'), syneresis and overall sensory acceptability over control, the addition of 1.5% OSA modified pearl millet starch was found optimum to prepare reduced fat yoghurt.

Reduced fat soft serve ice-cream

Conventional ice-cream formulations possess high fat content, at approximately 10 to 16 %, which can be replaced with carbohydrates or proteins based fat replacers. In order to reduce the fat content in soft serve ice cream, OSA-modified pearl millet starch (degree of substitution= 0.0208) was used at 1 and 2% level in ice cream samples with 7.5 and 5% fat, respectively. These were compared with control ice cream and other potential fat replacers i.e. inulin, WPC-70 and commercial brand of modified starch at same levels. The overrun of reduced fat ice cream samples containing 5% fat ranged from 29.7- 32.2%, while for ice cream samples with 7.5% fat, it varied from 32.9-34.3%. The apparent viscosity (Fig 25) of control ice cream mix (10% fat) was 417 m Pas^{-1}, which was very close to the samples having 7.5% fat and 1% OSA-starch. Further, the apparent viscosity values for the mix (5% fat) with WPC, OSA-starch and commercial starch at 2% level was higher than control ice cream mix (10% fat). The reduction of fat along with addition of fat replacer doesn't affect the sensory quality of the ice cream adversely. Thus, OSA-modified pearl millet starch can be



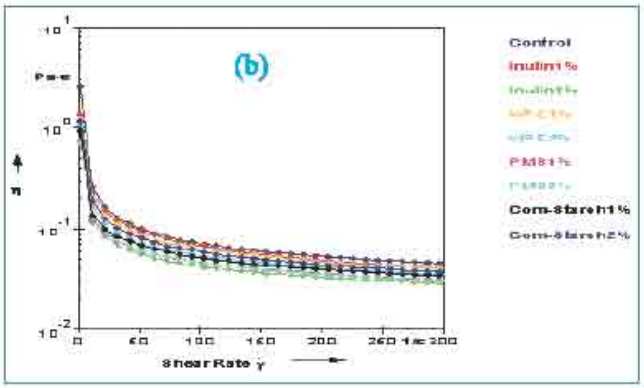


Fig 25. Viscosity of different ice-cream sample (a) after ageing & (b) before pasteurization as function of shear rate

incorporated at 1 and 2% as fat replacer for the preparation of reduced fat ice cream with 7.5 and 5% fat, respectively.

Quality protein maize based gluten free muffins

The quality protein maize flour was used to prepare muffins (Fig 26) with different protein sources (whole milk, egg proteins, casein, soy protein isolate and whey protein isolate). The QPM based muffin samples with egg proteins attained the maximum baked height of (34.1 mm) compared to control (26.4 mm). The hardness and chewiness of egg fortified QPM muffins were 49 and 16.6 N against 68.2 and 28.7 N for control samples, respectively. The samples were more acceptable (scored 8.0 on 9 point headonic scale) as compared to control (6.4). The muffins prepared from QPM with whole milk and whey protein were also well accepted (7.2 each). Quality protein maize (HQPM-5) can be used to prepare muffins.

Fig 26 QPM based Muffins

Protein and minerals rich expanded snack food with spinach

Protein and minerals rich expanded snack (Fig 27) food was developed utilizing maize (74%), defatted soy flour (15%), spinach powder (6%) and sesame seed (5%). Extrusion was performed on co-rotating twin screw extruder with 3 mm die opening. The process parameters *viz.* die head temperature

(100-120°C), screw speed (300-350 rpm) and feed moisture content (14-18% w.b.) were considered for optimization using response surface methodology following Box-Benken design. Optimized parameters were: feed moisture 14%, die head temperature 115°C and screw speed 335 rpm. The optimized sample had 18.2% protein, 3.0% total minerals, 24.6% antioxidant activity, 7.66 mg/100 g flavonoids. Its overall sensory acceptability on 9 point headonic scale was 8.1. The expansion ratio, water absorption, water solubility index and whiteness index was 3.36, 5.41 g/g, 28.1% and 54.9 respectively.

Fig 27 Protein and minerals rich expanded snack

Protein and minerals rich pasta with spinach and fenugreek

Different experimental combinations involving variations in spinach powder 2-6 g, carrot juice 20-30 ml and refined wheat flour 80-90 g were designed using box-benken design. Defatted soy flour (11%) and sesame seeds (4%) were also added to enhance the protein and calcium content. Optimized combinations of different raw materials was: 80.8% wheat semolina, 10.9% defatted soy flour, 5.9% spinach powder, 3.9% sesame seeds and 24 ml/100 g carrot juice. Pasta developed with these food materials contained 17.3% protein, 2.4% total minerals, 23.4% antioxidant activity, 10.0 mg/100 g flavonoids and had 7.4 overall sensory acceptability score. The rehydration ratio and cooking time was 2.38 and 6 min respectively. Similarly, pasta containing 4.5% fenugreek powder was also developed in order to have health benefits of fenugreek. Optimized combinations of different raw materials were 81.8% refined wheat flour, 10.0% defatted soy flour, 3.6% sesame seeds and 21.4 ml/100 g carrot juice. Developed pasta (Fig 28) had 17.6% protein, 2.0% total minerals, 36.5% antioxidant activity, 7.8 mg/100 g flavonoids with overall sensory acceptability score of 7.3. The rehydration ratio and cooking time was 2.5 and 6.1 min respectively.

Fig 28. Protein and minerals rich pasta with spinach

Soy flour & black gram mix *wadi*

Soy mix *wadi* was developed by incorporating soy flour in black gram based *wadi* dough. Black gram *dal* was soaked at 30°C for 4 h to attain the final moisture content of 55-58% followed by grinding. The soy flour was mixed at levels of 10, 20, 30 and 40 % along with salt (1%) and black pepper (0.75%) into the black gram paste. The paste was portioned into 20 g and placed on an oil smeared polythene sheet over a tray and dried at 60°C for 7-8 h. Incorporation of soy flour in the *wadi* samples increased the nutritional value.

Value Addition to Pear

Canning of pear in non-nutritive sweeteners

Canning of pear slices was carried out in stevia extract in order to produce a low calorie food. Sugar syrup of 40°B and stevia extract equivalent to the

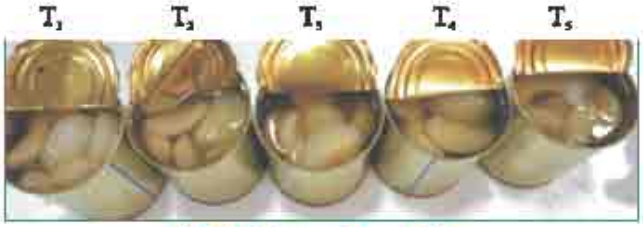


Fig 29. Canned pear slices

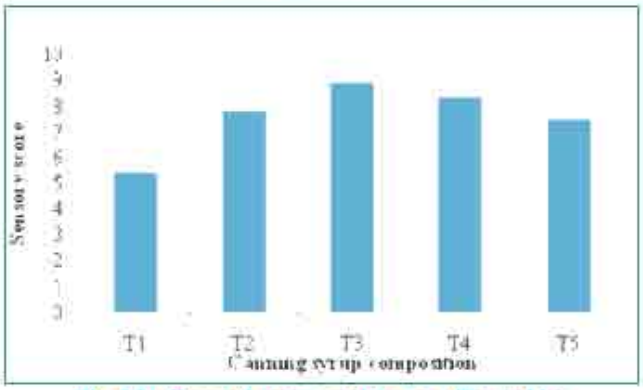


Fig 30. Canned pear quality as affected by non-nutritive sweeteners

sweetness of 40°B sugar syrup was prepared. These were mixed in five different proportions of sugar syrup to stevia extract as 100:0 (T1), 75:25 (T2), 50:50 (T3), 25:75 (T4) and 0:100 (T5) and used for canning (Fig 29). The level of stevia was optimized on the basis of sensory score and calorific value of canned pear slices. Highest sensory score was obtained for the pear slices canned in sugar syrup: stevia extract of 50:50 (T3) followed by 75:25 (T2) and 25:75 (T4) (Fig 30). Incorporation of stevia extract to the canning syrup not only reduced the browning of syrup and slices but also reduced the solid gain in pear slices.

Osmotically dried pear slices

Colour is an important parameter of any product quality. However, fruits like pears are prone to excessive browning during their processing. Therefore, effects of various pre-treatments (KMS, ascorbic acid, citric acid and hot water blanching) were evaluated to prevent browning during drying and storage. Pre-treatments were given as dip treatment in 1% solution for 15 min while blanching was performed for 5 min. Two drying methods *i.e.* osmotic and convective were used to dry the pear slices (Fig 31). The osmotic drying was performed in sucrose solution of 60°B at 40°C for 180 min. The convective drying was performed at 50°C. Higher reduction in L* value (21-43%) was recorded in the blanched samples (Fig 32) as compared to other pre-treatments. Minimum changes in all the colour parameters were recorded in pre-treated samples. A decrease in L value was also recorded during storage in all the samples but the change in L*, a* and b*chromates of pear sample treated with KMS were not significant during 6 months of storage.

Fig 31. Osmotically dried peal slices

The pear slices were also treated with five different calcium ion concentrations (0, 0.5, 1.0, 1.5, 2.0 and 2.5%) before soaking in 50°B sugar solution and subsequent drying at 50°C in order to improve the texture. Samples treated with Ca exhibited lower moisture content, water activity and apparent density as compared to control. The salt of calcium lactate (Ca-L) was more effective in lowering the water activity (a_w) than $CaCl_2$. Calcium chloride at more than 2.0% was also imparted undesirable bitter taste to the dried pear while the use of Ca-L at all concentrations did not impart any undesirable taste. Application of calcium treatment improved the colour and texture of the dried pear. Calcium lactate could be used as an alternative to $CaCl_2$ for the pre-treatment of fruits prior to drying as it offers improved dried fruit quality.

Pear juice blended with *Jamun* and *Karonda*

Blended pear juices were prepared by mixing *jamun* and *karonda* pulp each at 0, 5, 10, 15, 20 and 25%. Addition of *jamun* and *karonda* pulp increased the ascorbic acid, total phenol and anti-oxidant

Fig 32. Changes in colour value of osmotically dried pear during combined drying

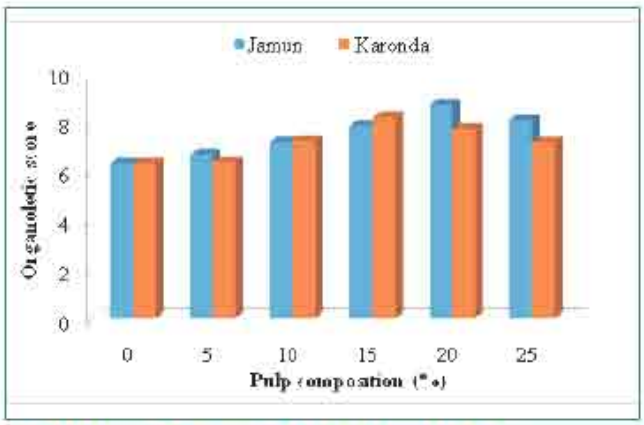


Fig 33. Overall rating of blended pear juice

capacity of pear juice. Total phenols and anti-oxidant increased by 13 and 17%, respectively after incorporation of 20% *jamun* pulp. Though all the blends were quite acceptable but the pear juice blended with 20% *jamun* and/or 15% *karonda* had the highest acceptability among the consumers (Fig 33). The study indicated that *jamun* pulp can be used to enhance the nutritional value of pear juice.

Pear pomace based soft toffee

Process technology and ingredient mixture were optimized for preparation of pear pomace based soft toffee. Soft pear toffee could be prepared (Fig 34) by mixing 30% sugar, 0.25% pectin and 1000 ppm KMS (based on pear pomace).The process comprised: boiling of pear pomace at low flame till its volume reduced to half, addition of sugar with continuous stirring followed by addition of pectin. The mixture was dried at 60°C for 8 h. The dried mass was rolled back manually to form round balls of desired size. Prepared toffee was stored for 6 months to assess the

Fig 34. Pear pomace based soft toffee

changes in physico-chemical and sensory quality. The colour of toffee did not show noticeable change during storage. The products were microbiologically safe.

Pear leather

Effect of three hydrocolloids viz. corn syrup, gum and pectin each at 0.12, 0.25 and 0.50 % levels were evaluated for improving physical properties of pear leather. The results revealed that most of the sample could hardly be differentiated with naked eye (Fig 35) but showed significant differences with instrumental analysis. Addition of corn syrup decreased a* value. It also decreased the springiness and increased the adhesiveness. In contrast, corn syrup increased the brightness (L* value) of pear leather. Changes in a* value were similar to L* value and could be attributed to non-enzymatic browning during fruit leather drying. Pectin did not significantly influence the colour value but texture

Fig 35. Hydrocolloid and corn syrup treated pear leather

was significantly affected. Pectin (0.25%) was found to be the most effective for obtaining a softer and more appealing fruit leather. On the other hand, addition of corn syrup softened the fruit leather compared to other hydrocolloids.

Process Protocols

Development of food biopolymer based micro and nano-scale delivery systems for bioactive ingredients in functional foods

Oil-in-water emulsion of flaxseed oil, garlic oil and in combination was prepared using soy lecithin as emulsifier and whey protein concentrate as a stabilizer. The emulsion is then mixed with the alginate as a coating material to obtain a homogenous mixture and microcapsules were produced (Fig 36). The following characteristics were studied.

Viscosity of emulsion

Apparent viscosity of emulsion was determined through steady-shear flow curves; shear stress was measured at varying shear rates from 0.01 to 300 (1/s). All the emulsions exhibited non-Newtonian, shear thinning (Pseudoplastic) behaviour as apparent viscosity decreased with increase in shear rate (Fig 37). The emulsion of flaxseed oil and garlic oil in combination was more viscous than emulsion of flaxseed oil alone and thinner than garlic oil emulsion. The microcapsules developed were found to be spherical in shape. The size of ten randomly selected microcapsules from different batches of flaxseed oil, garlic oil and flaxseed oil-garlic oil microcapsules was found to be in range of 800-894 μm.

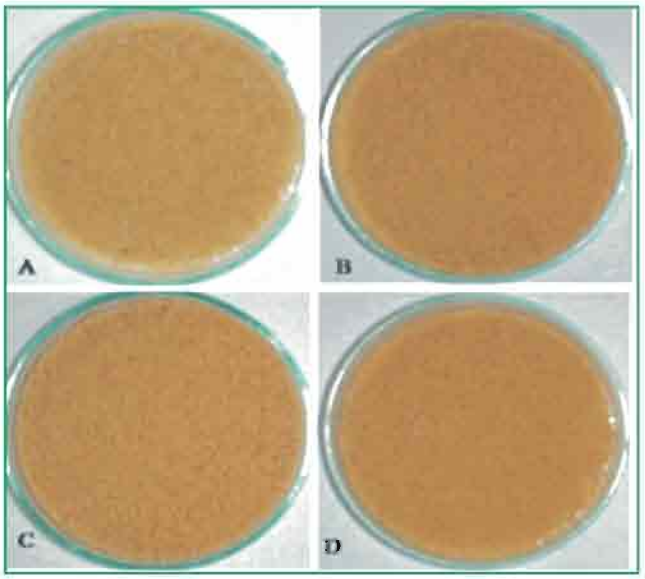


Fig 36. Microcapsules (A) Blank, (B) Flaxseed oil, (C) Garlic oil and (D) Flaxseed oil-garlic oil

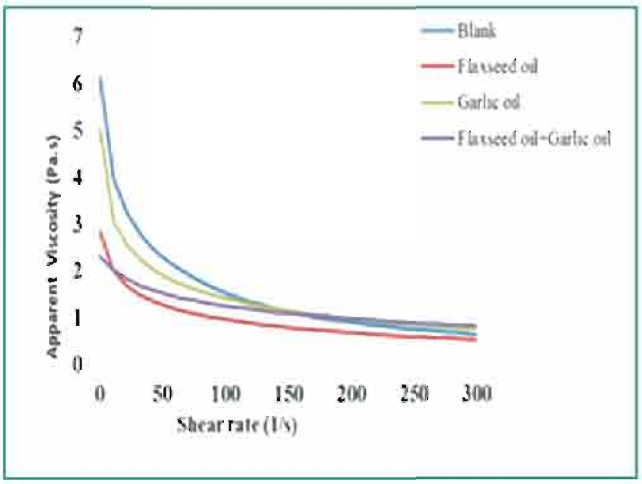


Fig. 37. Viscosity *vs* shear rate curve for emulsions

Encapsulation efficiency

The encapsulation efficiency determined for flaxseed oil, garlic oil and flaxseed oil-garlic oil microcapsule was found to be 85, 69 and 92% respectively after removing surface oil. The high entrapment efficiency suggests that the majority of oil was entrapped to prevent the oxygen rich aqueous phase to hinder oxidation.

Attenuated total reflection-Fourier transform infrared (ATR-FTIR) spectroscopy studies

Flaxseed oil spectrum showed a substantial contribution from the lipids particularly the sharp band at 1746 cm^{-1} assignable to (C=O) stretches of ester functional groups from lipids and fatty acids. Additional bands relevant to lipids are those at 1163 and 1099 cm^{-1} assigned to CH_2 out-of-plane deformation modes and (C–O–C) symmetrical stretches, respectively, which are primarily from triglycerides and cholesterol esters. In addition, the overlapped bands in the range of 1464-1237 cm^{-1} are due to the combination of deformation modes of methyl and methylene groups from lipids.

The FTIR spectrum of garlic oil consisted of the prominent absorption bands of C–H stretching (3008 cm^{-1}), of symmetrical stretching vibration of $=CH_2$ (2922 cm^{-1}), and of $–CH_2–$ stretching (2852 cm^{-1}). The very intense peak at 1742 $cm^{-1}$is attributed to C=O stretching vibration. The double peak at 1459–1377 cm^{-1} may be assigned to the stretching $–CH_2–$ group while $CH_2=CH–$ stretching is shifted to 1159 cm^{-1}. The other very intense peak at 916 cm^{-1} is attributed to C–S–C stretching vibration. Additionally, the IR spectrum displayed the S–C absorption between 800 and 700 cm^{-1} and S–S absorption located between 500 and 400 cm^{-1}.

FTIR spectrum of sodium alginate showed bands at 1609 and 1416 cm^{-1} are assigned to asymmetric and symmetric stretching peaks of carboxylate salt groups. In addition, the bands around 3438 (hydroxyl group), 1302 cm^{-1} (C–O stretching), 1097 cm^{-1} (C–O stretching), 1030 (C–O–C stretching) and 947 (C–O stretching) are attributed to its saccharide structure.

The spectrum of microcapsules in the high-wavenumber region reveals the strong (O–H) stretching modes of water at 3448 cm^{-1} from the moisture adsorbed in alginate powder and a significant contribution from lipids in the liquid flaxseed oil, which consists of the band at 3010 cm^{-1} (i.e., C–H stretches of cis-alkene –HC=CH–) specifically representing unsaturated fatty acids, and triplet bands present within 3000–2800 cm^{-1} attributable to C–H stretching modes of the methyl and methylene backbones of lipids. By a comparison with IR spectrum of flaxseed oil, the spectrum in this spectral region also shows a substantial contribution from the lipids in the flaxseed oil particularly the sharp band at 1746 cm^{-1} assignable to (C=O) stretches of ester functional groups from lipids and fatty acids, and is therefore indicative of total lipids in the microcapsules. Additional bands relevant to lipids are those at 1163 and 1098 cm^{-1} assigned to CH_2 out-of-plane deformation modes and (C–O–C) symmetrical stretches, respectively, which are primarily from triglycerides and cholesterol esters. In addition, the overlapped bands in the range of 1460 – 600 cm^{-1} are due to the combination of deformation modes of methyl and methylene groups from lipids.

Scanning Electron Microscopy (SEM)

Scanning electron microscopy was used to investigate the morphology of microcapsule (Fig 38 to 41). The microphotographs indicate that the microcapsules were almost spherical, discrete and covered continuously and completely with coating material sodium alginate. Most of the particles showed a rough external surface with a continuous wall and small pores distributed over entire matrices. The pores could form as a result of the migration of water molecules during the drying process and subsequent shrinkage of the polymeric gel. The results indicated that no apparent fissures or cracks on surface wall of microcapsules with compare to control, which is important to provide lower permeability to gases, better protection and core retention. This indicates that there was no intermixing of the wall material and the encapsulated oil. Small inward dents were observed in control microcapsules due to collapse of the microcapsule wall material. In almost all the cross-sectional view of the microcapsules depicted a sponge-like porous structure, in which the oil was entrapped. The cross-sectional view of control sample was depicted a large hollow space, which may be due to unavailability of active ingredient.

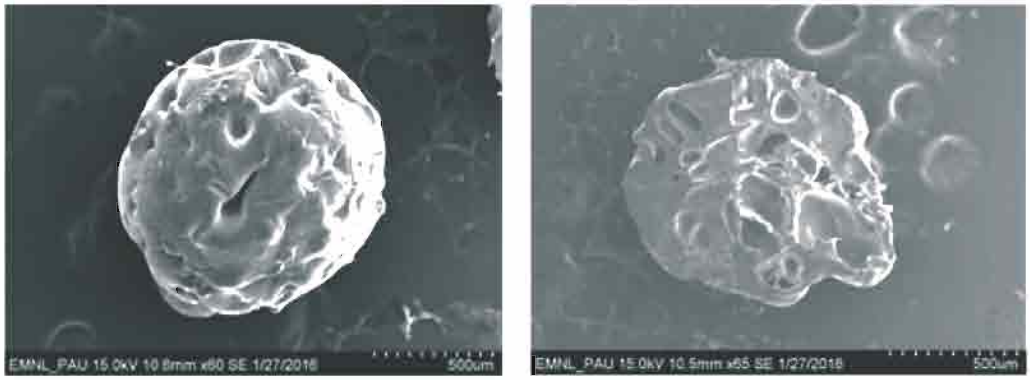


Fig 38. SEM image of microcapsule (control) and its cross-sectional view

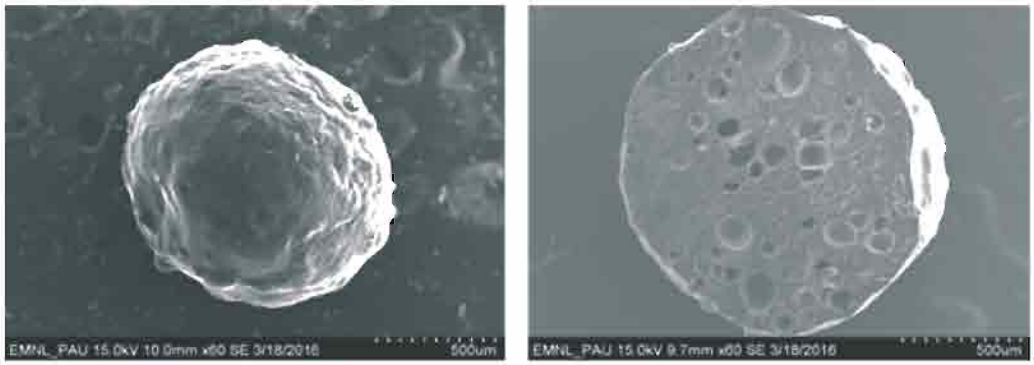


Fig 39. SEM image of flaxseed oil microcapsule and its cross-sectional view

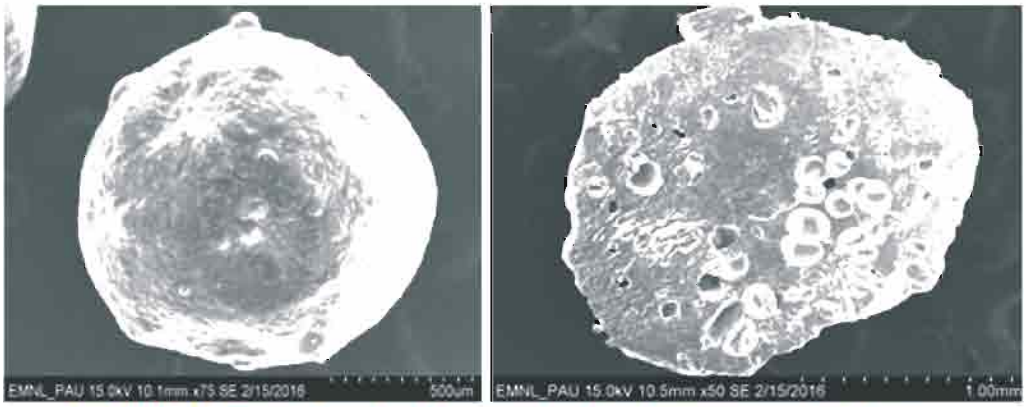


Fig 40. SEM image of garlic oil microcapsule and its cross-sectional view

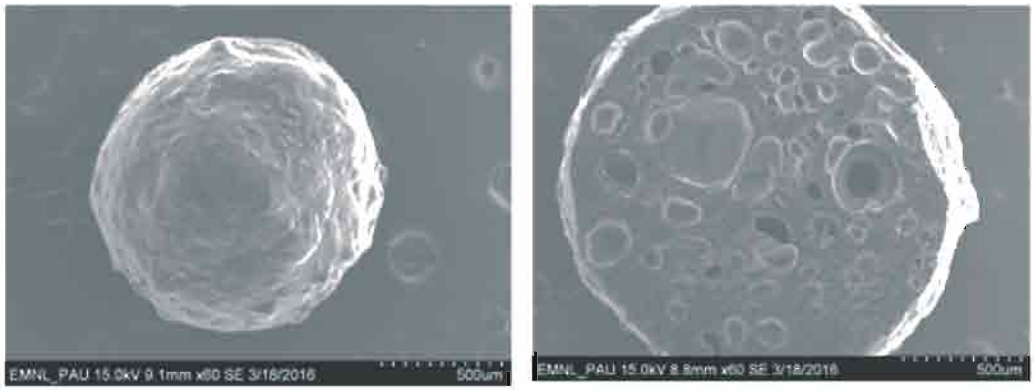


Fig 41. SEM image of flaxseed oil-garlic oil microcapsule and its cross-sectional view

Development of process protocol for de-bittering of *kinnow* juice

During juice processing and storage, an enzyme (Limonoate-D-ring lactone hydrolase mainly present in seeds), catalyses the conversion of limonoate A-ring lactone/LARL (a non-bitter precursor) to bitter limonin in acidic condition of juice, resulting in delayed bitterness of extracted *kinnow* juice. Hence, the enzyme LDLH was extracted and purified from *kinnow* seeds and its inhibition studies were carried out in order to curtail LDLH mediated bitterness in the processed juice.

Inhibition of bittering enzyme

The purified LDLH enzyme was treated with 50 units each of papain, bromelain and pepsin and the broth was incubated for 1 h at 50°C in a water bath. Other inhibitors, viz. EDTA, Histidine, 1,2-Cyclohexylenedinitrilotetraacetic acid (CDTA), L-glutamate, sodium hexmetaphosphate and DL-malic acid, were added directly in the reaction mixture @ 20 mM concentration in order to inhibit the LDLH activity. Papain, pepsin, histidine and DL-malic acid had no effect on LDLH activity. Bromelain could inactivate the enzyme by 11.5% while sodium hexmetaphosphate, L-glutamate and CDTA could inhibit enzyme activity approximately by 40%. EDTA was found to be the best inhibitor of LDLH (58.1%) and can be used effectively to inhibit the LDLH mediated conversion of LARL to bitter limonin under acidic pH of *kinnow* juice.

Effect of ripening on various components of *kinnow* juice

A number of biochemical changes take place while ripening of *kinnow* fruit. *Kinnow* fruits were harvested from local orchards at monthly interval from September, 2014 to April, 2015 and analyzed for bittering factors and other biochemical parameters. Naringin content in *kinnow* juice decreased from an initial value of 396.13 ppm (September, 2014) to 146.2 ppm (April, 2015) while the respective decrease in case of limonin content was from 52.37 to 12.7 ppm (Fig 42). TSS increased from an initial value of 7.43°B in September, 2014 to 12.63°B in April, 2015 while there was a corresponding decrease in % titratable acidity from 1.41 to 0.41%. Ascorbic acid content showed a bell shaped curve. It increased upto January, 2015 (from an initial value of 23.33 to 45.27 mg/ 100 ml) and decreased thereafter to 16.57 mg/ 100 ml.

Distribution of naringin and limonin in various portions of *kinnow* fruit

Different compartments of *kinnow* fruit contain different concentration of bittering factors. In order to devise a protocol of de-bittered juice, an experiment was carried out to find out the cencentration of limonin and naringin in various portions/compartments of *kinnow* fruits. Different portions were processed for extracting limonin and naringin separately and analyzed concentration via HPLC. The concentrations are elaboarated Table 3. Limonin was found highest in seed and the value corresponded to 224.37±5.58 ppm/g of seed tissue while lowest limonin was reported in extracted juice having 20.33±1.56 ppm/ml of juice. Albedo was found to contain negligible amount of limonin at that dilution level. On the other hand, naringin was found highest (13589.82±6.86 ppm/g) and lowest (105.67±0.95 ppm/ml) in flavedo and juice portions of *kinnow* fruit, respectively. On the basis of these data, it was concluded that if seeds and peel (albedo+ flavedo) are manually removed before juice extraction, we can cut down a major portion of bitterness being drifted in *kinnow* juice while processing due to tissue disruption. Manual separation of peel and seed, followed by juice extraction was found to have no limonin content.

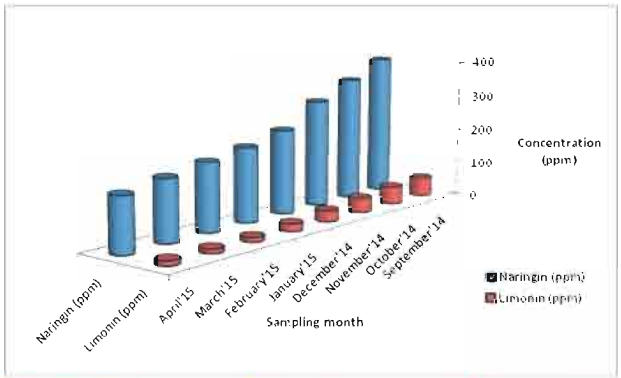


Fig 42. Naringin and limonin content in *kinnow* juice during ripening

Table 3: Distribution of naringin and limonin in various portions of *kinnow* fruit

Portion of *kinnow*	Limonin (ppm)	Naringin (ppm)
Flavedo	56.95±1.33	13589.82±6.86
Albedo	-	4037.83±9.18
*Juice	20.33±1.56	105.67±0.95
Seed	224.37±5.58	710.82±4.67
Pulp	114.91±2.26	131.84±1.46

*values in ppm/ml

Initial heating induces increase in naringin concentration

Another interesting finding was that Initial heating (90°C for 5 min) to reduce microbial load and inactivate internal enymatic activity caused increase in naringin content. The naringin content in fresh juice was 158.81±1.33 ppm which after heating increased to 344.93±4.98 ppm. To avoid the increased in naringin content during heating some alternate way should be explored.

Adsorbent filtration

After initial heating and centrifugation, an adsorbent filtration step was introduced where an activated charcoal filter was fitted in a vessel, the outlet of which was connected to a vacuum pump. The juice was placed with activated charcoal and allowed adsorption (of bittering factors) by giving a contact time of 2 h (between juice and activated charcoal) with intermittent shaking. After adsorption of bittering factors, the juice was allowed to filter through adsorbent using vacuum pump (Fig 43). Naringin content was reduced to 62.69±2.49 ppm from its initial value 344.93±4.98 ppm due to

Fig 43. Set-up of carbon filter and vacuum filtration of *kinnow* juice

Fig 44. Pictorial representation of *kinnow* juice de-bittering process

Selection of *kinnow* fruit

↓

Manual removal of *kinnow* peel (flavedo and albedo)

↓

Juice extraction using screw press without damaging seeds or manually separating seeds

↓

Blanching (90°C; 5 min)

↓

Centrifugation (10 min; 7000 rpm) to separate sticky pulp

↓

Treatment of centrifuged juice with activated charcoal for 2 h with intermittent shaking

↓

Addition of LDLH inhibitor and re-addition of centrifuged pulp

↓

Setting up of TSS and acidity

↓

Pasteurization and packing

Fig 45. Process flow chart for production of de-bittered *kinnow* juice

Table 4: Comparison of juice de-bittering process with existing technology

Existing Technology	New Process
First crushing everything including bittering factors and then separating by using resins	Manual separation of major bitterness producing components at initial step
Machinery for de-bittering *kinnow* juice using resins (like polystyrene divinyl benzene, indion NPA1 etc.) is costly	Adsorbents and inhibitors used in this intervention are extremely cheap
Costly instrumental set up is an essential requirement	Plant can be run with bare minimum requirement
Bitterness comes in tolerance range	Bitterness comes in tolerance range

adsorbent filtration. TSS changed from 12.73±0.07 to 12.20±0.11 °B. Titratable acidity got reduced to 0.49 % compared to control (0.56%) while ascorbic acid receded from 16.57 to 3.76 mg/100 ml. Fig. 6 is showing the pictorial representation of the events leading to final de-bittering process protocol for *kinnow* juice.

The activity of enzyme Limonoate-D-ring lactone hydrolase could be inhibited to 58.1 % using 20 mM EDTA. Initial heating (pasteurization) in order to inactivate enzymes and microbes augments the concentration of naringin. Level of bitterness decreases with ripening. January to March is the best season for *kinnow* juice processing. Treatment of *kinnow* juice with activated charcoal for 2 h along with intermittent shaking can reduce the concentration of naringin to its tolerance range. The final process for de-bittering involves sequentially: manually separating peel (albedo+flavedo) and seed; juice extraction; initial heating for 90°C for 5 min; centrifugation; treatment with adsorbent/ activated charcoal for 2 h; addition of centrifuged pulp and LDLH enzyme inhibitor, pasteurization and packing (Fig 44). Flow chart for production of de-bittered *kinnow* juice is presented in Fig 45. The salient advantages of current intervention over the existing juice de-bittering protocols are presented in Table 4.

Microwave assisted extraction of low methoxyl pectin from *kinnow* residue

Pectin is widely used in the food industry as a thickener, emulsifier, texturizer and stabilizer. The estimated annual worldwide production of pectin is 7,250 metric tons, approximately 60% of which is produced from citrus fruits. In general, commercially pectin is extracted using inorganic acids like HCl, H_2SO_4 etc., due to which the industrial acid effluents pose problem of waste water disposal and cause environmental pollution. Inorganic acids lower down the quality of extracted pectin/ low methoxyl pectin (LMP). Hence, a process was developed for pectin extraction from *kinnow* peel using microwave energy (Fig 46). After extraction and cooling, the pectin was precipitated with ethanol, drained and dried.

Optimization of pectin extraction parameters

Kinnow peel powder was soaked in water, microwaved at 900 W for different durations, cooled and precipitated with ethyl alcohol, decanted and dried. Dried pectin was washed with 60% alcohol for 2 h with constant shaking and finally dehydrated with organic solvent for 4 h with constant shaking. The alcohol and organic solvent used during various operations of pectin extractions was recovered up to 70% using soxhlet.

Fig 46. Pictorial representation of process for pectin extraction

Maximum yield up to 10.5% was obtained from 60 min of microwave incubation with combinatorial treatment of citric acid and degradative enzymes when pH 2.0 was maintained during microwave assisted extraction. The yield of control pectin samples was half of maximum amount or even less when given the same treatments. The extracted pectin was able to make gel in water without adding sugar in the presence of 2% calcium chloride.

Inhibition of pear juice browning

Pear juice was treated with different anti-browning agents *i.e.* cysteine (50, 100 & 250 ppm), ascorbic acid (250, 500 & 1000 ppm), citric acid (250, 500 & 1000 ppm) at three different pH (3.5, 4.5 & 5.5) for inhibiting PPO activity (Fig 47). Citric acid at all the concentrations was ineffective in inhibiting the PPO activity. Residual activity of PPO decreased with the increase in the concentration of ascorbic acid and cysteine in pear juice. However, there was no further significant decrease in PPO activity when ascorbic acid and cysteine were added beyond 250 mg/L and 100 mg/L, respectively. It was also observed that PPO activity decreased at lower pH and maximum reduction was recorded at pH 3.5. Though, PPO activity was completely inhibited at a pH below 3.5, but the pear fruit do not possess such low pH. The taste also becomes extremely acidic, which reduces its acceptability.

Fig 47 a) control and b) treated pear juice

Inhibition of fresh mushroom browning

In order to inhibit the post-harvest browning of fresh mushroom, GRAS chemicals *viz.* ascorbic acid (100 - 500 ppm), citric acid (0.1 - 1.5%), caffic acid, glutamic acid alone and in combination with aloe-vera gel were used. Dipping of mushroom in 60% aloe vera gel along with 1% citric acid for 5 min and subsequent drying at 60°C for 7 h retained the desirable color (L* 89.1, a* 46.9 and b* 36.18) of mushroom.

Process for preparation of Iron and calcium fortified wheat *dalia*

Micronutrient malnutrition affects about more than half of the world population, particularly in developing countries including India. Iron fortification of staple food is vital to compensate the inadequacies of this micronutrient. Wheat *dalia*, a traditional breakfast cereal of north India and preferably consumed by young children, elderly people and health conscious consumers. It may be one of the potential cereal vehicles for iron fortification. Iron fortified wheat *dalia* premix was prepared using spraying technique followed by tempering and coating using recommended biopolymers (Fig 48). Iron fortification resulted in brownish coloured grits with higher redness (a) values than unfortified one. In view of desired iron content in the premix, spraying of iron containing solution (Iron content-16 mg/ml), 30 min tempering time followed by drying was found optimum for preparation of iron fortified wheat *dalia* premix. Iron content in the fortified wheat *dalia* was 4.27 mg/100 g. Similarly, calcium fortified wheat *dalia* premix was also prepared by addition of calcium salt i.e. calcium chloride solution (calcium 90 mg/ ml), tempering for 90 min followed by drying. Calcium content in fortified wheat *dalia* premix was 28.8 mg/ g.

Fig 48. Iron fortified wheat *dalia*

Improvement in *chapati* making quality of maize dough

Chapati making quality of normal maize and quality protein maize flour was improved by the addition of casein and hydroxypropyl methylcellulose (HPMC). Dough prepared from both QPM and normal maize flour with addition of 10% casein and 3% HPMC showed highest extensibility (10.1 mm for maize & 8.8 mm for QPM). The *chapaties* prepared from same dough scored highest (7.7 for maize and 7.8 for QPM) during sensory evaluation.

Studies on water absorption kinetics of pigeon pea

Numbers of pigeon pea dehulling machines have been developed in the past by various research organizations and industries but they are useful for the grains having moisture content in the range of 8-12%. Machines for dehulling of pigeon pea in wet conditions or wet pigeon pea have not been reported in the literature. Pre-milling treatments such as scratching, soaking in water or enzyme solution is required for dehulling of pigeon pea in wet conditions. Data regarding changes in physical and mechanical properties during pre-milling treatments are important for designing of a suitable dehulling machine. The pigeon pea was scratched with fine grade emery for 60 s in order to create cracks. Scratched and unscratched grains were soaked in water at different temperatures (10, 20, 30, 40, 50 and 60°C) up to 9 h. Gain in weight and moisture content of the grains were recorded. It was found that the rate of water absorption was higher in scratched pigeon peas at all temperatures (10-60°C) during 9 h of soaking. After 5 h of soaking at 60°C, gain in weight decreased due to higher leaching losses at higher temperature (Fig 49). However, the moisture content continuously increased up to 9 h of soaking (Fig 50). Rate of gain in moisture content for scratched samples was relatively higher as compared to unscratched samples.

Milling and pasting characteristics of pigmented rice varieties

Many rice cultivars and hybrids have unique physical and chemical characteristics that affect milling performance. Milling characteristics of six pigmented rice varieties (*black* and *red*) from Manipur (*Chakhou Poreiton*), Kerala (*Athira, Jyothi, Kanchana* and *Thavalakannan*) and Tripura (*Guria*) were compared. The paddy samples were milled in

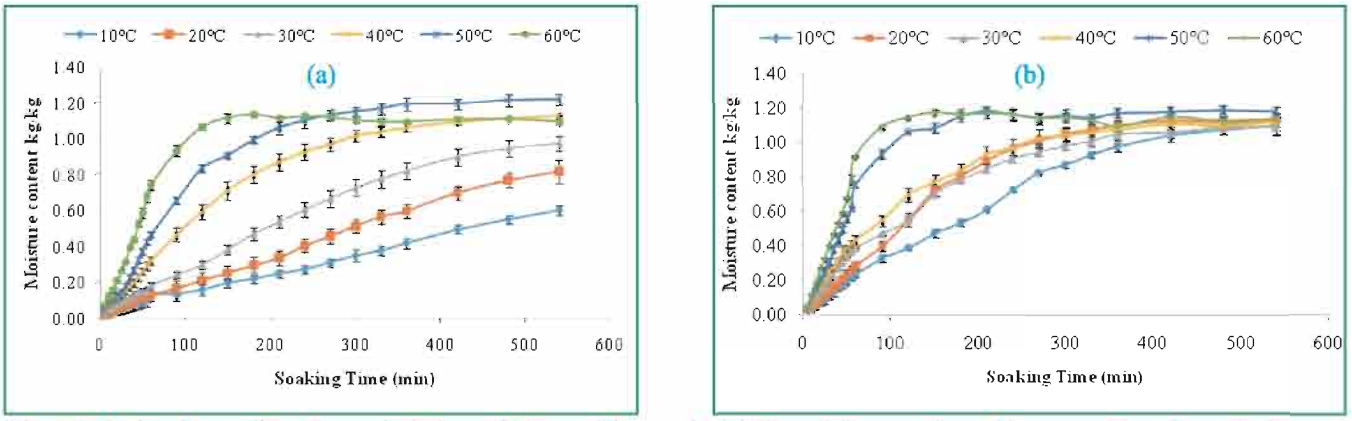


Fig 49. Water absorption characteristics of Pigeon Pea seed at different temperatures by measuring the gain in weight (a) before scratching, (b) after scratching

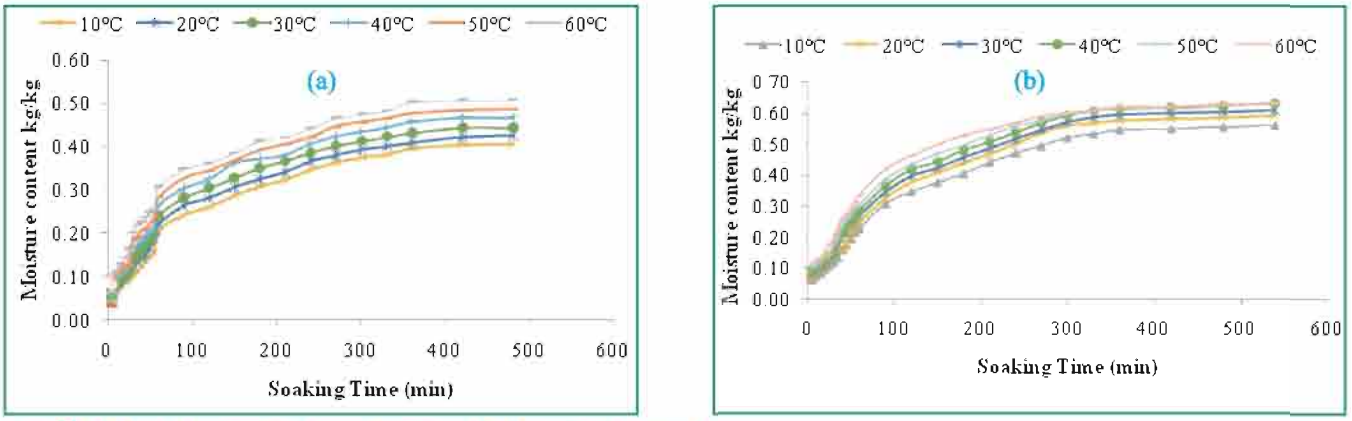


Fig 50. Water absorption characteristics of Pigeon Pea seed at different temperatures by measuring the moisture content using oven drying method (a) before scratching (b) after scratching

laboratory scale paddy dehusker and then polished in a rice polisher. The hull content (%) varied from 19.7-31.6%, bran from 4.6-11.7%. The un-hulled grains percentage was 0.5-1.2. Milling degree ranged between 88-96% with milling yield of 63.7-75.7%. Bran content in Manipur black rice was higher than red variety. The red variety of Tripura showed maximum percentage of hulls.

The pasting profile of pigmented rice varieties were determined using rapid viscosity analyser following standard AACC procedure. Peak viscosity ranged between 750-2061 cp, final viscosity 986-3740 cp, setback viscosity 373-1885 cp and peak time 4.7-6.7 min. The black variety showed lower pasting temperature (70°C) whereas, the red variety had higher pasting temperature. The red variety *i.e.* Thavalakannan had maximum (92°C) pasting temperature and lowest peak viscosity. In general, long grains showed higher pasting temperature and lower peak viscosity as a consequence of their high amylose content. The milling and pasting characteristics of black and red varieties differ significantly. The results obtained on milling and pasting characteristics can be effectively utilized while developing value added products from these varieties.

Food Quality and Safety

Detection of Aflatoxin M1 in Milk

The potential of Fourier Transform Infrared (FTIR) spectroscopy together with chemometrics was investigated as a rapid quality monitoring method for detection of Aflatoxin M1 in milk. Spectral signatures of Aflatoxin M1 spiked (20-100 ppt or 0.02-0.1 ppb) milk samples were acquired. Spectra revealed clear differences in the absorbance values of pure milk with and without Aflatoxin M1 (AFM1) supplementation (Fig 51).

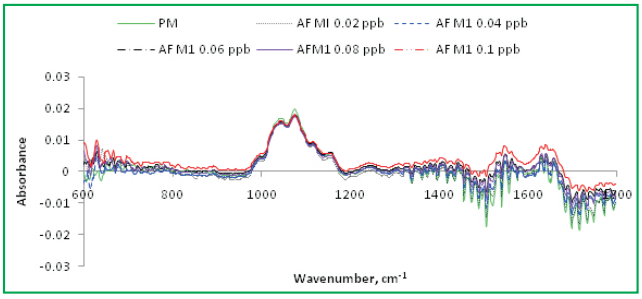


Fig 51. Spectra of pure milk and milk spiked with AFM1 (20-100 ppt) in wavenumber range 3997-632 cm^{-1}.

These differences in the absorbance values correspond to absorption frequency specific components of AFM1. Principal component analysis (PCA) showed clear clustering of samples based on level of adulteration, at 5% significance level (Fig 52).

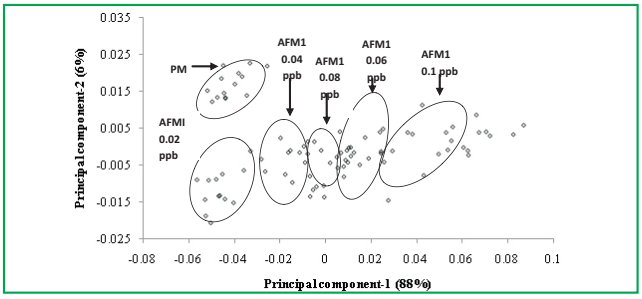
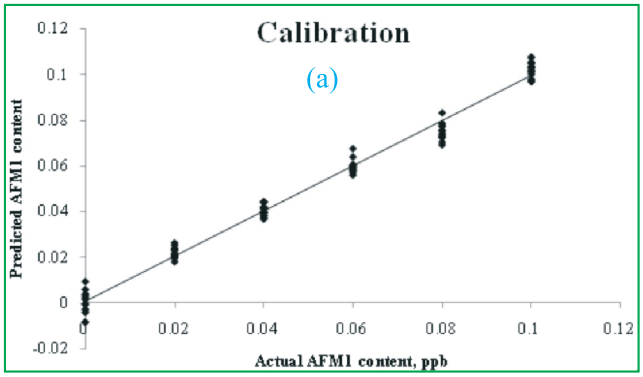


Fig 52. Principal component scores plot depicting clusters of pure milk and AFM1spiked milk.

Soft Independent Modelling of Class Analogy (SIMCA) approach was used to predict possible class membership of the samples. Four separate classes were obtained by SIMCA class projection. These classes represented pure milk (PM) and AFM1 spiked (0.02 ppb, 0.04-0.08 ppb and 0.10 ppb) milk samples. In four of the selected spectral windows 1558-1511, 1584-1424, 1584-1484 and 1408-1331 cm^{-1}, 100% correct classification was observed with minimum misclassification. It was observed that control sample was never classified as contaminated sample and vice-versa in selected wavenumber range.

For quantitative prediction of AFM1 in milk, regression models were built for all the selected spectral windows 3550-3499, 1800-650, 1744-1720, 1584-1424, 1558-1511, 1484-1424, 1423-1123 and 1408-1331 cm^{-1} using PLS (partial least square) technique. The best performance of models



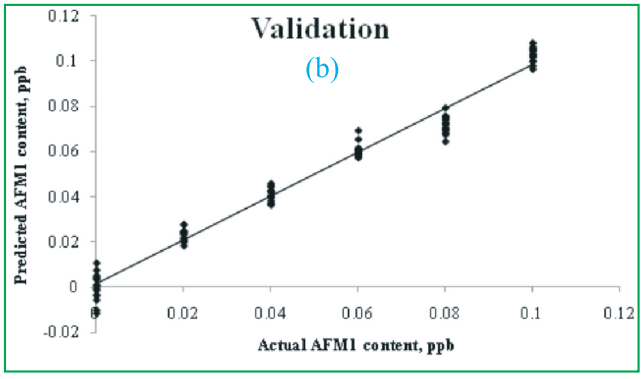


Fig 53. Actual *vs.* predicted levels of added AFM1 content in milk using PLS for (a) calibration and (b) validation sets of samples

were chosen based on lowest root mean square error of calibration (RMSEC) and validation (RMSEP) and highest coefficient of determination (R^2) for PLS. All the selected spectral windows had R^2 values >0.88. Scatter plots of actual *vs.* predicted values obtained for the best model showed predicted values were close to the experimental values (Fig 53).

Detection of Aflatoxin B1 in Milk

The potential of Attenuated Total Reflectance (ATR) -FTIR was evaluated as a rapid method for detection and quantification of Aflatoxin B1 (AFB1) in milk. Spectra (4000–500 cm^{-1}) of milk adulterated with known concentration of the mycotoxin (*viz.* 10, 20, 30, 40 and 50 ppb)were analyzed. The adulterated and non-adulterated milk showed clear differences in absorption values (Fig 54).

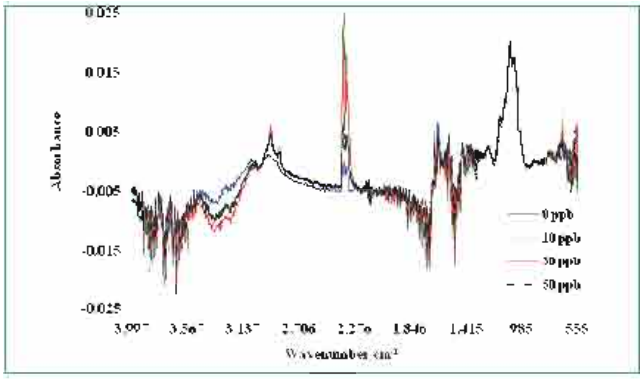


Fig 54.Typical spectral signature of pure and AFB1 spiked milk in the wavenumber range of 4000–550 cm^{-1}.

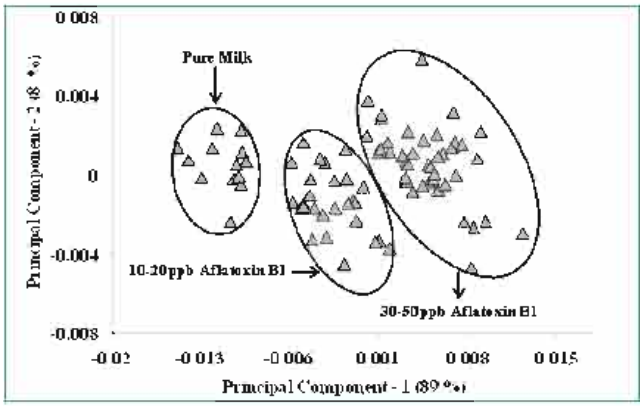


Fig 55. Principal component scores plot depicting clusters of pure and AFB1 spiked milk

Principal component analysis (PCA) showed clear clustering of samples based on level of adulteration, at 5% significance level (Fig 55).

Soft independent modelling by class analogies was used to assess the feasibility of detecting AFB1 in pure milk, and developed models could successfully classify contaminated with the pure milk samples. AFB1 concentration in milk was best predicted in the spectral range of 1484 - 1423 cm^{-1} using partial least square and multiple linear regression regressions with coefficient of determination of 0.92, 0.97 and 0.90, 0.92 for calibration and validation respectively. Scatter plots

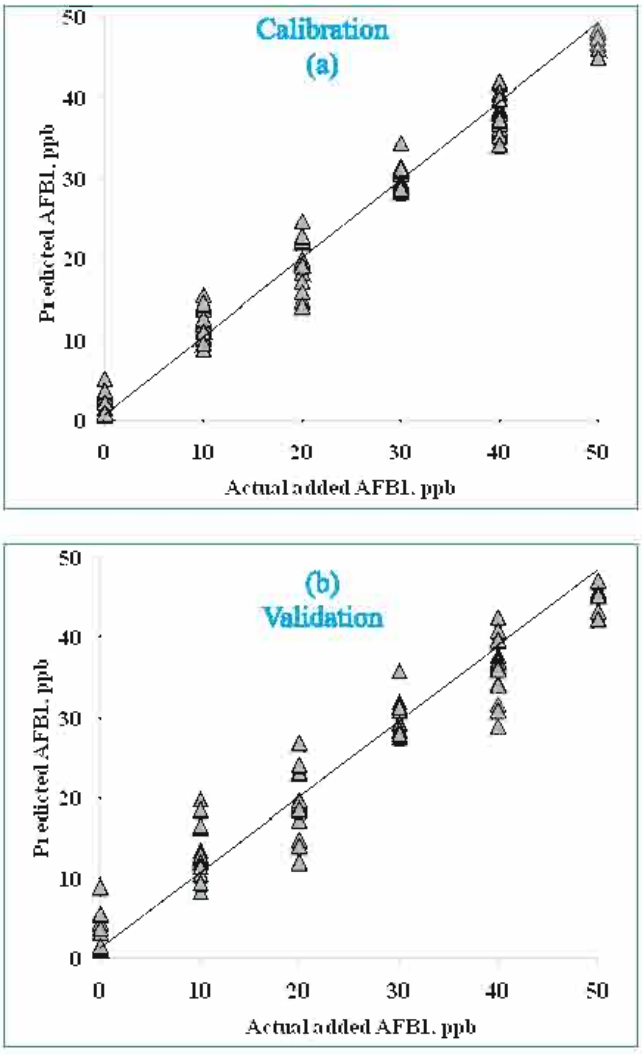


Fig 56. Actual *vs.* predicted levels of added AFB1 content in milk using MLR for calibration 'a' and validation 'b' sets of samples.

of actual *vs.* predicted values obtained for the best model showed predicted values were close to the experimental values (Fig 56).

Optimization and validation of process protocol for detection of Safflower adulteration in saffron by SCAR markers and DNA barcodes

Saffron is one of the most common spices that are adulterated. It is used as spice and food colorant and, less extensively, as a textile dye or perfume. Due to its analgesic and sedative properties folk herbal medicines have used saffron for the treatment of numerous illnesses for centuries. Dried stigmas of saffron (*Crocus sativus*), is one of the highest priced plant substances in the world and its high price and increasing demand, incites fraud, which is achieved mainly by inclusion of other cheaper substances coloured with additives that in many cases are not authorized by health organizations. Safflower is most commonly used biological adulterant of saffron. Therefore, PCR based methods for detection of safflower adulteration in saffron were optimized and validated.

Genomic DNA was isolated by method of Moller *et al.*, 1992 with minor modifications from safflower, saffron and their mixtures where the concentration of safflower in saffron was kept 1%, 3%, 5%, 7% and 10%. The isolated DNA was subjected to purification and the suitability of DNA was checked by Ethidium bromide stained 0.8% agarose gel.

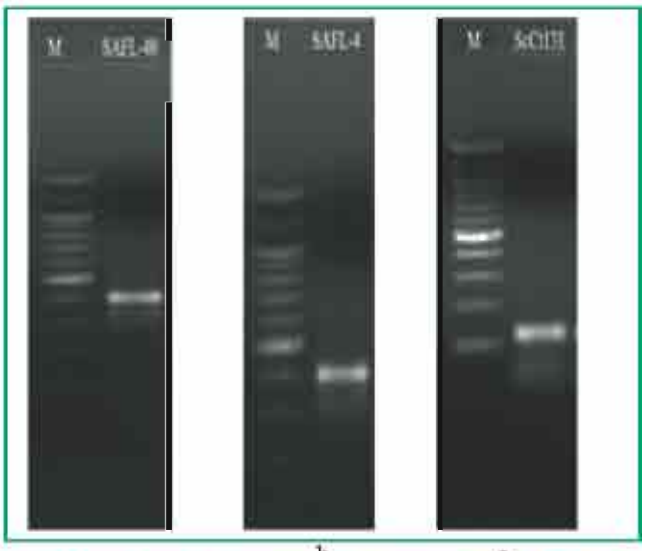
PCR based SCAR markers: ScCt131 (Torelli*et al.*, 2014), SAF L-40, SAF L-4 (Javanmardi*et al.*, 2011) and DNA barcodes: ITS2, psbA-trnH (Chen *et al.*, 2010) primers were synthesized and used for detection of safflower adulteration.

Gradient PCR was performed for the optimization of annealing temperature for all set of primers. PCR reactions for SCAR markers were performed in a 25 µl reaction containing 40 ng of DNA template, 1X Standard Taq reaction buffer (10 mM Tris-HCl, 50 mM KCl and 1.5 mM $MgCl_2$), 0.2 mM dNTP mix, 10 pmol forward and reverse primer, respectively and 0.5 units of Taq DNA polymerase. Magnesium concentration was varied in Taq reaction buffer from 1.5-2.5 mM and 2 mM concentration was found to be optimum. Amplification was performed as follows: 94°C for 7 min, 35 cycles of 94°C for 1 min, gradient temperatures(52- 60 °C) for 1:00/1:30 min, 72°C for 1:30/1:50 min, followed by one cycle of 72°C for 7 min.

The amplification product was resolved on 1.5% agarose gel and visualized under UV light in a gel documentation system.

Process protocol for amplification of SAF L-40 in safflower

PCR reactions were carried out by following the above mentioned conditions for SCAR markers. In case of SAF L-40, an annealing temperature of 55°C and 2 mM $MgCl_2$ was found to be optimum as



a b c

Fig 57. a. Amplification of safflower with SAFL-40, b. Amplification of safflower with SAFL-4, c. Amplification of safflower with ScCt131

compared to an annealing temperature of 58°C and 4 mM $MgCl_2$ reported by Javanmardi*et al.*, 2011. Amplification product of 414 bp for SAF L-40 (Fig 57a) was observed.

Process protocol for amplification of SAF L-4 in safflower

PCR reactions were carried out by following the above mentioned conditions for SCAR markers. In case of SAF L-4, an annealing temperature of 55°C and 2 mM $MgCl_2$ was found to be optimum as

compared to an annealing temperature of 60°C and 4 mM $MgCl_2$ reported by Javanmardi*et al.*, 2011. Amplification product of 412 bp for SAF L-40 (Fig 57b) was observed.

Process protocol for amplification of ScCt131 in safflower

PCR reactions were carried out by following the above mentioned conditions for SCAR markers. In case of ScCt131, an annealing temperature of 55°C and 2 mM $MgCl_2$ was found to be optimum as compared to an annealing temperature of 60°C reported by Torelli*et al.*, 2014. Amplification product of 131 bp for ScCt131 (Fig 57c) was observed.

Validation of process protocol for detection of safflower adulteration in Saffron with SCAR markers

The PCR reactions for mixture of safflower in Saffron were carried out in 25 µl reaction containing 1X Standard Taq reaction buffer (10 mMTris-HCl, 50 mM KCl and 1.5 mM $MgCl_2$), 0.2 mM Deoxynucleotide mix, 10 pmol forward and reverse primer respectively and 1.25 units of Taq DNA polymerase and amplification was performed as follows 94°C for 7 min, 35 cycles of 94°C for 1 min, 55°C for 1:30 min, 72°C for 1:30 min, followed by one cycle of 72°C for 5 min. Safflower concentration of as low as 1% was detected by using primer SAFL-40 and ScCt131 which gave the amplification product of expected size 414 bp (Fig 58a) and 131bp (Fig 58b), respectively.

Process protocol for amplification of DNA barcode ITS2 in safflower and saffron

PCR amplification of safflower with ITS2 was

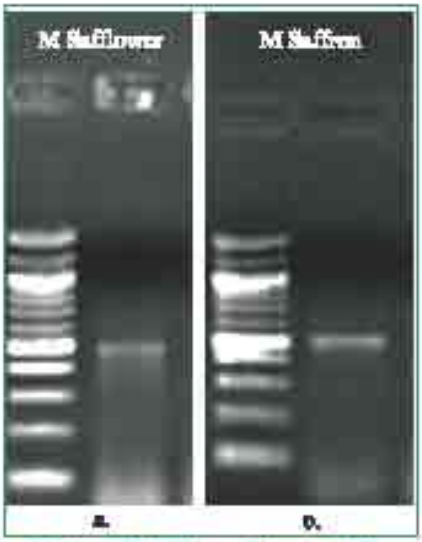


Fig 59 Amplification of ITS2 with a. safflower b. saffron; Lane M: 100bp

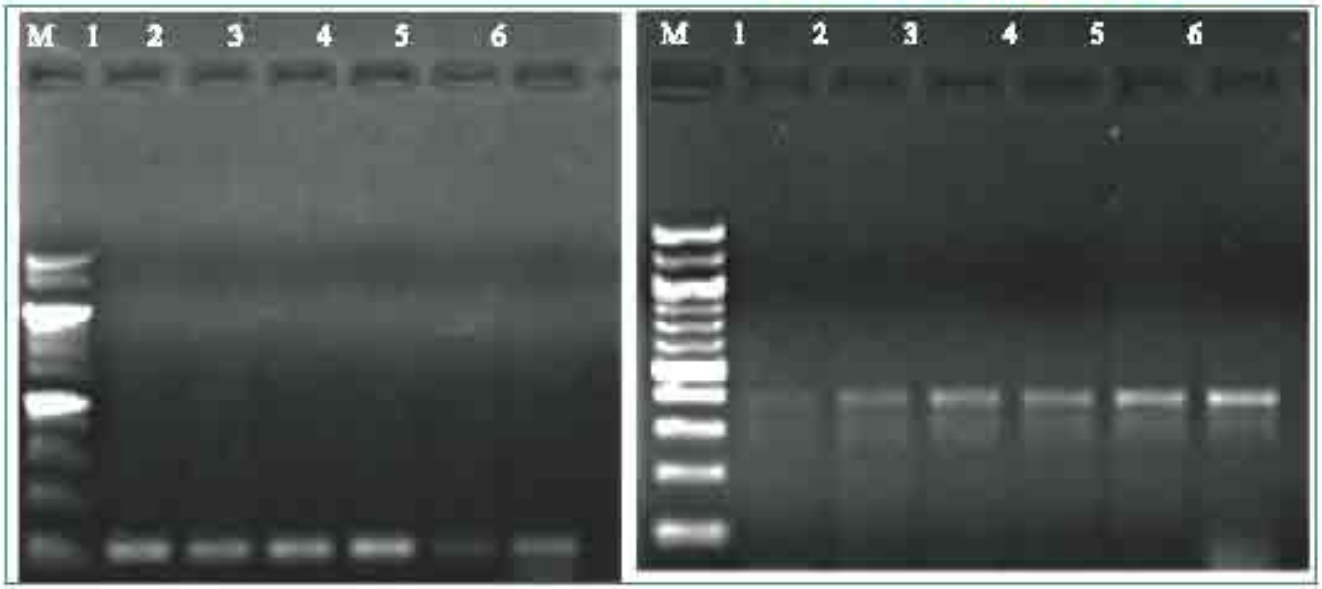


Fig 58. Amplification of safflower with a) SAFL-40 b) ScCt131; Lane no. M: 100bp DNA ladder; Lane 1-6: 1% safflower in saffron, 3% safflower in saffron, 5% safflower in saffron, 7% safflower in saffron, 10% safflower in saffron, and pure safflower

optimized as per the details given above. An annealing temperature 50°C and 2 mM $MgCl_2$ was found to be optimum that yielded the product of approximately 500 bp (Fig 59a). In case of saffron also, an annealing temperature of 50°C and 2 mM $MgCl_2$ yielded the product of approximately 500 bp (Fig 59b). So this barcode could not be used for detection of safflower adulteration in Saffron.

Fig 60. Amplification of psbA-trnH with a) safflower b) saffron; Lane M: 100 bp

Process protocol for amplification of DNA barcode psbA-trnH in safflower and saffron

PCR conditions for specific amplification of safflower and saffron utilizing psbA-trnH DNA barcode were optimized. An annealing temperature of 50°C and 2 mM $MgCl_2$ yielded the product of approximately 500 bp (Fig 60a). In case of saffron, same conditions resulted in amplification of product of approximately 650 bp (Fig 60b).

Validation of process protocol for detection of safflower adulteration in saffron with psbA-trnH barcode

The PCR reactions for mixture of safflower in saffron were carried out in 25 µl reaction containing 1X Standard Taq reaction buffer (10 mM Tris-HCl, 50 mM KCl and 2 mM $MgCl_2$), 0.2 mM Deoxynucleotide mix, 10 pmol forward and reverse primer, respectively and 1.25 units of Taq DNA polymerase and amplification was performed as follows 94°C for 5 min, 35 cycles of 94°C for 1 min, 50°C for 1 min, 72°C for 1:50 min, followed by one cycle of 72°C for 7 min. Safflower concentration (500 bp amplicon) of as low as 1% was detected by using primer set psbA-trnH and it could also detect saffron (650 bp amplicon) (Fig 61).

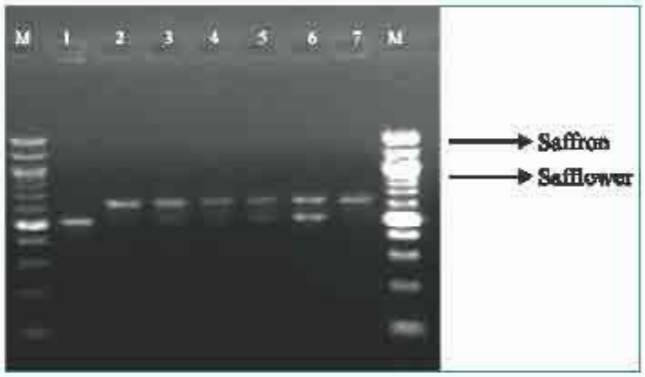


Fig 61. Amplification of Safflower and Saffron with psbA-trnH. Lane no. M: 100 bp DNA ladder; Lane 1-7: pure safflower , 1% safflower in saffron, 3% safflower in saffron, 5% safflower in saffron, 7% safflower in saffron, 10% safflower in saffron and pure saffron

AICRP on Post-Harvest Engineering and Technology

Food Grain Sector

Green chickpea pod stripping machine (Akola centre)

Green chickpea is high in fibre content and naturally low in fat, saturated fat, cholesterol and sodium. Stripping of green chickpea is done manually which is a tedious task. Green chickpea pod stripping machine was developed in order to reduce drudgery, save time and enhance returns to the growers (Fig 62). This practice will help in reducing transport cost and accumulation of garbage in the market. The machine (capacity: 11 kg/h) mainly consists of two units i.e. stripping roller and discharge unit. Stripping roller revolves clockwise from back to front. The pods from the green chickpea plants are stripped off due to the revolving movement. The revolving movement in stripping roller develops centrifugal force at the tip of the stripping lugs. The pods are rolled down and collected through a separate outlet chute. The optimum stripping efficiency (84.7%) was observed at roller speed of 190 rpm and feed rate of 11 kg/h. The unit cost of machine is Rs. 15000/- only. The estimated return to the entrepreneurs may be up to Rs. 40000/- in a season (90 days).

Fig 62. Green chickpea pod stripping machine

Amaranthus popping unit (Bhubaneshwar centre)

An amaranthus popping unit (capacity 2 kg/h) developed (Fig 63) at Bhubaneshwar centre. The unit consists of drum, stand, DC motor, feeding and discharge chute. The drum (15 cm diameter and 45 cm length) is mounted on the stand by bearing arrangemnet. Flight is provided inside the drum having pitch of 7 cm. The drum can be heated by LPG stove. Revolution of the drum can be regulated manually to have optimum heating and proper popping. Optimum popping was obtained at 210 ^{0}C drum surface temperature and 35 rpm drum speed. The residence time inside the drum was 15 s. The popping efficiency and expansion ratio were 85% and of 4.2, respectively.

Fig 63. Amaranthus popping unit

Improved maize dehusker-cum-sheller (Udaipur centre)

Earlier developed maize dehusker-cum-sheller was modified to enhance the capacity and efficiency (Fig 64). MS lugs and helical flights are welded on the periphery square cross section to facilitate the operation and material movement. Maize kernels passed through a perforated concave, cleaned and

Fig 64. Improved maize dehusker-cum-sheller

graded by cleaner-cum-grader provided below the cylinder. The blower helps in blowing away the light maize sheath. The cob heart stem and maize sheath are discharged from the tail end of the cylinder. The dehusking and shelling efficiency was 99% and 97%, respectively. The capacity of machine is 10 q/h and unit cost is Rs. 740000/- only.

Amorphous silica recovery from rice husk (Kharagpur centre)

The high silica (SPO_2) content in the rice husk ash has attracted interest in discovering ways to use it commercially. Silica powders have many technological applications as thermal insulators, composite fillers, etc. Rice husk (variety-*Badshabhog*) was collected and washed with water to remove dirt and foreign matters and dried. The cleaned husk was leached with 1 N HCl solution for 1 h followed by washing with water. The acid leached husk was dried up to 7% moisture level in a re-circulating cabinet tray dryer. Known weight of acid leached husk was kept in a muffle furnace for ash preparation at 550°C. The obtained white ash was characterized by XRD, SEM and EDX techniques for confirmation of structure, size and elemental composition. Amorphous white ash has 88.9% SiO_2 and some traces of Carbon. The microstructure of the silica falls in nano-meter range.

Phycocyanin- A natural colour from algae to replace synthetic blue colour (Raichur centre)

Algae collected from paddy fields were vacuum dried and ground into powder. Phycocyanin was extracted using super critical fluid extraction from algae powder. Obtained phycocyanin extract was spray dried. It contained 85.4 mg/g phycocyanin. Stability of phycocyanin in powder/product was more than four months at ambient temperature (27 ± 2°C). The technology was introduced to the M/s. Shekhar sweet confectionary of Raichur city for incorporation of phycocyanin (blue colour) in the preparation of vicks peppermint tablets. The phycocyanin has better scope in replacing synthetic blue colour in food industry. The estimated production cost of spray dried phycocyanin powder is Rs. 205/kg.

Ready-to-cook white *ragi*-malt based dairy food (Bengaluru centre)

Ready-to-Cook (RTC) white ragi-malt based dairy food was formulated by blending malted white *ragi* flour with malted green gram flour (11.5%), sugar (18.5%), multivitamins and minerals (Fig 65). The process technology has been optimized. Further, the formulation was also optimized after incorporating skim milk powder (SMP), whey protein hydrolyzate (WPH) and supplementation with honey and probiotics. Sensory evaluation studies of developed product and its variations clearly indicated good acceptability. Whey protein could be successfully incorporated as a protein source up to the level of 75% of SMP without affecting the acceptability of the product. The developed product needs to be cooked like porridge until it comes to viscous consistency. Blending of honey @ 5% level into the product improved the acceptability of white *ragi* malt based dairy food product. The nutritions composition of the developed product and its variations is presented as below. The shelf-life of the ready-to-cook formulation of millet-malt based dairy food was observed to be two months and the cost of production was estimated to Rs.118.5/kg. This will help in commercial exploitation of white *ragi* besides providing complete meal with the benefit of probiotic organisms to the targeted group.

Compositional Parameters	Range
Moisture	4.2 -5.0%
Fat	2.0 -2.4%
Protein	12.2 –14.9%
Carbohydrates	75.7 -79.7%
Crude fibre	2.8-3.0
Energy	384.34 -386.6 kcal/100 g

Fig 65. Ready-to-Cook white ragi-malt based food

Horticulture Sector

Pilot plant for pectin extraction (Solan centre)

The apple pomace generated by the apple juice processing industry causes environmental pollution and economic loss, which needs to be addressed immediately. Apple pomace contains about 16.95% pectin. Commercial mechanical method/process of pectin extraction from apple pomace is optimized. Based on optimized process, pilot plant for extraction of pectin has been designed and fabricated (Fig 66). The capacity of the pilot plant is 20 kg dried apple pomace/cycle (12 h) and efficiency is 1.4 kg pectin/10 kg apple pomace. The cost of pilot plant is approximately 25-30 lakhs. The cost of commercial pectin is about Rs. 3500/kg while cost of pectin produced from pilot plant fabricated by AICRP on PHET, Solan centre comes out to be Rs 2012/kg after adding 20% profit. Thus the pectin plant shall be profitable venture to the entrepreneurs.

Fig 66. Pilot plant for pectin extraction

Pineapple harvester (Imphal centre)

The conventional method of pineapple harvesting is not only time consuming and laborious but also causes backache as harvesters have to stoop while harvesting. A manually operated pineapple harvester (capacity: 250 fruits/h, effective efficiency: 70%) is fabricated with mild steel rod of 3 cm diameter, 150 cm length (Fig 67). The weight of the harvester is 9 kg. A sharp cutting blade of 12.5 cm diameter made of mild steel is attached at the end of the main frame. Rotation of the cutting blade is obtained through a transmission from a 1.5 hp petrol engine through a spiral rotating shaft. When the operator pulls the lever of the cranking wheel of engine mounted at the back of the operator which is connected to the cutting blade, the blade starts rotating and cuts the stalk just beneath the pineapple. The cut pineapple is held with the finger provided just above the cutting blade. The detached/cut pineapple can be shifted to a basket kept on the ground. A single operator is required for cutting the pineapple and putting it in the basket as well. The unit cost of harvester is Rs. 15000/ only.

Fig 67. Manually operated pineapple harvester

Turmeric washing machine (Akola centre)

Turmeric washing machine (capacity: 2.25 q/h) consists of washing and conveying system mounted on a single frame (Fig 68). The combined effect of pressurized water spray and rubbing action of turmeric rhizomes on bristles of brush cylinder wash and clean the turmeric rhizomes while passing through the brush cylinder. The necessary retention period of the material in the brush cylinder during the material washing process can be achieved by

Fig 68. Turmeric washing machine

adjusting the screw speed. The washed material outlet and the waste material with water outlets are provided separately. The optimum operating parameters for washing turmeric rhizomes in the mechanical washer were screw speed 8.2 rpm, brush cylinder speed 30 rpm and water pressure 1.77 kg/cm^2. The mechanical washing efficiency, microbial washing efficiency and bruise index of the developed washer were found to be 96.19%, 95.49% and 1.77, respectively. The unit cost of machine is Rs. 75,000/ and cost of washing was estimated to be Rs. 0.26/kg.

Curing and storage structure for onions (Hisar centre)

The *kharif* onion harvested in the months of November to January in Haryana has poor shelf life because of poor curing after the harvest. The curing and storage structure (height 240 cm, diameter 90 cm, chamber height 60 cm) for onions with four chambers of 25 kg capacity each was designed and developed (Fig 69). The curing was carried out by burning cow dung cake in evening and morning. The dung cakes fumes were passed through the inner drum to enter into onion chambers. This extended the shelf life of onions to 60 days.

Fig 69. Curing and storage structure for onions

Drying system for ginger suitable to North Eastern states (Imphal centre)

An indirect type natural convection biomass burner drying system suitable for small-scale processors to drying spices in non-electrified areas of North-Eastern regions was developed (Fig 70). The machine operates on the principle of space heating, consists of a separate biomass combustion chamber/furnace and a drying chamber. The overall dimension of the dryer is 2.4 (L) x 2.6 (B) x 1.25 m (H). The chimney height is 1.5 m. The combustion chamber having overall dimension of 0.47 x 0.84 x 0.31 m comprises of two chambers separated by perforated grates/metal trays. The wood charcoal/biomass briquette burns completely in smokeless environment and supply clean hot flue gas to pass through the rectangular ducts. The air surrounding the ducts gets heated up by natural convection and radiation. The hot flue gas is re-circulated below the combustion chamber to increase the fuel burning efficiency above 75%. The temperature in the drying chamber can reach up to 60±5°C. The vapour mixed humid air escapes out through a separate chimney, insulated with glass wool of 2.5 cm thickness. The capacity of the dryer is about 95-100 kg of fresh sample slices in a thin layer of 0.015 m thick per batch spread on perforated aluminum trays. Drying time is about 8-10 h to reduce the moisture content below 6-7% (wb) saves the drying time upto 64% compared to traditional *Bhatti* dryer and fuel upto 57.6%. Benefit-cost of drying system worked out to be 2.6.

Fig 70. Drying systems for important spices

Power operated continuous sapota cleaner (Junagarh centre)

Presently, the sapota fruits are cleaned by rubbing with cloth to make them more attractive and also for the removal of latex and scurf from its skin. Keeping in mind the need of farmers as well as cooperatives, a power operated sapota cleaner of 550 kg/h capacity is designed and developed (Fig 71). The drum (180 cm long and 45 cm diameter) is inclined from hopper to outlet with 2 degree slope. The inside surface of the drum is lined with jute cloth. The drum is rotated by ring provided over the outer surface at both the ends of the drum. The ring is rotated by spools loaded on shafts. Hopper and outlet are also lined with jute cloth to avoid damage to the sapota against rubbing action with metal sheet.

The performance of developed machine was evaluated and found cleaning efficiency of 100% without any damage. Optimum rotating speed of the drum is 35 rpm. The cost for cleaning is about

Fig 71. Continuous sapota cleaner (Capacity 550 kg/h)

Rs.0.20/kg, which is 90% less as compared to manual cleaning. The unit cost of machine is Rs. 18,000/- only.

Multi-mode solar dryer (5 tonnes capacity) (Raichur centre)

To achieve controlled dehydration process and to obtain premium product quality, a multi-mode solar drier was designed and developed utilizing different sources of energies *viz.*, solar photo voltaic cells, electrical energy and diesel fuel (Fig 72). The dryer capacity is 5 tonnes with the dimensions of 28 x 5.8 x 2.1 m covered with 200 micron UV stabilized thermic sheets. It has four racks each with four shelves for spreading the commodities. It also consists of two industrial fans each with air flow rate of 541 m^3/ min to create the forced convection of hot air inside the dryer as well as to remove the moist air from the dryer. The temperature inside the dryer can be maintained at desired level (30-50°C) depending upon the commodities to be dried. The horticultural commodities like, grapes, fig, onion, tomato and chilli are found suitable to be dried in the dryer.

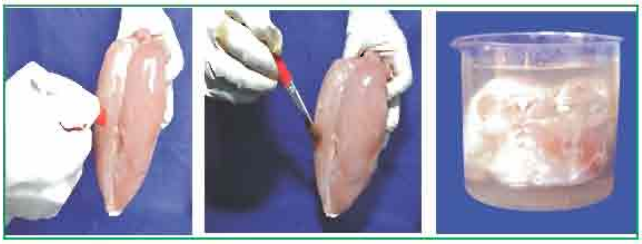
The experiments were conducted to dry the grapes, onion and chilli to produce good quality dried products. The temperature and humidity profile of inside and outside air was monitored throughout the drying process. The total drying time was observed to be 131 h for drying the grapes from an initial moisture content of 328.2% (db) to 22.6% (db). The heat utilization factors were found to be in the range of -0.92 to 0.35 for grapes and 0.07 to 0.88 for onion. The raisins obtained were analysed for the physic0-chemical properties *viz.,* moisture, TSS, colour, acidity, reducing sugars and microbial load. The quality was found to be on par with the premium quality raisins available in the market. The dryer was also used for dehydration of onions, figs & chilli and the products were found to be of superior quality. The cost of the multi mode solar dryer of five tonnes capacity is Rs. 8.50 lakhs. This can save 49.50% drying time and 54.50% labour cost. The cost to benefit ratio was found to be 1:1.75 for grapes and 1:2.25 for onions as compared to the values 1:1.20 and 1:1.35 observed for conventional drying, respectively.

Fig 72. Multi-mode solar dryer

Livestock sector

Edible coating of meat with hydrocolloids and cinnamon oil (Chennai centre)

Experiments were eonducted to identify and develop a suitable edible coating of hydrocolloids with cinnamon oil for preserving meat. The three hydroeolloid combinations i.e. (i) chitosan and cinnamon oil (0.05%) (ii) carrageenan, potassium chloride, eitric acid and einnamon oil (0.05%) (iii) sodium alginate, calcium chloride, citric acid and einnamon oil (0.05%) were examined. Cinnamon oil in combination with hydrocolloids was applied to the chicken breast using spraying, brushing and dipping techniques (Fig 73). Further, three experiments were also conducted to evaluate the effect of edible eoatings of different hydroeolloids viz. ehitosan, carrageenan and sodium alginate with cinnamon oil on the shelf-life of chicken breast stored under refrigeration temperature (4±1°C). The results revealed that chitosan in combination with cinnamon oil (0.05%) had synergistic effect to extend the shelf-life of chicken breast up to 7 days. The prepared chicken nuggets from treated samples were rated more acceptable by sensory panelists and had a shelf-life up to 28 days at refrigerated conditions.



(a) (b) (c)

Fig 73. Edible coating of meat with hydrocolloids an cinnamon oil by (a) spraying (b) brushing (c) dipping technqiues

Technology for the production of poultry feed using seafood industry waste (Mangalore centre)

The management of fish processing waste (i.e., viscera, frame, skin, fins and head) is a difficult task, which create environmental pollution. These wastes are good sources of protein and essential amino acids. Hence, these fish processing waste need to be utilized for production of livestock feed. The process protocols were developed for effective utilization of fish waste to produce protein and long chain fatty acid rich animal feeds. The process involved preparation of fish silage (chopped raw materials mixed with 3% formic and propionic acid in the ratio of 1:1), drying (dried with crushed corn in the ratio 85:15 at 40 °C for 2 weeks) followed by feed preparation as per ingredients mentioned in Table 5. All the ingredients except vegetable oil were mixed thoroughly in a large plastic basin and sufficient amount of water was added to get the required consistency. The mixed ingredients were subjected to cooking for 45 min. The cooked material was evenly spread on a tray and required amount of oil was mixed. Ingredients were then introduced into the pelletizer to get pellets. The prepared pellets were oven dried at 45°C for 24 h. The feed was named as 'KVAFSU Ocean Poultry Feed' (Fig 74).

Table 5. Composition and quantity of different feed ingredients

Ingredients	Composition (%)
Dried fish silage	5
Soya bean meal	35
Crushed corn	41
Rice bran	9.1
Calcite	2
Vitamin/ mineral premix	0.3
Salt	0.3
Vegetablc oil	5
Di-calcium pbosphate	2

Fig 74. KVAFSU ocean poultry feed

Study on storage losses of food grains in FCI and CWC warehouse and to recommend norms for storage losses in efficient warehouse system (Sponsored by FCI)

The aim of the study is to estimate the extent of storage losses in food grains (wheat, paddy, rice and maize) in FCI and CWC warehouses; to identify the factors responsible for losses in storage; to arriving at storage loss norms in different agro-climatic regions/ states with respect to various factors and the factors responsible for such losses; to suggest ways and means to reduce the extent of storage losses in different unit operations. This study covers 13 agro-climatic regions covering 48 locations in 21 states and one UT. The depots selected were 48 godown and CAP storage.

Wheat storage loss or gain of wheat procured under relaxed specifications during the year 2015-16 was determined under godown and CAP storage systems in four agro-climatic regions comprising the states of Punjab, Haryana, Uttar Pradesh, Rajasthan and Madhya Pradesh. The results revealed that wheat absorbed moisture and correspondingly the weight of wheat increased in the range of 0.41% to 0.43% in godown and 0.25% to 0.42% in CAP in three agro-climatic regions except Upper Gangetic Plain, where little losses in wheat was observed. Overall, there was appreciable gain in weight of URS wheat without any changes in quality parameters during three months storage period of study.

Technology transferred /adopted

1. 57 units PDKV mini *dal* mills were sold by its manufacturer during the period
2. *Mahua* seed decorticator (Bhubaneswar centre)
3. Process technology for preparation of beverage from stone apple, mango, pineapple and aloe-vera (Bhubaneswar centre)
4. Technology for preparation of probiotic finger millet porridge (Coimbatore centre)
5. Honey-heating-cum filtration system commercialized & licensed to AB Engineers (Ludhiana centre)
6. Technology for preparation of fish patties and fish chikuwa were transferred to a women entrepreneur Smt Joyce Dias (Mangalore centre)
7. Technology for the production of protein rich cassava pasta (Trivendrum centre)
8. Production of fried products from cassava (Trivendrum centre)
9. Mechanized jaggery granulator (MoU with three firms) (Anakapalle centre)

Success stories published

- Agro-Processing Centre for Turning Farmers into Entrepreneurs (ICAR web: http://www.icar.org.in/ dated 9-12-2015)
- Model Retail Outlet for Production of Hygienic Chicken Meat was published in the 'Yashogatha' (Success stories) of (MAFSU, Nagpur centre)

Patents Filed

1. Manual *mahua* seed decorticator, (Bhubaneswar centre)
2. *Mahua* stamen remover (Bhubaneswar centre)
3. Mini oil refining unit (Bhubaneswar centre)
4. Portable evaporative cooled vegetable storage cabinet (Bhubaneswar centre)
5. Cocoa pod breaker (Coimbatore centre)
6. Onion Umbel Thresher (Coimbatore centre)
7. Process for the production of low-moist gelatinised dough for using in cassava (tapioca) *papad* making machine (Trivendrum centre).

Agro processing centres/ processing units established (2015-16)

Sr.No.	State	Name of the Centres	Address	Total
1	Maharashtra	PDKV, Akola	• Shri Shivanand Waghmare, Kanshivni, Akola • Shri HimmatraoTekade, Ruikhed, Buldhana	2
2	Uttarakhand	VPKAS, Almora	• Shri Puran Chander Pandey, Dhaspar, Suwakhan, Bhanauli, Almora, Uttarakhand	1
3	Karnataka	UAS, Raichur	• Millet Processing Unit : Uttangi Village, Huvinahadagali, Bellary, • *Dhal* Mill, Athanur Village Manvi, Raichur	2
4	Odisha	OUAT, Bhubaneswar	• Cashewnut processing Kaluram Pradhan, Pitanpalli, Kalikote, Ganjam • *Dal* processing SORD, Bhanjapadar, G.Udayagiri, Kandhamal • *Dal* Processing Dharitri Sanchya Samiti, Siminai, Dhenkana • Oil processing Pradyumna Sahu, Naranpur, Nilagiri Balasore	4
5	Haryana	CCS HAU, Hisar	• Smt Pooja Garg, W/o Sh Vikas Jain, H No 435, Sector 9-11, Hisar–125005	1
6	Manipur	CAU, Imphal	• APC for training cum demonstration, CAU, Iroisemba, Imphal	1
7	Gujarat	JAU, Junagadh	• *Ekta Mahila Sahkari Mandli* (Tribal *Mahila Sangh*). Village–Vadala, Talala, GirSomnath.	1
8	Punjab	PAU, Ludhiana	• Baby oil expeller, S Gurpreet Singh, Churad, Muktsar • S Husandeep Singh Husandeep Agro Food Processing Model, Ramuwal, Bhatinda • S. Darshan Singh Dogar Basti, Street-11, Faridkot • S Iqbal Singh Flour Mill, VPO Dadha hoor, Ludhiana • S Sukhwant Singh "Sandhu Agro Food Processing" Patti, Amritsar	5
9	Uttar Pradesh	ICAR-IISR, Lucknow	• Shri H P Vasisth, FAPRRO, Ghugial, Hariana, Hoshiarpur, Punjab • Sri Himanshu Gangwar, Kuiyandhar, Kuiyankhora, Farrukhabad, U.P. • Sri Raghunath Singh, Sipian, Hajpur, Hoshiarpur, Punjab	3
10	Srinagar	SKAUST & T, Srinagar	• M/s Kashmir Gulbadan, Habak Hazratbal Srinagar • M/s Mannat Food Products, Bari Brahmana, Jammu	2
	Total			**22**

AICRP on Plasticulture Engineering and Technology

The AICRP on Plasticulture Engineering and Technology has total 14 co-operative centres throughout the country. Four new centres were started at BSKKV Dapoli; UAS, Raichur; ICAR-CIGR, Makhdoom and NRCY, Dirang and one was centre closed at CSKHPKV, Palampur, during 2015-16. The project has contributed in the development and modification of technologies related to plasticulture in horticulture, irrigation, intensive fish culture and animal housing as per the need of the mandated area of the centres. Following are the specific achievements made by cooperating centres during 2015-16.

Design and evaluation of Earth Tube Heat Exchanger (ETHE) coupled greenhouse

For hot and arid region of Punjab (ICAR-CIPHET, Abohar centre)

During study, ambient temperature as well as ground temperature at different three depths (0.9 m, 1.8 m and 2.7 m) was recorded. During winter months (December 2014 to January 2015), average ambient temperature at Abohar was found as 13.5°C whereas the average ground temperatures at 0.9 m, 1.8 m and 2.7 m depth was found as 16.5, 18.5 and 20.5°C, respectively. Thus ground temperatures at $\geqslant$ 1.8 m depth were found significantly higher than the ambient temperature. Similarly, during summer months (May 2015 to June 2015), average ambient temperature at Abohar was found about 42°C whereas the average ground temperatures at 0.9 m, 1.8 m and 2.7 m depth was found as 32°C, 31°C and 28°C respectively. It was found that when ambient temperature was as high as 49°C, ETHE produced air with a temperature of 34°C. It was also found that increase in flow rate did not affect the temperature of outgoing air significantly. At all flow rates, outgoing air temperature varied between 31- 34°C.

A polytunnel (volume 6.44 M^3) was constructed over ETHE system (Fig 75) and potential of ETHE in cooling the polytunnel was observed. When air with 25.44 m^3/min flow rate was circulated through ETHE pipes to cool the polytunnel, average temperature inside polytunnel was found to be 41°C. On the contrary, when the ETHE system was not operated, average temperature inside polytunnel was found to be 46°C. The average ambient temperature in both the cases was found as 35°C. Further performance evaluation of ETHE is still being carried out. After this, appropriate volume of greenhouse will be determined and the greenhouse will be constructed over ETHE. Thus, results underscored the potential of Earth Tube Heat Exchanger (ETHE) for space heating during winter and space cooling during summer.

Fig 75. Polytunnel with ETHE system

For NEH Region (ICAR-RC NEH, Barapani centre)

The earth air tube heat exchanger (EAHE) was designed and constructed in the field for experiments of heating/cooling of polyhouse (Fig 76). The blower was operated at one speed at 12.5 m^3/h. However, the length of flow changed from 12 m to 48 m inside the heat exchanger. The performances of the heat exchanger in terms of temperature difference of inlet and outlet air was 10°C higher in 48 and 36 m length of pipe as compared to 12 m and 24 m length. The optimum length of heat exchanger for a flow rate of 12 m^3/h was found to be 36 m as at this length performance of the heat exchanger was comparable

with 48 m length. High speed of air is also necessary for cooling/heating the polyhouse as total heat gain or loss will be higher as compared to low speed. When the inside temperature of polyhouse was higher, heat exchange was higher and it lowered at low temperature difference. Therefore, to maintain optimum temperature, the heat exchanger was only operated at day time in summer and in night time during winter. The blower was operated for 8 h from 9 am to 5 pm at day time in summer season and from 5 pm to 7 am at night time in winter season. The co-efficient of performance of the EAHE with 36 m length of pipe, total heat exchange was found to be 34.85 kW-h. In 24 h, total energy consumed by the motor of the blower is 9 kW-h.

Fig 76. Earth air tube heat exchanger integrated polyhouse for NEH region

Enhancing the energy use efficiency of vegetable based cropping system under protected condition (ICAR-VPKAS, Almora centre)

A field experiment on vegetable based cropping system (green onion-tomato-capsicum) involving four treatments was conducted under two growing conditions (polyhouse and open field) (Fig 77). All the inputs required for vegetable cultivation and outputs obtained were converted from physical to energy unit measures through conversion coefficients. When compared across growing conditions, green onion yield under polyhouse conditions was 48.9% higher than open field conditions (65.6 kg/100 m^2). Among treatments, highest green onion yield was obtained with recommended dose of carbendazim under both polyhouse as well as open field conditions followed by the treatment involving recommended doses of carbendazim + cabofuran. Lowest green onion yield was observed under control. In terms of net energy return, energy profitability, energy use efficiency and energy productivity; polyhouse conditions proved better than open conditions while in case of specific energy open conditions proved better.

Fig 77. Vegetable based cropping system under polyhouse and open field conditions

Development of improved aquaculture system in mid hills (ICAR-VPKAS, Almora centre)

The growth of the exotic carp; silver carp, grass carp and common carp is better in the polytanks followed by earthen pond, which might be due to the better plankton production (1.6-1.9 ml/50 L. in cemented pond; 1.8-2.6 ml/50 L in earthen pond and 2.4-3.2 ml/50 L in polytanks) at water temperature of 2.0- 23.2 °C). In Polytanks, growth of the Silver carp was better (52.3%) from the cemented pond and 35.6% from the earthen pond. Similarly, growth of the grass carp was better 129.0% from the cemented pond and 90.8% from the earthen pond. The growth of the common carp was better in polytanks as 67.0% from the cemented pond and 39.0% from the earthen pond. Among the three tested exotic carps, maximum growth was recorded for grass carp followed by common carp without any mortality. The total plankton volume varied from 1.6-3.2 ml/50 L in different experimental ponds with maximum in polytanks and minimum in cemented tanks. One peak of the plankton population was observed during the period of September-November.

Periphyton production on different types of coloured plastic strips in freshwater ponds for enhanced fish production (ICAR-CIFA, Bhubaneshwar centre)

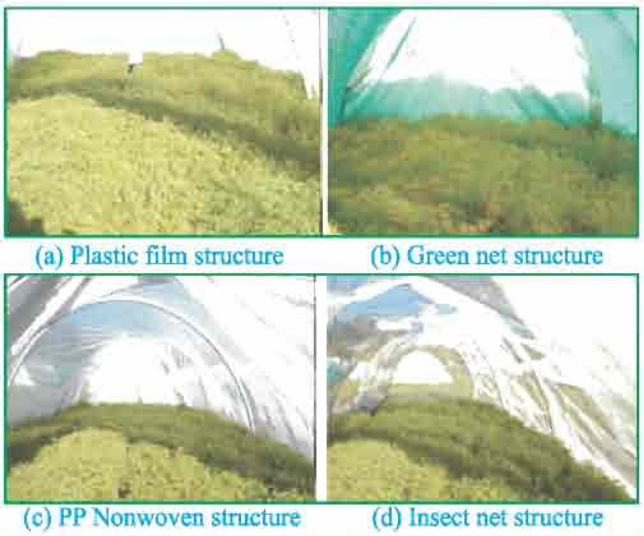
In bamboo mat and black coloured plastic sheet the light didn't penetrate to the back side, so there was no periphyton growth on them (in the back side)

Fig 78. Periphyton production on different types of coloured plastic stripes in freshwater ponds

(Fig 78). Blue colour had more amount of periphyton growth on it. The pond stocked with fish had quantitatively low amount of periphyton on it than the pond having no fish. 46.36% less periphyton was observed on sheets in ponds with fish, which means fish had eaten the periphyton. Two ponds of 0.1 ha each were selected for this experiment. One pond had five different colour plastic sheets for periphyton growth and another without plastic sheets. Each pond was stocked with 50 kg of fish (body wt of rohu 600-900 g). The fishes were reared for three months and supplementary feed was given in both the ponds with 2% fish biomass. The water parameters of both the ponds showed no significant difference. At the end of the experiment, 79 kg fish was harvested from the pond with plastic sheet and 72 kg fish from the pond without plastic sheets. The pond with plastic sheets had 9.72% higher growth rate than pond without plastic sheet.

Effect of different structures on protection of cumin crop against adverse climate (JAU, Junagadh centre)

Maximum temperature was recorded in plastic film (Fig79a) structure during morning and evening hours, it was found maximum in insect net structure. Minimum temperature was observed in green shade net structure (Fig79b) followed by ambient condition (control). Maximum relative humidity was observed in green shade net structure. Minimum relative humidity was observed in plastic film structure and insect net structure during morning hours and rest of the period, respectively. Maximum light intensity was observed inside plastic film structure and insect net structure during morning hours and evening hours, respectively. However, it was found higher in control than the structures. Minimum light intensity was observed in green shade net structure. Crop parameters viz., plant height (27.60 cm), no. of branches per plant (9.20), umbel per plant (16.40), seeds per umbel (10.80), 1000 seed weight of cumin (5.85 g) were observed highest in plastic film structure followed by PP nonwoven structure (Fig 79c). Minimum crop parameters were found in control. Minimum blight



(a) Plastic film structure (b) Green net structure

(c) PP Nonwoven structure (d) Insect net structure

Fig 79. a) plastic film structure (b) green net structure PP Nonwoven structure (d) Insect net structure for protection of cumin crop against adverse climate

intensity (9.38%), wilt incidence (9.40%) and seed infection (7.50%) was recorded in plastic film structure. Maximum diseases were observed in the control followed by green net structure. Total aphids (2.8) and thrips (7) per plant were observed minimum in plastic film structure. Maximum aphids (4.5) and thrips (20) were observed in green net

structure. Maximum yield of cumin (1267 kg/ha) was observed in plastic film structure followed by PP nonwoven structure (1062 kg/ha). Minimum yield of cumin (758 kg/ha) was observed in control. Net profit in plastic film structure is estimated to be Rs. 75,550 ha as compared with control.

Effect of protected environment on off-season seedling raising of papaya (JAU, Junagadh centre).

Maximum weekly average temperature (30.2°C) and minimum weekly average temperature (27.0°C) was recorded in walk-in-type tunnel and black shade net house respectively. Maximum weekly average relative humidity (41.9%) and minimum weekly average relative humidity (22.9 %) was recorded in walk-in-type tunnel and open field condition respectively. Maximum weekly average light intensity (46050 lux) and minimum weekly average light intensity (24320 lux) was recorded in walk-in-type tunnel and black shadenet house respectively. Morphological observations of papaya seedlings *viz.*, seedling height (38.9 cm), collar diameter (5.05 mm), number of leaves per plant (14.75) and tap root length (20.42 cm) were observed highest in poly-cum-shadenet house followed by black shadenet house whereas germination percentage (95%) was observed highest in black shadenet house which was at par with poly-cum-shadenet house. Quality parameters of papaya seedlings *viz.*, vigour index (3699) and sturdiness (10.70) were observed highest in black shadenet house followed by poly-cum-shadenet house. Benefit cost ratio for papaya seedling raised in different types of the structures was more or less same i.e. 4.08 to 4.64.

(a) Poly-cum-shadenet house (b) Walk-in-type tunnel

(c) Black shadenet house (d) Insect net structure

Evolvement of mulching technology for bunch type groundnut crop (JAU, Junagadh centre)

As compare to no mulch condition, germination percentage, crop growth and healthiness is good under mulch condition and it were best in silver black plastic mulch. As compare to no mulch condition and farmers' method. Crop parameters *viz.*, plant height (20 - 30 cm), number of branches (25 - 35), number of leaves (50 - 64), number of flowers (5 - 15) were found maximum under mulch condition and it were best in silver black plastic. Numbers of weed per square meter area (60) was found maximum in no mulch condition whereas it was minimum (10-18) in mulched condition. As the crop standing in the field, details of the observations and results will be prepared after completion of the field experiment.

Fig 80. Mulching technology for bunch type groundnut crop

Effect of mulch and irrigation level on water use efficiency and yield of water melon (JAU, Junagadh centre).

Maximum vine length (2.30 m) and node per plant (107.08) were found in silver black plastic mulch. whereas those were minimum for no-mulch. For black plastic mulch, vine length and node per plant were 1.55 m and 68.58, respectively. Minimum weed intensity (18.83 no/m^2) was found in silver black plastic mulch. Whereas, it were maximum (370.28 no/m^2) for no mulch. For black plastic mulch weed intensity was found as 32.92 no/m^2. Maximum crop yield (40.45 t/ha) was found in silver black plastic mulch. Whereas, it was minimum (1.07 t/ha) for control. For black plastic mulch crop yield was found as 26.21 t/ha. Total depth of water applied were 199.1

mm, 298.6 mm and 398.1 mm under 0.4, 0.6 and 0.8 ETc respectively. Maximum water use efficiency (163.36 kg/ha-mm) was found under silver black plastic mulch with 0.6 ETc irrigation level while it was minimum (2.47 kg/ha-mm) under no mulch condition with irrigation level of 0.8 ETc. Maximum soil moisture (33.06 %) was found under silver black plastic mulch with irrigation level of 0.8 ETc. While, it was minimum (25.88%) for no mulch with irrigation level of 0.4 ETc. Maximum soil temperature (33.62°C to 35.50 °C) was found under black plastic mulch with irrigation level of 0.4 ETc. While, it was minimum (21.73°C to 23.09°C) for silver black plastic mulch with irrigation level of 0.8 ETc.

Rain water harvesting and its utilization for better water efficiency, plastics lined ponds and low head gravity drip irrigation system. (BAU, Ranchi centre).

The size of plastic lined pond required for irrigation of cultural command area (PET field and PFDC field) is to be: side slope: 2:1, bottom of pond 15 x 15 m, depth of pond 3 m and top surface of pond 27 x 27 m. The calculated plastic film required is 30.42 x 30.42 m including 1 m length for bunging in soil and 1 m for shrinkage of plastic film. Volume of water that can be collected in this pond is 1359 m^3. However, actual volume of water collected in pond is 453 m^3.

Effects of the photo selective nets on yield and quality of tomato fruit (BAU, Ranchi centre).

The effect of various shade net materials (red, white, green with 50% perforation) under temporary structure was studied during cultivation of tomato in comparison to open field condition. It was found that under red shade net structure there is marked reduction in temperature recorded that is between 2-5°C in comparison to open field conditions. The temperature reduction under white and green was found to be between 1-2°C in comparison to open field condition but it was not consistent. There was reduction of around 50% in light intensity in comparison to open field conditions. The plant height under all the shade net structure was more than open field conditions. But the stem girth in red shade net structure was more than white, green shade net and open field conditions.

Design of gravity-fed drip irrigation system for hilly areas (SKUAST-K, Srinagar centre).

It was found that the soil water potential reading was zero on the days of applied irrigation and rainfall showing the soil is fully saturated or wet and as the time elasped the water potential reading increased. Irrigation was applied when the water potential reading vary in the range of 30-40 centi bar. Uniformity co-efficient variation along the lateral and along the sub main was evaluated on the basis of discharge from the emitters. Distribution co-efficient variation along the lateral and along the sub main was evaluated on the basis of discharge collected. The uniformity coefficient of the installed gravity fed system varied in the range of 90-94%.The water distribution efficiency of the system was found in the range of 65-75%. The emitter discharge was higher in the rows closer to the end plug of sub main, the reason might be the back pressure of plug. For different micro tubes it was found that the discharge was inversely proportional to the length of tube. The water distribution efficiency found to be inversely proportional to the length of micro tubes.

Fig 81. Gravity fed drip irrigation system for hilly areas

Comparative study of micro climate under existing poly-house and shade net house (MPUAT, Udaipur centre).

When fogging system was operated for 60, 120, 180 and 240 s with 30 min interval with continuous operation of fan-pad system; inside air temperatures

decreased by 2.6 - 2.9°C as compared to outside temperature from pad to fan along the width of polyhouse. The mean inside air temperature was 4.2 - 6.2°C more as compared to outside air temperature. Lengthwise variation of air temperature was 2.0°C while height-wise air temperature increased by1.5°C from 0.15 - 3 m height. Under same operating conditions, inside relative humidity (RH) increased by 7, 7, 8 and 6% respectively as compared to outside RH from pad to fan along the width of polyhouse. The mean inside RH increased by 8, 12, 16 and 18% respectively compared to outside. Lengthwise variation of RH was 8% while height-wise RH increased by 5%. It was lower at 3 m height and higher at 0.15 m height.

Multiple use of water harvested from poly lined farm pond and conjunctive use of ground water (MPUAT, Udaipur centre).

To achieve multiple use of rain water harvested from poly lined farm (Fig 82a) pond with adoption of the fish farming technology surplus water is being utilized for irrigation of vegetable crop i.e. onion (Fig 82b). The onion seedlings have been transplanted in the field under poly-mulched and un-mulched plots of size 7.5 X 1.0 m at plasticulture farm, CTAE, Udaipur with different levels of irrigation i.e., 100, 90, 80 and 70% ET. Maximum plant height (69.25 cm), no. of leaves per plant (10.05) and bulb diameter (7.98 cm) was repedaly under T_5 -Irrigation at 100% ET + with white mulch. The highest root length (7.36 cm), whole plant weight (149.64 g), fresh weight of bulb (142.03 g) and bulb yield/ sqm area (14202.50 g/sqm) was observed with treatment namely, T_7 -Irrigation at 80% ET + with mulch which was found closely at par with treatments other treatments condition. Though,

Fig 82 (a): Poly lined farm pond (b): Onion seedling field under poly mulch

all treatments of irrigation levels combined with poly-mulching proved significantly best over un-mulched treatments of irrigation levels. Further, the lowest final plant height (54.09 cm), no. of leaves per plant (7.59), bulb diameter (6.95 cm), root length (5.65 cm), whole plant weight (119.69 g), fresh weight of bulb (113.01 g) and bulb yield/ m^2 (11301.25 g/sqm) was observed with treatment namely, T_4-Irrigation at 70% ET + without mulch.

Evaluation of plastic mulch for engineering properties under onion cultivation (MPUAT, Udaipur centre).

The forward speed during the field test of mulch laying machine was recorded in the range of 3.61 - 3.97 km/h with the average operating speed of

3.78 km/h. The average theoretical field capacity was 0.203 ha/h. Mulch films of thickness 20 µm , 25 µm, 30 µm and 35 µm was recorded as 0.198, 0.198, 0.212 and 0.206 ha/h. The effective field capacity was 0.096 ha/h. The average field efficiency with all thickness was 47.45%. During the field test, the average wheel slippage of 4.53% and an average draft of 427 kgf. Quantity of plastic film required for covering 1 ha area for 20, 25, 30 and 35 µm are 181.82, 227.27, 297.35 and 318.97 kg respectively. Average production of onion in 60 m^2 experimental plot was 107.5 kg, which is equivalent to 17.92 t/ha.

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TRAINING AND CAPACITY BUILDING

HRD budget utilization in 2015-16

Allocated budget (Rs. in lakhs)	Budget utilized (Rs. in lakhs)
1.60	1.58

Following staff of ICAR-CIPHET Ludhiana/Abohar undergone training during the year 2015-16

Scientific Staff

Sr. No.	Name of scientist & designation	Title of training	Duration	Place
1.	Dr R K Gupta, Director	Science Governance & management	February 29-March 4, 2016	ASCI, Hyderabad
2.	Dr Rahul Kumar Anurag, Scientist Ms Surya Tushir, Scientist Dr Arvind Kumar Jaiswal, Scientist	"Laboratory Quality System Management and Internal Audit as per ISO/IEC 17025-2005"	December 28, 2015 to January 02, 2016	NIPHM, Hyderabad
3.	Dr Ramesh Kumar, Sr Scientist	"New vistas in food processing with quality assurance"	December 18-20, 2015	College of Technology and Engineering MPUAT, Udaipur
4.	Dr Sunil Kumar, Sr Scientist	"New vistas in food processing with quality assurance"	December 18-20, 2015	College of Technology and Engineering MPUAT, Udaipur
5.	Dr S K Tyagi, Head, AS&EC Division	"Management Development Programme on Leadership Development (A pre –RMP programme)"	November 30, 2015 to December 11, 2015	ICAR-National Academy of Agricultural Research Management (NAARM), Hyderabad
6.	Dr Dattatraya M Kadam, Head, HCP Division, Abohar	Training program on , "Advances in Applications of Nano technology"	October 5-9,2015	Central Institute for Research on Cotton Technology, Mumbai
7.	Dr Mridula D, Pr Scientist	"Stress Management"	June 16-19, 2015.	ICAR-NAARM, Hyderabad

Administrative Staff

Sr. No.	Name & designation	Title of training	Duration	Place
1	Sh Raj Kumar, SAO	Public procurement	November 16-21, 2015	NIFM, Faridabad
2	Sh Gurdial Singh, UDC	ICAR-ERP Training programme on Implementation Finance module	October 12- 14, 2015	ICAR-IASRI, New Delhi
3	Sh Tarsem Singh Purba, Assistant Sh Mohan Lal, Assistant Sh Gurdial Singh , UDC	HR and Payroll module	September 22-24, 2015	ICAR-IASRI, New Delhi
4	Sh Avtar Singh, Assistant Sh Ashwani Kumar, UDC Sh Rajinder Kumar Raheja, LDC	HR and Payroll Module	September 01-04, 2015	ICAR-IASRI, New Delhi
5	Sh Gurdial Singh, UDC Sh Ashwani Kumar, UDC Sh R K Yadav, LDC	Training on MIS-FMS	August 04- 05, 2015	ICAR-IASRI, New Delhi
6	Sh Raj Kumar, SAO	Stress Management	June 16-19, 2015	National Academy of Agricultural Research Management (NAARM), Hyderabad
7	Sh Manni Lal, AF&AO	Accrual Accounting in Govt	June 22-27, 2015	NIFM, Faridabad
8	Sh B C Katoch, AAO Sh Mohan Lal, Assistant Sh Rajinder Kumar Raheja, LDC Sh R K Yadav, LDC	Various Modules using oracle ERP under MIS-FMS	May 11-16, 2015	ICAR-IASRI, New Delhi

Technical Staff

Sr. No.	Name & designation	Title of training	Duration	Place
1.	Dr Mukund Narayan, Technical Officer	Competence Enhancement Training Programme for Technical Officers	December 14-23, 2015	ICAR-NAARM, Hyderabad
2.	Sh Rajesh Kumar, Sh Prithvi Raj	Application of CAD/CAM for designing and manufacturing of processing equipments and machinery	December 10-24, 2015	ICAR-CIAE, Bhopal

Trainings organized for various categories

Model Training Course on "Post-Harvest Management and Processing of Fruits and Vegetables for Sustaining Horticulture Industry"

Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare sponsored eight days Model Training Course on Post-Harvest Management and Processing of Fruits and Vegetables for Sustaining Horticulture Industry was organized by HCP division at Abohar campus during November 17-24, 2015. Seventeen officers from horticulture/ agriculture/extension departments covering six different states participated in the course. The training comprised of series of lectures and hands on training on post-harvest management and processing of fruits and vegetables. The officers were acquainted with the latest knowledge and technologies on post harvest handling, packaging, storage and processing of fruits and vegetables. They were also exposed to machinery and tools required for processing and value addition of horticultural produce and extraction of high value compounds from fruit waste. The participants were trained to establish small scale processing unit and exposed to existing fruit processing industry, small scale entrepreneurs and processors of adjoining areas through field visits.

Participants of model training course along with faculty members

Training on post-harvest management

Five days training on "Post-Harvest Management" was organized for 19 Agricultural officers from Vasantrao Naik State Agricultural Extension Management Training Institute (VANAMATI), Nagpur, Maharashtra at Ludhiana campus during April 14-18, 2015. This training program was sponsored by Agriculture Technology Management Agency (ATMA), Nagpur.

Participants of training on post-harvest management along with faculty members

Training on Post-Harvest Technology for Major Crops & Livestock Produce of Odisha

ICAR-CIPHET has organized Officers training on Post-Harvest Technology for Major Crops & Livestock Produce of Odisha for the Agriculture Officers/District Agriculture Officers of Govt. of Odisha during February 08-12, 2016.

Participants of training on post-harvest technology for major crops and livestock produce of Odisha wlaong with faculty members

Farmers training on Post-Harvest Management

TOT division, ICAR-CIPHET, Ludhiana has organized a five days training programme on "Post-Harvest Management" for 16 farmers from different parts of Haryana during March 07-11, 2016.

Participants of farmers training on post-harvest management along with faculty members

Entrepreneurship Development Program (EDP)

An Entrepreneurship Development Program (EDP) on "*Aonla* Processing and Value addition" was organized from February 29 to March 2, 2016 at HCP Division, ICAR-CIPHET Abohar. Four farmers/ entrepreneurs from Rajasthan and Punjab were participated in this EDP training. Hands-on training was given to the participants for the production of various products from *Aonla* such as *Aonla* Juice, RTS, Squash, *Murabba*, Pickle, Candy, mouth freshener, shreds etc. The participants have shown keen interest in product development during this training and expected to start their own business in coming days.

Distribution of certificates to the participants of EDP on *Aonla* processing and value addtion

Hands on training during EDP on Aonla processing and value addition

Farmers training on "Use of Plastics in Horticulture and Post-Harvest Management

AICRP on PET (Abohar centre) organized a three days farmers training on "Use of Plastics in Horticulture and Post-Harvest Management" during September 22-24, 2015. Total of 23 farmers from Abohar region participated and benefited from the training programme.

Participants of farmers training "Use of plastics in horticulture and post-harvest management"

Training cum exposure visit

Centre for Agriculture and Rural Development (CARD), New Delhi sponsored training-cum exposure visit of farmers from Maharashtra was organized during February 3 - 4, 2016.

Participants of training-cum-exposure visit from Maharashtra along with faculty members

Specialized training

Dried onion flakes and powder

Dr D M Kadam imparted hands on training to 5 entrepreneurs from Telangana and Maharastra during December 14 -16, 2015. Dr V E Nambi, I/c ITMU coordinated the training.

Participants of specialized training on "Dried onion flakes and powder" with faculty members

Entrepreneurship Development Program (EDP)

An Entrepreneurship Development Program (EDP) on "Manufacturing of Peanut Butter" was organized during August 6-7, 2015 at ICAR-CIPHET, Ludhiana. Ms Sabarjit Kaur, a women entrepreneur from M/s Gill Food Products, Jalandhar (Punjab) was trained regarding the process.

Hon'ble member ASRB, Dr V N Sharda visiting the peanuts products sold by Gill Food Products, Jalandhar

Training programme on preparation of peanut milk and paneer

Under *"Mera Gaon Mera Gaurav"* scheme one day training programme on preparation of peanut milk and paneer was organized by Dr S K Nanda (Team Leader), Dr Pranita Jaiswal, Dr R K Vishwakarma and Dr Swati Sethi for farmers of *Bagga Kalan* village on February 19, 2016 at ICAR-CIPHET, Ludhiana. Dr D N Yadav imparted the training as resource person.

Participants of *Bagga Kalan* village under training

Training on Development of Polymeric Nano-particles for Controlled Release Antimicrobial Packaging Material

Mr Nichrous Mlalila, Research Scientist and Ph. D Scholar, from The Nelson Mandela African Institute of Science and Technology (NM-AIST) of Tanzania has undergone research training on "Development of Polymeric Nanoparticles for Controlled Release Antimicrobial Packaging Material" from April 21, 2015 to September 17, 2015 at ICAR-CIPHET, Ludhiana under Research Training Fellowship for Developing Country Scientists (RTF-DCS) – Award of Fellowship for 2014-15 sponsored by NAM S&T Centre, New Delhi. Dr Dattatreya M Kadam, ICAR-CIPHET, Ludhiana was supervisor.

Summer schools/winter schools

Summer School on "Advances in Processing, Value Addition and By-product Utilization of Livestock and Fish Produce"

ICAR sponsored 21 days Summer School on "Advances in Processing, Value Addition and By-product Utilization of Livestock and Fish Produce" was organized at Ludhiana campus during July 8-28, 2015. Dr Armaan U M, as Course Director, Dr D N Yadav and Dr Yogesh Kumar as Co-Course Directors

Participants of summer school with faculty members

coordinated and organized the programme. Dr K Alagusundaram, DDG (Engg), ICAR inaugurated the event on July 10, 2015. There were 25 participants from different corners of the country. During the course of summer school, 30 lectures and 27 hands-on practicals were conducted in well equipped laboratories of ICAR-CIPHET, College of Fisheries (GADVASU), College of Veterinary Science (GADVASU) and College of Agriculture (PAU), Ludhiana. Experts were invited from different prestigious institutes such as ICAR-CIFE, Mumbai; Madras Veterinary College, Chennai; ICAR Head Quarter, New Delhi; BIS, New Delhi; Crescent Marine Foods & Additives, Mumbai and retired Professors from SAUs and CAUs. The participants extended overwhelming applauds to the organizers in the form of feedback.

Summer school on "Novel Approaches and Technologies for Processing and Value Addition of Agricultural produce"

ICAR sponsored 21 days Summer school on "Novel Approaches and Technologies for Processing and Value Addition of Agricultural produce" was organized during August 04-24, 2015 at Ludhiana campus. Dr S K Tyagi, Dr Manju Bala and Ms Surya Tushir were the Course-Director and Co-Course-Directors, respectively. Dr V N Sharda, Member ASRB, New Delhi inaugurated the summer school and released the compendium on the occasion. A total of 31 participants in the rank of Assistant/Associate professor from different SAUs across the country attended the summer school. Summer school was a blend of lectures, practical's, hands on experience, discussions, visits etc. The summer school concluded on August 24, 2016. On the occasion, Dr S M Illyas, Ex Project Director (Distance Education Cell) & Head (CPGS), NIRD, Rajendranagar, Hyderabad distributed the certificates to all the participants.

Winter school on "Recent Advances in Development of Automatic Systems/Machines for Secondary Agriculture"

ICAR Sponsored winter school on "Recent Advances in Development of Automatic Systems/Machines for Secondary Agriculture" was organized during November 18 to December 8, 2015 at Ludhiana campus. Dr R K Vishwakama was the Course Director and Dr Yogesh Kumar and Mrs Leena Kumari executed as course co-directors. Dr N S Rathore, DDG (Education), ICAR was the chief guest for the inaugural session. Twenty participants from different institution across the India attended the winter school. The winter school provided a platform for researchers to share scientific knowledge and discuss advancements in the area of secondary agriculture. Major topics covered in the winter school include modelling of processing operations, utilization of by products, hybrid hydroponic, industrial waste management etc. Dr R K Sinha, Director, CSIR-CSIO, Chandigarh graced valedictory session and distributed certificates to the participants.

DDG (Education) ICAR, New Delhi, Dr NS Rathore releasing the compendium of winter school

Students Training

Sixty six students (graduation and post graduation level) from different universities/institutes were under gone training at the institutes during 2015-16 on different topics related to post-harvest technology.

Sr. No.	Name of College /University	Duration of Training	Degree	No. of Students
1	College of Agricultural Engineering and Post-Harvest Technology (CAU) Ranipool, Gangtok –737135 (Sikkim)	June 01-30, 2015	B.Tech (Agril. Engg.)	10
2	Dr Budhajirao Mulik College of Agril Engg and Technology, Mandki –Palvan	June 01-30, 2015	B.Tech (Agril. Engg.)	5
3	KK Wagh College of Agril Engg. & Technology, Saeaswati Nagar, Panchvati, Nasik, Maharashtra	June 01-30, 2015	B.Tech (Agril. Engg.)	5
4	Vaugh School of Agricultural Engineering & Technology, SHIATS, Allahabad, U.P	July 01-31, 2015	B.Tech (Food Tech.)	5
5	College of Home Science, CAU University, Sangsanggre, Tura (Meghalaya)	July 03-31, 2015	B.Sc (Home Science)	4
6	Agril. Engg. College & Research Institute, TNAU, Kumulur, Trichy, Tamil Nadu	Aug 05- Sep 04, 2015	B.Tech (Agril. Engg.)	11
7	Agril. Engg. College & Research Institute, TNAU, Kumulur, Trichy, Tamil Nadu	Sep 01-Oct 20, 2015	B.Tech (Agril. Engg.)	10
8	Department of Agricultural Process and Food Engineering, College of Agricultural Engineering , Acharya N G Ranga Agricultural University, Baptala, A.P.	Sep 01-Sep 28, 2015	M. Tech (Agril. Engg.)	3
9	Central Institute of Fisheries Education, Mumbai	Dec 01-31, 2015	M. F Sc. (PHT)	1
10	Department of Agricultural Engineering & Technology, School of Engineering & Technology, Nagaland University, Dimapur	Jan 05 –Feb 04, 2016	B.Tech (Agril. Engg.)	4
11	College of Agricultural Engineering & Technology (AAU), Godhra, Gujarat	Feb 05 -May 31, 2016	B.Tech (Agril. Engg.)	4
12	College of Agricultural Engineering, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Adhartal, Jabalpur (MP)	March 01- April 30, 2016	B.Tech (Agril. Engg.)	4

Professional Attachment Training

As part of the ICAR-FOCARS programme, ICAR-CIPHET has assigned all its newly joined scientists for three months professional attachment training. Considering the scientist's academic background and Institutes prospect, ICAR-CIPHET has deputed its new scientist to Central Research/Academic Institutes or State Agricultural University for professional training. The knowledge earned during the course of training programmes would lay a strong foundation in our scientific fraternity in the field of post-harvest processing.

❖ **Er Akhoon Asrar Bashir** did his training work at Agricultural Engineering College and Research Institute, Department of Food and Agricultural Process Engineering, TNAU, Coimbatore from 11 May to 10 Aug, 2015. He worked on 'Performance Evaluation of Double Stage Centrifugal Dehuller for Millets' under the guidance of Dr N Varadharaju, Prof and Head, PHTC, AEC&RI. During the training Er Akhoon also visited College of Agricultural Engineering, Kumullur and IICPT, Thanjavur. The training was successful in imparting practical experience in different aspects of post-harvest processes and advanced concepts of testing and analysis which will aid in Er. Akhoon's future research endeavors.

❖ **Er Indore Navnath Sakharam** has undergone the training at Department of Food and Agricultural Process Engineering, Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore *w.e.f.* 11 May to 10 Aug, 2015. Er Navnath was trained on "Effect of pre-treatment on Blackgram milling and performance evaluation of TNAU black gram dehuller" under the supervision of Prof T Pandirajan. In this training programme he studied different pre-milling treatments of black gram dehulling, design of TNAU black gram dehuller and optimizing machine parameters to evaluate performance of dehuller for different pre-milling treatments. The knowledge acquired during through this training would help Er. Indore to continue his research work in the area of grain milling.

❖ **Mr Ajinath Shridhar Dukare** has undergone three months professional attachment training in the area of nanotechnology from Chemical and Bio Chemical Processing Division (CBPD), ICAR-CIRCOT, Mumbai *w.e.f.* November 12, 2015 - February 11, 2016. He was trained on "Nano starch: Preparation and characterization" under the supervision of Dr N Vigneshwaran. The training program was successful in imparting practical experience in the working of basic instruments and other techniques (Such as high speed homogenization, particle size analysis, Ultra centrifugation, differential scanning calorimetry(DSC), fourier transform infrared spectroscopy (FT-IR), x-ray powder diffraction (XRD) analysis, scanning electron microscope (SEM), and transmission electron microscope (TEM)) associated with nanotechnology science. The knowledge earned during the course of training programme may helpful in our scientific fraternity to carry out further research in the area of nano composite, biodegradable polymer, nano packaging and food processing. The three month attachment training has provided ample knowledge for professional, personal growth and future research endeavors.

❖ **Er Bibwe Bhushan Ratnakar** has done the training at ICAR-Central Institute for Cotton Research, Mumbai *w.e.f.* November 12, 2015 - February 11, 2016. He worked on "Study on Rheological Behaviour of Nano-crystalline Cellulose (NCC)" under the supervision of Dr N Vigneshwaran. The training was successful in imparting practical experience in handling a rheometer unit, nano-cellulose pilot plant facility and also other lab scale instruments of specific importance such as ultra-high pressure homogenizer, particle size analyzer, freeze drier, scanning electron microscope etc. The three month attachment training has provided generous knowledge for professional and personal growth. The knowledge earned during the course of training program may lay a good foundation in the areas of application of nanotechnology in food processing.

TECHNOLOGIES TRANSFERRED/ LICENSED

Following technologies were transferred during the year.

S.No.	Technology	Contracting Party	License Fee (Rs.)	Date
1	Groundnut flavoured beverage, curd and paneer	Mr Dinesh Soni, s/o Sh. Satish Kumar Soni, D-26, DDA Flats MIG, Saket, New Delhi. 110 017	15000.00	Jun 16, 2015
2	Dried onion flakes and powder	Mr TVL Narasimha Rao 6-3-199/5, Prem Nagar, Khairathabad, Hyderabad.500 004	50000.00	Dec 16, 2015
3	Dried onion flakes and powder	Mr Yashodeep Sadashiv Shinde Loknete Tukaram Patil Nagar, Chandwad Road, Manmad, Nasik	50000.00	Dec 16, 2015
4	Process for making green chilli puree & powder	M/s Organic World, Ranchhod Krupa, Dharmaj-388 430, Petlad, Anand	35000.00	Mar 05, 2016

Dr S N Jha handing over license certificate of process technology of "groundnut flavoured beverage, curd and paneer" to Mr Dinesh Soni, New Delhi on June 16, 2015

Dr R K Gupta, Director, ICAR-CIPHET handing over the license certificate of "process technology for dried onion flakes and powder" to entrepreneurs on December 16, 2015

Dr R K Gupta, Director ICAR-CIPHET handing over the license certificate of "green chilli puree & powder technology" to M/s Organic World, Anand on March 5, 2016

EXTENSION ACTIVITIES

Participation in Exhibitions/*Melas*:

During the period, the institute has participated in the following Exhibition/*Melas* to showcase its technologies.

Sr. No	Exhibition/*Mela*	Date	Place
1	Agri-Intex, 2015	July 17 -20, 2015	Coimbatore, Tamil Nadu
2	Agricultural Exhibitions, 2015	Aug 20 -21, 2015	Motihari, Bihar
3	*Kisan Mela*	Sep 25-26, 2015	PAU, Ludhiana
4	IASOWA (Delhi Chapter)	Nov. 31 Oct -01, 2015	Pandara Park, New Delhi
5	The 5th Global Economic Summit Expo 2015	Nov. 19 -21, 2015	World Trade Centre, Mumbai
6	IITE-2015,World Fisheries Day, 2015	Nov. 21, 2015	Pragati Maidan, New Delhi
7	Soil Day	Dec. 05, 2015	Samarala, Ludhiana
8	*Kisan Mela*, 2016	March 18-19, 2016	PAU, Ludhiana
9	*Krishi Unati*, 2016	March 19 -21, 2016	IARI, Pusa, New Delhi

Agricultural Exhibitions 2015, Motihari, Bihar. August 20 – 21, 2015

Kisan Mela, PAU Ludhiana. September 25 – 26, 2015

World Soil Day at Samarala, Ludhiana, December 05, 2015

Pamphlets/Posters

Pamphlets and Posters of 20 technologies in Hindi and English were prepared and printed.

Updated Video of the ICAR-CIPHET

In this era of social media, ICAR-CIPHET has updated its old video film that portrays glimpses of recent salient achievements and infrastructure of the institute in a brief way. The film is being displayed in the exhibitions, *melas* and other such platforms.

Screen shot of the ICAR-CIPHET updated video

Radio Talks

Scientists from ICAR-CIPHET, Ludhiana & Abohar Campuses has recorded radio talks on various topics during 2015-16. The talks were broad casted through All India Radio, Jalandhar under *"Do Duni Chaar"* programme. List of topics and scientists who contributed to the programme are given below:

S. No	Title of the programme	Scientist
1	Importance of Post-Harvest Management for value addition of crops	Dr R K Gupta, Director, ICAR-CIPHET
2	Importance & Establishment of APCs and animal feed from potato waste	Dr S K Nanda
3	Drying and dehydration of onion, garlic, ginger, turmeric and their value addition	Dr D M Kadam
4	Grading and waxing of *kinnow* and value added products of *anola*	Dr P C Sharma
5	Production of dairy analogues from groundnut and soybean	Dr D N Yadav/ Dr Sangita Bansal
6	Post-harvest handling and value addition of fish , meat and poultry	Dr A U Muzadaddi
7	Minimal processing of fruits and vegetables	Dr R K Vishwakarma,
8	Oil seed processing specific to mustard processing and by-product utilization	Dr S K Tyagi,
9	Value addition of coarse cereals (maize, sorghum and pearl millet)	Dr Mridula D
10	Guava, pomegranate, *ber* processing and valuc addition	Dr Ramesh K Jangra
11	Covered cultivation (Poly house + shade net + insect net) of vegetables	Mr Sakharam Gajan Kale
12	Proeessing of green and red chilli for valuc addition	Ms Kriti R Jalgaonkar
13	Skill development and entrepreneurship opportunities in the field of post-harvest technologics	Dr Ranjeet Singh

Farmers/ Officers/ Students visited ICAR-CIPHET, Ludhiana during 2015-16

Sr. No	Organization/Institute	Visitors*	Date
1	Participants of Summer School on EDP from PAU, Ludhiana	22 (O)	July 15, 2015
2	BTM, ATMA, Giyaspur (MP)	21 (F) + 01 (O)	July 31, 2015
3	GN Patel College of Dairy Science & Food Technology, S Dantiwada Agricultural University, Sardarkrushinagar	39 (S) + 04 (O)	Aug 5, 2015
4	ATMA Vidisha (MP)	18 (F) + 02 (O)	Sep 10, 2015
5	ATMA, Vidisha (MP)	18 (F) + 02 (O)	Sep 25, 2015
6	PAU, Ludhiana, Punjab	05 (F) + 01 (O)	Oct 14, 2015
7	SGGWV, Fatehpur Sahib	26 (S) + 01 (O)	Oct 31, 2015
8	PAU Ludhiana	26 (S) + 01 (O)	Nov 2, 2015
9	KCAET, Kerala Agril. University, Tavanur, Kerala	38 (S) + 02 (O)	Nov 2, 2015
10	College of Agril. Engg., University of Agricultural Sciences, Raichur	60 (S) + 02 (O)	Nov 4, 2015
11	PAU, Ludhiana, Punjab	16 (O)+01 (O)	Nov 5, 2015
12	Department of Food & Nutrition, PAU, Ludhiana	10 (S) + 01 (O)	Nov 30, 2015
13	ATMA, Vidosha (MP)	16 (F)+01 (O)	Dec 9, 2015
14	College of Agriculture, Hassan, University of Agricultural Sciences, Bengaluru	60 (S)+02 (O)	Dec 10, 2015
15	CHF, CAU, Pasigaht Arunchal Pradesh	14 (S)+1 (O)	Jan 05, 2016
16	Pipria, Hoshongabad	09 (F) + 01 (O)	Jan 28, 2016
17	Office of Deputy Director Agril., Ajmer, Rajasthan	96 (F) + 02 (O)	Feb 09, 2016
18	ATMA, Chhattisgarh	25 (F) 01 (O)	Feb 09, 2016
19	Dr. S.K. Acharya , College of Horticulture SD Agricultural University, Gujarat	39 (S) 01 (O)	Feb 22, 2016
20	University of Kashmir	19 (S) 02 (O)	March 07, 2016
21	Office of Deputy Director Agril., Ajmer, Rajasthan	40 (F)+02 (O)	March 16, 2016
22	Department of Horticulture, Alwar, Rajasthan	29 (F) + 01 (O)	March 17, 2016

* O: officers, F: farmers, S: students

Distinguished Visitors

Following distinguished personalities of different national and international organizations visited the institute during 2015-16.

S No	Visitor Details	Date of visit
1	Extension functionaries from Kenya, Liberia and Malawi	July 29, 2015
2	Dr Alagusundaram K, DDG (Engg), ICAR, New Delhi	July 11, 2015; January 28, 2016
3	Dr Harinder P S Makkar, FAO, Rome	August 11, 2015
4	Dr N S Rathore, DDG (Edu), ICAR, New Delhi	November 25, 2015
5	Dr R K Sinha, Director, CSIR-CSIO, Chandigadh.	December 08, 2015
6	Faculty and students from University of Illinois, USA	January 13, 2016
7	Sh Chhabilendra Roul, Additional Secretary (DARE) & Secretary (ICAR), New Delhi	January 16, 2016
8	Dr Gurubachan Singh, Chairman, ASRB	February 27, 2016
9	Prof Matthew Prasad, Vice-Chancellor VCSG Uttrakhand University of Horticulture and Forestry, Bharsar.	February 08, 2016

Extension functionaries from Kenya, Liberia and Malawi interacting with ICAR-CIPHET Scientific fraternity

Dr K Alagusundaram (second from left), DDG (Engg) reviewing value added products produced at Agro Processing Centre, ICAR-CIPHET

Dr Harinder P S Makkar (left), FAO interacting with Dr R K Gupta (middle), Director ICAR-CIPHET & Dr S K Nanda (right), Head FG&tOP, ICAR-CIPHET

Dr N S Rathore, DDG (Education), ICAR during his visit to various laboratories of the institute and interaction with scientists

Faculty and students from University of Illinois, USA interacting with Dr RK Gupta, Director ICAR-CIPHET

Dr DN Yadav (left), demonstrating protein isolate pilot plant to Sh Chhabilendra Roul Additional Secretary (DARE) & Secretary (ICAR)

Dr Gurubachan Singh, Chairman, ASRB visiting various laboratories of the institute

EVENTS ORGANIZED

Research Advisory Committee (RAC) Meeting

The first meeting of newly constituted (2015-17) RAC was held during May 07-08, 2015 at ICAR-CIPHET, Ludhiana. RAC was with the view that ICAR-CIPHET should act as repository and leading disseminator of information for post-harvest sector, coordinate the national efforts to address its mandate and evolve business models for speedy adaptation of the results. They also advocated the integration of advancements in contemporary sciences and technology in PHT. The RAC appreciated the strong R&D infrastructure created at ICAR-CIPHET. Report/ salient achievements of completed research projects (total 13) after previous RAC meeting were also presented and discussed during the meeting. Apart, 14 new project concepts were discussed. On new proposals, RAC team made valuable suggestions/recommendations for betterment and to convert those in the form of future projects of the institute.

Research Advisory Committee (RAC) with ICAR-CIPHET staff

The 2nd RAC meeting was held during March 20-21, 2016 at ICAR-CIPHET, Ludhiana. In this meeting, total 29 new project concept notes were presented by the scientists/ PIs as pre RPF-I documents. In order to have first-hand experience of the infrastructure and facilities available at ICAR-CIPHET, Chairman and members of the RAC visited different laboratories and facilities. Some of the general recommendations of the research advisory are: at the national level, expectations are much more high from CIPHET but achieve one high potential target for highlighting institute name nationally and internationally, mechanisation pertaining to PHET should take place first in the institute, adopt 1 or 2 village for technology demonstration and feedback, modern day tools, sensors, imaging systems, materials, design protocols/software, simulation techniques, statistical analysis tools, developments in industrial chemistry, biotechnology, IT need to be deployed in research projects for development of processes, equipment, machinery, pilot plants and systems.

2nd RAC meeting, March 20-21, 2016

Institute Research Council (IRC) Meeting

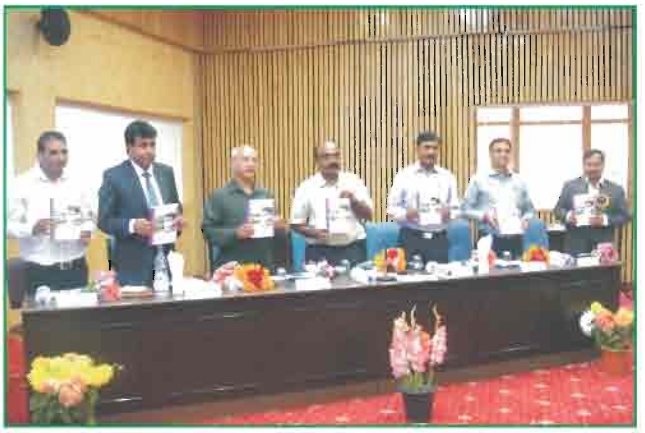
The 24th Institute Research Council Meeting was held during June 6-7, 2015 at ICAR-CIPHET, Ludhiana. Dr Nawab Ali, Former DDG (Engg), ICAR, New Delhi and Dr W S Dhillon, Director, PHPTC, PAU, Ludhiana were the invited experts. Director, ICAR-CIPHET highlighted the importance and need of inter-institutional research and informed the house that some of the new projects were framed in collaboration with different crop based ICAR institutes. Member secretary presented action taken report on suggestion/recommendation of the IRC held during June 20-21, 2014. Salient achievements

of individual divisions were presented by respective HODs followed by presentations of RPP-I, II & III. Experts appreciated the scientific, technical and other staff of ICAR-CIPHET for transforming the institute into a pleasant campus. They expressed their happiness towards the progress of the institute and said that the institute has grown enough to take up challenging research in the area of post-harvest engineering and technology.

24th Institute Research Council (IRC) Meeting (June 6-7, 2015)

XI Biennial workshop of AICRP on Plasticulture Engineering & Technology (PET)

The XI Biennial workshop of AICRP on PET was organized at SKUAST-K, Srinagar during September 10-12, 2015. Dr K Alagusundram, DDG (Engg) was the chief guest of inaugural session, Dr Tej Pratap, Hon'ble Vice-Chancellor, SKUAST-K, Srinagar presided over the session, Dr K K Singh, ADG (FE/PE) and Dr R K Gupta, Director ICAR-CIPHET were the Co-Chairmen of the session. Dr S K Nanda, I/c PC (PET) presented the progress report of the scheme during inaugural session. An industry session was organized after the inaugural session. Dr K Yella Reddy, Director (A&R), WALAMTARI, Hyderabad and Dr Nazir Ganai, ADR, SKUAST-K, Srinagar were the experts. In the workshop, results and achievements of last two years 2014-15 all were discussed and technical programme for next two years was finalized. 13 cooperating centres. Research scientists from all the centres, farmers, govt. officers and others participated in the workshop. Three industry representatives Mr Anand Zambre, Vice President – Agri Business, M/s ESSEN Multipack Ltd, Rajkot, Gujarat; Mr Vijay Bansal M/s Reliance Industry Ltd., Chandigadh and Mr Parminder Singh, M/s Blue Stallion Equipments (Pvt.) Limited, Ludhiana, Punjab shared their views on importance of plastics in agriculture and briefly presented their company profile. On this occasion, two technical bulletins and a folder were also released.



XI Biennial workshop of AICRP on PET, SKUAST-K, Srinagar (September 10-12, 2015)

XXXI Annual workshop of AICRP on Post Harvest Engineering & Technology (PHET)

AICRP on PHET organized 31st Annual workshop at Department of Food and Agricultural Process Engineering, Agricultural Engineering College and Research Institute, TNAU, Coimbatore during January 4-6, 2016. The workshop was chaired by Dr K Alagusundaram DDG (Engg), ICAR and graced by Dr S N Jha, ADG (PE), Dr R K Gupta, Director, ICAR-CIPHET Ludhiana, Dr C Divakar Durairaj, Dean, AEC&RI, TNAU and Dr M Maheswaran, Director (Research), Dr S Ganapathy, Professor and Head, TNAU. About more than 95 scientists participated in this workshop. Dr K Ramasamy, Vice-Chancellor, TNAU, Coimbatore was the chief guest and he informed and enlighten the gathering by expressing the need to exploit steel manufactured from Salem for food processing machinery. Dr K Alagusundaram, emphasized on the consortium and

XXXI Annual workshop of AICRP on Post-Harvest engineering & technology (PHET) TNAU, Coimbatore (January 4-6, 2016)

value chain mode of research rather than the conventional way of research which will facilitate the delivery of benefits to farmers immediately. Dr S N Jha, presented the progress and achievements of AICRP on PHET centres during last one year. Three publications were released during the workshop.

Pakhwada on mass awareness against residue burning

To create awareness among farmers about ill effects of residue burning and available interventions for management of wheat residue. Abohar campus has organized a *Pakhwada* on "mass awareness against residue burning", during April 16-30, 2015. The theme of the campaign was '*Vatavaran Ko Bachao, Bhuse Ko Na Jalao*' and '*Khet Ke Avsesh, Khet Main*'. Two seminars were organized at village *KeraKhera* (Abohar) on April 29, 2015.

Seminar organized at village Kerakhera on mass awareness against residue burning on April 29, 2015

Communal Harmony Week-2015

The Institute observed Communal Harmony Campaign and the Fund Raising Week meant to spread the message of Communal Harmony and National Integration to the people of the country during November 19-25, 2015.

Communal Harmony week 2015 (Nov 19-25, 2015)

Expert lecture on Introduction and Importance of Soil Health Card

A special lecture on "Introduction and Importance of

Special lecture on Introduction and Importance of Soil Health Card

Soil Health distribution programme organised at *Pawat* village, Ludhiana.

Soil Health Card" on December 2, 2015 was organized to sensitize the ICAR-CIPHET staff as well as farmers. The lecture was delivered by Dr Kuldip Singh, Sr Soil Analyst, Department of Soil Science, Punjab Agriculture University, Ludhiana. The scientists of the institute also participated and assisted KVK, Samarala in distributing the soil health card to farmers and igniting them about the importance and uses of soil health card. The function was organized at *Pawat* village of Ludhiana District.

Swa-Rozgar Mela

A *Swa-Rozgar Mela* on food processing was organized in collaboration with Dept of Employment Generation and Training, Punjab. About 50 entrepreneurs took part in *Rozgar Mela*. Deputy Director, Employment Generation and Training, Fazilka explained about different schemes of Central and State Govt to develop self-employment.

Jai Kisan Jai Vigyan Week

On the occasion of the birth anniversary of two former Prime Ministers (Shri Atal Bihari Bajpayee and Late Shri Chaudhary Charan Singh) of India, "*Jai Kissan Jai Vigyan*" week was organized during December 23-29, 2015 at both campuses of ICAR-CIPHET. Various farmer awareness programmes like scientist-farmers interaction, showcasing of technical know-how, post-harvest tools, machinery and products, group discussions on post-harvest management etc were conducted. Dr Ranjeet Singh and his team elaborated the importance of science in agriculture specially post-harvest management and

Jai Kisaan Jai Vigyan week (December 23-29, 2015)

Ms Sarabjeet Kaur, Gill food products, Jalandhar honoured by Dr B R Verma, Former Dean, College of Agriculturral Engineering, PAU, Ludhiana

value addition of agricultural produce to the school children of Government Sr Secondary School, *Ayalli Kalan*, Dist. Ludhiana. At Abohar campus, farmers from Jhalawar district of Rajasthan visited the

campus. On December 26, 2015, a '*Kisan Goshthi*' was organized in collaboration with Department of Agriculture, Punjab at village *Bhangala*, Dist. Fazilka. About 100 farmers attended the meet. Detailed interaction about processing and management of horticultural crop was held and facilities like *kinnow* waxing unit, APC, canning line were demonstrated. Progressive entrepreneur Mr Jain (Nishan Foods Abohar) also shared his experiences related to processing and value addition of various fruits in his processing unit. On this occasion an upcoming entrepreneur Ms Sarabjeet Kaur, Gill Food Products, Jalandhar (Punjab), trained by ICAR-CIPHET was honoured by the Dr S R Verma, Former-Dean, College of Agricultural Engineering, PAU, Ludhiana in concluding day ceremony, on December 29, 2015. During his remark, Dr S K Nanda, I/c Director, ICAR-CIPHET told that agriculture cannot progress as whole without the significant involvement of agro-based entrepreneurs. We need to focus on skill development among the youth of the country through training and demonstration as well as outreach programme in the area of post-harvest and value addition. Dr D N Yadav convener of the programme also told that to fulfill the dream of "Make in India" mission, the ICAR-CIPHET will organize more agri-business incubation and entrepreneurship development programmes in the imminent future.

Vigilance Awareness Week

Vigilance Awareness Week during October 26-31, 2015 was organized. The week started with the pledge taking ceremony which was observed at both

Pledge taking ceremony at Abohar Campus

the campuses. Different events such as workshop, poster and slogan competition etc. were organized. Mr Kamal Deep, Asstt. Commissioner of Income Tax, Ludhiana discussed various perspectives of vigilance in the workshop. The week concluded on October 31, 2015 with presentation of awards and an appeal by the Director, ICAR-CIPHET, Ludhiana to the institute's employees to be honest and vigilant.

26th Foundation day of ICAR-CIPHET

The Institute celebrated its 26th foundation day on December 29, 2015. Dr S R Verma, Ex-Dean, COAE, PAU, Ludhiana was the Chief Guest and Dr Ashwani Kumar, Former Director, ICAR-IIWM, Bhubaneswar (Odisha) and Prof (Dr) Jai Singh, Ex-OSD, ICAR-CIPHET, Ludhiana graced the occasion as Guest of Honour. On this auspicious occasion, the Chief Guest, Dr S R Verma emphasised to develop the strong linkages with all the stakeholders at National as well as International level. Dr Ashwini Kumar emphasised in his speech about the need for

Mr Kamal Deep, Asstt. Commissioner of Income Tax, Ludhiana discussing various perspectives of vigilance

26th Foundation day of ICAR-CIPHET

multi-disciplinary approach in research activities and also addressed about the need for skill development among youth. Prof Jai Singh highlighted about minimizing and utilization of waste, setting up of mini pilot-plant, adoption and creation of process villages, reinforcing the ICAR-CIPHET as a brand by establishing a sale centre exclusively for ICAR-CIPHET developed food products etc. All the dignitaries asked the ICAR-CIPHET scientists to address the post-harvest related issues in a holistic manner towards the loss reduction and value addition for making the agricultural, a more attractive and profitable sector. Director, ICAR-CIPHET has shared the institute progress and significant R&D developments during the year 2015 such as *ber* destoner, date palm decorer, extrusion processing, detection of aflatoxin in milk using FTIR and many more.

National Science Day

National Science Day was organized on February 26, 2016. The theme was "Make in India – Science & Technology driven Innovations". A seminar was organized for Class 10-11th students of Partap Public School, Ludhiana. Dr R K Gupta, Director, ICAR-CIPHET, Ludhiana delivered a lecture on the theme and enlightened the students regarding Post-harvest Engineering researches. Scientific staff of TOT division has showcased the institute's laboratories, agro processing centre and other facilities to the students.

ICAR-ASRB Examinations

ICAR-CIPHET, Ludhiana is a nodal centre for

online examinations conducted by ASRB and ICAR. Online NET/ARS (Preliminary) examination 2015 was conducted at ICAR-CIPHET, Ludhiana during December 04-10, 2015. This examination was conducted in three slots per day and total 877 candidates from different disciplines were allotted to the centre for entire examination period.

ICAR-All India entrance examination for admission to UG-2016-17 and AICE SRF (PGS) was conducted byiInstitute during May 21-22, 2016 at Ludhiana.

हिन्दी कार्यशालाओं का आयोजन

हिन्दी कार्यशालाएं

- सीफेट, लुधियाना में जून 25, 2015 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में डॉ हरदीप सिंह, प्रोफेसर (हिन्दी), सतीश चंदर धवन गवर्मेंट कॉलेज, लुधियाना ने ' राजभाषा हिन्दीः कार्यालय से लेकर सद्भावना तक 'विषय पर अपनी प्रस्तुति दे कर सभी को लाभान्वित किया।

- ❖ सीफेट, लुधियाना में सितम्बर 19, 2015 को हिंदी कार्यशाला का आयोजतन किया गया। इस काग्रशाला में डॉ. अनिल कुमार गुप्ता, प्रशासनिक अधिकारी (राजभाषा), न्यू इंडिया इंश्योरेंस कंपनी लिमिटेड, लुधियाना ने 'पारिभाषिक शब्दावली' एवं 'प्रयोजन मूलक हिन्दी' टिप्पणियां विषयों पर अपनी प्रस्तुति देकर सभी को लाभान्वित किया।
- ❖ सीफेट, लुधियाना में दिसंबर 30, 2015 को हिन्दी कार्यशाला का आयोजन किया गया। इस कार्यशाला में श्रीमती किरण साहनी, सहायक निदेशक राजभाषा एवं सदस्य सचवि रा.का.स., लुधियाना ने 'राज भाषा कार्यनवयन' में ई–टूलस् एवं नोटिंग/ ड्राफ्टिंग/ टिप्पणियां विषयों पर अपनी प्रस्तुति देकर संस्थान के सभी अधिकारियों एवं कर्मचारियों को लाभान्वित किया।
- ❖ सीफेट, लुधियाना में मार्च 19, 2016 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में श्री अखिलेश चंद्र, प्रशासनिक अधिकारी एवं राज भाषा अधिकारी, भारतीय जीवन बीमा निगम, मंडल कार्यालय, लुधियाना ने 'कार्यालयों में व्यवहारिक हिन्दी' एवं 'राजभाषा हिन्दी की उपयोगिता टिप्पणियां' विषयों पर अपनी प्रस्तुति देकर सभी को लाभान्वित किया।

हिन्दी पखवाडा

संस्थान में दिनांक सितम्बर 14–28, 2015 तक हिन्दी पखवाडा मनाया गया । समारोह का उदघाटन मुख्य अतिथि आदरणीय डा॰ अनवार आलम, पूर्व कुलपति शेर–ए–कश्मीर कृषि विज्ञान एवं प्रौद्योगिकी विश्वविद्यालय के कर कमलों द्वारा किया गया । समारोह के अन्तर्गत विभिन्न संयोजको के सहयोग से विभिन्न प्रतियोगिताएँ आयोजित की गई । दिनांक सितम्बर 28, 2015 को हिन्दी पखवाडा का समापन समारोह आयोजित

किया गया । इसमें मुख्य अतिथि निदेशक महोदय डा आर के गुप्ता, सीफेट, लुधियाना द्वारा विजेताओं को पुरस्कार वितरित किए गए । हिन्दी पखवाड़ा के अन्तर्गत आयोजित सभी प्रतियोगिताओं में संस्थान के सभी अधिकारियों एवं कर्मचारियों ने बढ–चढकर हिस्सा लिया व समारोह में सुचारू रूप से ग्यारह प्रतियोगिताएं जैसे हिन्दी कम्प्यूटर टंकण प्रतियोगिता, प्रार्थना पत्र प्रतियोगिता, हिन्दी अनुवाद प्रतियोगिता, वाद–विवाद, कविता प्रतियोगिता, एक दिवसीय (हस्तलिखित) पोस्टर पत्र प्रतियोगिता, मुहावरे युक्त तत्काल भाषण प्रतियोगिता, विज्ञान संबंधित संगोष्ठी प्रतियोगिता, प्रश्नोत्तरी प्रतियोगिता, लघु गीत प्रतियोगिता आयोजित की गई।

तालिकाः हिंदी पखवाड़े के अंतर्गत आयोजित विभिन्न प्रतियोगिताएं एवं परिणाम

क्रम संख्या	प्रतियोगिता का नाम	विजेता प्रतियोगी	स्थान
1	कविता प्रतियोगिता	डॉ योगेश कुमार	प्रथम
		श्री बी सी कटोच	द्वितीय
		श्रीमती सूर्या	तृतीय
		श्री भजन सिंह	तृतीय
2	हिन्दी कम्पयूटर टंकण प्रतियोगिता	श्रीमती सोनिया रानी	प्रथम
		श्री इकबाल सिंह	द्वितीय
		श्री अश्वनी कुमार	तृतीय
3	हिन्दी अनुवाद प्रतियोगिता	श्री विशाल कुमार	प्रथम
		श्री यशपाल सिंह	द्वितीय
		श्री जगतार सिंह	तृतीय
4	प्रार्थना पत्र प्रतियोगिता	श्री मानोज कुमार	प्रथम
		श्रीमती वीरांबाली	द्वितीय
		श्री सुखवीर	तृतीय
5	हिन्दी नोटिंग एवं ड्राफटिंग प्रतियोगिता	श्री इकबाल सिंह	प्रथम
		श्री अवतार सिंह	द्वितीय
		श्री राजिन्द्र कुमार रहेजा	तृतीय
6	मुहावरे युक्त तत्काल भाषण प्रतियोगिता	डॉ योगेश कुमार	प्रथम
		डॉ मुकुन्द नारायण	द्वितीय
		डॉ संदीप मान	तृतीय
7	विज्ञान संबंधित संगोष्ठी प्रतियोगिता	डॉ ए के दीक्षित	प्रथम
		डॉ प्रणीता जायसवाल	द्वितीय
		डॉ स्वाति सेठी	तृतीय
8	प्रशनोत्तरी प्रतियोगिता	डॉ प्रणीता जायसवाल, डॉ डी एन यादव श्रीमती लीना कुमारी, डॉ संगीता बंसल	प्रथम
		डॉ मुकुन्द नारायण, श्री विशाल कुमार स्वाति सेठी, वीरांबाली	द्वितीय
		ई चंदन सोलंकी, श्री धृतिमान साहा, अरूण कुमार	तृतीय
9	एक दिवसीय (हस्तलिखित) पोस्टर पत्र प्रतियोगिता	डॉ योगेश कुमार	प्रथम
		श्रीमती लीना कुमारी	द्वितीय
		डॉ संदीप मान	तृतीय
10	वाद विवाद प्रतियोगिता	डॉ एस के नन्दा	प्रथम
		श्री विशाल कुमार	द्वितीय
		डॉ योगेश कुमार	तृतीय
11	संस्थान में जिन्होने हिन्दी में अधिक कार्य किया	श्री सोहन लाल, श्री इकबाल सिंह	प्रथम
		श्री राजिन्द्र कुमार रहेजा, श्री यशपाल सिंह	द्वितीय
		श्री अश्वनी कुमार	द्वितीय
		श्री अवतार सिंह, श्री कुँवर सिंह, श्री जसवंत सिंह,	तृतीय
		श्री आर के यादव, श्री प्रदीप कुमार	तृतीय

LINKAGES AND COLLABORATIONS

Radio talk on Agri-Business Incubation (ABI): *Anola* Processing

Mr Gurvinder Singh Sandhu and his team from All India Radio Jalandhar visited ICAR-CIPHET, Abohar incubation facility and recorded a radio talk on Agri-Business Incubation (ABI): *Anola* processing with Dr Dattatreya M Kadam, I/c Head HCP on February 09, 2016 and interacted with incubates.

Dr Ramesh Kumar, Er Sakharam Kale and Er Kirti Jalgaonkar delivered a radio talk on 'Guava processing'; 'Mushroom cultivation in hot and arid region' and 'Covered cultivation of vegetables'; 'Processing of red chillies', respectively under '*Do Duni Chaar*' programme of AIR Jalandhar.

Implementation of *Mera Gaon Mera Gaurav* Scheme

An innovative Scheme *"Mera Gaon Mera Gaurav"* (My Village My Pride) of Hon'ble Prime Minister of India is also started to the Institute. The objective of the scheme is to provide required information, knowledge and advisories on regular basis to farmar by adopting villages. Dr D N Yadav, Sr Scientist, TOT Division, is nominated as Nodal Officer for the Scheme at ICAR-CIPHET. Ten teams of scientists were constituted in this regard. The team of scientists visited the nearby villages of Ludhiana and interacted with different village officials/ farmers and informed them about the Scheme. The ICAR-CIPHET has yet adopted 38 villages in Ludhiana district. The Scheme is suppose to promote the direct interface of scientists with the farmers to hasten the lab to land process especially in the area of post-harvest sector.

Testing centre for post-harvest technology machine and equipment:

ICAR-CIPHET, Ludhiana has received Rs. 1.42 crores fund for post-harvest technology machine and equipment (PHTME) testing centre proposal from DoAC, Ministry of Agriculture and Farmers Welfare, Govt. of India, New Delhi.

All India Radio (Jalandhar) programme on *"Do Duni Chaar"*

A series of programmes on Post-Harvest Technology under the title "*Do Duni Chaar*" was started by ICAR-CIPHET, Ludhiana. The programme contains 13 talks on different topics related to post-harvest management and value addition of agricultural commodities. The programme was broadcasted on every Sunday *w.e.f.* December 6, 2015 onwards in *Dehati* programme at 7:00 pm from All India Radio, Jalandhar.

Signing of MOU with NIFTEM, Kundli, Haryana

ICAR-CIPHET, Ludhiana has signed a memorandum of understanding (MOU) with National Institute of Food Technology and Entrepreneurship Management (NIFTEM), Kundli on June 18, 2015 during national conference on Sustainability Issues of Food Processing Sector (SIFPROS-2015). This MOU will lead to strengthening, betterment and benefit of both the organizations mutually and will enable the ICAR-CIPHET to jointly organize seminars, conferences workshops, short-term education programmes on topics of mutual interest, to jointly propose and engage in research or training programmes sponsored by funding agencies and to invite each other's faculty to participate therein. Dr K Alagusundaram, Deputy Director General (Agril Engg), ICAR, New Delhi; Mr Ranglal Jamuda, Secretary, MOFPI, New Delhi and Chancellor, NIFTEM; Dr Ajit Kumar, Vice-Chancellor, NIFTEM; Mr Rakesh Kacker, Director, India Habitat Centre, New Delhi; Dr Ashutosh Upadhyay, Acting Registrar, NIFTEM and other officials of ICAR-CIPHET, Ludhiana and NIFTEM were present on the occasion.

Dr R K Gupta, Director ICAR-CIPHET, signing MOU with NIFTEM, Kundli

AWARDS AND RECOGNITIONS

ISO 9001:2008 renewal to ICAR-CIPHET

ICAR-CIPHET, Ludhiana has been awarded ISO 9001:2008 certificate for operating Quality Management System on February 17, 2014 till February 16, 2017. In order to observe proper implementation of Quality Management System in compliance with ISO 9001:2008 at ICAR-CIPHET, annual surveillance audit was conducted by the external agency 'BSCIC' on January 12, 2016 and continuation of ISO 9001:2008 certificate for the year 2016-17 to ICAR-CIPHET was recommended.

Fellow, Eurasian Academy of Environmental Sciences (FEAES)

Dr Dattatreya M Kadam has received Fellow of Eurasian Academy of Environmental Sciences (FEAES) for his contribution towards the development of eco-friendly Nano-bio-polymers and Nano-bio-composites.

Venus International Foundation Research Award

Dr S K Tyagi and Dr Pranita Jaiswal has been awarded with outstanding scientist award -2015 by Venus International Foundation, Chennai for their contribution in the disciple of Chemical engineering and Microbiology respectively.

International Training Award:

Research Training Fellowship for Developing Country Scientists (RTF-DCS) – AWARD of Fellowship for 2014-15 of Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), DST (GOI) has been awarded to proposed project entitled "Development of Polymeric Nano-particles for Controlled Release in Antimicrobial Packaging Materials". Mr Nichrous Mlalila from Tanzania has undergone training under Dr Dattatreya M Kadam, Principal Scientist (APE) supervision at ICAR-CIPHET, Ludhiana from April 22 to September 17, 2015.

Distinguished Service Certificate Award

Dr Pranita Jaiswal received Distinguished Service Certificate award for the year 2015 by ISAE.

Best oral presentation award

Dr Sunil Kumar awarded with the best oral presentation award under "Integrated Nutrient Management" theme at International conference on "Natural Resource Management- Ecological Perspectives" held at Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, J&K during February 18-20, 2016.

Dr Sunil Kumar awarded at International Conference on "Natural Resource Management-Ecological Perspectives"

Other awards

Kirti R Jalgaonkar won 'Gold Medal' in Women's Badminton Single event and 'Silver Medal' in 100 m Women's race in ICAR Zonal sports meet (North Zone) organized during April 19-21, 2015 at ICAR-IISWC, Dehradun.

PUBLICATIONS

Research Papers

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Yadav DN (2016). Development of Protein Fortified Mango based Ready-to-Serve Beverage. Paper presented in International Conference on Food Value Chain: Innovations and Challenges-2016, held at NIFTEM, Kundli during 17-18 Mar, 2016.

Participation in Conferences/ Seminars/ Meetings

Arun Kumar TV (2015). AgriSearch-2050 meeting organized by ICAR at NASC Complex, New Delhi on 18 May, 2015.

Chandan Solanki (2015). 1st workshop of Nodal Officers of KRISHI at NASC Complex, New Delhi during August 4-5, 2015.

Dattatreya M. Kadam (2015). 3rd Uttar Pradesh Agricultural Science Congress (UPASC) at Allahabad during 14-16 June, 2015.

Dattatreya M. Kadam (2015). Agriculture Skill Development meeting organized by Agriculture Skill Council of India (ASCI) at Punjab Bhawan, Chandigarh on 16 May, 2015.

Dattatreya M. Kadam (2015). Meeting for revision of the guidelines for evaluation/testing of material/products at ICAR, KAB II on 08 Sep, 2015.

Dattatreya M. Kadam (2016). Annual Review Meeting of CRP on Health Foods and secondary Agriculture at ICAR-CIAE, Bhopal from 09-10 Mar, 2016.

Dhritiman Saha (2016). 50th Annual Convention of ISAE and Symposium on Agricultural Engineering in Nation Building: Contributions and Challenges at Orissa University of Agriculture & Technology, Bhubaneswar during 19-21 Jan, 2016.

Dattatreya M. Kadam (2015). Interaction Meet cum Workshop on National Agriculture Innovation Fund (NAIF) at NASC Complex, New Delhi on 23 Dec, 2015.

Dattatreya M. Kadam (2015). XII Zonal Workshop of KVKs of Zone–VII at Ujjain during 09-11 Sep, 2015.

Dattatreya M. Kadam (2016). 50th Annual Convention of ISAE and Symposium on Agricultural Engineering in Nation Building: Contributions and Challenges at Orissa University of Agriculture & Technology, Bhubaneswar during 19-21 Jan, 2016.

Gupta RK (2015). Seminar on Post-Harvest Technologies and Food Processing in India and New Zealand: Opportunities of Collaborative Research on July 22, 2015 at NIFTEM, Kundli.

Mridula D (2015). Hindi Karyashala on वैज्ञानिक संस्थानों में राजभाषा कार्यान्वयनः प्रयोग एवं प्रोत्साहन organized by Hindi Division & DKMA, ICAR at NASC Complex, New Delhi on 7 Dec, 2015.

Mridula D (2016).50th Annual Convention of ISAE and Symposium on Agricultural Engineering in Nation Building: Contributions and Challenges at Orissa University of Agriculture & Technology, Bhubaneswar during 19-21 Jan, 2016.

Muzaddadi AU (2015). International Conference on Food Processing and Analysis organized by Select Biosciences India Private Ltd. at Hotel Shivalik view, Chandigarh during August 20-21, 2015.

Muzaddadi AU (2015).Project review meeting at NFDB, Hyderabad on September 30, 2015.

Nanda SK (2015). Brain Storming Workshop on "Planning & Implementation of Farm Mechanization & Agro - processing in NEH Region" on August 7, 2015 at ICAR RC NEH Region, Umiam (Meghalaya).

Rahul K Anurag (2015). Progress review meeting of MoFPI for Food Testing Laboratories at PHD Chambers of Commerce, August Kranti Marg on August 24, 2015.

Rahul K Anurag, Tushir Surya and Arvind Jaiswal (2016). Training on Laboratory Quality System Management and Internal Audit as per ISO/IEC-17025:2005, at NIPHM, Hyderabad during 28 Dec, 2015 to 02 Jan, 2016.

Sakharam Jagan Kale (2015). Biannual Workshop of AICRP on PET held at SKUAST, Srinagar from September 10-12, 2015.

Sandeep Mann (2016). 31st Annual Workshop of AICRP on PHET at TNAU, Coimbatore during 4-6 Jan, 2016.

Sandeep Mann (2016). 50th Annual Convention of ISAE and Symposium on Agricultural Engineering in Nation Building: Contributions and Challenges at Orissa University of Agriculture & Technology, Bhubaneswar during 19-21 Jan, 2016.

Sandeep Mann, Arvind Kumar Jaiswal and Akhoon Asrar Bashir (2015) International Exhibition & Conference on Agri-Machinery & Equipment- EIMA Agrimach India 2015 at IARI, Pusa, New Delhi on December 03, 2015.

Sandeep Mann, Arvind Kumar Jaiswal and Akon Asrar Bashir (2015) Zonal Workshop Cum Training Programme on Cluster Front Line Demonstrations of Pulses & Oilseeds 2015-16 of Agro-Climatic Zone No. I (Western Himalayan Region) on December 02, 2015. & delivered invited lecture on "Prospects and opportunities in pulse processing".

Sandeep Mann (2015) Workshop of Agro-Climatic Zone No. I (Western Himalayan Region) on November 04, 2015 at SKUAST-Jammu.

Sandeep Mann (2015) Workshop for Developing a Road Map for Technological Support, Extension and Demonstration Services to the Farmers in Trans-Gangetic Plains Region (Agro-Climatic Zone-VI) at ICAR-Central Soil Salinity Research Institute (CSSRI) on October 5, 2015.

Sangita Bansal (2015). 38th meeting of the Project Screening Committee (PSC-2) for R&D at National Medicinal Plants Board, AYUSH Bhawan, New Delhi on 06 May, 2015.

Sangita Bansal (2015). National Conference on "Plant Science Research: Looking beyond 21st Century for Environment and Agriculture Revolution" at University of Delhi, Delhi during 5-7 Feb, 2015.

Sangita Bansal (2016). Annual Review workshop for CRPs as Deputy LCPC for CRP on Health Foods at ICAR-CIAE, Bhopal during 09-11 Mar, 2016.

Sangita Bansal (2016). International Conference on Food Value Chain: Innovations and Challenges (FVC-2016) held at NIFTEM, Kundli, Sonipat during 17-18 Mar, 2016.

Swati Sethi (2015). 1st workshop of Nodal Officers of KRISHI at NASC Complex, New Delhi during August 4-5, 2015.

Swati Sethi (2015). First Workshop of Nodal Officers of KRISHI at NASC complex, New Delhi during 4-5 Aug, 2015.

Tushir Surya (2015). AgriSearch-2050 meeting organized by ICAR at NASC Complex, New Delhi on 18 May, 2015.

Rahul K Anurag and Tushir Surya (2015). Workshop on Accreditation of food testing laboratories programme at NASC Complex, New Delhi during 18-19 Jun, 2015.

Indore Navnath Sakharam, visited NRC on Yak, Dirang Arunachal Pradesh to review progress and chalk out immediate technical program of ongoing project as Co-PI during 13 to 15th Dec, 2015.

Nanda SK (2016). 50th Annual Convention of ISAE and Symposium on Agricultural Engineering in Nation Building: Contributions and Challenges at Orissa University of Agriculture & Technology, Bhubaneswar during 19-21 Jan, 2016.

ON-GOING RESEARCH PROJECTS

Institute Funded Projects

Sr. No.	Project Title	Date of Start	Date of completion	Principal Investigator
1	Development of animal handling and automated cooling systems for dairy farms	Jan, 2013	Dec, 2016	Dr K Narsaiah
2	Development of nano-particle embedded biodegradable food packaging biopolymer	Jan, 2013	Dec, 2015	Dr D M Kadam
3	Development of hybrid cold storage structure for onion and tomato	Mar, 2013	Sept, 2016	Dr R K Vishwakarma
4	Processing of buckwheat, amaranth and oat	Jan, 2013	Mar, 2016	Dr Aleksha Kudos upto Dec 10, 2015 Dr Mridula D Dec 10, 2015 onwards
5	Development of process technology for browning inhibition, novel product development and by product utilization of pear	Jan, 2013	Dec, 2015	Dr Ramesh Kumar
6	Development of process protocol for de-bittering of kinnow juice.	Jan, 2013	Mar, 2016	Dr Sunil Kumar
7	Development of continuous primary processing and shrink packaging line for cauliflower and cabbage	Oct, 2013	Sep, 2016	Dr R K Vishwakarma
8	Development of fat replacer and hydrocolloid from pearl millet and barley	Oct, 2013	Sep, 2016	Ms Monika Sharma upto Nov 30, 2015 Dr D N Yadav Nov 30, 2015 onwards
9	Development of vegetable mixed-wadi making system	Oct, 2013	Mar, 2016	Dr Sandeep Mann
10	Design and development of Wonder Bag for wheat storage	Jul, 2014	Jun, 2016	Dr Sandeep Mann
11	Development of nutritious and convenience foods using extrusion processing technique for 'at risk' children	Jul, 2014	Jun, 2016	Dr Mridula D
12	Development of a process for extraction and utilization of low methoxyl pectin from citrus fruit residue	Apr, 2014	Jun, 2016	Dr Sunil Kumar
13	Impact assessment of technologies from ICAR-CIPHET and AICRP on PHET and PET	Jun, 2014	May, 2017	Dr Anil Dixit

Sr. No.	Project Title	Date of Start	Date of completion	Principal Investigator (2015-16)
14	Design development and evaluation of equipments/machine and storage structures for primary processing and low temperature storage of onions in bulk	Jul, 2015	Jun, 2018	Dr D M Kadam
15	Development and evaluation of active ethylene absorbing packaging film material for selected diametric fruits	Jul, 2015	Jun, 2017	Dr Rahul K Anurag
16	Development of quality sensing system for mushroom and minimally processed pomegranate arils	Jul, 2015	Jun, 2017	Dr Pranita Jaiswal
17	Development and mechanization of low fat high fibre functional meat products	Jul, 2015	Jun, 2018	Dr Yogesh Kumar
18	Development of improved Process and machinery for enhanced dhal recovery from Pigeon Pea	Jul, 2015	Jun, 2018	Dr R K Vishwakarma
19	Development of process protocol for extraction of anthocyanins from pigmented indigenous rice varieties and its utilization in functional foods	Jul, 2015	Jun, 2017	Dr S K Nanda
20	Development of process protocol for gluten analogue and its application in maize and millets flour	Jul, 2015	Jun, 2017	Dr Manju Bala
21	Newer methods for energy efficient oil extraction and novel product development from mustard seed	Jul, 2015	Jun, 2018	Dr S K Tyagi
22	Development of technology for destalking and packaging of dried chillies	Jul, 2015	Jun, 2017	Er Kirti R J
23	Process Protocol for production of quality Green Raisins	Jul, 2015	Jun, 2017	Ms Prerna N Kale
24	Development of mechanical peeler for sweet orange and kinnow	Jul, 2015	Jun, 2017	Dr M K Mahawar
25	Development of national database on NARES Technologies in Post-Harvest Sector	Jul, 2015	Jun, 2016	Dr S K Nanda
26	Development of impedance based portable instrument for determination of maturity of Mango and Pear	Jul, 2015	Jun, 2018	Ms Monika Kundu upto Nov 13, 2015

Externally Funded Projects

Sr. No.	Project Title	Date of Start	Date of completion	Project Leader (2015-16)	Funding Agency
1	Up-gradation of quality control Food testing laboratory	Sep, 2011	Mar, 2016	Dr S N Jha	MOFPI
2	Development of spectroscopic Methods for detection and quantification of adulterants and contaminants in fruit juices and milk	Jun, 2012	May, 2015	Dr S N Jha	NFBSFARA
3	Technology for enhancing oil recovery and production of edible grade de-oiled meal from sunflower and groundnut and their diversified uses	Jul, 2013	Jul, 2016	Dr Mridula D	DST
4	Development of molecular tools for detection of adulteration of medicinal oilseeds and spices for value addition and processing	Oct, 2013	Oct, 2016	Dr Sangita Bansal	WMPB
5	Study on determining storage losses in food grains in FCI and CWC warehouses and to recommend norms for storage losses in efficient warehouse management	Jul, 3013	Jun, 2017	Dr S N Jha upto Dec 29, 2015 Dr R K Gupta Dec 30, 2015	FCI
6	Development of nano-biocomposite based construction material for storage of food grains	Nov, 2013	Oct, 2017	Dr DM Kadam	DST
7	Studies and refinement of live-fish carrier system for mass transportation of table fish, brooders, fingerlings and aquarium fisher	Aug, 2014	Aug, 2016	Dr A U Muzadaddadi	NFDB
8	Development of food bio-polymer based micro & nano scale delivery systems for bioactive ingredients in functional foods	Jan, 2015	Jan, 2020	Dr K Narsaiah	ICAR-National Fellow
9	Pollution control of rice husk fly ash by its effective utilization for novel product development	Feb, 2016	Jan, 2018	Dr S K Tyagi	ICAR

Consortium Research Platform (CRP) on Health Foods

Sr. No.	Project Title	Date of Start	Date of completion	Project Leader
10	Development of micronutrients enriched flour formulation and food products	Apr, 2015	Mar, 2017	Dr Mridula D
11	Development of protein isolates and concentrates from de-oiled cakes and their application in health foods	Apr, 2015	Mar, 2017	Dr D N Yadav
12	Development of functional beverages and food products from fruit, vegetables and herbs for high risk groups (obesity, CVD, diabetes etc.)	Apr, 2015	Mar, 2017	Dr P C Sharma upto Dec 31, 2015 Dr D M Kadam Feb 20, 2016 onwards

Consortium Research Platform (CRP) on Secondary Agriculture

13	Establishment of modern fruits and vegetables Agro Processing Centre (APC)	Apr, 2015	Mar, 2017	Dr P C Sharma upto Dec 31, 2015 Dr D M Kadam Feb 20, 2016 onwards

AICRP on PET, HCP Division, ICAR-CIPHET, Abohar

14	Design and development of composite Solar Air-conditioning System coupled farm level cold store for hot and arid region of Punjab	Jan, 2015	Dec, 2016	Er Kale Sakharam Jagan
15	Design and evaluation of Earth Tube Heat Exchanger coupled greenhouse for hot and arid region of Punjab	Jan, 2015	Dec, 2016	Er Kale Sakharam Jagan
16	Design and development of mushroom polyhouse structure suitable for hot and arid region of Punjab	Jan, 2015	Dec, 2016	Er Kale Sakharam Jagan
17	Development of semi-permanent shade net house to reduce the sun burn of pomegranate fruits in hot and arid region of Punjab	Jan, 2015	Dec, 2016	Dr V S Meena

RESEARCH ADVISORY COMMITTEE

Research Advisory Committee of the ICAR-CIPHET, Ludhiana for the period of three years *i.e.* January 22, 2015 to January 21, 2018.

S No	Name and Address	Designation	Contact Details
1.	**Dr B S Bisht** Former ADG, ICAR & Director Birla Institute of Applied Sciences Bhimtal, Nainital Uttarakhand-263 136	Chairman	Ph: 05942 - 247032/247921/247095 Mob: 094109-05454 Fax: 05942-247095 Email: director@birlainstitute.co.in
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4.	**Dr Pitam Chandra** Professor & Head Department of Food Engineering NIFTEM, Kundli Sonepat-131 028, Haryana	Member	Ph: 91-130-2281099 Email: pc1952@gmail.com
5.	**Dr Ashok Kumar** ADR (Food Science, Nutrition and Engineering) Punjab Agricultural University Ludhiana –141 004 (Punjab)	Member	Mob: 98728-76077 Email: akdevgan@pau.edu
6.	**Dr Sanjod Kumar Mendiratta** Head Livestock Products Technology Division IVRI, Izatnagar-243 122, U.P.	Member	Mob: 094124-45311 Email: mendiratta_65@yahoo.co.in
7	**Dr R K Gupta** Director ICAR - CIPHET, PO: PAU Campus Ludhiana-141 004 (Punjab)	Member	Ph. 0161-2308669, 2313102 Fax: 0161-2308670 Mob: 098728-59024 Email : rkguptaciphet@gmail.com : director.ciphet@icar.gov.in
8	**Dr S N Jha** (Ex-Officio) Assistant Director General (PE) Indian Council of Agricultural Research Room No.-407, Krishi Anusandhan Bhawan-II, Pusa, New Delhi -110012	Member	Ph. 011-25846492 Mob: 094176-01715 Email: snjha_ciphet@yahoo.co.in
9.	**Dr D M Kadam** Senior Scientist, AS&EC Division, ICAR-CIPHET, PO: PAU Campus Ludhiana-141 004, Punjab	Member Secretary	Ph. 0161-2313123 Fax: 0161-2308670 Mob: 94175-96894 Email: kadam1k@yahoo.com

INSTITUTE MANAGEMENT COMMITTEE

S No	IMC Members	Contact Details
1.	Dr S K Jha Principal Scientist (AS&PE) PHT Centre Indian Agricultural Research Institute Pusa, New Delhi –110012	PA to Director : 011-25843375, 011-25842367 Mob. No. 09868427205 (O) 25842155 Fax : 011-25846420 Email: skj_ageg@iari.res.in
2.	Dr Nachiket Kotwaliwale Head (APPD) Central Institute of Agricultural Engineering Nabi Bagh, Berasia Road Bhopal –462 038	EPBAX : 0755-2521000-1 PA to Director : 0755-2737191 Tel: 0755-2521110 Mob. No. 09425522421 Fax : 0755-2734016 Email : nachiket.kotwaliwale@gmail.com
3.	Dr S K Chattopadhyay Head, MP Division Central Institute for Research on Cotton Technology (CIRCOT) Adenwala Road, Matunga (East) Mumbai -400 019	PA to Director: 022-24146002 Mob. No. 09850083130 Fax : 022-24157239, 24130835 Email : drskchattopadhyay@gmail.com
4.	Dr Gautam Basu Head, MP Division National Institute of Research on Jute & Allied Fibre Technology (NIRJAFT) 12, Regent Park Kolkata -700040 (West Bengal)	PA to Director: 033-24711807 Phone No. 033-24212115-17, Ext. 215,265 Mob. No. 09433003241 Fax : 033-24712583 Email : gbose91@gmail.com
5.	The Assistant Director General (PE) Division of Agricultural Engineering Indian Council of Agricultural Research Krishi Anusandhan Bhawan-II, Pusa New Delhi-110 012	Telefax : 011-25846492 Mob. No. 09582963548 (Dr. Kanchan K Singh) Fax: 011-25842660 Email : kksingh03@yahoo.co.uk
6.	Sh Abhijit Shantaram Rokade Shukrawar Peth, House No. 5 Taluka-Junnar, Distt. Pune-410 502 Maharastra	Mob. No. 09423011236, 09604561769 Email: grapessywines_beverages@yahoo.com
7.	The Director of Agricultural Department of Agriculture, Punjab Kheti Bhawan, Phase-6 Near Dara Film Studio Mohali, Chandigarh-160055	Tel: 0172-2970602 Mob. No. 9814138939 (Dr. Gurdial Singh) Fax : 0172-2970609 Email: directoragriculturepunjab@gmail.com PA's Email: agril67@gmail.com

S. No.	IMC Members	Contact Details
8.	The Finance & Accounts Officer Indian Institute of Wheat and Barley Research Karnal-132001 (Haryana)	Tel : 0184-2266762 Mob. No. 09050905843 (Sh. Jagdish Chander) Fax : 0184-2267390 Email: pao.dwr@gmail.com
9.	The Director of Research Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya (CSKHPKV) NH 20, Palampur-176062 Himachal Pradesh	Tel: 01894-230406 (O) 01894-231051 (R) Mob. No. Fax: 01894-230406, 230511
10.	Director (Horticulture) Govt. of Gujarat Directorate of Horticulture First Floor, Krishi Bhawan Sector 10 A, Gandhi Nagar-382 010 Gujarat	Dr. R.S. Sherasiya Tel: 079-23256104 079-23256013/23256227 PS (Sh. Chandresh) 09377829020 Mob. No. 09978405029 Fax: 079-23256113 Email: sherasiyara@yahoo.co.in dir-bag@gujarat.gov.in
11.	Sh. Sharanjit Singh S/o Sh. Sukhdeep Singh H. No. 109, Narula Colony Near Budha Dal Public School Lower Mall Road, Patiala-147021 Punjab	Mob. No. 9855055517 (Self) Mob. No. 9855470007 ®

PERSONALIA

Promotions

Sr. No	Name of the Officials	Date	Promoted to the post of
1	Dr Sandeep Maan, Sr. Scientist	07.09.2015	Pr. Scientist in the PB-4 Rs. 37400-67000 +RGP Rs.10000/-
2	Dr D M Kadam, Sr Scientist	24.09.2015	Pr. Scientist in the PB-4 Rs. 37400-67000 +RGP Rs.10000/-
3	Dr (Smt) Sangita Bansal, Sr Scientist	01.04.2014	Sr. Scientist in the PB-4 Rs. 37400-67000+RGP Rs. 9000/-
4	Dr Sunil Kumar, Sr Scientist	23.02.2014	Sr. Scientist in the PB-4 Rs 37400-67000 +RGP Rs. 9000/
5	Dr Rahul Kumar Anuarag, Scientist	11.05.2014	Scientist (SS) in the PB-3 Rs. 15600-39100+RGP Rs. 7000/-
6	Dr Tanbir Ahmed, Scientist	04.11.2014	Scientist (SS) in the PB-3 Rs. 15600-39100+RGP Rs. 7000/-
7	Dr Yogesh Kumar	06.11.2013.	Scientist (SS) in the PB-3 Rs. 15600-39100+RGP Rs. 7000/-
8	Dr (Smt) Indu Rawat, Scientist	20.04.2014	Scientist (SS) in the PB-3 Rs. 15600-39100+RGP Rs. 7000/-

New Joining

Sr. No	Name of the Officials	Date of Joining at ICAR-CIPHET	Designation
1	Er Akhoon Asrar Bashir	09.04.2015	Scientist
2	Er Indore Navnath Sakharam	10.04.2015	Scientist
3	Mr Ajinath Shridhar Dukare	12.10.2015	Scientist
4	Er Bibwe Bhushan Ratnakar	12.10.2015	Scientist

Transfers

Sr. No.	Name & Designation	Date	Name of place
1	Dr S N Jha promoted to the post of ADG (PE)	29.12.2015	ICAR-New Delhi
2	Dr P C Sharam	31.12.2015	Dr. Y.S. Parmar University, Solan
3	Dr Indu Rawat	30.4.2015	ICAR-CSWCR&TI Deherdum
4	Sh Rahul Subhash Yadav	31.5.2015	ICAR-DFR, Pune
5	Sh Rajiv Sharma	23.06.2015	CIPHET, Abohar
6	Sh Shalikgram Dwivedi	03.08.2015	NBAIM, MAU
7	Sh E Nambi	22.08.2015	CIPHET, Ludhiana
8	Dr Dinesh Kumar Bharti	20.04.2015	Compulsory retired
9	Smt Monika	13.11.2015	ICAR-IARI, New Delhi
10	Dr Monika Sharma	30.11.2015	ICAR-S R S, NDRI, Bengaluru
11	Dr Aleksha Kudos	10.12.2015	ICAR-CIAERS, Coimbatore

Retirements

Sl. No.	Name	Date	Designation
1	Sh. Chaman Lal	30.06.2015	T-3

INSTITUTIONAL STAFF

At Ludhiana Campus

Scientific

S No	Name	Designation	Discipline
1	Dr R K Gupta	Director	Agricultural Process Engineering
2	Dr S K Nanda	Head, FG&OP	Agricultural Process Engineering
3	Dr S K Tyagi	Pr Scientist	Chemical Engineering
4	Dr K Narsaiah	Pr Scientist	Agricultural Process Engineering
5	Dr (Mrs) Mridula Devi	Pr Scientist	Food & Nutrition
6	Dr Anil Kumar Dixit	Pr Scientist	Agricultural Economics
7	Dr Deep Narayan Yadav	Pr Scientist	Food Technology
8	Dr (Mrs) Pranita Jaiswal	Pr Scientist	Microbiology-Plant Science
9	Dr Sandeep Mann	Pr Scientist	Agricultural Structures & Environmental Management
10	Dr Dattatrya M Kadam	Pr Scientist	Agricultural Process Engineering
11	Dr Sangita Bansal	Sr Scientist	Biotechnology (Plant Science)
12	Dr R K Vishwakarma	Sr Scientist	Agricultural Structures & Process Engineering
13	Dr Manju Bala	Sr Scientist	Biochemistry (Plant Science)
14	Dr A U Muzaddadi	Sr Scientist	Fish Processing Technology
15	Er (Mrs) M K Grewal**	Scientist	Agricultural Structures & Process Engineering
16	Dr Yogesh Kumar	Scientist	Livestock Product Technology
17	Dr Tanbir Ahmad**	Scientist	Livestock Product Technology
18	Ms Deepika Goswami	Scientist	Food Technology
19	Dr Rahul Kumar	Scientist	Food Technology
20	Mrs Leena Kumari	Scientist	Electronics & Instrumentation
21	Smt Surya	Scientist	Agricultural Microbiology
22	Dr (Smt) Swati Sethi	Scientist	Food Technology
23	Er Chandan Solanki	Scientist	Agricultural Process Engineering
24	Er Dhritiman Saha	Scientist	Agricultural Process Engineering
25	Dr Ranjit Singh	Sr Scientist	Agricultural Process Engineering

***On study leave*

S No	Name	Designation	Discipline
26	Er Arun Kumar T V	Scientist	Agricultural Process Engineering
27	Dr Arvind Kumar Jaiswal	Scientist	Food Technology
28	Er Akhoon Asrar Bashir	Scientist	Agricultural Structures & Environmental Management
29	Er Indore Navnath Sakharam	Scientist	Agricultural Structures & Environmental Management
30	Er Eyarkai Nambi, V	Scientist	Agricultural Structures & Process Engineering

Administrative

S No	Name	Designation
1	Sh Raj Kumar	SAO
2	Sh Manni Lal	AF&AO
3	Sh B C Katoch	AAO
4	Sh Kunwar Singh	Assistant
5	Sh Avtar Singh	Assistant
6	Sh Tarsem Singh Purba	Assistant
7	Smt Jasvir Kaur	Assistant
8	Sh Gurdial Singh	UDC
9	Sh Harbhupinder Singh	UDC
10	Sh Iqbal Singh	UDC
11	Sh Ashwani Kumar	UDC
12	Smt Sunita Rana	LDC
13	Sh Ram Khelawan Yadav	LDC
14	Sh Sohan Lal	LDC
15	Sh Rajinder Kumar	LDC
16	Sh Sughar Singh Verma	PS to Director

Technical

S No	Name	Designation
1	Sh V K Saharan	Chief Technical Officer
2	Dr Mukund Narayan	Technical Officer (Agril. Structure)
3	Sh Gurdeep Singh	Technical Officer (Lab. Tech.)

S No	Name	Designation
4	Sh Hardev Singh Sekhon	Sr Technical Assistant (Driver)
5	Sh Beant Singh	Sr Technical Assistant (Driver)
6	Sh Vishal Kumar	Sr Technical Assistant (DEO)
7	Sh Lakhwinder Singh	Technical Assistant (Fitter)
8	Sh Bhajan Singh	Technical Assistant (Fitter)
9	Sh Jaswant Singh	Technical Assistant (Welder)
10	Smt Sonia Rani	Technical Assistant (DEO)
11	Sh Jaswinder Singh	Technical Assistant (Machinist)
12	Sh Jagtar Singh	Technical Assistant (Electrician)
13	Sh Pradip Kumar	Technical Assistant (Field Asstt)
14	Sh Yashpal Singh	Sr Technician (Field Asstt)
15	Sh Satwinder Singh	Sr Technician (Lab Technician)
16	Sh Sarup Singh	Technician (Lab Technician)

Supporting

S No	Name	Designation
1	Sh Sukhbir	Skilled Support Staff
2	Smt Viran Bali	Skilled Support Staff
3	Sh Manoj Kumar	Skilled Support Staff

At Abohar Campus

Scientific

S No	Name	Designation	Discipline
1	Dr Ramesh Kumar	Sr. Scientist	Horticulture
2	Dr Sunil Kumar	Sr. Scientist	Biochemistry (Plant Science)
3	Sh Vijay Singh Meena	Scientist	Horticulture
4	Dr Bharat Bhushan	Scientist	Biochemistry (Plant Science)
5	Mrs Prerna Nath	Scientist	Food Technology
6	Er Manoj Kumar Mahawar	Scientist	Agricultural Process Engineering
7	Er Kale Sakharam Jagan	Scientist	Agricultural Structures & Environmental Management
8	Er Jalgaonkar Kirti Ramesh	Scientist	Agricultural Process Engineering
9	Er Bibwe Bhushan Ratnakar	Scientist	Agricultural Process Engineering
10	Er Dukare Ajinath Shridhar	Scientist	Agricultural Microbiology

Administrative

S No	Name	Designation
11	Sh Pawan Kumar	AAO
12	Sh Mohan Lal	Assistant
13	Sh Sanjay Kumar Gaur	LDC

Technical

S No	Name	Designation
1	Sh Prithvi Raj	Sr. Technical Officer (Filed Form.)
2	Sh Rajesh Kumar	Sr. Technical Officer (Filed Form.)
3	Sh Ganpat Ram	Technical Assistant (Driver)
4	Sh Devinder Kumar	Technical Assistant (Fitter)
5	Sh Dalu Ram	Technical Assistant (Fitter)
6	Sh Pawan Kumar	Technical Assistant (Electrician)
7	Sh Hardeep Singh	Technical Assistant (Turner)
8	Sh Rajiv Sharma	Technical Assistant (Lab. Technician)

Supporting

S No	Name	Designation
1	Sh Surinder Kumar	Skilled Support Staff

Annexure - I

RESULTS - FRAMEWORK DOCUMENT (RFD)

(2014 – 2015)

SECTION 1:

Vision, Mission, Objectives and Functions

Vision

Higher profitability of agricultural production systems through efficient post harvest engineering and technological interventions

Mission

Creating prosperity through minimization of post harvest losses and increase in value addition to produce and by-products from crops, horticulture, livestock and fisheries sector.

Objectives

1. To design, develop and evaluate post-harvest processing equipment, tools and gadgets
2. To develop process protocols and value added products
3. To organize human resource development and capacity building programmes

Functions

- To undertake basic, applied and adaptive engineering and technology research in post production sector of produce of plant origin, livestock and aquaculture produce including agricultural 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 private and public sector in the mandated areas

SECTION 2:
Inter se Priorities among key Objectives, Success indicators and Targets

S.No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target/Criteria Value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1.	To design, develop and evaluate post-harvest processing equipment, tools and gadgets	25	Design & development of post harvest processing equipment, tools and gadgets	Equipment designed and developed	Number	15	10	8	6	4	2
			Testing and evaluation of post harvest processing equipment, tools and gadgets	Final validated design of machine	Number	10	9	7	5	3	1
2.	To develop process protocols and value added products	22	Development of process protocol	Process protocols	Number	10	13	11	9	7	5
			Development of value added products	Value added products	Number	12	8	7	6	5	4
3.	To organize human resource development and capacity building programmes	33	Transfer of technology, capacity building	Trainings, FLDs, Exhibitions & Licensing of improved postharvest technologies	Number	23	36	30	24	18	12
			Documentation and IPR management	Patents filed	Number	02	4	3	2	1	0
				Other Pub. (Leaflets, Brochures, success stories, News items, Newsletters, mass media etc.)	Number	08	30	25	20	15	10
4.	Publication/Documentation	05	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	11	9	7	5	3
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	June 30, 2014	July 2, 2014	July 4, 2014	July 7, 2014	July 9, 2014
5.	Fiscal resource management	02	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90

S.No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target/Criteria Value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
6.	Efficient functioning of the RFD system	03	Timely submission of draft RFD for 2014-2015 for approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014
			Timely submission of results of RFD 2013-2014	On-time submission	Date	1	May 1, 2014	May 2, 2014	May 5, 2014	May 6, 2014	May 7, 2014
7.	Enhanced Transparency/ Improved Service delivery of Ministry / Department	03	Rating from Independent Audit of implementation of Citizen's Client's Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80
			Independent Audit of implementation of Grievance redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80
8.	Administrative reforms	07	Update organizational strategy to align with revised priorities	% of Implementation	%	2	Nov. 1, 2014	Nov. 2, 2014	Nov. 3, 2014	Nov. 4, 2014	Nov. 5, 2014
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of Corruption (MSC) Implementation of agreed milestones for ISO 9001	% of Implementation	%	1	100	90	80	70	60
				% of Implementation	%	2	100	95	90	85	80
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of Implementation	%	2	100	90	80	70	60

SECTION 3:
Trend Values of the Success Indicators

S.No.	Objectives	Actions	Success Indicators	Unit	Actual Value for FY 12/13	Actual Value for FY 13/14	Target Value for FY 14/15	Projected Value for FY 15/16	Projected Value for FY 16/17
1.	To design, develop and evaluate post-harvest processing equipment, tools and gadgets	Design & development of post harvest processing equipment, tools and gadgets	Equipment designed and developed	Number	4	6	8	8	9
		Testing and evaluation of post harvest processing equipment, tools and gadgets	Final validated design of machine	Number	3	6	7	7	8
2.	To develop process protocols and value added products	Development of process protocol	Process protocols	Number	8	14	11	11	11
		Development of value added products	Value added products	Number	7	10	7	7	8
3.	To organize human resource development and capacity building programmes	Transfer of technology, capacity building	Trainings, FLDs, Exhibitions & Licensing of improved postharvest technologies	Number	35	40	30	30	32
		Documentation and IPR management	Patents filed	Number	4	3	3	3	3
			Other Pub. (Leaflets, Brochures, success stories, News items, Newsletters, mass media etc.)	Number	26	-	25	25	25
4.	Publication/Documentation	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	28	--	9	12	12
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	--	--	July 2, 2014	-	-

S.No.	Objectives	Actions	Success Indicators	Unit	Actual Value for FY 12/13	Actual Value for FY 13/14	Target Value for FY 14/15	Projected Value for FY 15/16	Projected Value for FY 16/17
5.	Fiscal resource management Efficient functioning of the RFD system	Utilization of released plan fund	Plan fund utilized	%	--	--	96	85	85
		Timely submission of draft RFD for 2014-2015 for approval	On-time submission	Date	-	-	May 16, 2014	-	-
6.	Enhanced Transparency/ Improved Service delivery of Ministry / Department	Timely submission of results of RFD 2013-2014	On-time submission	Date	-	-	May 2, 2015	-	-
		Rating from Independent Audit of implementation of Citizens'/ Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	--	--	95	--	--
7.	Administrative reforms	Independent Audit of implementation of Grievance redress Management (GRM) system	Degree of success in implementing GRM	%	--	--	95	--	--
		Update organizational strategy to align with revised priorities Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of Corruption (MSC)	% of Implementation	%	--	--	Nov. 2, 2014	--	--
			% of Implementation	%	--	--	90	--	--
		Implementation of agreed milestones for ISO 9001	% of Implementation	%	--	--	95	--	--
		Implementation of milestones of approved Innovation Action Plans (IAPs)	% of Implementation	%	--	--	90	--	--

Section 4(a): Acronyms

S. No	Acronym	Description
1.	CIPHET	Central Institute of Post-harvest Engineering and Technology
2.	FLDs	Field Level Demonstrations
3.	R&D	Research and Development
4.	SAUs	State Agricultural Universities
5.	IPR	Intellectual Property Right
6.	MOFPI	Ministry of Food Processing Industries
7.	CSIR	Council of Scientific and Industrial Research
8.	GDP	Gross Domestic Product
9.	KVK	Krishi Vigyan Kendra
10.	FLD	Front Line Demonstration
11.	TSP	Tribal Sub Plan

Section 4 (b): Description and definition of success indicators and proposed measurement methodology

S. No.	Success indicator	Description	Definition	Measurement	General Comments
1.	Equipment designed and developed	Success indicators cover number of equipment, tools and gadgets developed.	Development of post-harvest engineering and technology related equipment, tools and gadgets.	Number of equipment, Tools and gadgets developed	Nil
2.	Final validated design of machine	Post-harvest processing equipment, will be evaluated including refinement of developed/ existing equipment, tools and gadgets.	Evaluation and refinement of developed/existing post-harvest processing equipment, tools and gadgets.	Performance, efficiency and accuracy along with low cost and energy efficiency.	Nil
3.	Process protocols	Development of protocols for value added products.	Process protocol for value added products	Number of protocols developed	Nil
4.	Value added products	Development of value added products using developed protocols.	Manufacture of products from commodities and co-products	Number of value added products	Nil
5.	Trainings, FLDs, Exhibitions & Licensing of improved postharvest technologies	Training conducted for farmers and upcoming entrepreneurs, private and government officials, R&D and extension personnel. Licensing and training on CIPHET developed technologies.	Trainings, FLDs, exhibitions for transfer of technology and commercialization along with human resource development.	Number of training, FLDs, & exhibitions conducted/ participated. Numbers of technologies licensed.	Nil
6.	Patents filed	Patenting innovative technology and process/ products.	A license to use exclusive rights to a process/design	Number of patents filed.	Nil
7.	Other Pub. (Leaflets, Brochures, success stories, News items, Newsletters, mass media etc.)	Publishing Leaflets, Brochures, success stories, News items, Newsletters, mass media etc.	Preparation of printed /electronic material and issuing for public distribution or sale to bring to the public attention	Number of Publications/ mass media items	Nil

Section 5: Specific performance requirements from other departments that are critical for delivering agreed results

Location Type	State	Organization Type	Organization Name	Relevant Success Indicator	What is your requirement from this organization	Justification for this requirement	Please quantify your requirement from this Organization	What happens if your requirement is not met
State Govt.	All states	Other	Other	Trainings, FLDs, Exhibitions & Licensing of improved postharvest technologies	Sponsorship for conducting trainings and sponsored candidates	For dissemination of developed technologies to the end users.	Number of trainings and candidates	Dissemination of developed technologies to the end users will be affected.

Section 6: Outcome / Impact of activities of Department /Ministry

S. No.	Out Come	Jointly responsible for influencing this outcome / impact with the following organization(s)/ department (s) / ministry(ies)	Success Indicator (s)	Unit	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
1	Reduction in post-harvest losses and increase in value addition of agricultural produce	SAUs, CSIR, MOFPI, Entrepreneurs, Food Processing Industry	Increase in nu mber of food processing units over previous year	%	1.1	1.1	1.2	1.3	1.4
			Contribution of food processing to GDP of Agriculture	%	12	12	12.5	13	13.5
2	Human resource development	SAUs, KVKs, Manufacturers, Entrepreneurs	Skilled manpower developed	Number	350	412	430	500	560

Annual (April 1, 2014 to March 31, 2015) Performance Evaluation Report of RFD of RSCs i.e. Institutions for the year 2014-2015

S.No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target/Criteria Value					Achievements	Performance	
							Excellent	Very Good	Good	Fair	Poor		Raw score	Weighted score
							100%	90%	80%	70%	60%			
1.	To design, develop and evaluate post-harvest processing equipment, tools and gadgets	25	Design & development of post harvest processing equipment, tools and gadgets	Equipment designed and developed	Number	15	10	8	6	4	2	**10**	**100**	**15**
			Testing and evaluation of post harvest processing equipment, tools and gadgets	Final validated design of machine	Number	10	9	7	5	3	1	**09**	**100**	**10**
2.	To develop process protocols and value added products	22	Development of process protocol	Process protocols	Number	10	13	11	9	7	5	**13**	**100**	**10**
			Development of value added products	Value added products	Number	12	8	7	6	5	4	**08**	**100**	**12**
3.	To organize human resource development and capacity building programmes	33	Transfer of technology, capacity building	Trainings, FLDs, Exhibitions & Licensing of improved postharvest technologies	Number	23	36	30	24	18	12	**53**	**100**	**23**
			Documentation and IPR management	Patents filed	Number	02	4	3	2	1	0	**00**	**00**	**00**
				Other Pub. (Leaflets, Brochures, success stories, News items, Newsletters, mass media etc.)	Number	08	30	25	20	15	10	**26**	**86.67**	**6.94**
4	Publication/Documentation	05	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	11	9	7	5	3	**13**	**100**	**3**
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	June 30, 2014	July 2, 2014	July 4, 2014	July 7, 2014	July 9, 2014	**June 27, 2014**	**100**	**2**
5	Fiscal resource management	02	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	**99.3**	**100**	**2**

6	Efficient functioning of the RFD system	03	Timely submission of draft RFD for 2014-2015 for approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014	**May 8, 2014**	**100**	**2**
			Timely submission of results of RFD 2013-2014	On-time submission	Date	1	May 1, 2014	May 2, 2014	May 5, 2014	May 6, 2014	May 7, 2014	**April 26, 2014**	**100**	**1**
7	Enhanced Transparency/ Improved Serviee delivery of Ministry / Department	03	Rating from Independent Audit of implementation of Citizen's Client's Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80	**100**	**100**	**2**
			Independent Audit of implementation of Grievance redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80	**100**	**100**	**1**
8	Administrative reforms	07	Update organizational strategy to align with revised priorities	% of Implementation	%	2	Nov. 1, 2014	Nov. 2, 2014	Nov. 3, 2014	Nov. 4 , 2014	Nov. 5, 2014	**Nov 03, 2014**	**80**	**1.6**
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of Corruption (MSC)	% of Implementation	%	1	100	90	80	70	60	**100**	**100**	**1**
			Implementation of agreed milestones for ISO 9001	% of Implementation	%	2	100	95	90	85	80	**100**	**100**	**2**
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of Implementation	%	2	100	90	80	70	60	**100**	**100**	**2**
													Composite Score =	**96.50%**
													Rating	**Excellent**