Central Institute of Post Harvest Engineering & Technology
Ludhiana
Our Slogan: Produce, Process and Prosper

CIPHET E – Newsletter for June 2009
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Director's Column

Dear All,

The summer rice is an important crop of Chhattisgarh. However very low humidity and high temperature in summer results in higher fissuring and chalky grain due to lower filling during fruiting. This increases broken percentage during milling and low Head Rice Recovery. Though parboiling is one of the simplest and effective methods to improve the milling quality of the paddy variety, there is no market for parboiled rice in the state of Chhattisgarh. The effect of high milling losses is that it is not economical for the millers for processing and ultimately farmers are facing the problem of marketing of their produce. To review this situation an expert group meeting was held under chairmanship of Dr M. M. Pandey, Deputy Director General (Engg), ICAR New Delhi on June 19, 2009 at IGKVV, Raipur. All the related issues were thoroughly discussed and it was concluded that it is essential to conduct trials for screening/develop varieties for cold tolerance for early sowing and heat tolerance at the time of physiological maturity with active collaboration of DRR, Hyderabad CRRI, Cuttack and IGKVV, Raipur. Another approach suggested was through process engineering i.e. by adopting value addition to rice brokens such as nutrient enriched rice flour, extruded rice flour as well as conventional rice flour in small packages, developing ready to constitute *kheer* mixes, adoption of novel extrusion technology for production of nutrient enriched quick cooking rice analog developed at Cornell University, USA.

Followed by this I got an opportunity to attend the Food and Agribusiness Management Programme jointly offered by Cornell University, USA and Sathguru Consultant, India. The information on emerging bio-technologies and food processing such as thermal processing with extrusion to develop VITA-RICE from brokens and non-thermal processing with high pressure and pulse electric heat was of great value. The interaction with learned faculty at Cornell University and with American Small Businesses was highly enlightening and useful in improving the research and extension program at CIPHET, Ludhiana.

Fermentation is a rapid process for production of commercially important products like enzymes, alcohol, organic acids, amino acids, biocolours, flavours etc using microorganisms. CIPHET has developed a facility for both submerged fermentation (SmF) and solid state fermentation (SSF) for production of enzymes, ethanol and organic acids. Fermentation laboratory at CIPHET presently has 2 l, 5l and 30 l batch fermenters and we are in the process of adding a solid state bioreactor, especially for production of enzymes like amylase, cellulase, pectinase and xylanase under controlled conditions.

Peanuts (Arachis hypogea) are commonly called poor man's almond and it is one of the most nourishing foods available in the world. The CIPHET has developed a commercially viable process for the inactivation of lipoxygenase enzyme in peanuts before processing. This coupled with use of modern air less grinding and de-odourising technique prepared peanut milk with negligible nutty flavour.

Lotus seeds are currently manually processed. High labour requirement and low efficiency has restricted the expansion of lotus seed industry at production catchment and deprives the farmer's benefit of farm level processing. Hence CIPHET has developed is a Lotus seed decorticator. The machine gives maximum decortication efficiency of 65.4 % at moisture content of 5.21% (wet basis) and operational capacity of 105 kg per hour and can help develop processing industry in lotus growing areas.

With best regards

R.T. Patil
Director

In this issue

Food and Agribusiness Management Programme offered by Cornell University, USA and Sathguru Consultant, India

Dr R T Patil, Director CIPHET attended this programme. The programme was jointly offered by Cornell University, USA and Sathguru Consultant, India. It was designed in two modules. The first module in India was held at Hyderabad from June 12-16, 2009. In this module the global scenario of food system, food regulations, food safety standards, import regulation, food marketing was covered. The emerging technologies on crop yield improvement such as bio-technologies and emerging technologies in food processing such as thermal processing with extrusion and non-thermal processing with high pressure and pulse electric heat were also covered. The food marketing strategies IPR issues, technology transfer and supply chain management were also covered by the faculty from Cornell University namely: Dr. K.V. Raman, Professor, Plant Breeding & Genetics; Dr. K. Vijayaraghavan, Director, Sathguru Management Consultants; Dr. Ram Rao; Dr. Syed Rizvi; Dr. S.P. Raj and Dr. Ragunathan. This module also included discussions on food marketing case study, biotech case study, and video conferencing with alumni of this programme and video conferencing with the international experts from Cornell University.

The faculty and participants of Food and Agribusiness Management Programme

The second module was conducted in USA at Cornell University campus, Ithaca, New York. The topics covered by different faculty members of Cornell University were as follows:

Topic	Faculty Member
Current Food Security Crisis on Account of the Energy Crops and Other Factors.	Dr. Robert Herdt, Prof. of Applied Economics & Management
Impact of Global Recession the Food Retail and Strategies Adopted to Mitigate the Downslide	Rod Hawkes, Sr. Lecturer, Applied Economics & Management.
Competitive Advantages for Bioenergy.	Dr. Norman Scott, Prof. Biology & Environmental Engineering
Emerging Global Concerns for Food Safety- Trends in Enhancing Traceability and Food Safety Stewardship	Dr. Martin Weidmann, Assoc. Prof., Food Science
Global Trends in Extension and Relevance for Emerging Agricultural Systems and Partnership, Models in Extension	Dr. Terry Tucker, Director of Academic Programs, International Programs
Green Composites: From Sports gear to Ballistic Applications	Dr. Anil Netravali, Prof. of Fiber Science & Apparel Design.
Controlled Atmospheric Storage and Post Harvest Issues in Tropical Fruits/ Vegetables.	Dr. Jacqueline Nock

The US module also included tour of the university library for accessing the resource bases in Food Processing and Plant Biotechnology. The module also included visit to retail stores of processed foods in US such as; Wegmans Supermarket, Walmart, 6 Mile Creek Winery etc. The visit was also arranged to M/s. Worm Farm, an industry manufacturing vermi compost and vermi wash. A visit was also arranged to Oatka, Dairy product processing plant at Batavia, New York. The agriculture farm owned by Mr. Craig Yunker, a Cornell University trustee was also visited. The farm size was 5200 acres, which had dairy cattle farm, grower finisher farm, and pack house for vegetables and ventilated structures for storage of onion. A visit was also arranged to Boyce Thompson Vegetable Farm of Cornell University and organic farming of strawberry by an entrepreneur where they followed U pick and pay system. We also visited Cornell Apple Orchards and looked at the facility of

controlled atmosphere storage of apple. The visit was also arranged to bio-fuel facility of Department of Bio-resources Engineering which was explained by Prof. Dr. Larry Walker. The group also visited NY State Agriculture Experiment, Geneva where novel product development and pilot plant operation activities were handled. At Geneva the state of New York in collaboration with Cornell University has established Agriculture Food Technology Park, which serves as incubation center for upcoming entrepreneurs for establishing industry based on Cornell developed technology. During the US module, the participants were divided into three groups and were given a project on developing business strategies for improving the existing food processing industry. Our group was given project on multinational company having multi-product lines and we worked out business structures for next five years to make it No. 1 Company. The opportunity of interacting with American Small Businesses and the vast knowledge and experience of the faculty members of one of the best university in the world was highly enlightening and will be useful in improving the research and extension program at CIPHET, Ludhiana.

The participants of the programme with Prof. Dr. David J. Skorton, President of Cornell University and Dr. Susan A. Henry, Dean, College of Agriculture and Life Sciences at Cornell.

Expert group meeting on high milling losses in summer rice in Chhattisgarh at IGKVV, Raipur

The summer rice is an important crop of Chhattisgarh. In the year 07-08 the area under summer rice was 1.62 lakh ha producing 3.9 lakh tones of paddy and giving 2.4 tonnes of rice /ha and in the year 08-09 the area further increased to 1.7 lakh ha producing 5.44 lakh tones of paddy and increasing the rice productivity from 2.40 to 2.53 t/ha. During wet season (2005) at IGKVV, Raipur, 102 advanced breeding lines along with five checks were studied for head rice recovery. It was found that the minimum to maximum range varied from 30.08% to 56.82%. That means at 70% milling yield (HR+Brokens), the broken percentage varied from 13.18-39.92%. Due to very low humidity and high temperature in summer results in higher fissuring and chalky grain due to lower filling during fruiting. This increases broken percentage during milling and low Head Rice Recovery. Though parboiling is one of the simplest and effective methods to improve the milling quality of the paddy variety, there is no market for parboiled rice in the state of Chhattisgarh. The effect of high milling losses is that it is not economical for the millers for processing and ultimately farmers are facing the problem of marketing of their produce.

To review this situation an expert group meeting was organized under chairmanship of Dr M. M. Pandey, Deputy Director General (Engg), ICAR New Delhi, on June 19, 2009 at IGVVV, Raipur. Dr R T Patil Director CIPHET also participated as one of the members. All the related issues were thoroughly discussed under the chairmanship of Dr. MM Pandey, DDG Engineering. To lead the discussion the presentation were given by Dr. MP Pandey VC, IGKVV, Director of Research, Director of Extension, Director, CRRI, Director CIPHET, Treasurer of Chhattisgarh Rice Millers Association, Additional Director of Agriculture (Engg). Later on, the house was open for discussion in which rice millers, extension personnel, retired officers of the University, Secretary, Dept of Agriculture, Director Agriculture and their staff also participated.

Important conclusions to get the solution to this problem were to conduct trials for screening/developing varieties with cold tolerance for sowing early and heat tolerance at the time of physiological maturity. For this the active collaboration of DRR, CRRI and IGKV was suggested. Another approach was through process engineering by developing value added products from rice brokens. Various technologies look feasible like pre fermented rice flour, extruded rice flour as well as conventional rice flour in small packages to increase their consumption by developing various recipes/dishes, developing ready to constitute kheer mixes etc. The adoption of novel extrusion technology for production of fabricated nutrient enriched long or short rice with rice brokens as raw material also looks promising. The Wenger Inc and Cornell University has developed this technology and with growing demand for instant and convenient foods in urban population offers great scope for using rice brokens for value addition and thus wealth can be created from the so called waste.

Fermentation Research at CIPHET Ludhiana

Fermentation is a rapid process for production of commercially important products like enzymes, alcohol, organic acids, amino acids, biocolours, flavours etc using microorganisms. CIPHET has developed a facility for both submerged fermentation (SmF) and solid state fermentation (SSF) for production of enzymes, ethanol and organic acids. Fermentation laboratory at CIPHET presently has 2 l, 5l and 30 l batch fermenters and we are in the process of adding a solid state bioreactor, especially for production of enzymes like amylase, cellulase, pectinase and xylanase under controlled conditions. Presently, the projects already in operation at CIPHET are aimed at optimization of parameters for production of cellulase, xylanase and pectinase from agro-residues and by-products like whey, rice straw, wheat bran, fruit and vegetable residues. Such in-house produced enzymes are being exploited for different food and industrial applications like oil extraction, fruit juice clarification and production of concentrated sugar syrups. The Institute is developing a state-of-art facility for production of cellulosic ethanol and thus, a few more instruments like pelletizers, pretreatment set up, high pressure cookers, industrial microwave ovens, Lyopholizer, HPLC, ethanol detection systems are being added to the laboratory under different approved projects. The near future goal includes development of cost effective technologies for production of organic acids, biosurfactants and platform chemicals through fermentation using agro-residues. Our long-term endeavor includes development of recombinants through conventional techniques like mutagenesis and protoplast fusion and also by employing techniques like gene cloning and over expression. Such recombinants would be tried to improve the overall process productivity for production of desired compound.

Fermenter of 30 litre capacity with controls for temperature, pH, DO and CO_2 monitoring installed at CIPHET, Ludhiana

Review of Institute activities by Deputy Director General (Engineering) ICAR, New Delhi

Dr. M.M. Pandey, Deputy Director General (Engg.), ICAR New Delhi visited the Institute on June 10, 2009 to review the Institute activities. Dr. Pitam Chandra Asst Director General (PE) was also graced the occasion. Dr. R.T. Patil welcomed the Deputy Director General and organized tree plantation in honour of his first visit at the Institute. Dr R T Patil presented a brief account of programs and achievements of CIPHET, Ludhiana. He informed the DDG that the Institute has made a significant progress during past years. Dr. M.M. Pandey, Deputy Director General (Engg), ICAR informed the house that ICARs expectations from CIPHET are very high due to priority of post harvest technology at National level. To deliver, Institute should prioritize its programs, focus them and work as per commitment in the XIth Plan. He told that Institute is working fine however; there is still possibility of doing better. Dr. Pitam Chandra stressed in his remarks that the Institute should work in coordinated fashion and linkages should be developed with all stakeholders. The Institute should develop project proposals based on Institute XIth Plan priorities and deliver quality output to the end users. The DDG and ADG appreciated the lab developed in ASEC division on "Non – destructive evaluation of quality" under NAIP. It was also suggested that efforts should be made to procure GLP certificate. DDG (Engg) desired that the other lab of CIPHET should also be furnished similar to this lab. The DDG and ADG also conducted a meeting with AO and AFAO separately and reviewed the administration and financial progress made by the Institute. The DDG also addressed the staff of the Institute.

Tree plantation by Dr. M. M. Pandey DDG(Engg) at CIPHET, Ludhiana Campus

Dr. MM Pandey DDG (Engg) in meeting with CIPHET staff

Application of plastics in agriculture through All India Trials

The application of plastics in agriculture is gaining importance. The scope of adoption of plastics in agriculture is very wide in agricultural system including conserving the natural resources, enhancement of production, productivity and quality of produce. In the developed countries, plastics have become an inevitable part of agricultural production to utilization system. The CIPHET Ludhiana through its All India Coordinated Research Project on APA is under taking all India trails of plastics for use in agriculture through its centers through out the country. The CSHPKV, Palampur cooperating centres is engaged on Poly house production including nursery and vegetable cultivation and fertigation. At Research Station, HPKV, Nagrota Plastic Bee-hives have been tried for Bee-Keeping. However the hives are not working well due to problem of moisture in the hives, poor crawling of bees on surface and rise in temperature. The public private partnership trial in farmer's field of Mr. Prem Saini at Vallar-Kotakwala village in Kangra district demonstrated that in a polyhouse (10 x 6 m), 3 nursery crops per year could be taken with earning more than Rs 80,000 as profit per year. Another farmer beneficiary of the project Mr. Dinesh Kumar Sharma in Kullu district constructed two polyhouse (42 x 12 m and 50 x 10 m) for growing capsicum and earned Rs 1,50,000/- per year. Dr. P. R. Bhatnagar, PC (APA) visited these places during June 21–26, 2009 to review the progress and encourage the farmers adopting the technologies.

Dr. Bhatnagar PC(APA) discussing about working of plastic bee-hives with researchers.

International Symposium on Pomegranate and Minor Mediterranean Fruits

International Society of Horticultural Sciences (ISHS) organized 2nd International Symposium on "Pomegranate and Minor Mediterranean Fruits (ISPMMF2009) at University of Agricultural Sciences, Dharwad (Karnataka), India during 23-27 June, 2009 with aim to promote and encourage research to discuss various issues related to the Pomegranate and minor including Mediterranean fruits. The symposium provided an opportunity to interact with the horticultural group about the problems related to processing of Pomegranate and minor fruits. The mechanization of horticulture in pre as well as post harvest is the need of hour and future programmes needs to be taken in this line. The task ahead seems to be challenging however, the engineering application in this sector may help in higher production and processing with least post harvest losses. There was a session on post harvest having unique content on post harvest aspect like, development of tool and machine, processing and

therefore received attention of the many audiences. Dr. A. K. Thakur, Sr. Scientist (AS & PE) attended the symposium from CIPHET and presented his paper on “Development of tool and machine for safe separation of arils from Pomegranate”. Many participating members have demanded the hand tool for easy separation of arils developed by CIPHET. The Pomegranate growers association of Karnataka and Maharashtra and industry delegates had discussion with the CIPHET scientist about the commercial availability of the hand tool and machine. The presentation was adjudged as “Best Paper Presentation” in the session of PHT.

Development of groundnut based flavoured beverage and curd (Dahi)

Groundnut (*Arachis hypogea*) is commonly called poor man's Almond and is one of the most nourishing foods available in the world. Traditionally eating fresh, roasted peanut with jaggery and goat milk is a very nutritious food for children, pregnant women and nursing mothers. Groundnut contains about 25 % good quality protein, 40 % oil rich in essential fatty acids, 3 % fiber and 2.5% minerals. Milk and other dairy products are generally accorded great prominence in nutritional consideration, mainly because of their high nutritional value. This is always accompanied by essential trace materials necessary for optimum utilization of proteins from other sources. In developing countries, the ever-increasing gap between available resources and population has led to severe inadequacy in nutrient supply including milk and its products. The scarcity in milk supply has led to efforts towards the development of alternative milk like products.

The groundnut has a potential to play a role in combating malnutrition. Like beany flavour in soybean milk, the peanut milk also has unwanted nutty flavour. The nutty flavour in peanut milk is due to the hexanal compound which is generated by the action of lipoxygenase on fatty acids. The CIPHET has developed a commercially viable process for the inactivation of lipoxygenase enzyme in peanuts before processing. This coupled with use of modern air less grinding and de-odourising technique prepared peanut milk with negligible nutty flavour. By using such prepared peanut milk, highly acceptable chocolate / vanilla flavoured beverages have been developed with about 12 % total solids and 3.25 % protein. The process for the preparation of acceptable curd (*Dahi*) with 15 % total solids and 4.25 % protein has also been optimized.

The groundnut is the richest source of Niacin 19.9 mg/100g and Thiamine 0.90 mg/100g. Similar to soybeans, the peanuts have also been reported to contain bioactive phytochemicals, particularly isoflavones (genistein, daidzein, and biochanin A) and trans-resveratrol. The high levels of the isoflavones in peanut products are mainly due to heat-induced conversion of conjugate glycosides to aglycons. The availability of genistein and trans-resveratrol has been reported as significantly higher in the processed peanuts, hence peanut milk is also highly healthful as that of soybean milk with added advantage of not having strong beany flavour. Based on this technology and modern processing equipment available at CIPHET, we are planning to offer an EDP course on production of groundnut milk and its products for the upcoming entrepreneurs.

Peanut milk based curd

Peanut milk based flavoured beverage

The modern processing plant with airless grinding and deodorizer to get flavour free ground nut milk at CIPHET Ludhiana

Upcoming Events

1. ICAR sponsored Winter School on **"Quality assurance and shelf-life enhancement of fruits and vegetables through novel packaging technologies"** will be held at CIPHET, Ludhiana during September 25 to October15, 2009. The Course Director is Dr. D.R. Rai, Principal Scientist, Agricultural Structures & Environmental Control Division. You can contact him on Tel: +91 - 161-2313123, 0161-2819934 (R), 09417366034 (Cell), Fax: 0161-2308670, Email:d_r_rai@yahoo.com, drrai66@gmail.com.

2. ICAR sponsored Winter School on **"Recent developments in post harvest processing and value addition to livestock produce"** will be held at CIPHET, Ludhiana during October 22 to November 11, 2009. The Course Director is Dr. K. Narsaiah, Senior Scientist (ASPE). You can contact him on Tel: +91 - 161-2313124, 09417143925 (Cell), Email:knarsan@yahoo.com Fax: 0161-2308670.

3. ICAR sponsored Winter School on **"Mathematical modeling and simulation of agricultural structure, process and product Quality"** will be held at CIPHET, Ludhiana during September 3-23, 2009. The Course Director is Dr. Dilip Jain, Senior Scientist (TOT Division). You can contact him on Tel: +91 - 161-2313122, 09216125933, Email:jaindilip25@sify.com Fax: 0161-2308670.

Joining

Er. Manpreet K. Grewal, joined CIPHET, Ludhiana on 15.06.2009 as Scientist (Agril Structures & Process Engineering). She has obtained her B.Tech. (Agril Engg) and M.Tech in Processing and Agril Structures from Punjab Agril University, Ludhiana. During her M.Tech, she worked on freeze preservation of carrot and cauliflower.

Appointments

Dr. D.M. Kadam, Scientist (SS) joined as Sr. Scientist on 17-06-2009 at CIPHET, Ludhiana.

Promotions

- Sh. Gurdeep Singh, Lab. Asstt (T-3) has been promoted to T-4 (Lab. Asstt) w.e.f. 01-01-2009
- Sh. Beant Singh, Driver (T-2) has been promoted as Driver (T-3) w.e.f. 04-03-2009.

List of Masters Projects completed by students with CIPHET scientist as Guide/Co-Guide during June 2009

S.No.	Name of the Students	Topic	Guide
1.	Sh. Vaveen Kumjar M.	Utilization of beetroot powder in Biscuits & RTS beverages	Dr. Mridula D.
2.	Ms. Rupali Verma	Mathematical modeling & computer interfacing of fermenter	Dr. S.K. Tyagi
3.	Ms. Anamika	Drying and dehulling characteristics of gorgon nut	Dr. S.N. Jha
4.	Ms. Monika Thakur	Characterization of popped makhana (*Euryale Ferox*) and its value added products	Dr. S.N. Jha
5.	Mr. Arun Kumar Thakur	A process for the production of soya beverages with reduced beany flavour	Dr. S. Balasubramanian
6.	Ms. Parul Jain	Development of small-scale process for the production of nutty flavor free peanut milk	Dr. D.N. Yadav
7.	Ms. Manisha	Studies on quality aspects of foam mat dried kinnow and tomato juice powders	Dr. D.M. Kadam
8.	Ms. Nazuk Kakkar	Antioxidant effects of kinnow and pomegranate byproducts	Dr. Suresh K. Devatkal
9.	Ms. Avneet Kaur Dhillon	Micro encapsulation of enzymes	Dr. K, Narsaiah
10.	Ms. Urvashi Malhotra	Dehulling of pigeon pea using chemical and enzymatic methods	Dr. D. Dhingra
11.	Ms. Simranjit Kaur	Dehulling of black sesame seed using chemical and enzymatic methods	Dr. D.Dhingra
12.	Mr. Amit Sud	Enzymatic pre-treatment for dehulling of flaxseed	Dr. K.K. Singh
13.	Sh. Vikram Singh	Investigations into isolation and characterization of Tempeh Mould	Dr. S.N. Bhowmik
14.	Ms. Shika Guleria	Extraction of dietary fibre from potato peel using chemical and enzymatic method	Dr. Sangeeta Chopra
15.	Ms.Vaishali Pathania	Effect of enzymatic & salt pre-treatment on cooking quality of pigeon pea	Dr. Mridula D.
16.	Ms. Joyti Arora	Extraction dietary fiber from pigeon pea husk	Dr. D. Dhingra
17.	Ms. Shilpi Sharma		
18.	Ms. Neha Bhardwaj	Isolation, modification and	Dr. S.

		characterization of selected starches	Balasubramanian
19.	Ms. Gurpreet Kaur Khaira	Effect of salt and enzymatic treatment on cooking time of pigeonpea	Dr. Mridula Devi
20.	Ms. Shaik Reshma	Enhancement of oil recovery from mustard seeds using cellulose	Dr. Dilip Jain
21.	Ms. Pavneet Kaur	Enzyme aided alternative process for the extraction of oil from *Brasica Juncea*	Dr. Dilip Jain
22.	Mr. Sagar Abhishek Jhamb	Effect of enzymatic pretreatment on the oil recovery from the linseed (Flaxseed)	Dr. K.K.Singh
23.	Ms. Kanika Mehta	Enhancement of oil recovery from mustard seeds using cellulose	Dr. Dilip Jain
24.	Mr. Rahul Kumar	Studied on quality aspects of foam mat dried kinnow and tomato juice powders	Dr. D.M.Kadam
25.	Ms. Sakshi	Studies on the production & product quality attributes of selected dehulled legumes incorporated cereal based expanded snack food using low cost collect food extruder.	Dr. S. Balasubraminian
26.	Mr. Ajay Kumar V.R.	Studies on foam mat drying of mango	Dr. D.M.Kadam
27.	Mr. Amanpreet Singh Brar	Studies on physico chemical properties of yoghurt prepared from the blend of groundnut and dairy milk`	Dr. K.K.Singh
28	Ms. Stuti Behl	Shelf life extension of fresh cut vegetable (*Brassica Oleracea*) using modified atmosphere packaging and analyzing the changes in bioactive compounds	Dr. Deepak Raj Rai
29	Ms. Manikshi Chug		

Technology of the Month

Lotus Seed Decorticator

Lotus *(Nelumbo nucifera)* is a large glaucous perennial aquatic, herbaceous plant and cultivated for religious, ornamental and medicinal purposes besides food. It is a symbol of purity, enlightenment and almost whole plant is edible. Besides its sanctity and aesthetic value, lotus is used as a food and medicine. Lotus seeds are used as rosaries *makhanas* and in medicines. The seeds are used to treat diarrhea, piles, skin disorders, etc. The sweet tasting seeds contain Protein - 17.2%, Starch - 66.6%, Sucrose - 4.1%, Iron - 2.3%, traces of fat, fiber and calcium. After decortication, lotus seeds are eaten in raw, roasted, boiled, candied or in powdered form. Lotus seeds are currently manually processed. High labour requirement and low efficiency has restricted the expansion of lotus seed industry. Due to non availability of this technology, the production catchment processing is not possible which deprives the farmer's benefit of farm level processing. Hence, the need was felt to develop machinery for removing shell without damaging film and kernel.

The decorticator has been designed at CIPHET based on the principle that lotus seeds are allowed to rotate in the presence of air and strike the inner walls of the outer cover laid with marble chips. The impact force generated is in the range of 70 - 80 kgf such that shell is broken without damaging the kernel. The decortication unit consists of two circular discs. The two discs are joined with four propellers and ends of propellers are provided with rubber lining so as to prevent breakage of seeds at the time of impact. The discs are covered with outer cover having inner lining of marble and granite.

Material is fed through a hopper and enters in between the discs. The impellers make the seeds to strike the outer cover, by which the shell gets removed. After decortication, the kernel gets separated in the cleaning and grading assembly. The decorticator is operated with 2 hp electric motor at a desired rpm. One person is required to operate the machine. The machine has been designed such that it requires minimum lubrication and quick attachments.

To optimize the performance, machine was tested at different rpm (500 -1400) and with different levels of moisture content of lotus seeds (5 - 20%, wet basis). Best performance was noted at 960 rpm. Maximum decortication efficiency of 65.4 % was found at a moisture content of 5.21% (wet basis). Maximum operational capacity was found as 105 kg per hour. Capacity of the machine declined at higher moisture contents.

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