ANNUAL REPORT

2019

ICAR-CIPHET

ICAR-Central Institute of Post-Harvest Engineering & Technology

Ludhiana, 141 004 (Punjab)

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The ICAR–Central Institute of Post–Harvest Engineering and Technology (CIPHET) was established on 3rd October,1989 at Ludhiana, Punjab, India as a nodal institute to undertake lead research in the area of the Post–Harvest Engineering and Technology appropriate to agricultural production catchment and agro–industries.

The institute's second campus was established on 19th March 1993 at Abohar, Punjab, India that is primarily responsible for conducting research and development activities on fruits and vegetables, and commercial horticultural crops. ICAR–CIPHET, Ludhiana is also the headquarter for two All India Coordinated Research Projects (AICRPs) viz. AICRP on Post–Harvest Engineering and Technology (PHET) with 31 Centres and AICRP on Plasticulture Engineering & Technology (PET) with 14 Centres across the country.

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2019

वार्षिक प्रतिवेदन

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ICAR-Central Institute of Post-Harvest Engineering & Technology
Ludhiana, 141 004 (Punjab), India

भाकृअनुप–केन्द्रीय कटाई–उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान
लुधियाना–141004 (पंजाब), भारत

भाकृअनुप
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Annual Report 2019

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Preface


R K Singh
Director

Our Mandate is to reduce Post-Harvest Losses of Agricultural Produce through Engineering & Processing Interventions

In order to achieve a sustainable future food supply, we need to surmount the issues like depleting natural resources, climate change, rapid urbanization, changing demographics, and a growing population. This, of course, is a colossal challenge and has no direct solution. But, if policy makers, academicians and researchers agree on adopting a holistic approach towards over coming these challenges, the sky is the limit. Agricultural post-harvest management is a chief area that can offer a pivotal framework to address sustainable food supply goals of the country. Government of India has announced to boost growth in the food processing sector by leveraging reforms such as 100 per cent Foreign Direct Investment (FDI) in marketing of food products and various incentives at Central and State Government levels along with a strong focus on supply chain infrastructure. These timely policies reflect the growing confidence of the government in the post-harvest sector and thus call for strengthening the research framework in the area to assist public authorities with scientific innovations and technical interventions. The food processing sector which is called as Sunrise sector has potential to enhance farmers' income by 20-25% and is bound to pay an important role in attaining the goal of doubling farmers' income.

India has surplus production but suffers huge post-harvest losses due to inadequate post-production processing facilities and technologies. Our studies have estimated that the post production losses in food commodities is up to Rs 100000 crore per annum. In highly perishable fruits and vegetables, post-harvest loss ranges from 4.58-15.88 percent of the production. These losses can be reduced by proper post-harvest management and help save precious fiscal resources for the country.

I am privileged to serve and direct ICAR-CIPHET which is a premiere institute entrusted with responsibilities of developing post-harvest technologies, protocols, novel machineries and products with aim to reduce post-harvest losses and enhancing farmers' income. Our institute is committed towards contributing substantially to the national goal of food, nutritional and economic security of India and her people.

I feel delighted to place before you Annual Report (2019) of our institute to give you insights about our R&D activities, outreach programmes and our significant accomplishments during the past year. During the past year, our institute made concerted efforts to develop various machines, storage and fumigation structures, process protocols and different value added products in line with our central mission of realizing higher value of agricultural produce. Our efforts are reflected through our IPR portfolio, research publications, technology transfers & licensing, machine testing and revenue generation records. Two patents were granted and five were filed during 2019. One granted patent pertains to predicting maturity stage and eating quality of mango non-destructively. The other granted patent is: Autoclavable microencapsulation system with multistage breakup two fluid nozzle for clean production of microcapsules.

Four technologies were licensed during 2019 which include a mechanized system for popping and decortication of makhana seeds, Live fish carrier system, processing of aonla for manufacture of value added products, and High volume low speed fan. The technology licensing generated a revenue of Rs 465000 during the past year.

ICAR-CIPHET has generated Rs 37.92 lakh revenue from sale proceeds against target of 30.23 lakh. Our Post-Harvest Machnery and Equipment Testing Centre (PHMETC) tested 32 machines from different parts of the country, earning a total revenue of Rs 3190843 while Food Testing Laboratory (FTL) generated Rs 830000. The process for obtaining NABL accreditation for FTL is in advanced stage.

I feel pleasure to share that under AICRP on PHET, 28 post-harvest tools/equipments, 49 process protocols and products were developed during 2019. A total of 57 technologies were transferred to farmers and entrepreneurs during the reported period. AICRP on PHET also established 23 new agro-processing centres during 2019.Twenty two success stories emerged from AICRP on PHET during the reported period.

Under AICRP on PET, 18 plasticulture technologies were developed and 3 successful technologies were transferred. During the reported year, 5 success stories emerged from AICRP on PET. Besides, 2400 persons were trained in different aspects of plasticulture applications; 120 trainings, outreach activities, FLDs/Melas etc were organized to train farmers and other interested personnel for Plastic lined pond installation, FRP carp hatchery installation and maintenance etc. AICRP on PET also commercialized the technology for 'roof top nutritional garden model for urban agriculture'. This technology was licensed to four private firms during 2019. The other important technologies transferred are Portable Solar Dryer and Polytunnel Dryer.

During the reported period, total of 648 participants were trained for post-harvest management of agricultural and livestock produce through one model training course, twenty one entrepreneurship development programs (EDP), thirteen farmers' trainings, and two sensitization programmes. A total of 121 students were trained during this period in the area of post-harvest engineering and management.

The institute owes all its success to its hardworking and sincere scientist. Our scientists were conferred with many awards and honours like Eminent Scientist Award, Member (Scientific Panel) FSSAI, Young Engineer Award etc. in recognition of their contributions in research and development in post-harvest sector.

In our continuing efforts to reach out to farmers and other stakeholders, we showcased and demonstrated our technologies at different exhibitions and melas such as 106th Session of the Indian Science Congress 2019, 14th Agri Science Congress Coastal Agr. Expo 2019, Kisan Mela etc. The farmer welfare schemes of the government were implemented through organizing Soil Health Card Scheme, World Soil day and Mahila Kisan Divas. Several other important extension activities were carried out at Ludhiana and Abohar campus through Pradhan Mantri Kisan Samman Nidhi, Swacchh Bharat and Mera Gaon Mera Gaurav programme, etc.

I take this opportunity to place on record my sincere thanks and gratitude to Hon'ble Director General, ICAR and Secretary, DARE; Additional Secretary, DARE; DDG (Agril Engg); ADG (Process Engineering) 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 to achieve the goal of this premier institute.

Our country is strongly positioned to become a world leader in food processing through Make in India and many other flagship schemes and programs of our government. We are ready to be a research partner in this journey. We welcome farmers, millers & processors, entrepreneurs, joint venture partners, investors, technology developers, research institutions and startup ideas to come and join hands with us for the next stage of food revolution.

R K Singh
Director

प्रभागीय भवन, आईसीएआर–सीफेट, लुधियाना

कार्यकारी सारांश

कम लागत वाली स्वचालित स्वदेशी मीट उत्पाद (मीट बाल्स/पैटीज आदि) बनाने की मशीन

विकसित मशीन, स्वचालित रूप से अंतिम उत्पाद की एक समान मोटाई के साथ संसाधित मांस उत्पादों का तय वनज अनुसार विभिन्न रूपों का निर्माण करती है। उत्पाद बनाने के लिए मैनुअल प्रक्रिया की तुलना में मशीन 5.3 गुना (433 प्रतिशत) अधिक सक्षम है। यह कम लागत वाली मशीन पूर्णतया खाद्य ग्रेड स्टेनलेस स्टील से बनी है। सांचे के छेद को बदलकर मांस उत्पादों के आकार और मोटाई को बदला जा सकता है। यह मशीन एक घंटे में 55 ग्राम वजन की 960 पेटीज बनाने में सक्षम है। मशीन की औसत क्षमता 52.8 किलोग्राम/घंटा है। विकसित मशीन मैनुअल प्रक्रिया की तुलना में हाइजेनिक और आसान संचालन प्रदान करती है।

फल की पट्टी के विनिर्माण के लिए मशीनीकृत प्रणाली

फल की पट्टी (फ्रूट–बार) निर्माण के लिए एक मशीनीकृत प्रणाली विकसित की गई है जिसमें स्टेनलेस स्टील शीट (2.56 मिमी मोटी) से बना क्यूबॉइडल के आकार का वाटर बाथ (812 x 306 x 250 मिमी) शामिल है। पानी के उचित ताप को सुनिश्चित करने, जल स्तर और प्रवाह को बनाए रखने और ताप क्षय को नियंत्रित करने के लिए यंत्र बनाए गये हैं। तीन समायोज्य निकास पंखे सूखते हुए पल्प से निकलने वाले जल वाष्प के संग्रह के लिए उपयोग किए गये हैं। आम के गूदे को चलते हुए पारदर्शी फीते पर चिपकने से रोकने के लिए ग्लिसरीन के अनुप्रयोग के लिए भी एक तंत्र दिया गया है। ग्लिसरीन के प्रवास दर का समायोजन बेल्ट की गति के अनुसार किया जा सकता है।

खट्टे फलों के लिए मशीनीकृत और निरंतर छीलने वाली प्रणाली

खट्टे फलों के लिए एक मशीनीकृत और निरंतर छीलने वाली प्रणाली का निर्माण माइल्ड स्टील से बने 1940 x 755 x 1560 मिमी ढांचे वाले को 9180 मिमी के चैन (श्रृंखला) के साथ जोड़ करके किया गया है। जिसमें फल की गति के लिए 238 लिंक लगाए गये। चेन को रैखिक गति प्रदान करने के लिए कुल 15 स्पर गियर्स फिट किए गये हैं। एक मोटर (1440 आरपीएम, 0.5 एचपी) और 4 नं. गियर बॉक्स को मशीन के काम करने वाले घटकों को वांछित गति प्रदान करने के लिए लगाया गया है।

हरे मटर डिपोडर मशीन के लिए मशीनीकृत गर्म पानी प्री–ट्रीटमेंट प्रणाली

भंडारण के बावजूद मटर की फली को समान रूप से मशीन में जाते रहने के लिए गर्म पानी की प्री–ट्रीटमेंट प्रणाली को डिज़ाइन किया गया है। यंत्रीकृत गर्म जल प्रणाली में 80–90 लीटर क्षमता का स्टेनलेस स्टील (16 गेज) वाटर बाथ, गर्म करने वाले हीटिंग एलिमेंट, इन्सुलेशन कक्ष/टैंक (एसएस शीट–22 गेज), अंतहीन कन्वेयर बेल्ट, टेफ्लॉन रोलर्स, और वेरिएबल फ्रीक्वेंसी ड्राइव वाला मोटर शामिल है। विकसित यूनिट को पहले से विकसित हरे मटर डिपोडर मशीन के

फीडिंग सेक्शन से पहले लगाया जायेगा ताकि गर्म पानी प्री–ट्रीटमेंट और मटर के अंदर जाने की प्रक्रिया को एक समान किया जा सके।

दालों के लिए प्रयोगशाला स्तर का IoT आधारित स्मार्ट भंडारण संरचना

दलहन (हरे चने) की धूमन प्रक्रिया को प्रभावी ढंग से नियंत्रित करने और निगरानी के लिए एक प्रयोगशाला स्तर का IoT-आधारित स्माट्र स्टोरेज संरचना विकसित और परीक्षण किया गया। इसमें तीन सेंसर मॉडयूल, नियंत्रण कक्ष, नियंत्रण वाल्व, कार्बन डाइऑक्साइड सिलेंडर और वितरण प्रणाली शामिल हैं। प्रत्येक सेंसर मॉडयूल में एक कार्बन डाइऑक्साइड सेंसर, तापमान और आरएच सेंसर, और एक डिस्प्ले यूनिट होती है, और तीन मॉडयूलों में से एक में ऑक्सीजन सेंसर भी होता है। कार्बन डाइऑक्साइड 2 की आपूर्ति एक कंट्रोल पैनल द्वारा नियंत्रित की जाती है, जिसमें कंट्रोलर कार्ड, एसएमपीएस, सॉलिड स्टेट रिले, सोलेनोइड वाल्व और एचएमआई एलईडी डिस्प्ले होते है।

डेटा लॉगिंग एक वाई–फाई से जुड़े डेटा–लॉगर द्वारा किया जाता है जो डेटा को ऐसे क्लाउड तक पहुंचाता है जिसे पीसी या स्मार्ट फोन डिवाइस द्वारा किसी दूरस्थ स्थान से संचालित और नियंत्रित किया जा सकता है। यह प्रणाली आवश्यक गैस की ±2% सघनता बनाए रखती है।

मक्का के भुट्टों को गर्म हवा से सुखाने की प्रणाली

मक्का के भुट्टों को गर्म हवा सुखाने की एक प्रणाली तैयार की गई है जो मक्का के भुट्टों की नमी को 35–38% से 17–18% तक लाने के लिए सक्षम है और छिलके निकालने के लिए आदर्श है। ड्रायर की क्षमता प्रति बैच 150 किलो है। इसमें मुख्य रूप से तीन भाग शामिल होते हैं। हीटिंग यूनिट, ड्राई बिन, और कंट्रोल यूनिट। विकसित ड्रायर के समग्र आयाम (एल x डब्ल्यू x एच) 1.85 x 0.912 x 2.800 मीटर है, जबकि सुखाने वाला बिन बेलनाकार आकार का (एच x डी) 0.990 x 0.834 मीटर आयाम वाला है। मक्का के भुट्टों की लोडिंग और अनलोडिंग मैनुअल है।

गेहूं और उसके प्राथमिक मिल्ड उत्पादों के लिए तीव्र गुणवत्ता निगरानी प्रणाली

यदि गेहूं या उसके उत्पादों को लंबी अवधि के लिए संग्रहित किया जाना है तो इसे खरीदने के समय निर्णय लेने के लिए गुणवत्ता मूल्यांकन बहुत अहम् हो जाता है। यह अध्ययन स्टोरेज के दौरान गेहूं की गुणवत्ता के गुणात्मक और मात्रात्मक माप के लिए तेजी से विश्लेषण विधि के रूप में एफटी–एनआईआर स्पेक्ट्रोस्कोपी की तकनीकों की परिकल्पना करता है। गेहूं के आटे के नमूनों को लाल बीटल (*ट्रिबोलियम कैस्टेनम*) के साथ संक्रमित किया गया और 90 दिनों तक नियंत्रित व सामान्य तापमान की स्थिति में प्लास्टिक के कंटेनर में संग्रहित किया गया। छह महीने के संग्रहण डेटा के परिणामों का उपयोग स्पेक्ट्रल मॉडलिंग के लिए किया जाएगा और इसे भौतिक/रासायनिक पैरामीटर के साथ सहसंबंधित किया जाएगा।

चावल और गेहूं का माइक्रोवेव–आधारित कीटाणु शोधन

इंडस्ट्रियल माइक्रोवेव रिसर्च सेंटर, प्रदीप मेटल्स लिमिटेड, R-205, MIDC, रबाले, नवी मुंबई–400701, भारत ने माइक्रोवेव ऊर्जा का उपयोग करके चावल और गेहूं के कीटाणु शोधन की प्रक्रिया के अनुकूलन के लिए एक परियोजना प्रायोजित की। इस अध्ययन में अलग–अलग नमी वाले बासमती, अन्य गैर–बासमती चावल और गेहूं के माइक्रोवेव उपचार का विश्लेषण किया गया। अनाज की गुणवत्ता को प्रभावित किए बिना 100% मृत्यु दर प्राप्त करने के लिए प्रभावी उपचार बासमती और गैर–बासमती चावल के लिए 30–40 s था जबकि गेहूं के लिए यह 50–60 s था। भंडारण के 6 महीने बाद तक उपचार के बाद परीक्षण किए गए अनाज में गुणवत्ता की कोई गिरावट नहीं देखी गई।

फूलगोभी और पत्ता–गोभी के लिए सतत प्राथमिक प्रसंस्करण और श्रिंक पैकेजिंग लाइन

फूलगोभी और पत्ता–गोभी के लिए एक पैकेज बनाने, सील करने और लपेटने की प्रणाली विकसित की गयी विकसित पैकेज फोल्डिक सिस्टम में एक विशिष्ट अवस्था (ट्रायल और एरर के आधार पर) में बने दो एस एस शीट होते हैं। एक छोर प्लास्टिक शीट की लाइन में है, जबकि दूसरा सिरा टॉप सीलर की लाइन में है। फोल्डर के विभिन्न वर्गों के आकार और लंबाई ने एक महत्वपूर्ण भूमिका निभाई। शीर्ष सीलर तापमान को अनुकूलित किया गया और उचित सील के लिए ऑपरेटिंग तापमान 120^{0} से. था।

संग्रहित अनाज में कीट का पता लगाने के लिए स्मार्ट डिवाइस

संग्रहित गेहूं अनाज के नमूनों में कीड़ों का पता लगाने और उनकी गणना करने के लिए एम्बेडेड विजन सिस्टम विकसित किया गया। विकसित प्रणाली 95–100 % सटीकता के साथ गेहूं के दानो में भंडारण कीट का पता लगा सकता है और गणना कर सकता है।

महिलाओं के लिए अनुकूल अर्ध–स्वचालित मछली सफाई–सह–ड्रेसिंग प्रणाली का उन्नयन

एक सिंगल फेज एसी मोटर (0.25 एचपी, 180 वाट, 1380 आरपीएम, 50 हट्र्ज) का उपयोग मशीन की शक्ति और आघूर्ण बल को बढ़ाने के लिए किया गया। दाएं तरफ की निकासी को 120 मिमी तक बढ़ाने के लिए शाफ्ट की लंबाई 300 मिमी से 420 मिमी तक बढ़ाई गयी। शाफ्ट व्यास को 17 मिमी से 24 मिमी तक बढ़ाया गया। वर्किंग टेबल के सामने के किनारे की ऊंचाई से मछली को काटने के दौरान पकडने में हो रही असुविधा के कारण इसकी ऊंचाई को 40 मिमी से घटाकर 15 मिमी कर दिया गया। धातु से बने टंकी की बजाय प्लास्टिक से बनी पानी टंकी का उपयोग किया गया। बहुत महीन तार की जालीदार स्क्रीन के साथ सूती बिस्तर का उपयोग अपशिष्ट जल के निस्पंदन के लिए किया गया जो ठोस कचरे को अलग करता है। टैंक की जल धारण क्षमता को भी बढ़ाकर 40 लीटर कर दिया गया।

कम वसा, उच्च फाइबर वाले कार्यात्मक मांस उत्पादों के लिए संशोधित वायुमंडलीय पैकेजिंग

वसा प्रतिकृति के उपयोग से उच्च गुणवत्ता वाले मांस उत्पादों को बनाया जा सकता है जिनमें वसा की मात्रा कम होती है। इस अध्ययन में 4 प्रतिशत पीपीडीएफ (मटर के छिल्कों से प्राप्त रेशे) स्तर पर संवेदी स्वीकार्यता पूर्ण वसा वाले मांस उत्पाद के नमूनों के बराबर थी। माइक्रोस्ट्रक्चरल (एसईएम) चित्रों में अधिक समरूप संरचना पायी गयी। हालांकि, लालिमा और संवेदी स्वीकार्यता 6 प्रतिशत पीपीडीएफ स्तर पर कम थी। नाइट्रोजन, ऑक्सीजन और कार्बन डाइऑक्साइड की विभिन्न सांद्रता में विकसित कम वसा वाले, उच्च फाइबर कार्यात्मक मांस उत्पादों के लिए संशोधित वायुमंडलीय पैकेजिंग (एमएपी) भंडारण अध्ययन भी किया गया। एमएपी, वैक्यूम पैकेजिंग, और इनकैप्सुलेटेड अमरूद लीफ एक्सट्रैक्ट ने कम वसा, उच्च फाइबर मांस उत्पादों के समग्र शेल्फ–जीवन में सुधार किया।

विभिन्न कपड़ों की प्राकृतिक रंगों से रंगाई

गेंदा, चुकंदर, प्याज के छिलके, और काली गाजर से रंगों का पारंपरिक निष्कर्षण किया गया। निष्कर्षित रंग और सॉल्वेंट को 1:10 अनुपात में बनाए रखा गया। लगभग 24 घंटे तक 60 डिग्री सेल्सियस तापमान पर निष्कर्षण किया गया और जब विभिन्न रंगों के संतृप्त घोल मिल गए तो इस प्रक्रिया को रोक दिया गया। सूती और रेशमी कपडे की प्राकृतिक रंगों से रंगाई के लिए प्री–मॉर्डनटिंग विधि का उपयोग किया गया। कपडों को चार चयनित सिंथेटिक मोर्डेंट्स अर्थात् क्यूप्रिक सल्फेट, फेरस सल्फेट, पौटेशियम डाइक्रोमेट और फिटकरी के साथ मिलाया गया था। अलग–अलग रंगों के लिए, रंगाई का समय 1 घंटे था और अंत में, कपडे पर रंग चढाने के लिए 2.5 सोडियम क्लोराइड का उपयोग का उपयोग किया गया।

विभिन्न खाद्य उत्पादों में फोर्टिफिकेशन के लिए केर आधारित खनिज युक्त पाउडर

ब्रोकोली और लेमनग्रास को केर से संयोजित कर खनिज युक्त पाउडर बनाया गया। सूखने के बाद, सामग्री को बारीक पाउडर बनाकर छान लिया गया। विभिन्न संयोजनों को बनाने के लिए 180 माइक्रोन आकार के विभिन्न पाउडर का उपयोग किया गया। उच्च खनिज सामग्री और ऑर्गेनोलेप्टिक स्कोर के आधार पर केर, लेमनग्रास और ब्रोकोली पाउडर के संयोजन में क्रमशः 66.67, 16.66 और 16.66 प्रतिशत अनुपात को अनुकूल पाया गया। अनुकूलित पाउडर ने 78 प्रतिशत डीपीपीएच गतिविधि (% अवरोधन) दिखाया। अनुकूलित खनिज युक्त केर पाउडर का उपयोग करके गेहूं आधारित बेक्ड मठरी को तैयार किया गया जिसमें 92.50 आटा और 7.5 पाउडर से बनी मठरी को उच्च इन्द्रिय–ग्राही पाया गया।

सांगरी के फली की लम्बी जीवन अवधि के लिए श्रेष्ठ संरक्षण विधि

उच्च कार्यात्मक गुण होने के बावजूद बड़ी मात्रा में सांगरी फलियॉ फसल की कटाई के बाद के सही प्रबंधन के अभाव, अपर्याप्त प्रसंस्करण सुविधाओं और जानकारी नहीं होने के कारण खराब हो जाती है। 3 से 4 सेटीमीटर लंबी हरी सांगरी की फली 3 प्रतिशत सोडियम क्लोराइड, 0.8% एसिटिक एसिड, 200 पीपीएम जिंक क्लोराइड, और 2000 पीपीएम केएमएस में संरक्षित 180 दिनों के भंडारण के बाद भी 7.90 समग्र स्वीकार्यता रेट पायी गयी।

तेल निकाले जा चुके खल्ली से प्रोटीन आइसोलेट के उत्पादन की नवीन प्रक्रिया

तेलीय खल्ली अथवा अन्य प्रकार के स्रोतों (पोधे या पशु) से बिना किसी सांद्र अथवा द्रवित अम्ल द्वारा निष्काशन की एक नवीन प्रक्रिया विकसित की गयी जिसकी अम्ल विधि के तुलना में लगभग 5 प्रतिशत अधिक उपज है। उत्पादित प्रोटीन आईसोलेट में 91.5 प्रतिशत प्रोटीन पाया गया। अम्ल विधि के तुलना में उत्पादित प्रोटीन आइसोलेट की पानी में घुलनशीलता, फैलाव, वेटेबिलिटी और हाइड्रोलिसिस डिग्री जैसे कार्यात्मक गुण अधिक है।

कीडों के खिलाफ सरसों आधारित फार्मूलेशन की जैव–प्रभावकारिता

सरसों आधारित इको–फ्रेंडली फॉर्मूलेशन कपास में चूसने वाले कीटों को नियंत्रित करने में प्रभावी पाए गए (थ्रिप्स–77 से 85 प्रतिशत, लीफहॉपर्स–64 से 84 प्रतिशत, वाइटफ्लाई–38 से 55 प्रतिशत, अगर एकमात्र इस्तेमाल किया जाता है, क्रमशः 91, 93 और 65 प्रतिशत यदि मिश्रण का उपयोग किया जाता है)।

कटाई–उपरान्त कार्यक्षेत्र में एनएआरईएस तकनीकों का राष्ट्रीय डेटाबेस

किसानों, उद्यमियों, शोधकर्ताओं, नीति निर्माताओं, कृषि इंजीनियरिंग और प्रबंधन के छात्रों के साथ सूचना और ज्ञान साझा करने की सुविधा के लिए देश में फसल के बाद के क्षेत्र के बारे में एक राष्ट्रीय डेटाबेस विकसित किया गया है और इसे नियमित रूप से संस्थान द्वारा अपडेट किया जाता है। डेटाबेस का डिजाइन CPHP आधारित वेब फ्रेमवर्क पर विकसित किया गया है जो कटाई के बाद की संबंधित जानकारी को तेजी और आसानी से साझा करने की सुविधा प्रदान करता है। इस प्रणाली में एक अनुमति प्रबंधन प्रणाली भी शामिल है जो सूचना को आसानी से अद्यतन करने में सक्षम बनाती है। कोई भी उपयोगकर्ता सूचना प्रणाली से डेटा पुनः प्राप्त कर सकता है। प्रत्येक प्रमुख संस्थान में प्रमाणित उपयोगकर्ताओं को डेटाबेस के माध्यम से जानकारी जोडने की अनुमति होगी। विकसित डेटाबेस किसानों, उद्यमियों, स्टार्ट–अप और भारत सरकार की कौशल विकास योजनाओं और उद्योगों के लिए उपयोगी है।

पंजाब में अनाज, दालों और तिलहन के प्रसंस्करण और मूल्य संवर्धन की स्थिति के लिए अनुसंधान पद्धति

उद्यमियों/एफपीओ/एसएचजी/एफपीसी जो खेती में शामिल हैं और अपनी उपज का प्रसंस्करण करते हैं, जो सीधे किसानों और प्रक्रिया से कच्चे माल की खरीद करते हैं, और जो किसानों और व्यक्तिगत किसानों को प्रसंस्करण की कस्टम हायरिंग सेवा प्रदान करते हैं ऐसे उद्यमियों की पहचान करने के लिए एक खोजपूर्ण अनुसंधान पद्धति तैयार की गयी। कार्यप्रणाली का उद्देश्य किसानों द्वारा विभिन्न प्रसंस्करण

मशीनों और उपकरणों को अपनाने के स्तर का अध्ययन करना है। अध्ययन में विभिन्न अनाज, दलहन और तिलहन फसलों और कृषि स्तर पर विकसित उत्पादों के प्रसंस्करण का विश्लेषण किया जाएगा।

सौर आधारित बहु–वस्तु कोल्ड–स्टोरेज कक्ष

पेल्टियर मॉडयूल का उपयोग करके एक बहु–वस्तु कोल्ड–स्टोरेज चेंबर विकसित किया गया। एक कक्ष (नियंत्रण कक्ष) एक डीसी प्रशंसक (12 वी और 0.20 ए) के साथ संचालित किया गया, जबकि दूसरे कक्ष को दो पेल्टियर मॉडयूल के साथ संचालित किया गया। दोनों चेंबर की 3–5 किग्रा क्षमता है। कोल्ड चेम्बर परिवेश तापमान से 8 डिग्री कम जबकि नियंत्रण कक्ष परिवेशीय स्थिति से 1–2 डिग्री कम तापमान पर पहुंचता है।

स्प्रे चिलिंग प्रक्रिया की वास्तविक समय में तापमान और सापेक्ष आर्द्रता मापने का उपकरण

ताड़ के तेल के स्प्रे चिलिंग की वास्तविक समय में निगरानी के लिए एक कम लागत वाला तापमान और सापेक्ष आंर्द्रता मापने वाला उपकरण विकसति किया गया। डिवाइस दो घटकों से बना है: (1) सॉफ्टवेयर प्लेटफॉर्म और (11) हार्डवेयर। डिवाइस की प्रक्रिया एल्गोरिदम को आर्डिनो एकीकृत विकास वातातरण (IDE) सॉफ्टवेयर में प्रोग्राम किया गया। विकसित डिवाइस की तुलना मान माप उपकरणों (टेस्टो 608HI, थर्मो हाग्रोमेटेर, टेस्टों इंडिया प्राइवेट लिमिटेड) से की गयी और तापमान और सापेक्ष आंर्द्रता डेटा में एक भिन्नता (0.5 प्रतिशत) नहीं पाई गयी।

राजस्व उत्पत्ति

2019–20 के दौरान, संस्थान ने लगभग सत्तर लाख सैंतीस हज़ार रुपये (72.37 लाख रु) का राजस्व अर्जित किया। संस्थान ने प्लान 2019–20 के तहत बजट आवंटन का 99. 20 प्रतिशत उपयोग किया।

पुरस्कार और सम्मान

संस्थान के वैज्ञानिकों को फसलोत्तर कटाई क्षेत्र में अनुसंधान और विकास में उनके योगदान के लिए कई पुरस्कारों और सम्मानों से सम्मानित किया गया है, जिनमें प्रख्यात वैज्ञानिक पुरस्कार, ऑल इंडिया बेस्ट पब्लिकेशन अवार्ड, सदस्य (वैज्ञानिक पैनल) एफ एस एस ए आई, यंग इंजीनियर अवार्ड आदि मुख्य हैं।

प्रौद्योगिकी अनुज्ञप्ति और एकस्व अधिकार पत्र (पेटेंट)

हमारे अनुसंधान प्रयास और उनके परिणाम आईपीआर पोर्टफोलियो, प्रौद्योगिकी लाइसेंसिंग और व्यावसायीकरण से परिलक्षित होते हैं। गत वर्ष संस्थान को दो पेटेंट प्रदान किये गये तथा संस्थान ने पाँच नये पेटेंट और दायर किये। 2019 के दौरान चार तकनीकों का लाइसेंस दिया गया। प्रौद्योगिकी लाइसेंसिंग से बीते वर्ष के दौरान 465000 रुपये की आय हुई।

फसलोत्तर उपयोगी यंत्र एवं उपकरण जाँच केंद्र

कटाई उपरान्त फसलो के लिये उपयोगी यंत्र एवं उपकरण जाँच केंद्र ने 2019 के दौरान 32 मशीनों का परीक्षण किया। जिसमें परीक्षण शुल्क के रूप में कुल 31.91 लाख रुपये प्राप्त हुऐ।

प्रशिक्षण, मानव संसाधन विकास और विस्तार

भा.कृ.अनु.प.–सीफेट, कटाई के बाद फसल प्रबंधन और खाद्य प्रसंस्करण के क्षेत्रों में मानव संसाधन विकास और विभिन्न हितधारकों को प्रशिक्षण देने के लिए प्रतिबद्ध है। वित्तीय वर्ष 2019 में कुल 751 प्रतिभागियों को आईसीएआर प्रायोजित ग्रीष्म व शीतकालीन पाठ्यक्रम, मॉडल प्रशिक्षण पाठ्यक्रम, उद्यमिता विकास कार्यक्रम (ईडीपी), किसानों के प्रशिक्षण, कार्यशालाओं के माध्यम से फसलोत्तर प्रबंधन के लिए प्रशिक्षित किया गया। इसके अलावा कुल 121 छात्रों को भी प्रशिक्षित किया गया। विभिन्न हितधारकों को संस्थान प्रौद्योगिकियों से अवगत कराने के लिए संस्थान ने देश भर में कई प्रदर्शनियों में भाग लिया।

प्रकाशन तथा उद्धरण (साइटेशन)

वर्ष के दौरान, 22 शोध पत्रों को राष्ट्रीय और अंतर्राष्ट्रीय शोध पत्रिकाओं में प्रकाशित किया गया है। पिछलें वर्षों में अंतर्राष्ट्रीय शोध पत्रिकाओं में प्रकाशित पत्रों में से 28 को 100 से अधिक (प्रत्येक) उद्धरण (साइटेशन) मिले हैं। संस्थान के अन्य प्रमुख प्रकाशनों में कम्पेंडियम, बुक चैप्टर, लोकप्रिय/तकनीकी लेख, तकनीकी बुलेटिन, वार्षिक रिपोर्ट, समाचार पत्र और पत्रक शामिल हैं।

जय जवान, जय किसान
जय विज्ञान, जय अनुसंधान

Aerial view of Divisional Building at ICAR-CIPHET, Ludhiana

Executive Summary

Low-cost indigenous meat product forming machine (meatballs/patties etc)

The developed machine weighs and forms processed meat products with a uniform thickness of the final product, automatically. The machine is around 5.3 times (433% higher) more efficient than the manual process for product forming. This low-cost machine is made of food-grade stainless steel. The size and thickness of meat products can be altered by changing the openings of the mold plate. This machine is capable of making 960 patties of 55 g weight in one hour. The average capacity of the machine is 52.8 kg/h. The developed machine offers hygienic and easy operation over the manual process.

Mechanized system for fruit bar manufacturing

A mechanized system for fruit bar manufacturing has been developed which consists of a cuboidal-shaped water bath (812×306×250 mm) made of stainless steel sheet (2.56 mm thick). Mechanisms are made to ensure proper heating of water, maintaining water level and flow, and controlling the heat loss. Three adjustable exhaust fans are used for collection of water vapour emanating from drying pulp. A mechanism is also provided for application of glycerine on the moving transparent belt to prevent the sticking of the mango pulp. . The adjustment of the flow rate of glycerine can be made according to the speed of the belt.

Mechanized and continuous peeling system for citrus fruits

A mechanized and continuous peeling system for citrus fruits consisting of 1940×755×1560 mm framework made of mild steel angle iron and attached with 9180 mm chain having 238 links for fruit movement was developed. A total of 15 spur gears are fitted to provide linear motion to the chain. One motor (1440 rpm, 0.5 HP) and 4 no. of gear boxes are fitted to provide the desired motion to the working components of the machine.

Mechanized hot water pretreatment system for green pea depodder machine

The hot water pretreatment unit is designed and fabricated to assist uniform feeding of pea pods irrespective of storage time. The mechanized hot water system consists of stainless steel (16 gauge) water bath of 80-90 liter capacity, heating elements, insulation chamber/tank (SS sheet-22 gauge), endless conveyor belt, Teflon rollers, motor with variable frequency drive (VFD). The developed unit will be attached before the feeding section of the earlier developed green pea depodder machine to offer uniform hot water pretreatment and feeding of pea pods.

Lab scale- IoT-based smart storage structure for pulses

A lab-scale IoT-based Smart Storage Structure for Pulses was developed and tested for effectively controlling and monitoring fumigation process of green gram. It includes three sensor modules, Control panel, Control Valves, Carbon dioxide cylinder, and distribution system. Each Sensor modules have a Carbon dioxide sensor, temperature & rH sensor, and a display unit, and one among the three modules has an oxygen sensor also. The supply of CO_2 is regulated by a control panel which consists of a Controller Card, SMPS, Solid State Relay, Solenoid valve, and HMI LED display.

The data logging is performed by a Wi-Fi-connected data-logger that transmits data to a cloud that can be accessed and controlled from any remote location by either a PC or Smart Phone device. The system was observed to maintain the concentration in the range of ±2%.

Hot air dryer for maize cob

A hot air drying system for maize cobs is designed and developed to bring the moisture content of maize cobs from 35-38% at the time of harvest to 17-18% which is ideal for shelling. The capacity of the dryer is 150 kg per batch. It consists of mainly three parts viz., heating unit, drying bin, and control unit. The overall dimensions (L×W×H) of the developed dryer is 1.815×0.912×2.800 m whereas, the drying bin is of cylindrical shape with dimensions (H×D) of 0.990 × 0.834 m. The airflow rate, blower RPM, and temperature of the heating unit are electronically controlled by a control panel. The loading and unloading of maize cobs are manual.

Rapid quality monitoring system for wheat and its primary milled products

Quality evaluation is warranted for making decisions at the time of procurement of wheat, in case it or its products are to be stored for a longer time period. This study envisages the techniques of FT-NIR spectroscopy as a rapid analysis method for qualitative and quantitative measurements of wheat quality during storage. Wheat flour samples were infested with Red Flour Beetle (*Tribolium castaneum*) and stored in plastic containers for up to 90 days under ambient and controlled temperature conditions. The results of six months of storage data will be used for spectral modelling and correlating it with the physical /chemical parameter.

Microwave-assisted disinfestation of rice and wheat

Industrial Microwave Research Centre, Pradeep Metals Ltd., R-205, MIDC, Rabale, Navi Mumbai – 400701, India sponsored a project for optimization of the process for disinfestation of rice and wheat using microwave energy. The study optimized the microwave treatment for basmati & no-basmati rice, and wheat at different moisture contents against stored product insect pests. The effective treatment to achieve 100% mortality without significantly affecting grain quality was 30-40 s for basmati and non-basmati rice whereas for wheat it was 50-60 s. No significant deterioration of quality was observed in the grains tested after treatment till 6 months of storage.

Continuous primary processing and shrink packaging line for cauliflower and cabbage

A package forming, sealing and wrapping system was designed and developed for cauliflower and cabbage. The developed package folding system consists of two SS sheets made in a specific configuration (based on trial and error). The one

end is in the line of plastic sheet, whereas the other end is in the line of top sealer. Shape and the length of different sections of the folder played a crucial role. Top sealer temperature was optimized and the operating temperature was 120°C for proper sealing and avoids melting of plastic when the machine stops for side sealing and cutting. A pneumatic system was adopted topside sealing. Automation of the package forming, sealing and floret detection system was done.

Smart device for detection of insect pest in stored grains

The embedded vision system was developed to detect and count the insects in the stored wheat grain samples. The developed program can detect and count the storage insect/pest in images of wheat grain samples with 95-100% accuracy.

Up-gradation of woman-friendly semi-automatic fish cleaning-cum-dressing system

A single-phase AC motor (¼ HP, 180 W , 1380 rpm, 50 Hz) was used to increase power and thus torque of the machine. Shaft length was increased from 300 mm to 420 mm for increasing right side clearance to 120 mm. Shaft diameter was increased from 17 mm to 24 mm. The height of the front edge of the working table was causing inconvenience in holding the body of the fish while cutting and therefore, it was reduced from 40 mm to 15 mm.

The height of the front edge of the working table was reduced from 40 mm to 15 mm for convenient handling. Plastic water tank was used instead of metallic one. A cotton bed added with a very fine wire meshed screen was used for filtration of wastewater that separated the solid wastes. The water holding capacity of the tank was also increased to 40 L.

Modified atmospheric packaging studies of low-fat, high-fibre functional meat products

The use of fat replacers results in high-quality meat products with lower fat content. The sensory acceptability at 4% PPDF level was comparable to full-fat meat product samples. Ingredient concentrations were optimized and cooking losses, shrinkage, and emulsion stability analyzed. Microstructural (SEM) images revealed a more homogenous structure in the treated samples. However, redness and sensory acceptability were lower at 6% PPDF level. Modified atmospheric packaging (MAP) storage studies have also been done for developed low-fat, high-fibre functional meat products at various concentrations of nitrogen, oxygen, and carbon dioxide. MAP, Vacuum packaging, and encapsulated guava leaf extract improved the overall shelf-life of low-fat, high-fibre meat products.

Dyeing of different fabrics using natural extracts

Conventional extraction of dyes from marigold, beetroot, onion peels, and black carrots was performed in soxhlet extractor composed of a 500 ml round bottom flask, extractor, and condenser. Ratio of extracted dye to solvent material was maintained at 1:10. Extraction was carried out at a temperature of 60 °C for around 24 h and was stopped when saturated solutions of different dyes were obtained. A pre mordanting method was used in the dyeing of cotton and silk fabric with natural dyes. The fabric samples were mordanted with four selected synthetic mordants namely, cupric sulphate, ferrous sulphate, potassium dichromate, and alum. The dyeing time for different dyes was 1 hour and finally, the fixation of dye over fabric was done with 2.5% NaCl Solution.

Ker based mineral-rich powder for fortification into different food products

Ker in combination with broccoli and lemongrass was selected for the preparation of mineral-rich powder. After drying, the material was ground to make fine powder followed by sieving. Different powders at 180-micron size were used for making different combinations. A combination of ker, lemongrass, and broccoli powders having proportions as 66.667, 16.66, and 16.66%, respectively was considered optimized based on its high mineral content and organoleptic scores. The optimized powder

showed DPPH activity (% inhibition) as 78%. Wheat-based baked *mathri* were prepared using optimized mineral-rich ker powder. *Mathri* with flour and powder percentage as 92.50 and 7.5% was considered optimized based on high organoleptic scores.

Optimal preservation method for longer shelf-life of sangri

Although having good functional qualities, the large quantities of sangri beans perish during glut season due to poor post-harvest management, inadequate processing facilities, and unawareness in other parts of India. The 3-4 cm long green sangri pods steeped in 3% NaCl, 0.8% acetic acid, 200 ppm zinc chloride, and 2000 ppm KMS were rated best with maximum mean overall acceptability (OAA) score (7.90) after 180 days of storage.

Plastic and organic mulching during tomato cultivation

The effect of different mulches (organic, silver, black, red, white, yellow, and no mulch) on soil microbes, soil microbial biomass at the crop rhizosphere during the time of harvest of tomato, fruit size, fruit yield and nutrient status of tomato leaves/fruits were analyzed. All the parameters improved under plastic and organic mulch condition in comparison to no mulch conditions.

Novel process for the production of protein isolates from de-oiled cakes

A novel process to produce protein isolates/concentrates from oilseed cakes/meals or from other similar type of sources either plant or animal origin without the addition of strong or diluted acid is developed. The yield obtained is about 5% higher than acid precipitation method. The produced protein isolate contains 91.5% (dwb) protein. The functional properties like solubility in water, dispersibility, wettability, and degree of hydrolysis are higher as compared to protein isolate produced following acid (HCL) precipitation method.

Bio-efficacy of mustard-based formulations against insects

Mustard based eco-friendly formulations (EC & SC) were found effective in controlling sucking pests in cotton (thrips-77 to 85%; leafhoppers-64 to 84%; whitefly-38 to 55% if used as sole; 91, 93 and 65% respectively, of used mixture), and pomegranate thrips [on and around 90% (NS)].

National database on NARES technologies in post-harvest sector

In order to facilitate information and knowledge sharing with farmers, entrepreneurs, researchers, policymakers, agricultural engineering, and management students regarding post-harvest sector in the country, a national database has been developed and is regularly updated by ICAR-CIPHET. The design of the database is developed on PHP based web framework which facilitates fast and easy sharing of the post-harvest related information. This system also consists of a Permission Management System which enables easy updating of the information. Any user can retrieve data from the information system. Authenticated users in each major institute will be permitted to add information through the database. The developed database is useful for farmers, entrepreneurs, start-ups, and skill development schemes of the Government of India and industries.

Research methodology for status of processing and value addition of cereals, pulses, and oilseeds in Punjab

An exploratory research methodology was formulated to identify the entrepreneurs/FPO's/SHG's/FPC's who are involved in farming and processing their produce, who procure raw material directly from farmers and process, and who provide custom hiring service of processing to farmers and individual farmers involved in processing. The methodology also aims to study the extent of the adoption of different processing machines and equipment by the farmers. The extent of processing of various

cereals, pulses, and oilseed crops and the products developed at the farm level will be analyzed in the study.

Solar based multi-commodity cold-storage chamber

A multi-commodity cold-storage chamber was developed using Peltier module (TECI-12706). One chamber (control chamber) was operated with a DC fan (12 V and 0.20A) whereas the other chamber was operated with two Peltier module. Both the chamber has 3-5 kg capacity. The cold chamber could achieve 8 °C less temperature than the ambient temperature whereas the control chamber could attain 1-2 °C less than the ambient condition.

Temperature and relative humidity measuring device for real-time monitoring of spray chilling process

A low-cost temperature and relative humidity measuring device was developed for real-time monitoring of the spray chilling of palm oil. The device is composed of two components: (i) software platform and (ii) hardware. The process algorithm of the device was programmed in the Arduino integrated development environment (IDE) software. The developed device was compared with standard measuring instruments (Testo 608-H1, Thermo-Hygrometer, Testo India Pvt. Ltd.) and a non-significant variation (0.5%) was observed in temperature and relative humidity data.

Revenue generation

In 2019, our institute generated a revenue of around rupees seventy two lakh thirty seven thousand (Rs 72.37 lakh). ICAR-CIPHET also utilized 99.20% of budget with respect to allocation under plan RE 2019-20.

Awards and recognitions

Our scientists were conferred with many awards and honours like Eminent Scientist Award, All India Best Publication Award, Member (Scientific Panel) FSSAI, Young Engineer Award etc. in recognition of their contributions in research and development in post-harvest sector.

Technology licensing and patents

Two patents were granted and five were filed during 2019. One granted patent pertains to predicting maturity stage and eating quality of mango non-destructively. The other granted patent is: Autoclavable microencapsulation system with multistage breakup two fluid nozzle for clean production of microcapsules. Four technologies were licensed during 2019 which include a mechanized system for popping and decortication of makhana seeds, Live fish carrier system, processing of aonla for manufacture of value added products, and High volume low speed fan. The technology licensing generated a revenue of Rs 465000 during the past year. Besides, AICRP on PHET transferred 57 technologies to farmers and entrepreneurs during the reported period whereas 2 successful technologies were transferred by AICRP on PET.

PHMETC

Our Post-Harvest Machinery and Equipment Testing Centre (PHMETC) tested 32 machines from different parts of the country, earning a total revenue of Thirty one lakh ninety thousand eight hundred forty three rupees (Rs 3190843).

Training, capacity building and extension

During the reported period, total of 648 participants were trained for post-harvest management of agricultural and livestock produce through one model training course, twenty one entrepreneurship development programs (EDP), thirteen farmers' trainings, and two sensitization programmes. A total of 121 students were trained during this period in the area of post-harvest engineering and management. We also participated in different exhibitions and melas such as 106th Session of the Indian Science Congress 2019, 14th Agri Science Congress Coastal Agr. Expo 2019, Kisan Mela etc.

Publications

More than 22 research papers were published in high quality national and international peer reviewed journals. The other major publications of the institute include Compendiums, Book, Book chapters, Popular/Technical Articles, Technical Bulletins, Annual Reports, Newsletters, and Leaflets.

Introduction

Indian agriculture is characterized by a large number of tiny, marginal, and small farm holders who are unable to derive adequate monetary benefits from production activities alone. Most of the farmers are employed only for 100-150 days in a year in farm activities. Therefore, while their incomes are not only abysmally low but they remain inadequately employed also. Supply chain from farm gate to markets is highly fragmented. There is inadequate infrastructure for storage, packaging, handling and transport from the place of production to markets and processors. As a result, huge post-harvest losses take place, which reduce the farmers' income and processors get poor quality of the raw materials. The accounted post-harvest losses in the country are still in the range of 3-16% for all food commodities and the level of value addition and processing is still below 10% in fruits and vegetables. Because of the higher post-harvest losses, monetary loss is nearly Rs. 1 Lakh crores. Thus, there is an essential requirement of post-harvest management and appropriate value addition in production catchments to minimize the quantitative and qualitative losses. Agricultural produce management and appropriate level of value addition in production catchments could meet these twin objectives of providing additional off-farm employment and income.

ICAR-Central Institute of Post-Harvest Engineering and Technology (ICAR-CIPHET) was established on 03 October, 1989 at PAU Campus, Ludhiana, Punjab, India. It is a nodal institute that undertakes lead researches in the area of the postharvest engineering and value addition technologies appropriate to agricultural production catchments and agro-processing industries. Another campus of the Institute was established on 19 March 1993 at Abohar, Punjab, India that is primarily responsible to undertake research and development activities for processing and value addition of fruits, vegetables and commercial crops. ICAR-CIPHET is also headquarters of two All India Coordinated

Research Projects (AICRPs) viz. AICRP on Post-Harvest Engineering and Technology (PHET) with 31 Centres and AICRP on Plasticulture Engineering and Technology (PET) with 14 Centres across the country.

ICAR-CIPHET is the only institute in India which works entirely on applied post-harvest technology and value addition of all commodities for farmers, orchardists, rural youth and entrepreneurs directly as well as generates basic knowledge by taking various basic and strategic research projects in the mandated areas. At present the institute has four divisions: 1. Food Grains and Oilseeds Processing, 2. Agricultural Structures and Environmental Control, 3. Transfer of Technology, and 4. Horticultural Crop Processing (Abohar).

The Institute has developed nearly 120 technologies containing several equipment for food processing, structures for safe handling and shelf-life enhancement of farm produce, process protocols for value added products, novel products and technologies for farmers and processors. Out of theses developed technologies, 55 technologies have been licensed/ commercialized to about 126 entrepreneurs/end users. The technologies developed by ICAR-CIPHET helped the farming community in reduction in post-harvest losses, value addition to the farm produce, development of functional foods and food safety through interventions in the arena of protected cultivation, threshing, milling, processing, improved storage, preservation, non-destructive quality evaluation, enhancement of shelf life for crops and livestock produce and by-product utilization. These technologies have helped the relevant stakeholders in augmenting the income and employment generation. ICAR-CIPHET has filed 63 patents out of which 9 have been granted to its credit. ICAR-CIPHET has established Food Testing Laboratory, Agri-Business Incubation Centre, and Post-Harvest Machinery and Equipment Testing Centre.

OUR 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.

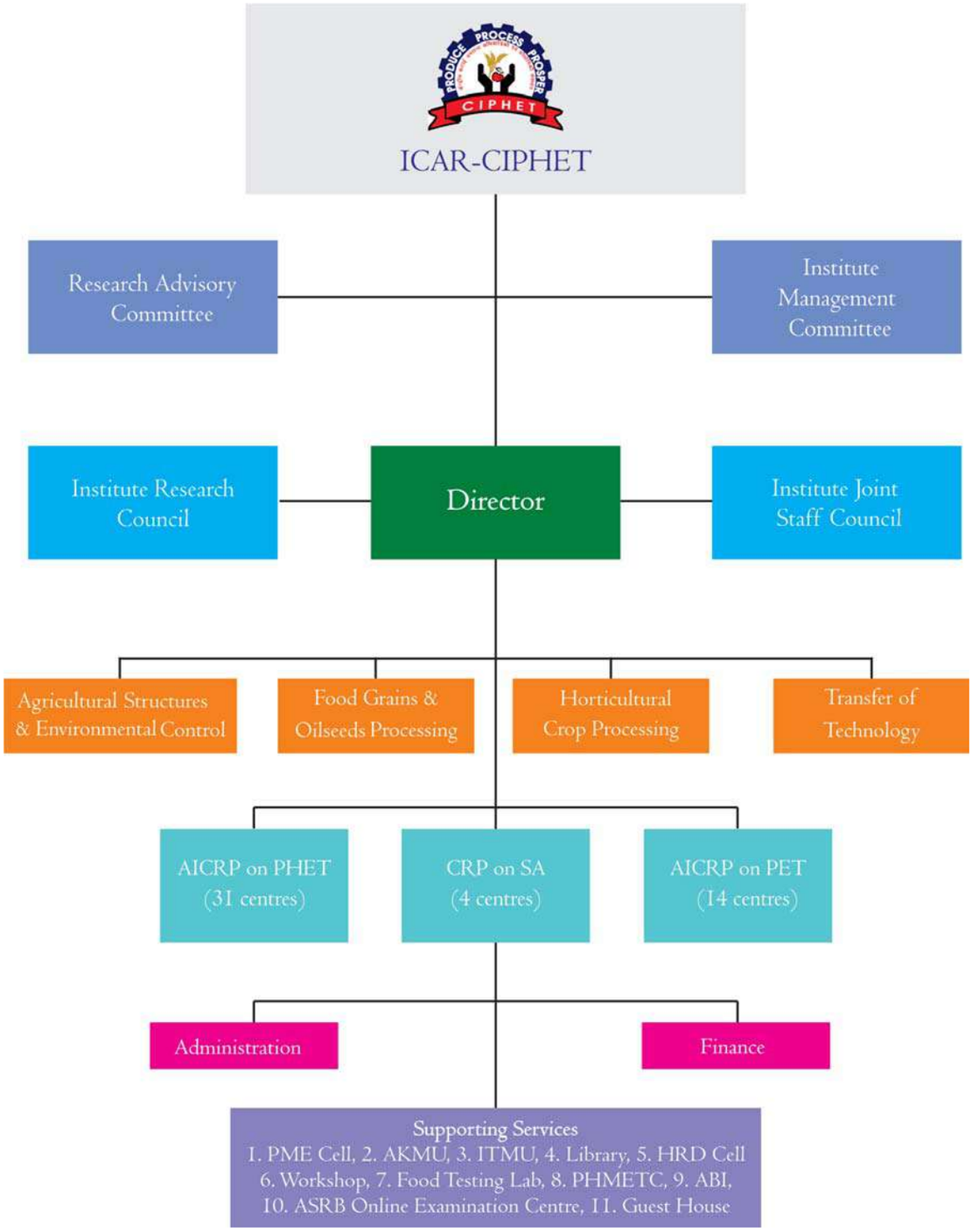
OUR MISSION

Creating prosperity through minimization of post-harvest losses from 15% to 5% and increase in value addition from present level of 10% to 30% to produce and by-products from crops, horticulture, livestock and fisheries sectors.

Mandates

- 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

Organizational Structure



Aerial view of ICAR-CIPHET, Ludhiana

Infrastructure

Workshop

The workshops at ICAR-CIPHET, Ludhiana and Abhor manage fabrication and modification of post-harvest machineries, 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. Workshops have machines/ equipment such as lathe machines, 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. Besides, the APC 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.

Agro Processing Centre

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 a good collection of books and journals in the area of post-harvest engineering, food processing, engineering, microbiology, biochemistry, biotechnology etc. During the reported year, the total number of books and standards in the library were 4284. The library as a member of consortium for e-Resources in Agriculture (CeRA) is getting access to online full text journals and e-books. In addition of these, a number of national and international serial

Library

publications, annual reports, newsletters and research bulletins were received on gratis. Current content service of journals and list of new arrivals is also being circulated among the ICAR-CIPHET staff. Library received one Punjabi, two Hindi and three English Newspapers namely Ajit, Dainik Jagran, Amar Ujala, Hindustan Times, The Tribune and The Economic Times, respectively and also received Frontline and India Today magazine (both Hindi and English). Student Trainees coming from different Universities avail this facility.

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

Guest House

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 63 patent applications have been filed through ITMU out of which nine patents have been granted. Vigorous efforts of ITMU lead to commercialization of 55 technologies developed by ICAR-CIPHET.

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.

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

Post-Harvest Machine and Equipment Testing Centre (PHMETC)

The Post-Harvest Machine and Equipment Testing Centre (PHTMETC), ICAR-CIPHET, Ludhiana is approved by Mechanization & Technology Division, Department of Agriculture & Cooperation, Ministry of Agriculture and Farmers' Welfare, Govt. of India. The institute is authorized for testing of all types of Post-Harvest Equipment and Machinery 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. Purpose of establishment of "PHMETC" at ICAR-CIPHET, Ludhiana (Punjab) is to provide platform and develop confidence in PHT machine and equipment manufacturers and also buyers / entrepreneurs who is going to start his business. PHMETC at ICAR-CIPHET will test all machines related to processing of agricultural and allied produces.

All India Co-ordinated Research Projects (AICRP)

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 at 31 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 during critical stages/operations, (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 development and process refinement with a view to develop complete packages for post-harvest utilization of crops/commodities and their by-products, (v) Multi-location trail and demonstration of the post-harvest technologies.

AICRP on Plasticulture Engineering and Technology

The AICRP on Plasticulture Engineering and Technology is operational since 1988 and has 14 centres in different agro-climatic zones. The project has contributed in the development and modification of Plasticulture technology in the area of water harvesting and management, surface cover cultivation, irrigation systems, plastic mulching, animal shelters, aquaculture technology and use of plastics in farm tools, machinery, post-harvest handling and packaging processes.

Staff Position

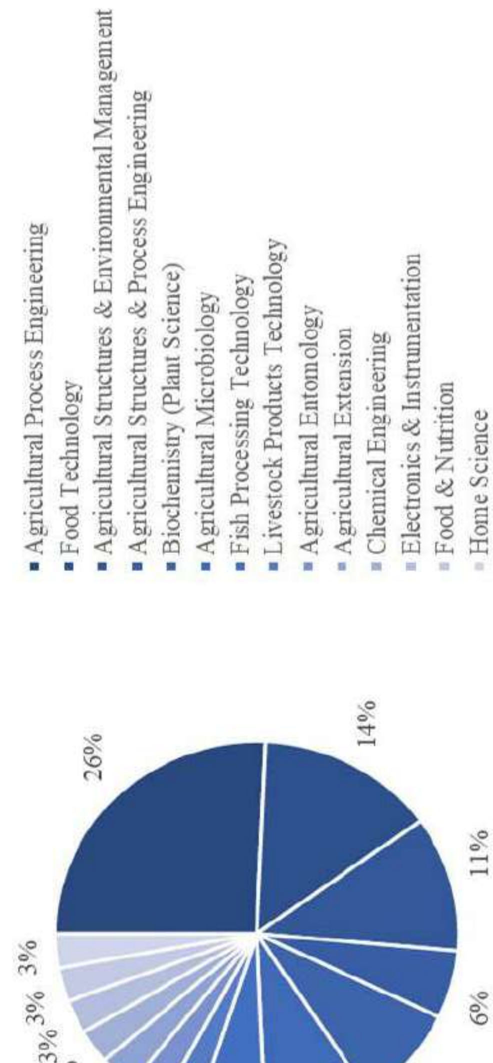
(31 December, 2019)

Category	Sanctioned	Filled		Total Filled	Vacant
		Ludhiana	Abohar		
Scientific	76*	32	07	39	37
Administrative	21#	14+1 (AFAO)	03	17+1 (AFAO)	04
Technical	29	17	08	25	04
Supporting	03	02	01	03	00
Total	130	64+1 (AFAO)	19	84+1 (AFAO)	45

*Excluding Director, #Including SAO

Discipline-wise distribution of scientific strength

Discipline	Principal Scientist	Senior Scientist	Scientist	Total
Agricultural Process Engineering	-	1	8	9
Food Technology	1	-	4	5
Agricultural Structures & Environmental Management	1	-	3	4
Agricultural Structures & Process Engineering	2	-	-	2
Biochemistry (Plant Science)	2	-	1	3
Agricultural Microbiology	-	-	3	3
Fish Processing Technology	1	-	1	2
Livestock Product Technology	-	-	1	1
Agricultural Entomology	-	-	1	1
Agricultural Extension	-	-	1	1
Chemical Engineering	1	-	-	1
Electronics & Instrumentation	-	-	1	1
Food & Nutrition	1	-	-	1
Home Science	-	-	1	1
Horticulture	1	-	-	1
Vegetable Science	-	-	1	1



Discipline-wise percent distribution of scientific strength

Budget and Expenditure
(2019-20)

ICAR-CIPHET (Amount in Lakh)

RE/Remittance	Expenditure	% Utilization
1764.08	1749.90	99.20

AICRP-PHET (Amount in Lakh)

RE/Remittance	Expenditure	% Utilization
2317.37	2313.94	99.85

AICRP-PET (Amount in Lakh)

RE/Remittance	Expenditure	% Utilization
531.96	531.60	99.94

CRP-SA (Amount in Lakh)

RE/Remittance	Expenditure	% Utilization
99.91	96.69	96.78

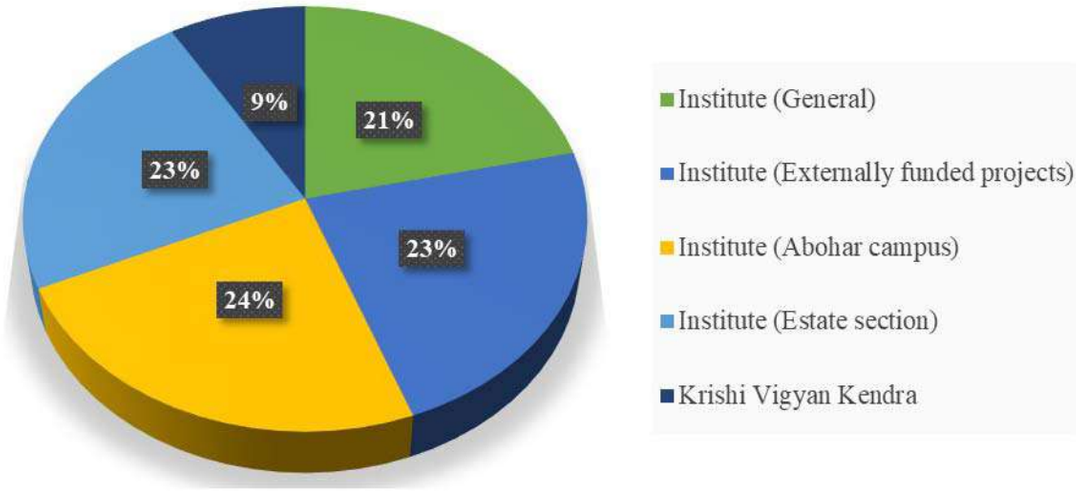
Revenue Generated
(2019-20)

Particulars	Amount (Rs.)
Testing of post-harvest machinery and equipment	3190843
Sale of farm produce	2693712
License fee	1326026
Internal resource generation	1021213
Leave salary and pension contribution	1182167
Recoveries of loans and advances	637538
Interest earn on loans and advances	185035
Miscellaneous receipts	751774
Analytical and testing fee (All Institute labs.)	76635
Grand total	11064943

Purchase on GeM
(2019-20)

(Amount in Lakh)

Institute (General)	Institute (Externally funded projects)	Institute (Abohar campus)	Institute (Estate section)	Krishi Vigyan Kendra	Total
995717	1062456	1112000	1075396	399474	4645043



Ongoing Research Projects

Institute Projects

Sr. No.	Project Name	Leader & Associates (as on 31.12.2019)		Period
1.	Development of continuous primary processing and shrink packaging line for cauliflower and cabbage	PI Co- PI	Dr. R.K. Vishwakarma Dr. Manoj Kumar	01.10.2013 30.09.2019
2.	Design and development of Wonder Bag for wheat storage	PI Co- PI Co- PI	Dr. Sandeep Mann Er. Akhoon Asrar Bashir Dr. Guru P.N.	01.07.2014 30.06.2019
3.	Design development and evaluation of equipments/ machine and storage structures for primary processing and low temperature storage of onions in bulk.	PI Co- PI Co- PI	Dr. Bhupendra M. Ghodki Dr. Dukare Ajinath Shridhar Dr. Pankaj Kumar Kannaujia	01.07.2015 31.03.2019
4.	Development and evaluation of active ethylene absorbing packaging film material for selected climacteric fruits.	PI Co- PI	Dr. Rahul K. Anurag Dr. Tanweer Alam, Indian Institute of Packaging, New Delhi	01.07.2015 30.06.2019
5.	Development of quality sensing system for mushroom and minimally processed pomegranate arils	PI Co-PI Co-PI	Dr. Rahul Kumar Anurag Dr. Shammi Kapoor, Sr. Mycologist, PAU Ludhiana Dr. Th. Bidyalakshmi	01.07.2015 30.06.2019
6.	Development and mechanization of low-fat high-fibre functional meat products	PI Co-PI Co-PI Co- PI	Dr. Yogesh Kumar Dr Nitin Mehta, GADVASU Er. A.A. Bashir Dr. Sandeep Mann	01.07.2015 31.03.2019
7.	Newer methods for energy efficient oil extraction and novel product development from mustard seed	PI Co-PI Co-PI Co-PI Co-PI	Dr. S. K. Tyagi Dr. Manju Bala Er. Chandan Solanki Dr. A U Muzaddadi Dr. Yogesh Kumar	01.07.2015 30.06.2019
8.	Development of National Database on NARES Technologies in Post-Harvest Sector	PI Co-PI Co-PI	Dr. Sandeep Mann Dr. Renu Balakrishnan Er. Sandeep Dawange Popatro	01.07.2015 30.09.2019
9.	Development and Evaluation of Eco-Friendly mustard based antimicrobial formulation using other botanicals for eradication of bacterial blight in pomegranate	PI Co-PI Co-PI Co-PI Co-PI	Dr. S.K. Tyagi Dr. J. Sharma (NRC-P) Dr. Manju Bala Dr. K.Dhinesh Babu, (NRC-P) Mr. Mallikarjun Harsur (NRC-P)	01.04.2016 31.03.2019
10.	Development of spectroscopic techniques for instant detection of honey adulteration	PI Co-PI Co-PI	Dr. Rahul Kumar Anurag Dr. Gagan Jyot Kaur (PAU) Dr. Poonam	01.04.2016 31.03.2019
11.	Development of rapid spectroscopic and molecular techniques for detection of animal species in meat products	PI Co-PI	Dr. Yogesh Kumar Sh. Vikas Kumar	01.04.2016 31.03.2020

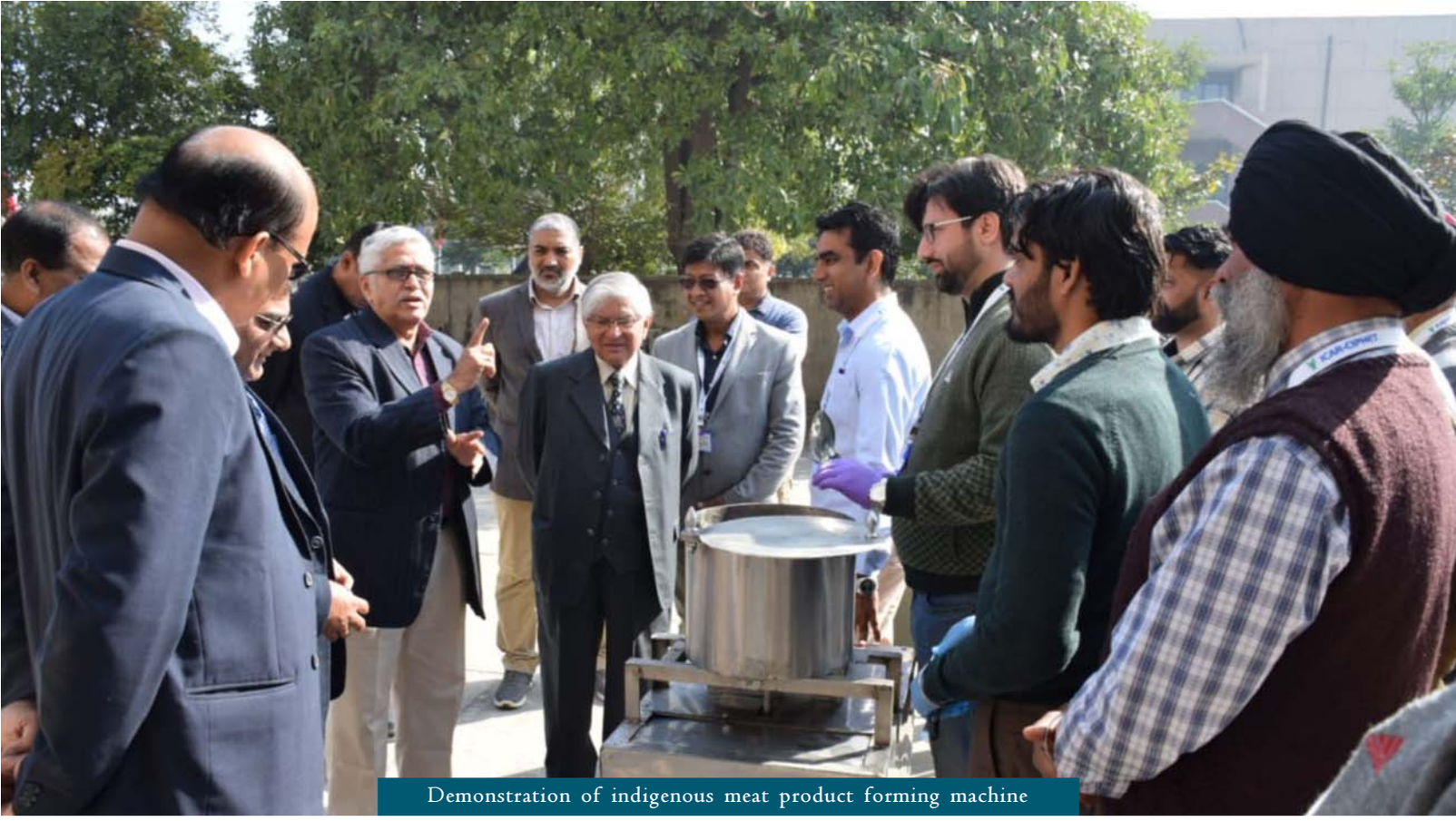
Sr. No.	Project Name	Leader & Associates (as on 31.12.2019)		Period
12.	Design and development of dehumidified hot air dryer for maize.	PI Co-PI	Dr. Pankaj Kumar Er. Dhritiman Saha	01.04.2016 31.03.2020
13.	Development of improved flaking system for small scale production of rice flakes	PI Co-PI	Er. Dhritiman Saha Dr. Swati Sethi	01.04.2016 31.03.2019
14.	Development of convenient breakfast products using sprouting and extrusion technology	PI Co-PI	Dr. Swati Sethi Dr. Mridula D.	01.04.2016 30.06.2019
15.	Utilization of fruit waste and plant extracts in developing antimicrobial coatings for extending shelf-life of fruits.	PI Co-PI Co-PI	Dr. Sunil Kumar Dr.Dukare Ajinath Shridhar Dr. Ramesh Kumar	01.04.2016 31.03.2019
16.	Design and Development of Mechanized System for Fruit Bar Manufacturing	PI Co-PI Co-PI	Dr. Kirti Jalgaonkar Mrs. Prerna Nath Dr. Manoj Kumar Mahawar	01.04.2016 30.09.2019
17.	Development of technology for de-poding of green pea & cowpea.	PI Co-PI	Dr. Bibwe Bhushan Ratnakar Dr. Kirti Jalgaonkar	01.04.2016 31.03.2019
18.	Development of user friendly android based mobile application (Mobile app) for technology dissemination and outreach program on postharvest processing and value addition	PI	Dr. Ranjeet Singh	01.04.2016 31.03.2019
19.	Development of smart device for automatic detection and identification of insects in stored grains using machine vision technology	PI Co-PI	Dr. Ranjeet Singh Dr. B.B. Ratnakar	01.04.2016 31.03.2020
20.	Development of hermetically sealed storage structure of 01 Tonne capacity for pulses	PI Co-PI	Er. Akhoon Asrar Bashir Dr V. Chandrasekar	01.04.2017 31.12.2019
21.	Development of process for color extraction from black carrot and its byproducts and its utilization in value added product	PI Co-PI Co-PI	Dr. Prerna Nath Kale Dr. Sunil Kumar Dr. Ajinath Dukare	01.04.2017 31.03.2020
22.	Development of mechanized litchi de-stoner.	PI Co-PI Co-PI	Dr. Bibwe Bhusan Ratnakar Dr. Kirti Jalgaonkar Dr. Pankaj Kumar. Kannaujia	01.04.2017 31.03.2020
23.	Designing Extension Strategies for Wider Adoption of Post-Harvest Technologies based on Adoption Behaviour of End Users	PI Co-PI Co-PI	Dr. Renu Balakrishnan Dr. Sandeep Mann Dr Arvind Kumar (PS), ICAR-ATARI	01.04.2017 31.03.2020
24.	Development of pigmented cereals based expanded/ extruded products and their nutritional evaluation	PI Co-PI	Dr. K. Bembem Dr. Pankaj Kumar	01.04.2017 31.03.2020
25.	Development of automatic Sorter/Grader for Pomegranate and Tomato	PI Co-PI	Er. Yogesh Kalnar Associated Er. Sandeep Dawange Popatro	01.04.2017 31.03.2020
26.	Design and analysis of greenhouse structures for selected Regions of India	PI Co-PI Co-PI	Er. Indore Navnath Sakharam Dr. Sakharam Kale Er. Akhoon Asrar Bashir	01.04.2017 30.09.2019
27.	Development of collagen hydrolysate from buffalo (*Bubalus bubalis*) skin and its effect on osteoarthritis.	PI Co-PI Co-PI	Dr. Tanbir Ahmad Dr A.U. Muzzadadi Dr. Yogesh Kumar	01.10.2018 30.09.2020

Sr. No.	Project Name	Leader & Associates (as on 31.12.2019)		Period
28.	Development of process protocol for cryogenic grinding of selected medicinal plants/herbs (Curry leaf, Nutmeg and Safed Musli)	PI Co-PI	Dr. Pankaj Kumar Dr. Manju Bala	01.10.2018 30.09.2021
29.	Mega-Project: Value chain improvement through post-harvest handling, storage and processing of mango. Sub-project 2: Production of bio-active ingredients from mango seed kernels	PI Co-PI Co-PI	Dr. Poonam Dr. Th. Bidyalakshmi Er. Sandeep Dawange Poputrao	01.10.2018 30.09.2021
30.	Development of ACE-Inhibitory Peptides from Fish and Livestock Processing Waste	PI Co-PI	Sh. Vikas Kumar Dr. Yogesh Kumar	01.10.2018 30.09.2020
31.	Development of Lab-on-a-Chip method for detection of animal species in meat products	PI Co-PI Co-PI Co-PI	Dr. Yogesh Kumar Dr. K Narsaiah Dr. Tanbir Ahmad Dr Poonam	01.04.2019 31.03.2022
32.	Development of Infra Red Spectroscopy Based Rapid Detection Methods for Adulterants in Chick pea flour (*Besan*)	PI Co-PI	Dr. Manju Bala Dr. Swati Sethi	01.04.2019 31.03.2021
33.	Enhancing value of pigeon pea, black gram and their by-products through secondary agriculture	PI Co-PI Co-PI	Dr. Deepika Goswami Dr. D. Mridula Dr. Manju Bala	01.04.2019 31.03.2021
34.	Development of ripening delaying kit for enhancing the shelf-life of fresh fruits	PI Co-PI	Dr. Sunil Kumar Dr. Ramesh Kumar	01.04.2019 31.03.2021
35.	Postharvest Management and Value Addition of Ker and Sangri for their Commercial Exploration	PI Co-PI Co-PI Co-PI	Prerna Nath Sakharam Kale Sunil Kumar Ramesh Kumar	01.04.2019 31.03.2021
36.	Development of mechanized system for deodorization and safe handling of dried fish	PI Co-PI Co-PI Co-PI	Dr A.U. Muzaddadi Dr. Sandeep Mann Dr. Khawairakpam Bembem Dr. Bipul Kakati	01.04.2019 31.03.2022
37.	Design and development of mechanized and continuous peeling system for citrus fruits	PI Co-PI Co-PI	Dr. Manoj Kumar Mahawar Dr. Kirti R. Jalgaonkar Dr. Pankaj Kumar Kannaujia	01.04.2019 31.03.2021
38.	Development of technology for depoding of green pea and cowpea	PI Co-PI	Dr. B.B. Ratnakar Dr. Kirti Jalgaonkar	01.04.2019 31.03.2020
39.	Upgradation and commercialization of woman-friendly semi-automatic fish cleaning-cum dressing system	PI	Dr. A.U. Muzaddadi	01.04.2019 31.03.2020

Externally Funded Projects

Sr. No.	Project Name	Leader & Associates (as on 31.12.2019)		Period
1.	Studies and refinement of live-fish carrier system for mass transportation of table fish, brooders, fingerlings and aquarium fishes. (NFDB)	PI	Dr. A.U. Muzaddadi	08.08.2014 30.06.2019
2.	Development of food Bio-polymer based micro & nano scale delivery systems for bioactive ingredients in functional foods. (Under ICAR-National Fellow)	PI	Dr. K. Narsaiah	02.01.2015 01.01.2020
3.	Processing and Value Addition of Agricultural Produce for Enhancing Farmers income and Employment in Production Catchment. (FFP)	PI Co-PI Co-PI Co-PI Co-PI	Dr. Sandeep Mann Dr. Rahul Kumar Anurag Dr. Renu Balakrishnan Er. Yogesh Kalnar Prof. B.V.C Mahajan, Director & PHPTC, PAU	30.01.2017 31.03.2020
4.	Refinement of process protocol for preparation of traditional fermented fish products of North east India by using biotechnological tools and its process mechanization. (DBT)	PI Co-PI	Dr. A.U. Muzaddadi Dr. Sandeep P Dawange	23.03.2018 22.03.2020
5.	Valorization of industrially produced soybean and groundnut de-oiled meals/cakes by extraction, purification and production of protein isolates. (NASF)	PI Co-PI Co-PI Co-PI	Dr. D.N. Yadav (PI) Dr. R.K. Vishwakarma Ms. Surya Dr. Swati Sethi	01.08.2018 31.07.2021
6.	Design and Development of protective structures for high valued crops to reduce damage from hail and frost. (NICRA)	PI Co-PI	Er. Indore Navnath S. Dr. R.K. Singh	23.08.2018 31.03.2020

Sr. No.	Project Name	Leader & Associates (as on 31.12.2019)		Period
7.	Development of protocols for shelf life, safe storage, milling outturn and indicative norms for procurement of major pulses. (DOCA)	PI Co-PI Co-PI Co-PI Co-PI	Dr. R.K. Vishwakarma Dr. Mridula D. Dr. D.N. Yadav Dr. Deepika Goswami Er. Navnath Indore Sakharam	27.03.2019 26.03.2021
8.	Development of rapid quality monitoring system for wheat flour and its primary milled products. (LSRB-DRDO)	PI Co-PI Co-PI Co-PI Co-PI	Dr. D.N. Yadav Dr. V.Chandrasekar Mrs. Surya Dr. Bhupendra M. Ghodki Dr. Rahul Kumar Anurag	02.05.2018 01.05.2021
9.	Microwave Assisted Disinfestation of Selected Food Grains (Rice and Wheat) (Consultancy Project-Pradeep Metals Limited)	PI Co-PI Co-PI Co-PI	Dr. D.N. Yadav Dr. Swati Sethi Dr. Guru PN Dr. R.K. Singh	01.03.2019 29.02.2020
10.	Development of Hand-Held Instrument for Non-Destructive Quality Testing of Mango. (ICAR-Extramural)	PI	Dr. K.Narsaiah	01.10.2019 30.09.2021
11.	Study on Determining Storage Losses of Wheat and Paddy Stored in CAP System and to Recommend Norms for Storage Losses. (FCI)	LCPI LCCo-PI LCCo-PI LCCo-PI	Dr. R.K. Vishwakarma Dr. Mridula D. Dr. Bhupendra M. Ghodki Dr. Guru P.N.	20.11.2019 19.05.2021



Demonstration of indigenous meat product forming machine

Research Highlights

Mechanized system for fruit bar manufacturing

The cuboidal-shaped water bath (812×306×250 mm) was constructed using a stainless steel sheet (2.56 mm thick). An opening of 125.17 mm diameter was provided at the top side for water makeup and to measure water temperature through a digital thermometer. The water is heated using two electric heaters of capacity 2 kW each which were placed on the side of the water bath, separated by a distance of about 40.0 cm. In order to maintain the water level in the water bath and to maintain the flow in the tank, inlet and outlet pipes of 20.9 mm diameter each is provided. The inlet pipe is provided on the top side of the water bath while the outlet is provided at the bottom end. In order to control heat loss, water bath is entirely covered with foam (thickness 7 mm). The inlet and outlet pipes are covered first with cotton thread and then with the foam of thickness 7 mm to reduce the heat loss. A free space of 30 mm is provided on the top of the water bath to allow the pressure release of steam when water is heated.

An exhaust fan is provided to collect the released water vapour to the atmosphere. The frame is made of hollow square pipes of width 10 mm. The dimensions of the frame are mentioned in Fig. 1. Three exhaust fans (230V, 0.25A, 35W , 2750 rpm) are installed on the exhaust frame. The height can be varied accordingly by moving the frame vertically. The frame is covered with a transparent acrylic sheet to have a watch on the functioning of the setup and to avoid contamination of the product.

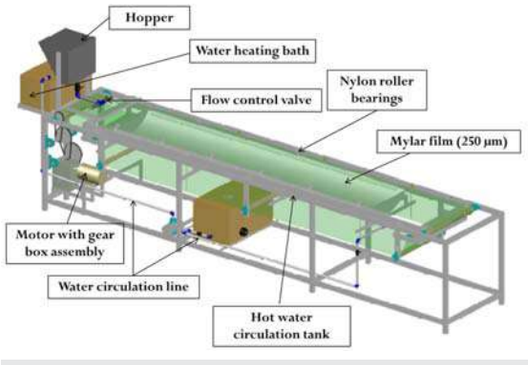


Fig. 1. Isometric view of the continuous refractance window drying system

Fig. 2. Pictorial view of assembled refractance window dryer

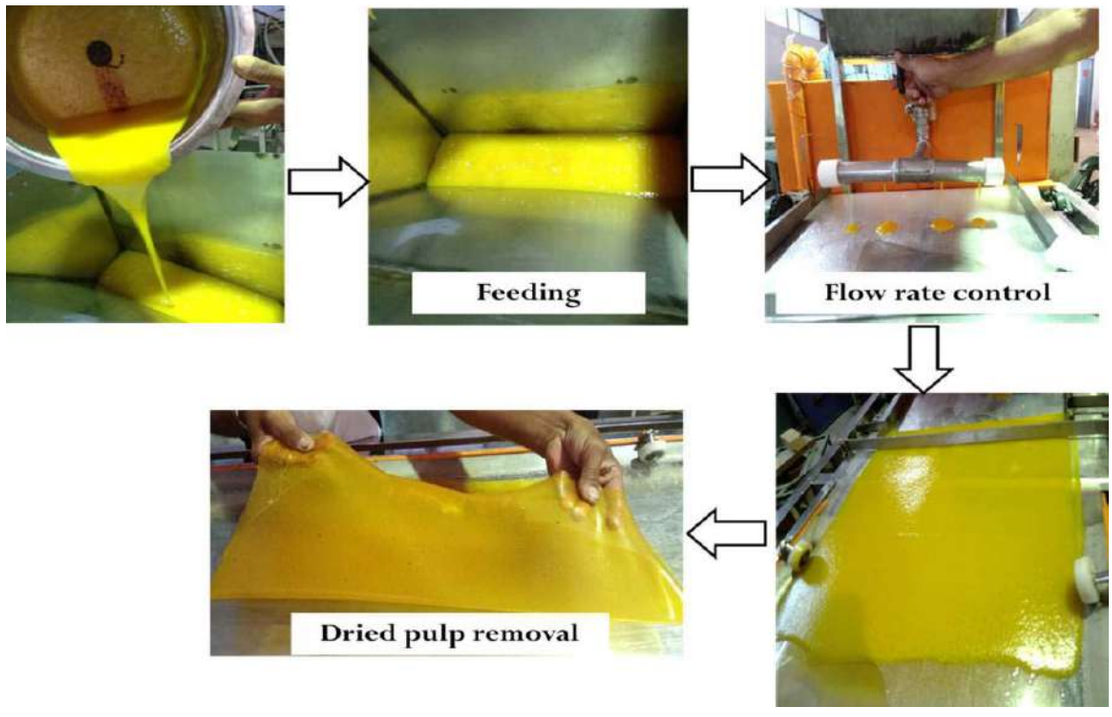


Fig. 3. Process flow chart for drying of pulp on refractance window dryer

Glycerine is spread on the moving transparent belt to prevent the sticking of the mango pulp. The tank is made from a transparent acrylic sheet in a hut shape. A flow control valve was attached to the bottom to control the rate of glycerine application. It is further connected to a square pipe at right angles, which have holes to spread the glycerine. Wipers are installed along the width of the belt to ensure even spreading of glycerine on the belt. End caps are fitted into the sides of the hollow square pipe to prevent loss of glycerine. The adjustment of the flow rate of glycerine can be made according to the speed of the belt.

Low-cost indigenous meat product forming machine (meat balls/patties etc)

The honourable Prime Minister's idea of 'Vocal for Local' and 'Aatmnirbhar Bharat' can improve the economy of Indian market. Apart from economy, this can also alleviate the problems faced by Indian entrepreneurs which are much dependent on foreign equipment and machineries to start their business. There is an utmost requirement of mechanization of meat product preparation. Although some high-cost processing machineries are available in international market but are not suitable for small and medium meat processing entrepreneurs/industry. Hence, this low-cost indigenous meat forming machine is developed keeping in view the requirement of Indian market. The machine weighs and forms processed meat products with uniform thickness of the final product, automatically. This low-cost machine is made of food grade stainless steel. The machine is around 5.3 times (433% higher) more efficient than manual process for the

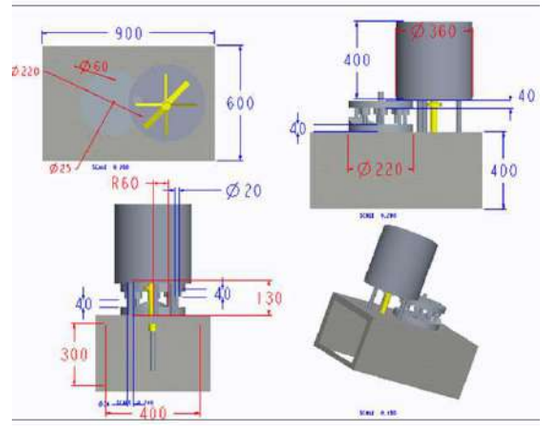


Fig. 4. Demonstration of indigenous meat product forming machine developed by ICAR-CIPHET to RAC members, ITMU section, PME Cell and Director Cell

Fig. 5. Demonstration of indigenous meat product forming machine developed by ICAR-CIPHET to experts and entreprenuers

product forming. The modification in the machine is also possible with only minor adjustments to form any kind of product with required shape and weight. This machine is capable of making 960 patties of 55 g weight in one hour. The average capacity of the machine is 52.8 kg/h. The developed machine offers hygienic and easy operation over the manual process.

Modified atmospheric packaging studies of low-fat, high-fibre functional meat products

The use of fat replacers results in high-quality meat products with a lower fat content. In the present study, the replacement of fat by a combination of strategies resulted in good technological properties of goat meat batter. The sensory acceptability at 4% PPDF level was comparable to full-fat meat product samples. Thus, multiple emulsion, AG, and PPDF up to 4% level are promising ingredients as fat replacers to develop low-fat meat products. Results showed that the addition of PPDF led to a significant ($P < 0.05$) decrease in the cooking losses (%) and shrinkage (%) with an increase ($P < 0.05$) in the emulsion stability of low-fat meat batter samples. Oxidative stability was higher ($P < 0.01$) in treated low-fat samples in comparison to the control samples. Microstructural (SEM) images revealed a more homogenous structure in the treated samples. However, redness and sensory acceptability were lower at 6% PPDF level. Modified atmospheric packaging (MAP) storage studies have also been done for developed low-fat, high-fibre functional meat products at various concentrations of nitrogen, oxygen and carbon dioxide. Microbiological, oxidative, color,

Fig. 6. MAP studies of developed low-fat, high-fibre and control meat products with higher antioxidant compounds from guava leaf extract

sensory analysis has been analyzed. MAP, Vacuum packaging, and encapsulated guava leaf extract improved the overall shelf-life of low-fat, high-fibre meat products.

Comparative antioxidant capacity of plant leaves and herbs in meat system under accelerated oxidation conditions

This study evaluated the comparative antioxidant effects of nine leaves extracts (pomegranate, PL; citrus, CL; kinnow, KL; mango, ML; guava, GL; peppermint, PM; oregano, OL; rosemary, RM; thyme, TL) in the meat system (MS) formulated with a healthier oil consisted of high level of polyunsaturated fatty acids. Total phenolic content of the extracts varied from 10.1 ± 1.44 to 98.8 ± 2.15 mg TAE/g; whereas, total flavonoid content varied from 1.6 ± 0.16 to

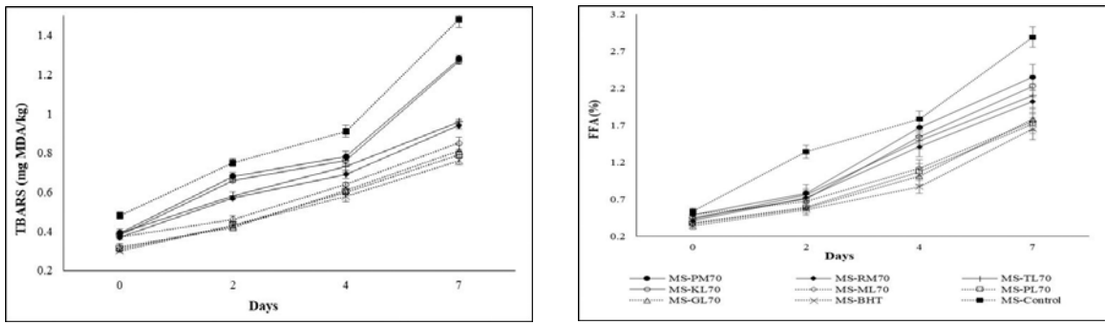


Fig. 7. (A) TBARS (mg malonaldehyde/kg), (B) FFA (%) values of meat systems with peppermint leaves extract (MS-PM, ●), rosemary leaves extract (MS-RM, ◆), thyme leaves extract (MS-TL, +), kinnow leaves extract (MS-KL, ○), mango leaves extract (MS-ML, ...◇.....), pomegranate leaves extract (MS-PL, ...□.....), guava leaves extract (MS-GL, ...△.....), BHT (MS-BHT, ... x .....), and control without extract or BHT (MS-Control, ...■.....) during storage at 60 °C for 7/ days. Bars indicate the standard error. 70-extracts were prepared at 70 °C. The results are expressed as means/ ±/ standard error of three replicates of independent experiments, each analyzed three times.

64.8 ± 0.41 mg CE/g. The DPPH scavenging activity of the extracts varied from 29.8/ ±/ 0.87% to 58.5/ ±/ 1.57%. Total antioxidant activity varied from 0.91/ ±/ 0.14 to 3.90/ ±/ 0.16. The descending order for the antioxidant potential of the extracts in the meat system was MS-GL70 = MS-PL70 = MS-BHT > MS-ML70 > MS-RM70 = MS-TL70 > MS-KL70 = MS-PM70 > MS-Control. The addition of KL extract exerted negative effects ($P < 0.05$) on the color attributes. The addition of ML extracts increased in the emulsion stability (TEF% and EFAT%).

Process for production of microbial protein using corn cob as substrate

The corn cob contains approximately 40% cellulose, 32% hemicellulose and 18% lignin. Higher lignin acts as a barrier for the utilization of corn cob as a substrate during fermentation. Steam assisted alkali pretreatment process was standardized to minimize the lignin content (< 5%) and to enhance cellulose recovery by 30%. The pre-treated corn cob powder was subjected to enzymatic hydrolysis to prepare corn cob hydrolysate. Suitable food grade microbes specifically *Saccharomyces cerevisiae* were selected for microbial protein production. The process for microbial protein production using corn cob hydrolysate as a substrate was optimized. Parameters like inoculum concentration, temperature, pH, and duration for obtaining maximum culture biomass was optimized. Microbial protein so obtained contains 45.5% crude protein.

Amino acid profiling showed that it is rich in sulfur-containing amino acids like cysteine (5.22 mg per 100 mg) and methionine (5.65 mg per 100 mg), whereas most of the cereal proteins lack in these two amino acids. Hence, this protein can be utilised for the fortification of cereal-based products to maintain a balanced amino acid profile. The protein was further utilized to prepare fortified biscuits with all-purpose wheat flour in different ratios. Organoleptic evaluation of microbial protein fortified biscuits (up to 2%) were found acceptable based on colour, texture, flavour and overall acceptability score (7.8 on 9 point on hedonic scale). This protein is suitable for human consumption and thus can be used as an ingredient or a substitute for fortification.

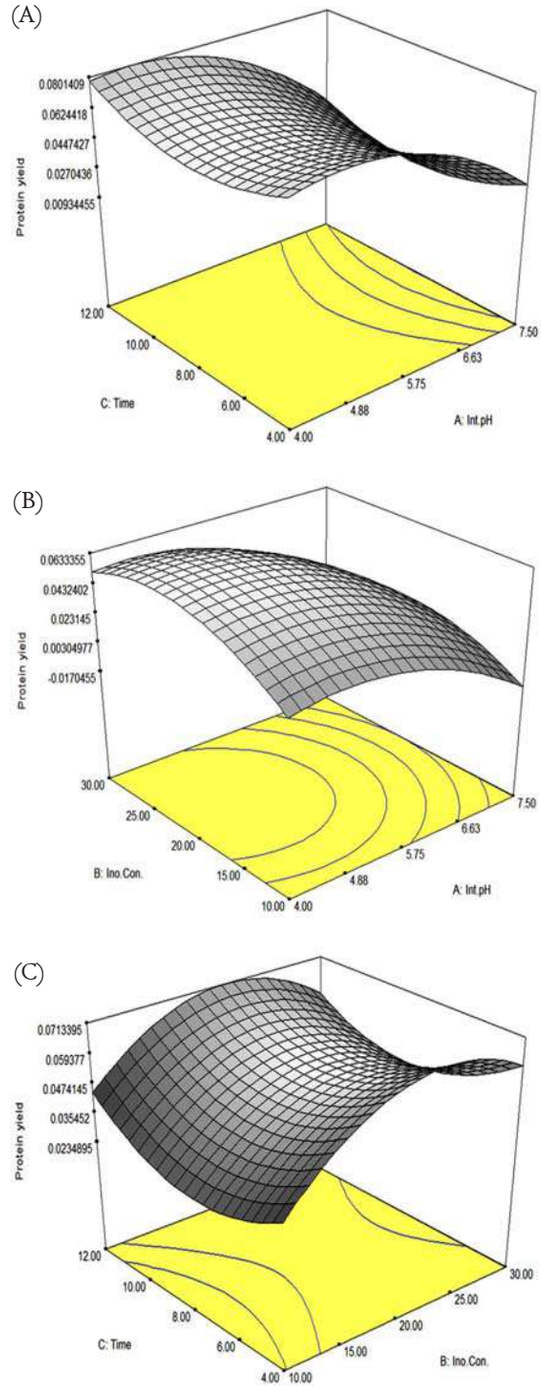


Fig. 8. Effect of pH and time (A) pH and inoculum concentration (B) inoculum concentration and time on protein yield (C)

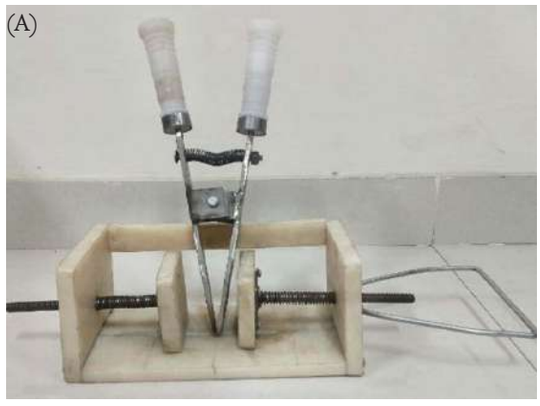
Phase change material-based (PCM) chamber for thermal storage

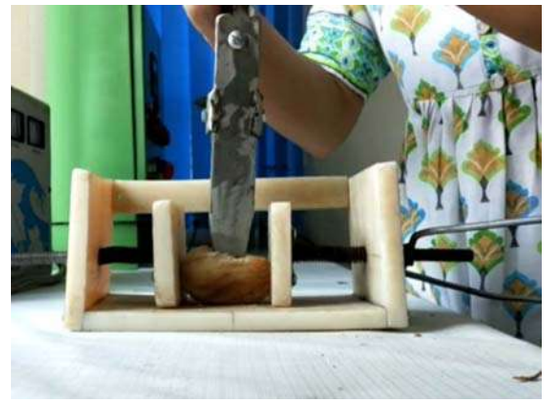
Thermal storage (Phase change material, PCM chamber) chamber has been fabricated for the storage of thermal energy for smart solar dryer. The dimension of the PCM chamber is (70x58x6) cm with 9 holes having diameter of 5.5 cm for the hot air to pass and recharge the PCM. Recharging of the PCM is done during sunshine hours through solar energy which is stored in the form of latent heat. Thus, during charging PCM gets liquified whereas it gets solidified as it gets discharged and supplies heat to the dryer during off sunshine hours. The chamber is kept above the plenum chamber. The hot air passes to the dryer through the PCM chamber and thus charging takes place. The PCM used is the paraffin wax which acts as a medium for storage of the thermal energy. The melting point of the paraffin wax is 60-62 °C.

Design and development of mango hand tool decorticator

Hand tool for separation of the kernel from mango stone comprises of wooden mango stone holder (22 x 10) cm and a stone opener made of stainless steel with handles. The seed is fixed inside two frames which are adjustable depending on the length of the seed.

Another hand tool has also been designed to compare the performance. It consists of a wooden frame having dimension of (32 x 20) cm with 36 cm long fixed seed holder along with adjustable width. A sharp vertical blade with handle (38 cm) press the seed while holding it firmly and open the kernel through the handle by tearing process.





Mechanized and continuous peeling system for citrus fruits

A 1940×755×1560 mm framework using mild steel angle iron is attached with 9180 mm chain having 238 links for fruit movement. A total of 15 spur gears are fitted to provide linear motion to the chain. One motor (1440 rpm, 0.5 HP) and 4 no. of gear boxes are fitted to provide the desired motion to the working components of the machine.

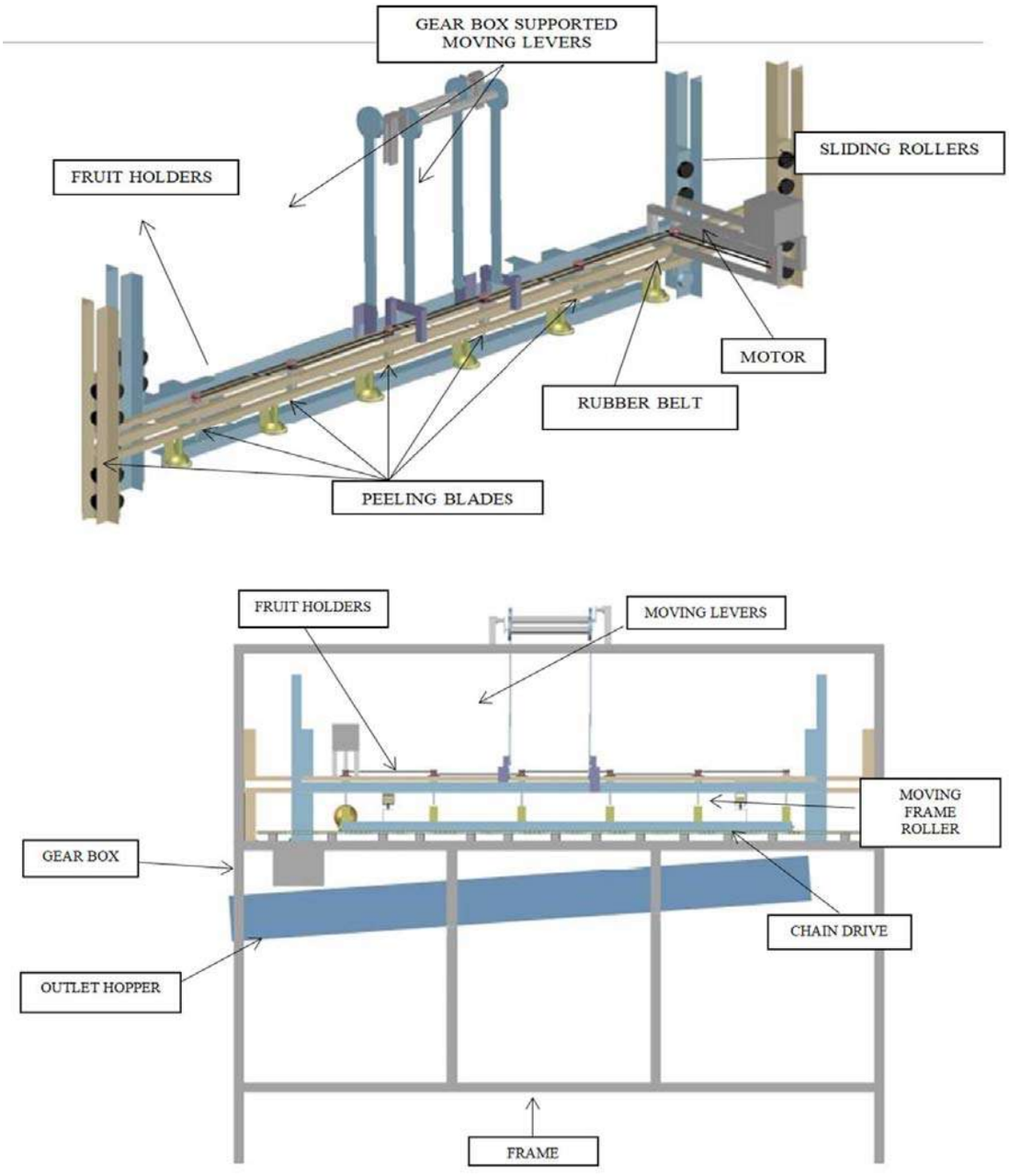


Fig. 9. Pictorial view showing different components of the proposed prototype

Fig. 10. Pictorial view of the framework with components of the prototype

Dyeing of different fabrics using natural extracts of *Tagetes erecta, Beta vulgaris, Allium cepa and Daucus carota*

Conventional extraction of dyes from marigold, beetroot, onion peels, and black carrots was performed in soxhlet extractor composed of a 500 ml round bottom flask, extractor, and condenser. The extractor was filled with respective plant material. Extraction solvent used for the isolation of pigments was alcohol. Ratio of extracted dye to solvent material was maintained at 1:10. Extraction was carried out at a temperature of 60 °C for around 24 h and was stopped when saturated solutions of different dyes were obtained and the volume of extracted dye was noted. A pre mordanting method was used in the dyeing of cotton and silk fabric with natural dyes obtained from marigold, beetroot, onion, and black carrot. The fabric samples were mordanted with four selected synthetic mordants namely, cupric sulphate, ferrous sulphate, potassium dichromate, and alum. In the

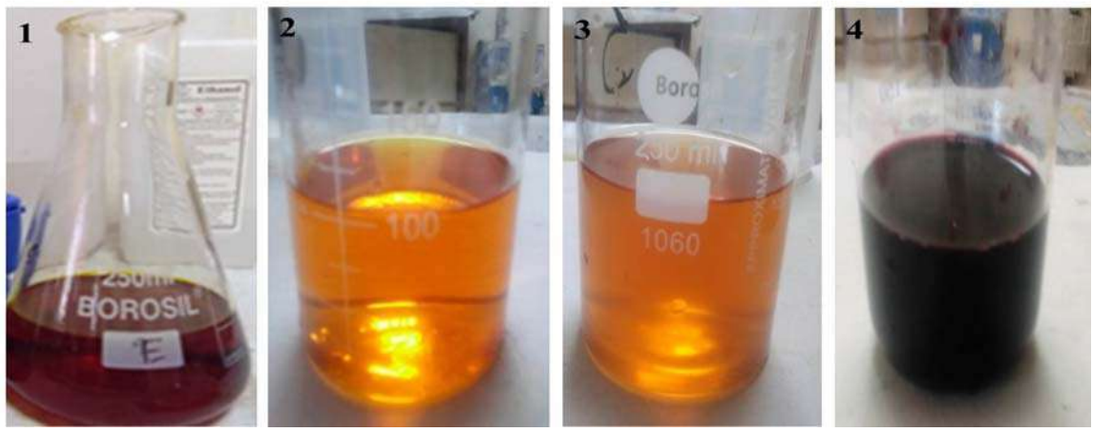


Fig. 11. Extracted natural dye from (1) *Tagetes erecta,* (2) *Beta vulgaris,* (3) *Allium cepa* and (4) *Daucus carota*

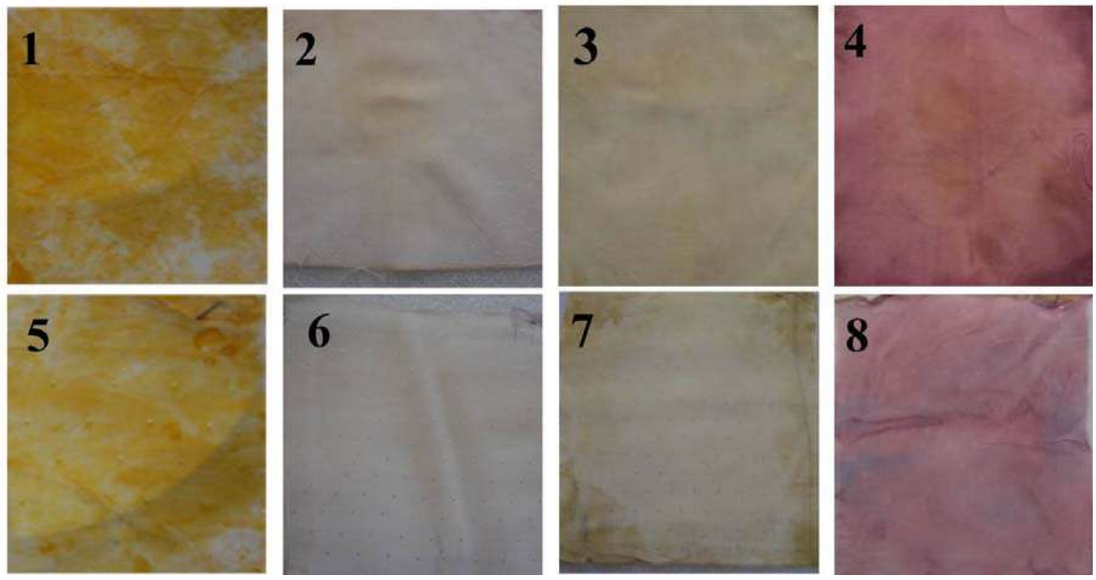


Fig. 12. Dyed cotton (1-4) and silk (5-8) fabrics with natural dyes from *Tagetes erecta* (1, 5), *Beta vulgaris* (2, 6), *Allium cepa* (3, 7) and *Daucus carota* (4, 8) using alum as mordant

beginning, fabric treatment was performed with 2.5 gm/500 ml sodium carbonate + 1.5 gm/500 ml detergent for one hour followed by pre-mordanting at 4% for 30 minutes. The dyeing time for different dyes was 1 hour and finally, the fixation of dye over fabric was done with 2.5% NaCl solution.

Ker based mineral-rich powder for fortification into different food products

Ker in combination with broccoli and lemongrass was selected for the preparation of mineral-rich powder. Ker, broccoli, and lemongrass were purchased from the local market of Abohar, Punjab. Subsequently, they were washed and tray dried at 60 °C for different time intervals till the moisture content was below 5±0.5% (db). After drying, the material was ground to make fine powder followed by sieving. Different powders at 180-micron size were used for making different combinations. Proportions of three different powders were decided using mixture design carried out with the help of MINITAB software. Simplex lattice design was used to determine different proportions of powders and total seven combinations were prepared. A combination of ker, lemongrass, and broccoli powders having proportions as 66.67, 16.66, and

Fig. 13. Prepared powder mixture samples with ker, lemongrass and broccoli powder

16.66%, respectively was optimized based on its high mineral content and organoleptic scores. The optimized powder showed DPPH activity (% inhibition) as 78%.

Baked mathris fortified with ker based mineral-rich powder

Wheat-based baked *mathri* were prepared using optimized mineral-rich ker powder. Proportions of flour and powders were decided using mixture design (in MINITAB software) and total five

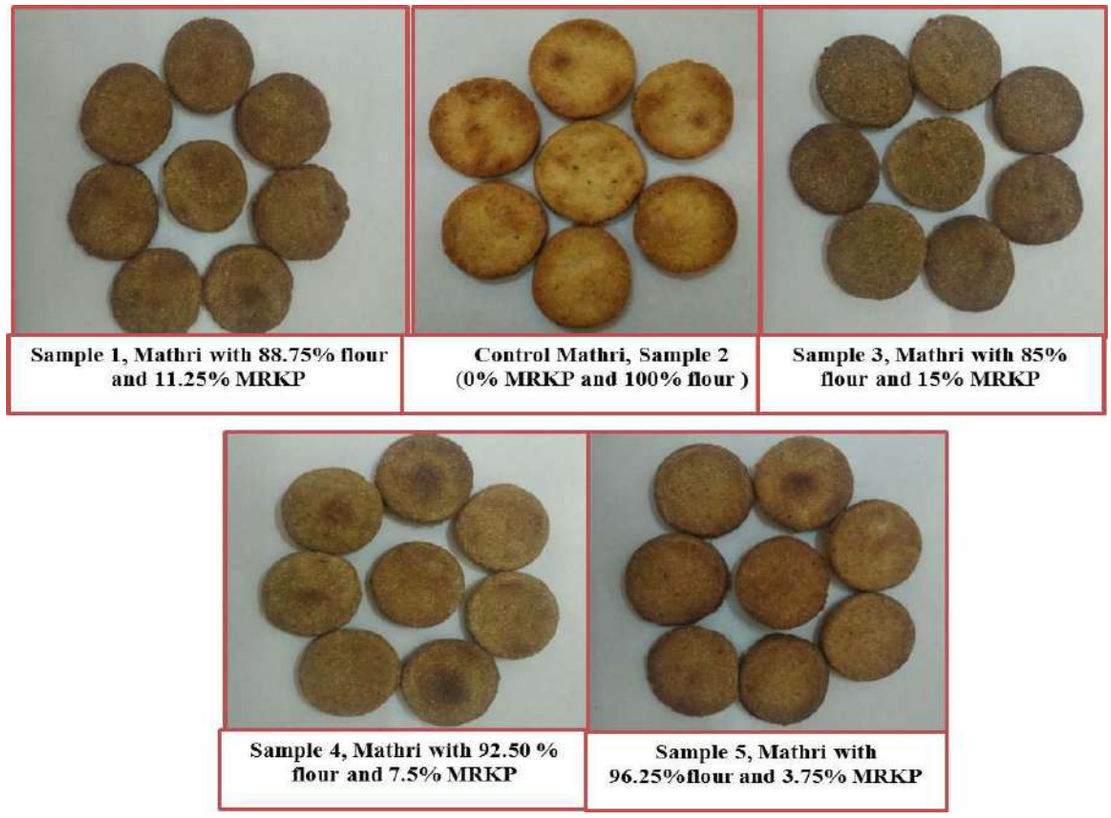


Fig. 14. Baked *mathri* with different combinations of mineral rich powder

combinations were prepared. *Mathri* with flour and powder percentage as 92.50 and 7.5% was optimized based on high organoleptic scores. The scores for appearance, flavor, aroma, taste, texture, and overall acceptability of optimized formulation of baked *mathri* were 7.0, 6.2, 6.6, 6.4, 6.6, and 7.0, respectively.

Steeping based preservation method for longer shelf-life of sangri pods

Sangri is a rich source of proteins, vitamin C, calcium, and other minerals and also a very important underutilized vegetable having maximum availability in some regions of Rajasthan, Haryana, and Punjab during April to May. Although having good functional qualities, the large quantities of sangri beans perish during glut season due to poor post-harvest management, inadequate processing facilities, and unawareness in other parts of India. The suitable steeping preservation methods may help harness the useful characteristics of vegetables during the lean season. The green sangri pods of 3-4 cm long were steeped in sodium chloride (NaCl, 3%), acetic acid (0.8%), ascorbic acid (200 and 400 ppm), and zinc chloride (200 and 400 ppm). Steeped pods were filled in glass jars and 2000 ppm KMS was added in all the treatments and stored at room temperature. The sangri samples steeped in 3% NaCl, 0.8% acetic acid, 200 ppm zinc chloride, and 2000 ppm KMS were rated best with maximum mean overall acceptability (OAA) score (7.90) after 180 days of storage.

Fig. 15. Steeped green sangri pods 1) control, 2) Ascorbic acid (200 ppm), 3) Ascorbic acid (400 ppm), $ZnCl_2$ (200 ppm), $ZnCl_2$ (400 ppm)

There has been a sharp decrease in pH values after 20 days of storage in all the treatments of preserved sangri samples. The decrease in browning, ascorbic acid, and total phenolic content in sangri samples was reported in all the treatments during 180 days of storage at room temperature. The optimum concentration for maximum desirability in the preservation of sangri consisted of 3.0% sodium chloride, 0.8% acetic acid, and 200 ppm zinc chloride.

Mechanized hot water pretreatment system for green pea depodder machine

The hot water pretreatment unit is designed and fabricated to assist uniform feeding of pea pods irrespective of storage time. The mechanized hot water system consists of stainless steel (16 gauge) water bath of 80-90 liter capacity, heating elements, insulation chamber/tank (SS sheet-22 gauge), endless conveyor belt, Teflon rollers, motor with variable frequency drive (VFD). Two electric heating elements (1 kW) were fitted for heating water (70-85 °C) in a water bath that is covered with an insulation chamber filled with glass wool as insulating material. The drain plug is provided below the hot water bath to remove the water after use. The holding time of pods depends upon the speed of endless belt which is governed by VFD drive. The developed unit will be attached before the feeding section of the earlier developed green pea depodder machine to offer uniform hot water pretreatment and feeding of pea pods.

Litchi seed removing tool

Different types of hand tools and feed cups are developed for the removal of seed from peeled litchi with minimum damage to the pulp before canning. The design is based on the measured physical properties of peeled litchi and seed of different cultivars. The cylindrical-shaped feed cups (outer diameter 50 mm, height 45 mm) are fabricated using food grade silicon roller material. Depending upon the size of litchi, different cylindrical tools (diameter range 9-16 mm) of stainless steel material are fabricated and tested for removal of seed from peeled litchi. The tool helps remove the seed from peeled litchi

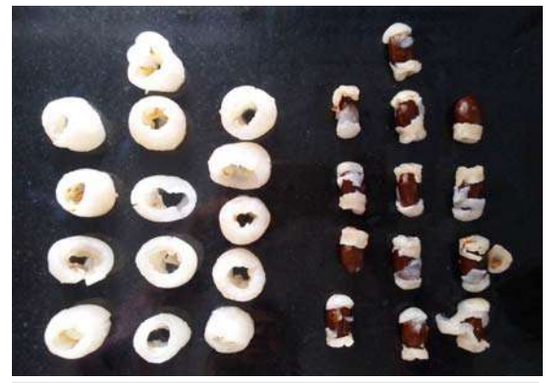


Fig. 16. Litchi pulp and seeds separated using the developed tool

with minimum damage ($\leq$ 6-7%) to the pulp so that it can be used for litchi canning.

Ethylene evaluation vessel

For continuous monitoring and evaluation of ethylene gradients during experimentation, lab-scale setup consisting of an airtight container/gas chamber, control valves, pressure gauge, and gas sensors is designed and fabricated. The chamber consists of a glass container having dimensions 230 x148 mm (length x diameter; inner diameter 122 mm) with a volume of 3888 cc. The adjustable valves/knobs are used for the controlled release of ethylene in the chamber and towards the gas sensor. These valves and pressure gauge are fitted on the closure lid of the container. The chamber is with a vacuum pump at one outlet to expel air and with an arrangement to inject ethylene gas at another inlet/outlet. The latter outlet can be utilized for monitoring and analysis of ethylene gas using

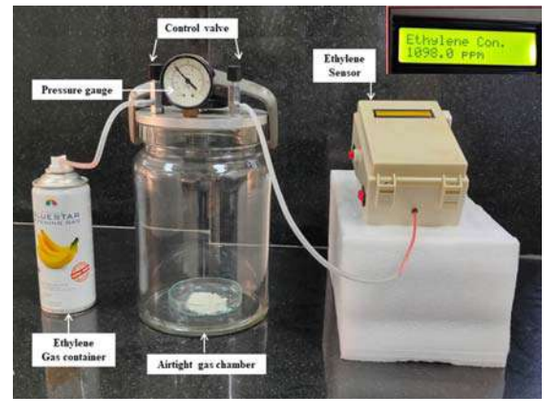


Fig. 17. Designed set-up for evaluation of ethylene gradient using sensors

an ethylene sensor. The ethylene sensor has a sensitivity range of 20-2000 ppm. The complete experimental setup is shown in Fig. 17. Ethylene gas was purchased from Ms. Bluestar Ripening Gas (a professional firm) at 10 kg pressure in a pressure tin container. The gas was injected at various pressure values and evaluated using the ethylene sensor.

Effect of antimicrobial coating on storage of guava fruits

The standardized coating formulation for guava comprised of shellac (10%) with glycerol, gum acacia, casein, and antimicrobial compound (grapefruit essential oil). The formulation was prepared and evaluated using two different coating methods (Foam and Spray) and two levels of package perforation {without (0) and with (4) holes of 1 cm diameter each} in corrugated fiber boxes (CFB). The guava fruits (var. Allahabad safeda) were stored at low temperature (10±1°C) and ambient (22±2°C) storage. Various physicochemical parameters were recorded during cold storage and the results revealed that the physiological loss in weight (PLW) increased with an increase in storage duration. These losses were more or less the same in control as well as treated samples. However, PLW did not cross the threshold limit of 10% in all fruits including control after 20 days of storage irrespective of their method of application and perforation level. Percent decay loss during cold storage with shellac coating has been elaborated in Fig. 18. Control guavas crossed 10% decay loss (15%) at 20th day of cold storage while coated samples comparatively had less decay loss during the same period i.e 10 and 13.3% loss respectively, for with and without perforation (Fig. 18). Although decay loss increased beyond 16 days of storage in all treated and untreated samples; but even then the decay loss was comparatively low in spray-coated

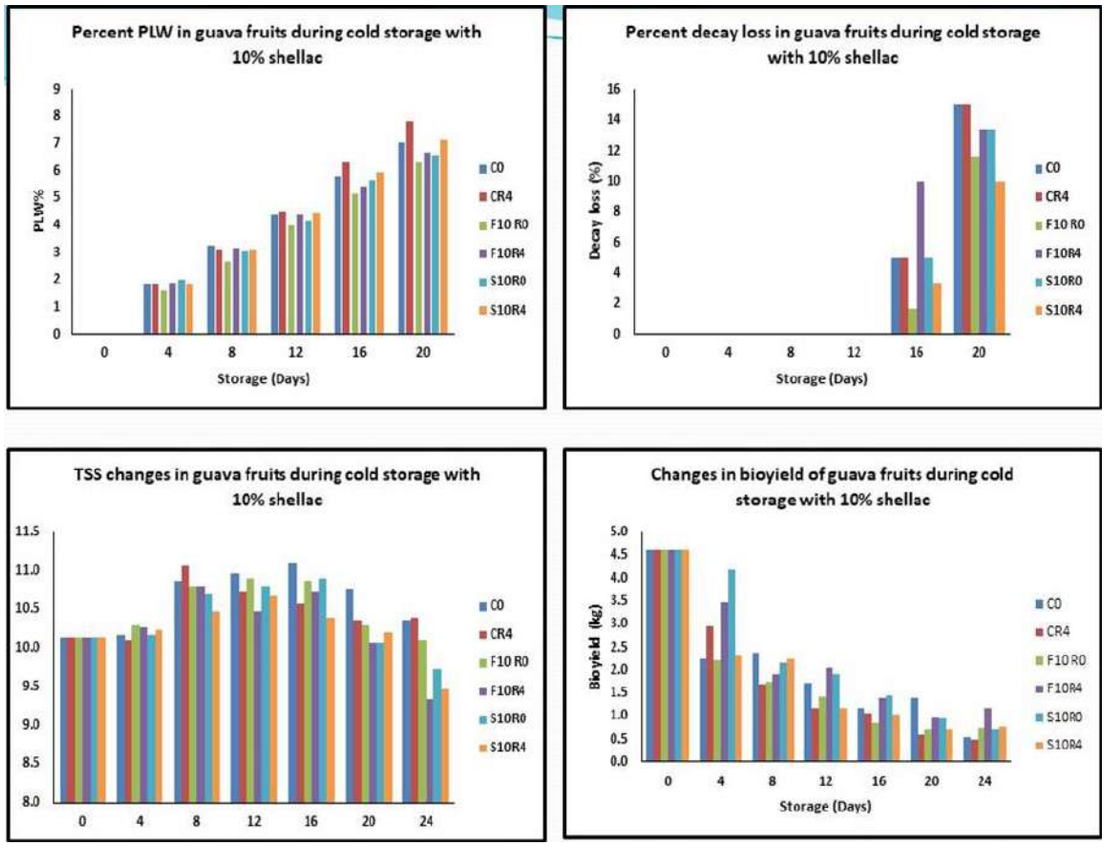


Fig. 18. Physico-chemical profile of guava with various coating combinations and perforation types during cold storage

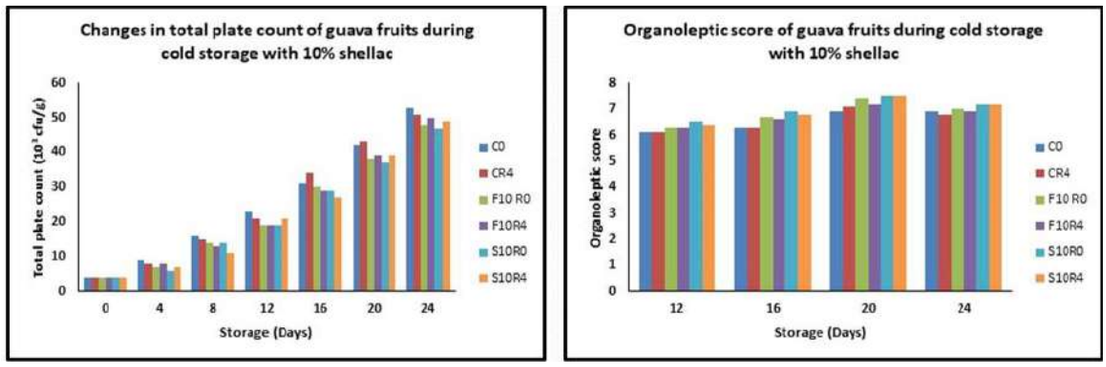


Fig. 19. Microbiological and sensory profile of guava with various coating combinations and perforation types during cold storage

samples as compared to control as well as foam coated samples. Total soluble solids increased slightly followed by a decrease during the storage of guava in perforated and non-perforated boxes (Fig. 18). Textural profiling of treated and untreated guavas indicated that both bio-yield point and flesh firmness decreased with the advent of storage period irrespective of perforation and application methods but the coated fruits were still firmer as compared to control fruits (Fig. 18). Total plate count increased continuously from an initial value of $4x10^3$ cfu/g to a maximum of $53x10^3$ cfu/g and $50x10^3$ cfu/g in control and treated fruit samples, respectively (Fig. 19). However, there is no upper limit for the microbial count for fresh fruits as per FSSAI standards. Control samples had a sensory score of 7.1 up to 20th day. The corresponding values

Fig. 20. Visual appearance of cold-stored guava fruits after 24 days of storage

of foam and spray-coated cold-stored guavas were 7.4 and 7.5 respectively (Fig. 19). Also, there was no development of off-smell in coated guava fruits from inside. Based on the overall biochemical profile, the shelf-life with 10% shellac coated guava fruits was found to be 20 d as against 14-16 d for uncoated guava under low-temperature storage conditions. The fruits were acceptable even up to 24 days of storage, however, they crossed 10% decay loss in coated fruits up to that time at low temperature (10±1°C) storage (Fig. 20).

The physicochemical data of ambient stored guava samples has been elaborated in Fig. 21. There was an increase in percent PLW with the increase in storage period, but it was slightly more in control samples than in shellac coated samples throughout the sampling period. Decay loss crossed 10% value on the 10th day of storage while it crossed 10% value on the 12th day for shellac coated samples (Fig. 21). Decay loss was comparatively lower (12.5%) for spray coated samples when compared to control (22.5-27.5%) and foam coated (20-25%) samples on the 12th day of ambient storage. Total soluble solids increased slightly followed by a decrease during the storage of guava in perforated and non-perforated boxes (Fig. 21). Bio-yield point dropped continuously from an initial value of 4.63 kg and decreased to 0.56, 0.73, and 1.37 kg respectively for control, foam, and spray-coated guavas on the 12th day of ambient storage (Fig. 21). Total plate counts increased during

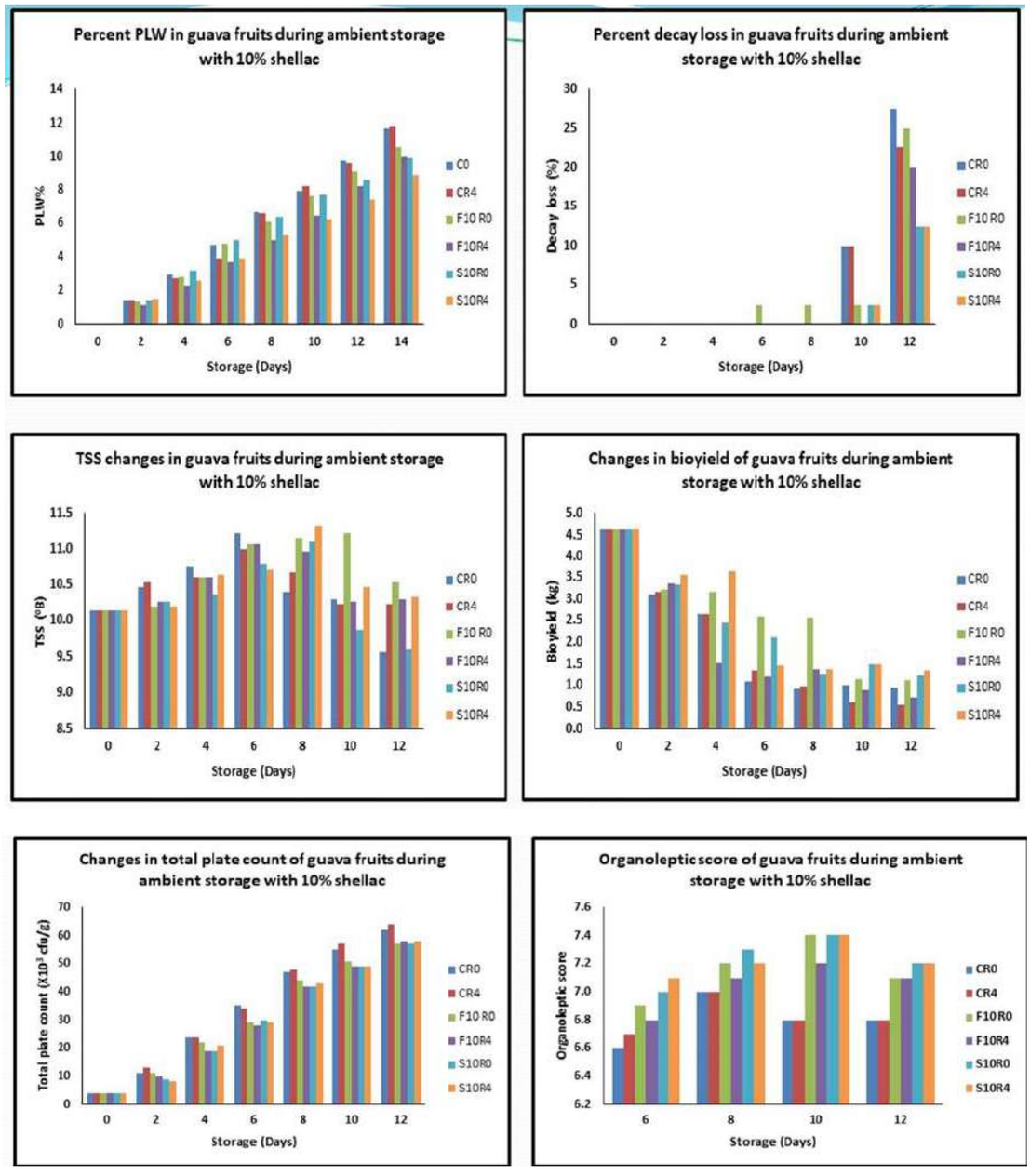


Fig. 21. Microbiological and sensory profile of guava with various coating combinations and perforation types during ambient storage

storage and it was slightly higher for control samples (Fig. 21). The treated guavas were acceptable in taste with a sensory score of 7.2 (spray coated) and 7.1 (foam coated) up to 12th day while the control samples had a sensory score of 6.8 by the same storage period (Fig. 21). Taking into consideration all the physicochemical, sensory, and textural data, the shelf-life of treated guava fruits was found to be 12 days compared to 8 days for control fruits under ambient storage. The visual appearance of ambient stored guava fruits has been depicted in Fig. 22 after 12 days of storage.

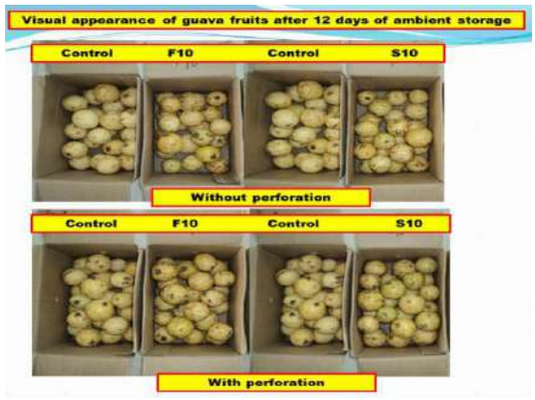


Fig. 22. Visual appearance of ambient stored guava fruits after 12 days of storage

Charcoal production and activation

For ethylene adsorption experimentation, activated charcoal is required for curbing ripening gas as it imparts a large surface area. Even for the potassium permanganate and other metal ions to adsorb/oxidize ethylene gas, activated carbon, zeolites, etc. are required for enhancing surface area of adsorption. For the same, a protocol was adopted for making activated carbon from rice straw, an agro-waste. The straw was washed with hot water, dried, and chopped. A known quantity of chopped and powdered straw was carbonized/pyrolyzed at 400 °C for 4 h in a muffle furnace. The obtained pyrolyzed material was impregnated with activating agents like KOH and cupric chloride. After the impregnation process (24 h), the carbonized material was activated at 800 °C for 4 h in a muffle furnace. Finally, the obtained material was washed with acid followed by water till neutral pH. The activated carbon was dried at 105 °C for 12 h.

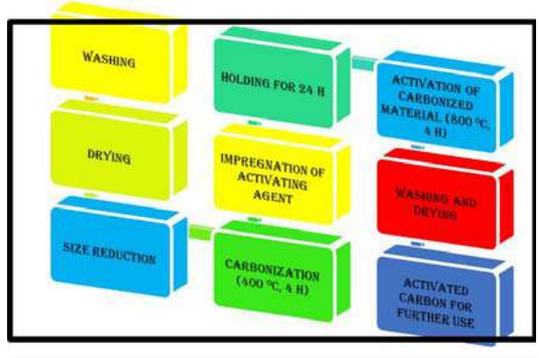


Fig. 23. Flow diagram for charcoal production and activation using activating agents

The entire process has been elaborated as a flow diagram in Fig. 23. The yield of carbonized charcoal from rice straw came out to be 15-17%. When the carbonized charcoal was activated further using activating agents, the yield of activated carbon was approximately 64 and 78% respectively for potassium hydroxide and cupric chloride. The activated carbon with activating agents has been shown in Fig. 24 and will be used for adsorbing ethylene.

Fig. 24. Fig. showing carbonization and activation of charcoal

Physical properties of sangri seeds affected by hydro-thermal and dry-heat treatments

Khejri or Jandi (*Prosopis cineraria*) grow in dry and arid regions of north-western and southern India and the pods of the tree are called '*Sangri*'. The importance and medicinal value of this tree have been highlighted in ancient and modern literature.

Sangri pods and seeds have proven health benefits, however scarce information is available on their engineering properties. Hence, a study was undertaken to evaluate some physical properties of fresh pods, dried pods, raw seeds, and hydro-thermally (hydration at 90 °C) and dry-heat (heating in salt at 150±10 °C) treated sangri seeds. The potentiality of the development of roasted sangri seeds was also evaluated in the study. Results indicated that average peel weight (g), seed weight (g), and the number of seeds of

Fig. 25. Dry sangri seeds (A) Dry-heat treated (roasted) sangri seeds (B)

freshly harvested sangri pods were 0.9, 0.4, and 7.0, respectively whereas for dried pods, values were 0.4, 0.2 and 7.0, respectively. Moisture content (w.b.) of dried seeds was 8.32% whereas that of hydro-thermal treated and dry-heat treated seeds was 49.24 and 12.40%, respectively. Values of length (mm), breadth (mm) and thickness (mm) of dried seeds were 5.88 mm, 5.15 mm and 4.95 mm, respectively whereas that of hydro-thermal and dry-heat treated seeds were determined as 9.49 mm, 6.18 mm and 2.08 mm; and 7.21 mm, 4.64 mm and 3.99 mm, respectively. Results also indicated that the geometric mean diameter of dried seeds was 3.62 mm and it significantly (P=0.05) increased after hydro-thermal (4.94 mm) and dry-heat treatment (5.11 mm). Single seed volume of dried seeds was 28.63 mm^3 and after hydro-thermal and dry-heat treatments, values of this property were determined as 84.12 and 70.16 mm^3, respectively. Increase in volume after hydro-thermal treatment was due to water uptake during hydration of the seeds whereas increase in volume after dry-heat heat treatment was due to heat-induced volumetric expansion of the seeds during thermal treatment. The porosity of dried seeds was calculated as 55.42 % whereas that of hydro-thermal and dry-heat treated seeds were 36.38 and 70.22%, respectively. Densities and frictional properties of sangri seeds were also influenced by hydro-thermal and dry-heat treatments. From observations, it was found that roasted sangri seeds can be developed by employing dry-heat treatment or the combination of hydro-thermal and dry-heat treatments as desired volumetric expansion can be achieved after employing these treatments.

Microbiological safety of bread fortified with black carrot color and black carrot pomace powder

Storage studies on freshly prepared wheat bread fortified with colour and pomace powder extracted from black carrot were performed to assess their microbial safety at ambient conditions. Different breads were examined for the presence of bacteria, i.e. total viable count (on plate count agar), yeast (on yeast extract peptone dextrose agar), fungi (on Potato dextrose agar) and food borne human pathogens such as *Salmonella* sp, *Shigella* sp., (on Deoxycholate citrate agar) and *Salmonella typhi* (on Xylose-Lysine Deoxycholate agar) for 2 days interval during ambient storage (25±2 °C) of 7 days. In all samples, the total viable count ranged from 0 to 90 CFU/g × 10^5 while the yeast population was varied from 27 to 247 CFU/g × 10^4. The population count of fungi and all foodborne pathogens were observed as nil (0 CFU/g at 10^4 dilutions). According to the International Commission on Microbiological Specifications for Foods (ICMSF) guidelines, microbial safety and quality of bread samples were satisfactory.

Microbiological safety of black carrots anthocyanin infused potato chips

Potato chips infused with anthocyanin extracted from black carrots were evaluated for microbial safety and quality during 06 months of storage at ambient conditions (25±2 °C). The samples were examined for total viable count, yeast, fungi,

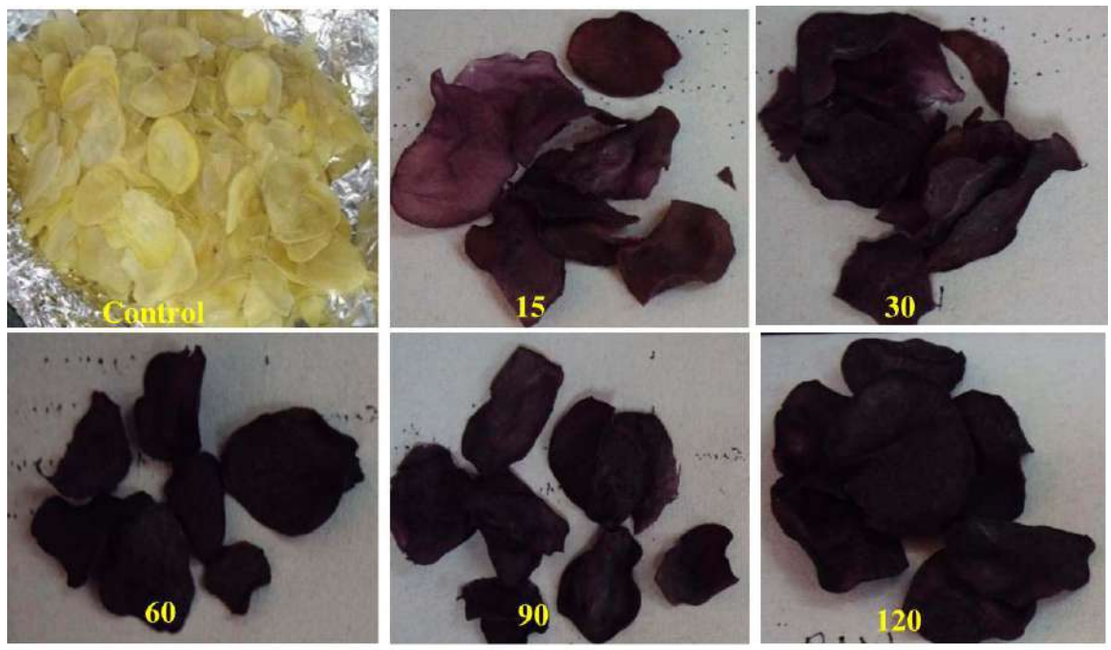


Fig. 26. Black carrot infused dried potato chips

and other foodborne pathogens viz., *Salmonella* sp, *Shigella* sp. and *S. typhi*. The population was enumerated at an interval of 30 days. Observation on total viable and yeast count revealed that their population increased steadily up to 90 days. The fungal population was negligible during the initial period of storage while it was completely absent from 4th months onwards. The population counts for all food borne pathogens were observed as nil (0 CFU/g at 104 dilutions). Microbial safety and quality in all treatments were satisfactory for both general count and pathogens count as per the guidelines and criteria of ICMSF.

Testing of IoT-based smart storage structure for pulses during testing in lab-scale bin

A fumigation protocol was developed for the fumigation of Green gram with carbon dioxide. Subsequently, a control and monitoring system for the fumigation is developed for effective disinfection of green gram. It includes three sensor modules (Fig. 27), Control panel, Control Valves, Carbon dioxide cylinder, and distribution system. Each Sensor modules have a Carbon dioxide sensor, temperature & rH sensor, and a display unit, and one among the three modules has an oxygen sensor also. These sensor modules are supposed to be spaced at three depths of one-tonne storage bin for monitoring and measurement of different parameters. The supply of CO_2 is regulated by a control panel which consists of a Controller Card, SMPS, Solid State Relay, Solenoid valve, and HMI LED display.

The data logging is performed by a Wi-Fi-connected data-logger that transmits data to a cloud that can be accessed and controlled from any remote location by either a PC or Smart Phone device.

Testing of the said system was done using two sensor modules placed in a lab-scale Storage bin, filled with 20 kg Green gram. The sensor modules were placed inside the bin and the opening top lid was sealed. The carbon dioxide was injected from the bottom of the bin using a 6 mm duct. All the push-in connectors were closed using plugs. The data logger was connected to wifi. The carbon dioxide concentration was set as 60 percent in the developed programme from HMI. The system was observed to maintain the concentration in the range of ±2%.

Fig. 27. Components of IoT-based Smart Storage Structure for Pulses during testing in lab-scale bin

Effect of plastic and organic mulching on soil microorganisms during tomato cultivation

The population of important soil microbes involved in the plant growth promotion via soil nutrient supply was assessed at initial, mid-crop, and post-harvest stages of tomato with different mulch applications. Though, in general, an increase in the population of these important microorganisms was noticed under silver, black and yellow mulch at the mid/vegetative crop growth. The population of phosphorous solubilizing microorganism was found highest (176.5±24.54 CFU gm^{-1} at 10^{-6} dilution), while lowest was in no mulch (45.5±0.87 CFU gm^{-1} at 10^{-6} dilution, followed by organic mulch treatment in black mulch treatment (Table 1) The increased microbial population and metabolic activities was probably due to positive modification of soil microclimate and ecosystem

Table 1: Influence of different plastic and organic mulches on the population of agriculturally important soil microorganisms observed at harvest stage of tomato

Mulches type	Important soil microbes associated with soil nutrient mineralization and its uptake by the plant				
	Pseudomonas (CFU$gm^{-1}\times10^{-6}$)	P-Solubilizers (CFU$gm^{-1}\times10^{-6}$)	K-Solubilizers (CFU $gm^{-1}\times10^{-5}$)	Iron bacteria (CFU$gm^{-1}\times10^{-4}$)	Sulfur bacteria (CFU $gm^{-1}\times10^{-4}$)
No	54.5± 5.48	45.5±0.87	177.5±3.75	44±0.58	363.5±4.33
Organic	60± 1.15	46±1.15	241±4.04	41±1.15	297±8.08
Black	56.5±10.10	176.5± 24.54	120±39.84	46.5±0.87	343.5±2.60
Silver	64±23.09	80±3.46	259±22.52	34±0.58	307±9.24
Red	99±6.93	51.5±11.26	243.5±12.99	25.5±0.87	293.5±4.91
White	33± 0.58	79±14.43	147.5±3.75	22±1.73	299±8.08
Yellow	105± 21.36	87±6.35	191±1.73	29.5±0.87	379±5.20

under mulch. A slight decrease in these microbial populations was observed at the time of crop harvesting.

Effects of plastic and organic mulches on soil microbial biomass at crop harvest stage of tomato

The effect of different mulches (organic, silver, black, red, white, yellow, and no mulch) on the soil microbial biomass at the crop rhizosphere during the time of harvest of tomato were analyzed. Soil microbial biomass (SMB) generally measures the mass of the living component (bacteria and fungi) of soil organic matter (SOM). SMB decomposes plant/animal residues and other organic portion of soil and releases nutrients that are further made available for the uptake and growth of plants. At the crop harvest stage, the highest SMB of 237.17 ug/gram of fresh soil was observed in the black mulched soil while it was lowest (34.07 ug/gram of fresh soil) in no mulch applied control (Fig. 28).

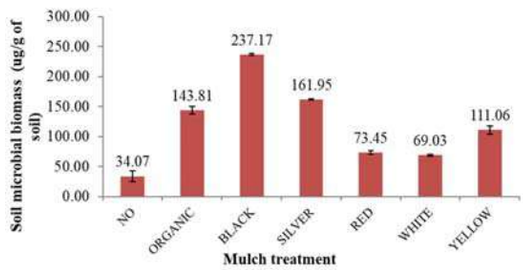


Fig. 28. Influence of different plastic and organic mulches on soil microbial biomass observed at harvest stage of tomato

Impact of plastic and organic mulching on the fruit size and fruit yield of tomato

The application of different plastic colored mulches had considerably increased the size of tomato fruit and overall quality. In general, all dimensions (length, height, and breadth in mm) were found to be highest in the silver mulch treatment. In case of crop yield, under both open field and polyhouse conditions, the application of different colored plastic mulches increased crop yield significantly as compared no mulch (control), almost 90% increase in crop yield under yellow mulched crop as compared to no mulch was observed under open field conditions. Similarly, as compared to no mulch (control), an almost 43% increase in crop yield under yellow mulched crop was observed under polyhouse conditions.

Impact of plastic and organic mulching on nutrient status of tomato leaves/fruits

The nutrient status of plant leaves and tomato fruits were measured with inductively coupled plasma-optical emission spectrometry (ICP-OES) at the citrus estate (Hort. Depart.) Punjab Govt. Abohar. Concentrations of nutrients were recorded in g/kg (for macronutrient) and mg/kg (for micronutrients). Mulching had a variable response on the nutrient content of both leaves and fruits and even though, most of the nutrient status was improved under different plastic and organic mulch as compared to no mulch conditions.

Hot air dryer for maize cob

A hot air drying system for maize cobs is designed and developed at ICAR-CIPHET, Ludhiana (Fig. 29). The capacity of the dryer is 150 kg

Fig. 29. Hot air dryer for maize cobs

per batch. It consists of mainly three parts viz., heating unit, drying bin, and control unit. The overall dimensions (L×W×H) of the developed dryer is 1.815×0.912×2.800 m whereas, the drying bin is a circular shape with dimensions (H×D) of 0.990 × 0.834 m. The heating unit length, width, and height are 0.827, 0.750, and 2.800, respectively. The airflow rate, blower, RPM, and temperature of the heating unit are electronically controlled by a control panel. The insulation has been provided over the heating unit and the drying bin to reduce the heat losses of the dryer. The loading and unloading of maize cobs are manual.

A novel process for the production of protein isolates from de-oiled cakes

Alkaline extraction followed by acid precipitation or ultrafiltration method for preparation of protein isolates from oilseeds cakes/meals is followed. The strong alkaline and acidic conditions alter the functional properties of the protein, which adversely affects its quality. A novel process to produce protein isolates/ concentrates from oilseed cakes/meals or from other similar type of sources either plant or animal origin without the addition of strong or diluted acid is developed. The protein is extracted in aqueous media or alkaline aqueous media with or without containing specified salt for specified duration, centrifuged, and precipitated. The precipitated protein is recovered by centrifugation and dried (with a suitable method for example spray dryer) to get protein isolates/ concentrates. The process is convertible to a purely chemical-free process as the extraction of protein in potable water (pH 7.0), precipitation followed by drying using a

Fig. 30. (a) Groundnut cake (b) Soy meal

Soy protein isolated through novel method

Groundnut protein isolated through novel method

suitable method. The yield so obtained is about 35% of the total weight of soymeal used and 25% of the total weight of groundnut cake used and is about 5% higher than acid precipitation method. Thus produced protein isolate contains 91.5% (dwb) protein. The functional properties like solubility in water, dispersibility, wettability, and degree of hydrolysis are higher as compared to protein isolate produced following acid (HCL) precipitation method.

Rapid quality monitoring system for wheat and its primary milled products

Losses during storage of wheat and its primary milled products are mainly due to attack by storage insect-pests, loss of moisture in grain, fungus infestation, rodent attack, and spillage. Consumption of cereals and legumes by pests such as insects during storage and microbial spoilage or contamination makes them inedible. It warrants for a quality evaluation for making decisions at the time of procurement, in case wheat or its processed products are to be stored for a longer time period. The defence forces procure rations and store them in varied environmental conditions; making the losses during storage in greater amounts; if before purchase the wheat quality is inferior, which further results in rapid storage losses. The project objective in our study envisages the techniques of FT-NIR spectroscopy as a rapid analysis method for qualitative and quantitative measurements of wheat quality during storage.

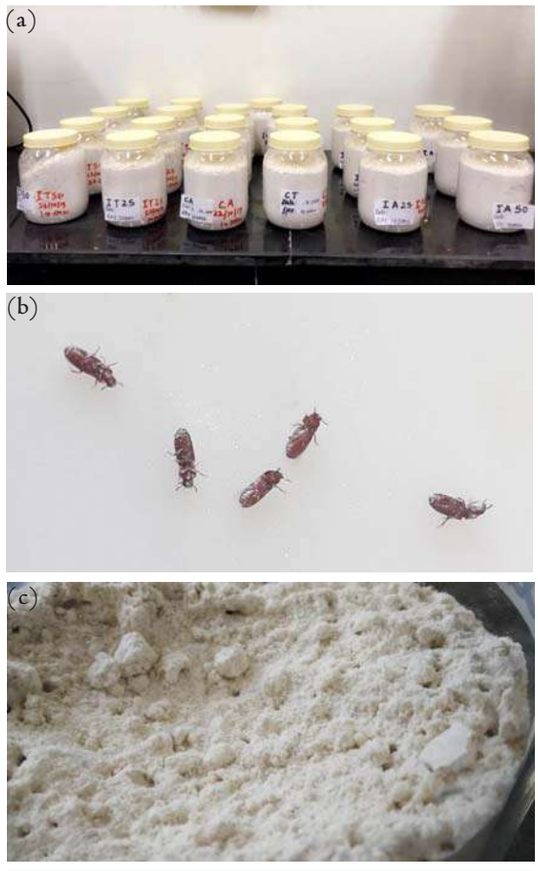


Fig. 31. a) Wheat flour samples at the time of insect (Red Flour Beetle) infestation; b) Red Flour Beetle for infestation; c) Infested sample with insects at larval stage on 15th-day interval

Wheat (PB-343) variety was procured from the Punjab Agricultural University, Ludhiana, and was milled into flour at the Agro Processing Centre of the Institute facility for further use in experiments of storage studies. Wheat flour samples were infested with Red Flour Beetle (*Tribolium castaneum*) and stored in plastic containers for up to 90 days under ambient and controlled temperature conditions (Fig. 31). The wheat flour was divided into five lots and kept in PET containers. Two samples were kept as control at ambient and controlled temperature of 37°±0.5 °C and remaining four samples were infested with two different numbers of insects (5 and 10 per 100g of wheat flour) of Red flour beetle and kept at ambient and controlled temperature conditions. The openings of the containers were covered with a muslin cloth for ensuring air supply to the insects for rearing. Stored samples of wheat flour at every 10 days of the interval were evaluated for selected quality parameters namely moisture content, protein content, gluten content, fat acidity, peroxide value, ash content, thermal conductivity, pH, and total solids. The liquid extracts of all samples were prepared following the process of aqueous dilution, solvents dilution, centrifugation, filtration, and acquiring the NIR spectra of the liquid samples for qualitative changes during storage. The changes in the moisture content, gluten content during 70 days of storage are presented in Table 2. The protein content values decreased and the peroxide value and fat acidity showed an increase (Table 3) during storage of

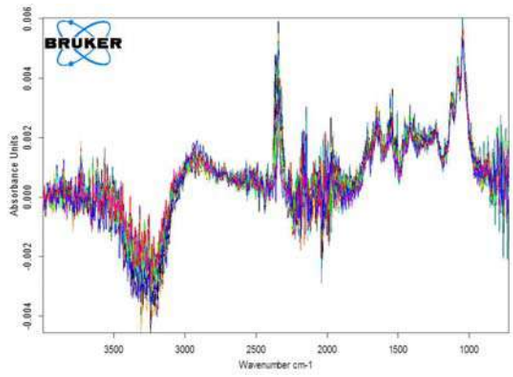


Fig. 32. NIR spectra of liquid supernatant from wheat flour fresh sample in the wavenumber range of 4000-725cm-I (obtained from OPUS software version 7.2)

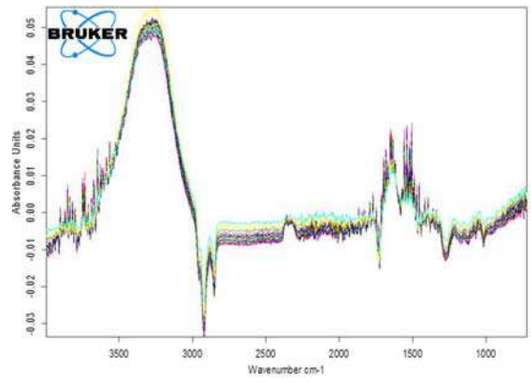


Fig. 33. NIR spectra of liquid supernatant from wheat flour 70 days stored sample the wavenumber range of 4000-725cm^{-1} (obtained from OPUS software version 7.2)

Table 2: Changes in moisture and gluten content of wheat flour during storage period of 70 days

Parameter	Moisture (%)			Gluten content (% dry basis)		
Sample	0 days	30 days	70 days	0 days	30 days	70 days
Control	9.54±0.17*	9.51±0.14	9.11±0.11	8.91±0.13	8.86±0.17	8.23±0.16
CA	9.54	9.50±0.11	9.16±0.12	8.91	8.56±0.12	8.21±0.14
CT	9.54	9.09±0.12	9.09±0.14	8.91	8.21±0.11	8.14±0.11
IA25	9.54	9.81±0.15	9.01±0.13	8.91	8.61±0.14	8.04±0.11
IA50	9.54	9.33±0.11	8.94±0.15	8.91	8.52±0.17	8.01±0.12
IT25	9.54	9.76±0.12	8.97±0.15	8.91	8.21±0.14	8.12±0.13
IT50	9.54	9.06±0.14	8.86±0.14	8.91	8.03±0.11	8.06±0.14

Mean values of stored samples (50 No.) with Standard Deviation
CA= Control Ambient, CT= Control at 37°C
IA25= Infested sample with 25 insects in 500g sample at ambient temperature
IA50=Infested sample with 25 insects in 500g sample at ambient temperature
IT25= Infested sample with 25 insects in 500g sample at 37°C temperature
IT50= Infested sample with 50 insects in 500g sample at 37°C temperature

Table 3: Changes in peroxide value and fat acidity of wheat flour during storage period of 60 days

	Fat Acidity value (mg NaOH/ 100g)			Peroxide Value (Meq O_2 /kg)		
Sample	0 days	30 days	60 days	0 days	30 days	60 days
Control	0.12	37.56	61.43	0	0.02	0.11
CA	0.12	26.75	58.28	0	0.02	0.10
CT	0.12	43.61	89.12	0	0.03	0.08
IA25	0.12	51.27	77.14	0	0.04	0.05
IA50	0.12	48.16	69.37	0	0.04	0.06
IT25	0.12	47.14	77.25	0	0.05	0.09
IT50	0.12	38.07	63.94	0	0.05	0.08

Mean values of stored samples (50 No.) with Standard Deviation
CA= Control Ambient, CT= Control at 37°C
IA25= Infested sample with 25 insects in 500g sample at ambient temperature
IA50=Infested sample with 25 insects in 500g sample at ambient temperature
IT25= Infested sample with 25 insects in 500g sample at 37°C temperature
IT50= Infested sample with 50 insects in 500g sample at 37°C temperature

60 days. NIR based spectral data collection and evaluation is in progress (Fig. 32 and 33). The results of six months of storage data will be used for spectral modelling and correlating it with the physical /chemical parameter.

Process for detection of metanil yellow in chickpea flour (besan)

Chickpea seeds (PBG-7 variety) procured from PAU Ludhiana were dehulled and dal was prepared using dal mill. This dal was used to prepare fresh chickpea flour (*besan*). Samples of *besan* were spiked with Metanil yellow dye. Pure metanil yellow, pure *besan,* and spiked samples were scanned using FTIR in the range of 400-4000cm^{-1} (Fig. 34).

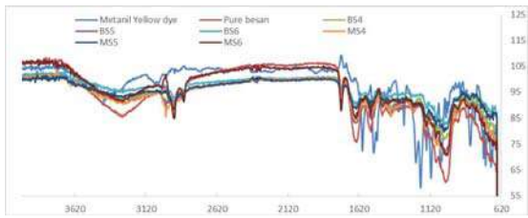


Fig. 34. FTIR spectra of pure besan, pure metanil yellow dye and besan samples spiked with metanil yellow dye

Method for detection of rhodamine B dye in chilli powder using fluorescent spectroscopy

Fluorescent spectroscopy-based method for detection of Rhodamine B dye in chilli powder was standardized. The dye showed excitation and emission spectra at wavelength of 556 nm and 577 nm, respectively. Scan of pure chilli and spiked samples of chilli with rhodamine B dye was performed in the range of 550-700nm. Pure chilli did not give any peak in this range. The standard curve of RhB was prepared in the range from 0.4 – 2.4µg/ml concentration. Similarly, various amounts of RhB standard solutions were spiked into the blank extract to prepare a series of working solution coexisting with the chilli matrix (Fig. 35). Under experimental conditions, the limit of detection and limit of quantification for pure dye and dye in chilli matrix was 0.19µg/ml and 0.63µg/ml and 0.42µg/ml and 1.47µg/ml, respectively. Rhodamines B dye in spiked chilli samples could be recovered with a limit of 92.5%.

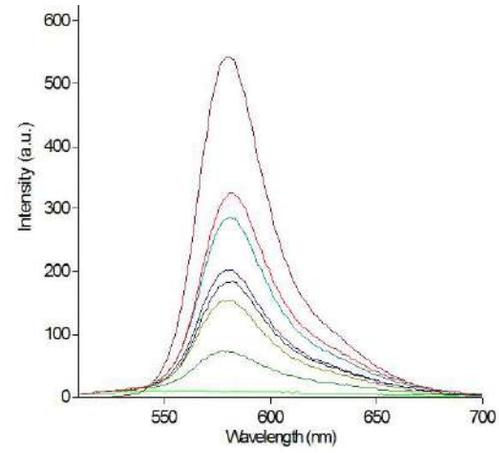


Fig. 35. Fluorescence emission spectra of chilli powder spiked with different concentration of Rhodamine B dye

Effect of particle size on different properties of chickpea flour

Chickpea flour was prepared using PBG-7 variety. Flour samples of different particle sizes (300-250, 250-212, 212-180, 180-150, 150-106, 106-63 µm) were prepared by sieving chickpea flour through 52, 60, 72, 85,100 and 150 BSS mesh sieves. Physicochemical, functional, and rheological properties showed significant ($p < 0.05$) differences among different samples. Proximate composition revealed that a reduction in particle size caused a significant increase in protein, fat, and ash content and a decrease in the carbohydrate content. Particle size analysis showed that all flour samples except the flour with the particle size of 300-250 µm showed bimodal particle size distribution (Fig. 36). Different functional properties viz. flowability, water absorption capacity, oil absorption capacity, and foaming stability decreased while the least gelation concentration, foaming capacity, and color values were increased with a reduction in particle size of the flour. Pasting properties were significantly ($p< 0.05$) affected and flour samples with particle size of 150-106 and 106-63µm showed decreased stability ratio of starch and higher value for setback ratio (Table 4). Rheological

Table 4: Effect of particle size on pasting properties of chickpea flour

Flour particle size	Pasting temperature (°C)	Peak viscosity (cP)	Breakdown Viscosity (cP)	Final Viscosity (cP)	Setback Viscosity (cP)	Stability ratio (SR)	Setback ratio (SBR)
300-250µm	82.9±1.2^{bc}	707±43^{cd}	41±1.4^{a}	823±44^{c}	157±0.0^{b}	0.94±0.01^{a}	1.24±0.02^{b}
250-212 µm	81.6±0.5^{bc}	868±41^{abc}	41±8.4^{a}	1005±29^{bc}	177±20^{b}	0.95±0.01^{a}	1.22±0.03^{b}
212-180 µm	81.2±0.4^{c}	993±28^{a}	38±7.1^{a}	1133±40^{a}	177±19^{b}	0.96±0.01^{a}	1.18±0.02^{b}
180-150 µm	81.6±0.6^{bc}	925±22^{a}	38.5±2.^{a}	1048±35^{b}	161±14^{b}	0.95±0.00^{a}	1.18±0.01^{b}
150-106 µm	85±0.6^{a}	607±40^{d}	37.5±3.5^{a}	808±41^{c}	238±4.9^{a}	0.93±0.00^{b}	1.41±0.02^{a}
106-75 µm	84.5±1.1^{ab}	712±90^{c}	61.5±9.1^{a}	917±66^{bc}	266±1.4^{a}	0.91±0.00^{c}	1.41±0.06^{a}

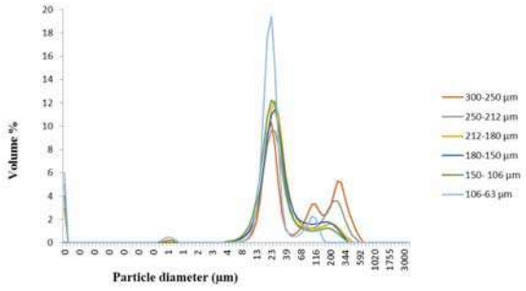


Fig. 36. Particle size distribution patterns of chickpea flour samples of different particle sizes

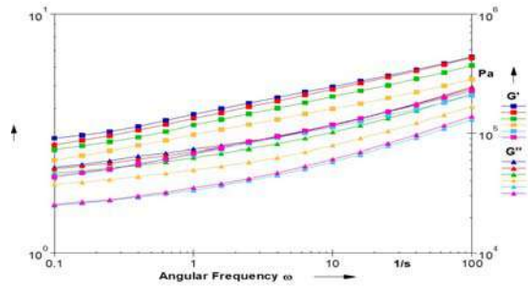


Fig. 37. Frequency sweep for chickpea flour samples of different sizes as a function of storage (G') and loss (G") modulus

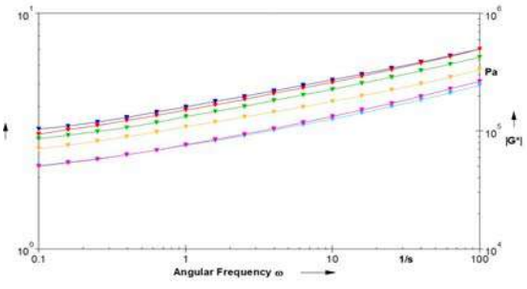


Fig. 38. Frequency sweep for chickpea flour samples of different sizes as a function of G*

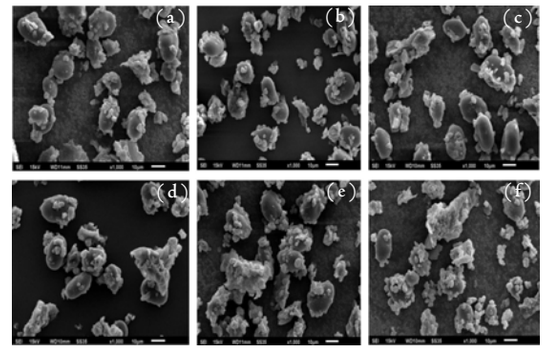


Fig. 39. Scanning electron micrographs at (1000x) magnification for chickpea flour samples of different sizes (a) 300-250 µm (b) 250-212 µm (c) 212-180 µm (d) 180-150 µm (e) 150-106 µm (f) 106-63 µm

studies revealed that dough prepared from flour sample with 300-250 µm particle showed highest values for elastic modulus (G'), loss modulus (G"), and strength (G*) are shown in Fig. 37 & 38. SEM studies revealed as the particle size of chickpea flour samples decreased, oval shaped starch particles seen in coarse powder became rounded and smaller in size (Fig.32).

Microwave-assisted disinfestation of rice and wheat

The use of Microwave radiations for the disinfestation of food grains is having great potential to solve problems of grain storage and export. In industries, also microwave is being used for food processing and preservation. Microwave radiations were reported lethal to insects. This can be used as a pre-treatment before packaging and storage, to avoid the initial inoculum of insects. Keeping n view above facts, Industrial Microwave Research Centre, Pradeep Metals

Ltd., R-205, MIDC, Rabale, Navi Mumbai – 400701, India sponsored a project for optimization of the process for disinfestation of rice and wheat using microwave energy.

Samples (2.0 cm layer) of non-basmati rice and basmati rice were treated in a domestic microwave oven (900W) with 04 moisture levels viz., Control ~11% (no moisture addition), 12, 13 and 14%. The artificial infestation was done with adult insects like flat grain beetle (25 no's), rice weevils (10 no's), and flour beetles (10 no's). Samples were exposed at six different exposure periods like 10, 15, 20, 25, 30 and 40 seconds Mortality rates were significant at treatments of 30 and 40 seconds after 24 h of exposure and storage. It was found that the samples treated with an additional 1-2% of moisture as surface sprinkling before treatment recorded significant mortality. No significant deterioration of quality was observed in the grains tested after treatment in the above-said exposure range till 6 months of storage.

Similarly, samples of wheat (2.0 cm layer) were treated in a domestic microwave oven (900W) with 05 moisture levels viz., Control ~9.50% (no moisture addition), 11, 12, 13, and 14%. The artificial infestation was done with adult insects like khapra beetle (10 no's), lesser grain borer (10 no's), and flour beetles (15 no's). Samples were exposed at seven different exposure periods like 20, 30, 40, 50, 60, 70, and 80 seconds. Mortality rates were varied significantly across different exposure periods. Complete mortality was observed at higher exposure periods. The mortality of added insects was 100% after treatment of 60 s at 9.5% moisture, however, it can be achieved in 50 s at 11% moisture and in 40 s at 13% moisture. The exposure time for 100% mortality is slightly higher in wheat than rice, this may be owing to grain physical properties as well as heat resistance of insects. Also, after treatment quality of grains was not deteriorated until 70 seconds of exposure. Increase of moisture level > 13% found non-significant as the mortality rate found almost a similar trend as 13% moisture. Surface addition of moisture to 12 and 13 % achieved complete mortality of added insects within 24 h with a minimum of 40 seconds of exposure. After treatment grain quality was not affected significantly during storage of 05 months. Hence, for wheat minimum of 12% moisture found preferable with 40 seconds of exposure to microwave radiations for achieving complete mortality of insects.

Table 5: Effective treatment to achieve 100% mortality without significantly affecting grain quality

Grain type	Effective treatment range
Basmati rice	30-40 s
Non-basmati rice	30-40 s
Wheat	50-60 s

Note: Duration of treatment depends upon Grain layer thickness, grain moisture content, microwave power used etc.

Fig. 40. (a) Dead insects after microwave treatment of rice (b) ICAR-CIPHET Scientist and IMRC staff during experimentation at IMRC, Mumbai

Development of continuous primary processing and shrink packaging line for cauliflower and cabbage

A package forming, sealing and wrapping system was designed and developed. The problems in plastic sheet folding were an unparalleled movement of both ends resulting in improper sealing, fall of sheet from top sealer mechanism; improper flow of top sealed package on the conveyor. Therefore, 10 different kinds of plastic sheet folding systems were evaluated and only one system worked well. The developed package folding system consists of two SS sheets made in a specific configuration (based on trial and error). The one end is in the line of plastic sheet, whereas the other end is in the line of top sealer. Shape and the length of different sections of the folder played a crucial role. Top sealer temperature was optimized and the operating temperature was 120°C for proper sealing and avoids melting of plastic when the machine stops for side sealing and cutting.

To develop topside sealing system, 3 mechanisms namely cam operated sealing, counter weight-based sealing, and pneumatically operated sealing systems were evaluated. The counterweight type system was working well and most economical. However, the synchronization was not achieved. In side sealing system, both conveyors have to stop for 5 seconds, the sealer has to come down, seal and cut within 3 seconds, and then the sealer has to move up, and then both conveyors have to start moving again. Therefore the pneumatic system was finally adopted. The system is fitted and worked successfully. The sealing system is based on solid dry heating, sealing for small time, and cutting. Automation of the package forming, sealing and floret detection system was done. A view of the cauliflower packaging machine is given below:

Fig. 41. Cauliflower packaging machine

Bio-efficacy of mustard-based formulations against insects

Mustard based eco-friendly formulations (EC & SC) were found effective in controlling sucking pests in cotton (thrips-77 to 85%; leafhoppers-64 to 84%; whitefly-38 to 55% if used as sole; 91, 93 and 65% respectively, if used mixture), and pomegranate thrips [on and around 90% (NS)]. The formulations found compatible with one other and synergistic effect was observed in insect population control. These water-soluble formulations were not clogged with the nozzle. Formulation mix formed precipitation in the initial but later was miscible in water.

Co-encapsulation of probiotic with different prebiotics using alginate matrix

The potential probiotic strain *Lactobacillus rhamnosus GG* (ATCC-53103) was co-encapsulated with complementary prebiotics viz. inulin and fructooligosaccharide (FOS) by air atomization technique with an in-house developed autoclavable encapsulator. Two different prebiotics (1.5%) selected by agar plate and *in vitro* fermentation assay were separately encapsulated with probiotic strain. Results indicated that encapsulated probiotic bacteria showed encapsulation efficiency of 93.87%, 94.90%, and 94.30%, respectively, for alginate, alginate & inulin and alginate & FOS hybrid microcapsules. The co-encapsulated microcapsules were tested for the efficiency in improving the viability compared to free non-encapsulated bacteria during storage and under *in vitro* simulated gastric-intestinal conditions. The percent survival rate of probiotic bacteria in inulin hybrid MCs (90.10%) was highest followed by alginate-FOS hybrid MCs (88.41%) and was minimum in alginate MCs without prebiotic (84.87%) during 4 weeks storage at 4 °C. Significant improvement ($P < 0.05$) in the survival of co-encapsulated cells was found when exposed to simulated small intestinal fluid (4h) after sequential incubation in simulated gastric fluid (2h). The mean size of 10 randomly selected different hybrid microcapsules such as alginate, inulin-alginate, and FOS-alginate was found to be 505.2 µm, 502.4 µm, and 496 µm respectively. SEM analysis of alginate microcapsule without bacteria presented a relatively smooth surface as compared to the rough surface of the alginate-prebiotic hybrid microcapsule where the probiotic bacteria were densely loaded in alginate matrix. FTIR analysis revealed the existence of an interaction between two polymers. The characteristic fingerprint peaks of both alginate and prebiotics such as FOS and inulin can be identified from spectra bands of hybrid alginate prebiotic microcapsules. Shift of spectra to lower wave numbers indicated the interaction of OH group of prebiotic oligosaccharides with carboxyl group of the alginate.

Table 6: Specific growth rate, mean doubling time and acidification rate

S.No.	Prebiotics + Probiotics	Agar Plate assay	Specific growth rate $\mu(h^{-1})$	Mean doubling time T_d (h: min)	Acidification Profile (pH)
1	Inulin+ LGG	+	0.28^{b}	2h 48min	4.8^{b}
2	FOS+ LGG	+	0.32^{b}	2h19min	4.5^{b}
3	Positive control + LGG	+	0.52^{a}	1h 34min	3.5^{c}
4	Negative control + LGG	-	0.11^{c}	6h 30min	6.4^{a}
	CD (5%)		0.069		0.45

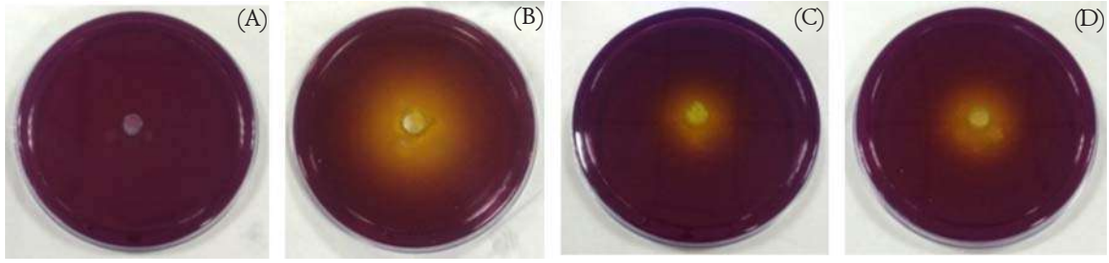


Fig. 42. Agar plate assay depicting the growth of probiotic strain in different prebiotics. (A) Negative control without prebiotics; (B) Positive control; (C) Inulin; (D) FOS

* Initial pH of the medium - 6.5) (+) Clear color change of the agar medium (purple to yellow); (-), no color change of the medium. Results are expressed as mean of triplicate values. Different superscript letter indicates statistically significant ($p<.05$) differences in a column

Table 7: Microencapsulation efficiency of probiotic bacteria and its viability on storage

S.No.	Hybrid Microcapsules (MCs)	Initial cell load	After release (Log CFU g^{-1})	Encapsulation efficiency (%)
1	Alginate MCs	9.78	9.18	93.87
2	Alginate + Inulin hybrid MCs	9.60	9.11	94.90
3	Alginate + FOS hybrid MCs	9.84	9.28	94.30
4	CD (5%)			NS

*NS -Non significant

Table 8: Survival rate of probiotic bacteria during 4 weeks of storage at 4°C

S.No.	Hybrid Microcapsules (MCs)	Survival Rate (%)					
		I^{st} day	7^{th} day	14^{th} day	21^{st} day	28^{th}day	CD (5%)
1	Free non-encapsulated bacteria	97.98^{a}	90.91^{b}	86.86^{c}	79.82^{d}	73.73^{e}	1.72
2	Alginate MCs	93.87^{a}	93.35^{ab}	91.03^{c}	86.70^{d}	84.87^{e}	1.82
3	Alginate + Inulin hybrid MCs	94.90^{a}	94.38^{ab}	92.74^{c}	91.04^{d}	90.10^{d}	1.38
4	Alginate + FOS hybrid MCs	94.30^{a}	93.10^{ab}	91.68^{bc}	90.85^{cd}	88.41^{e}	1.76

Results are expressed as the mean of triplicate values. The different superscript letter indicates statistically significant ($p<0.05$) differences in a row.

Table 9: Survival rate of free and encapsulated probiotic strain *Lactobacillus rhamnosus* GG in simulated small intestinal fluid (4h) after sequential incubation in simulated gastric fluid (2h)

S.No.	Hybrid Microcapsules (MCs)	Before passage (Log CFU g^{-1})	After passage (6h) (Log CFU g^{-1})	Survival rate (%)
1	Free non-encapsulated bacteria	9.85	6.30	^{d}63.96%
2	Alginate MCs	9.20	6.95	^{c}75.54%
3	Alginate + Inulin hybrid MCs	9.18	8.04	^{a}87.58%
4	Alginate + FOS hybrid MCs	9.15	7.30	^{b}79.78%
5	CD (5%)			1.67

Results are expressed as mean of triplicate values. Different superscript letter indicates statistically significant ($p<0.05$) differences in a column.

Size and shape analysis

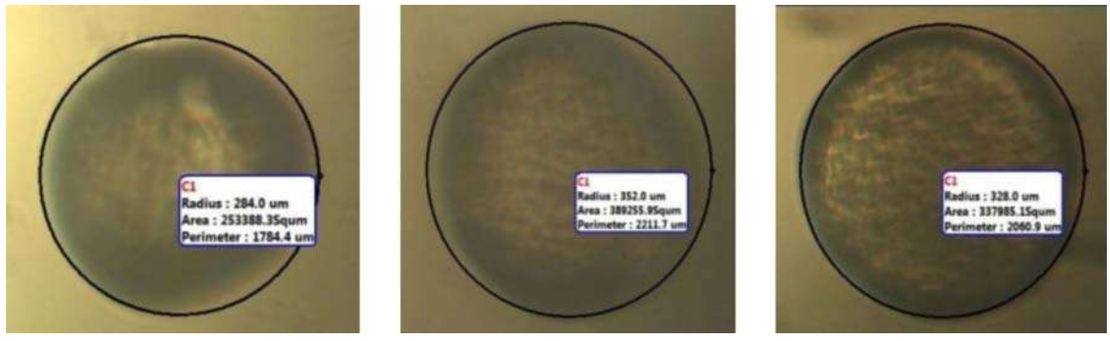
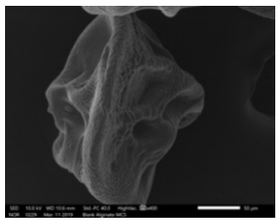
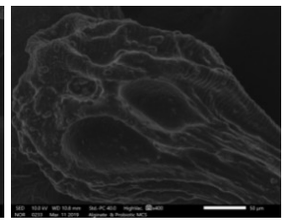


Fig. 43. (A). Alginate Probiotic MCs; (B). Alginate Inulin Hybrid MCs; (C). Alginate FOS Hybrid MCs

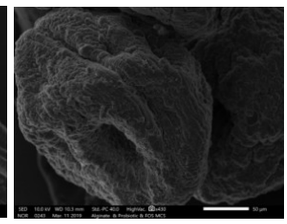
Morphological analysis by scanning electron microscopy



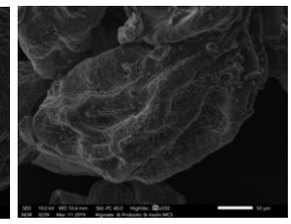
35(A). Blank Alginate Microcapsule



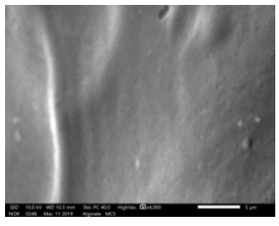
35(B). Blank Probiotic Microcapsule



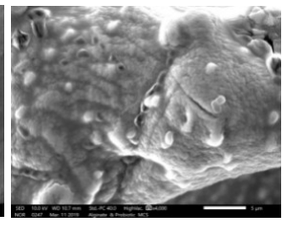
35(C). Blank FOS hybrid Microcapsule



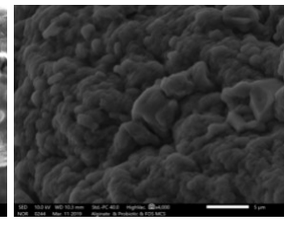
35(D). Blank Inulin hybrid Microcapsule



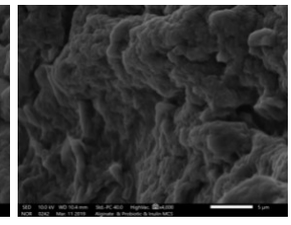
35(E). Blank Alginate Microcapsule



35(F). Blank Probiotic Microcapsule



35(G). Blank FOS hybrid Microcapsule



35(H). Blank Inulin hybrid Microcapsule

Fig. 44 (A-D). Scanning electron micrograph (SEM) images of microcapsules at low magnification (x 300-450) and Fig. 35(E-H). at high magnification (x4000)

Fourier transform infrared (FTIR) spectroscopy analysis

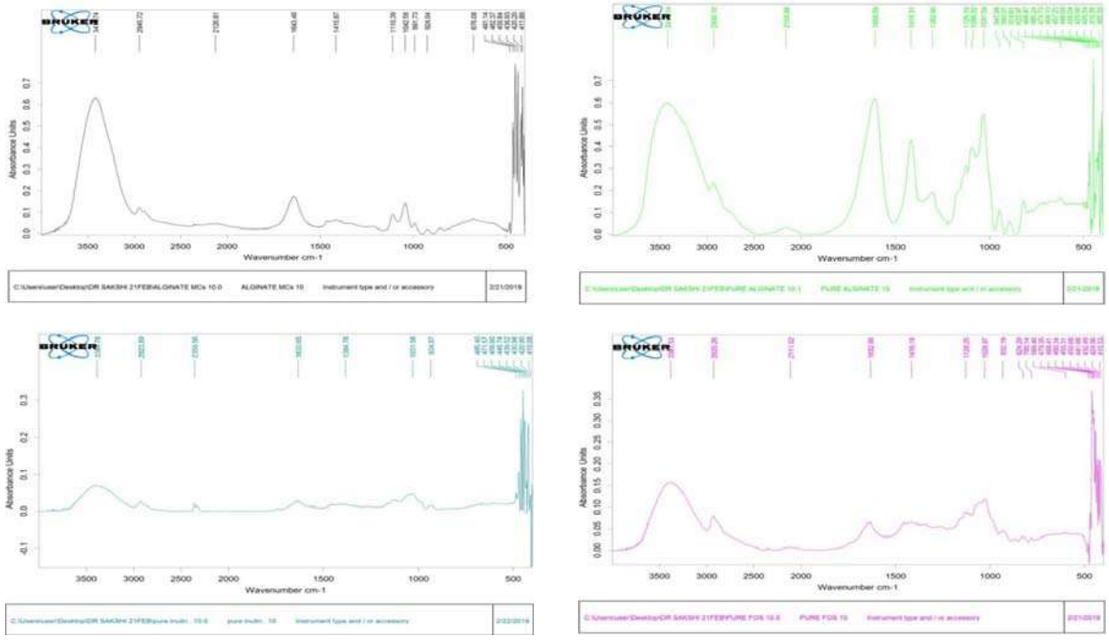


Fig. 45 (A). FTIR spectrum of Alginate Microcapsules; (B). FTIR spectrum of Pure alginate; (C). FTIR spectrum of Pure Inulin; (D). FTIR spectrum of Pure FOS

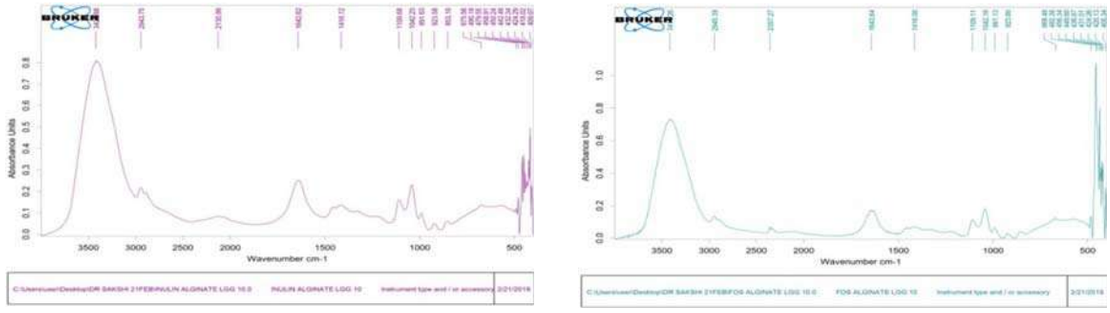


Fig. 45 (E). FTIR spectrum of Inulin alginate hybrid microcapsules; (F). FTIR spectrum of FOS alginate hybrid microcapsules

Extraction of lutein from marigold flowers

Lutein was extracted from fresh marigold flowers by the solvent extraction method in a stepwise procedure. The steps included digestion with hexane, rotary evaporation, vacuum drying, saponification of marigold oleoresin so obtained, semi-preparative column chromatography of lutein stock solution so obtained, vacuum distillation of light yellow, dark yellow and orange chromatography fractions obtained. The last step was vacuum distillation after which a crude extract of lutein was obtained. This crude extract of lutein so obtained contained traces of organic solvents in it. Supercritical fluid extraction is the preferred method of extraction at the first stage in place of organic solvent extraction. This yields marigold oleoresin which does not contain any traces of organic solvents. As seen from the following table, the yield and purity are both higher in case of SFE as compared to organic solvent extraction. The marigold oleoresin thus obtained from supercritical fluid extraction can directly be used for encapsulation.Lutein content and yield at each step was determined by HPLC. The reversed-phase HPLC analysis was carried out using Agilant 1260 Infinity C-18 column (15 cm length), a Diode Array Detector Module 335, and an automatic injector. The mobile phase was a gradient solvent system composed of acetonitrile: methanol (9:1, v/v) (A) and ethyl acetate (B). The gradient system was run by linearly increasing solvent B from 0% to 100% over 30 min, at a flow rate of 1 ml/minute. The sample (lutein stock solution) injection volume was 20 micro litres and the detection wavelength was set at 450 nm. The lutein standard procured from Sigma-Aldrich was run using the same method to obtain lutein standard curve. The results of the samples have been shown below.

Fraction	Fraction Name	Purity (%)	Yield (mg)	Volume (ml)	Concentration (mg/ml)	Yield (%)
1	Before rotary evaporation	68.4	1.25	250	0.005	0.00125
2	By organic solvent extraction	78.46	20	10	0.2	0.005
3	By supercritical fluid extraction	83.48	50	10	0.5	0.0125
4	Red lutein stock solution	99.56	1285.2	400	3.213	32.12
5	Dark yellow chromatography fraction	97.4	22.95	95	0.241	1.78
6	Light yellow chromatography fraction	68.62	192	331	0.538	14.93
7	Orange chromatography fraction	98.08	214.076	436	0.491	16.65
8	Vacuum distillation fraction 1	94.43	0.3	3	0.1	1.3
9	Vacuum distillation fraction 2	99.82	4.44	2	2.22	2.3
10	Vacuum distillation fraction 3	93.34	2.7	3	0.9	1.26

Extraction of marigold oleoresin by supercritical fluid extraction

Marigold powder obtained was dried in an oven. It was sieved in a sieve shaker system. Then it was subjected to supercritical fluid extraction with supercritical carbon dioxide. The temperature maintained was 70 °C and pressure was 45 MPa. Marigold oleoresin was obtained after 2 h. It was kept in a refrigerator. This marigold oleoresin so obtained did not contain traces of organic solvents in it. So it was suitable for microencapsulation. The lutein yield and content as determined by HPLC analysis is given below.

Fraction	Fraction Name	Purity (%)	Yield (mg)	Volume (ml)	Concentration (mg/ml)	Yield (%)
3	By supercritical fluid extraction	83.48	50	10	0.25	0.0125

The results clearly indicated that yield and lutein content is greater when extracted by SCF as compared to organic solvent extraction.

Microencapsulation of marigold oleoresin

Different formulations (0.01% to 0.1%) of marigold oleoresin were made using gum Arabic (2%), maltodextrin (2%) and sodium alginate (1%) as wall material, sunflower oil (5%) for solubilizing marigold oleoresin and soya lecithin (0.01%) as emulsifier. Encapsulation was carried out in an in-house developed microencapsulator. The encapsulation efficiency of all the formulations made was determined using the standard curve of marigold oleoresin. Release kinetic studies of 0.01% marigold oleoresin formulation was done in PBS buffer.

Encapsulation efficiencies of various formulations is given below

Formulation	Encapsulation efficiency
0.01% Marigold oleoresin	88.5%
0.03% Marigold oleoresin	91.66%
0.05% Marigold oleoresin	97.2%
0.07% Marigold oleoresin	96.4%
0.09% Marigold oleoresin	95.4%
0.1 % Marigold oleoresin	98.2%

0.1% marigold oleoresin formulation had maximum encapsulation efficiency

Fitting of models to release kinetics data

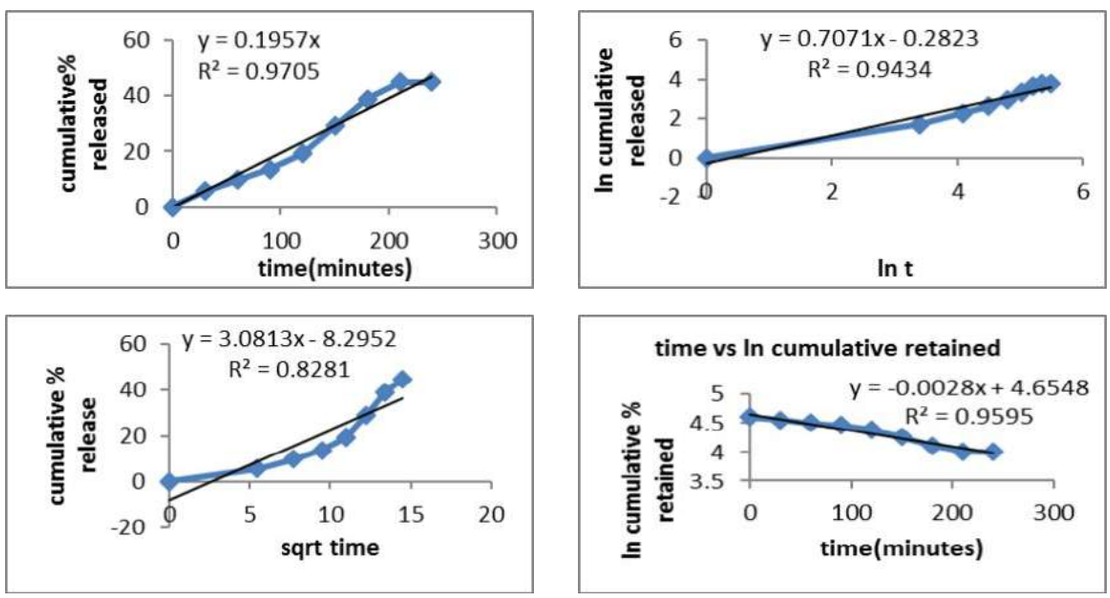


Fig. 46 (A). Zero order kinetic model; (B). Power law model; (C). Higuchi release model; (D). First order release model

National database on NARES technologies in post-harvest sector

Information is a vital resource in any developmental activity. To accelerate the growth of the post-harvest sector in the country, farmers, entrepreneurs, researchers, policymakers, agricultural engineering, and management students need information pertaining to post-harvest technologies and value-added products on a continuing basis. Several post-harvest technologies, process protocols, and value-added products were developed under NARES, but the information is not available on a single platform. To overcome this lacuna, a database has been developed which includes information from AICRP's, SAU's, and ICAR institutes related to post-harvest technologies/ equipment/ machinery etc. A format was designed for collection and compilation of commodity wise information related to various post-harvest machines and equipment, process protocols, and value-added products developed in the National Agricultural Research and Extension System. Information was collected on different machineries/ equipment used in various post-harvest operations including their capacity, dimensions, efficiency, approximate cost, and source of the manufacturer/ supplier. The prepared format was sent to ICAR institutes and SAU's for collecting information regarding post-harvest technologies.

Technical information was also collected through secondary sources. Technology inventory of around 167 post-harvest machinery (43 in cereals, 15 in pulses, 10 in oilseeds, 47 in the horticultural sector, 7 in the plantation sector, 9 in tubers, 30 in spices & condiments, 4 in sugarcane and 2 in others such as Honey) available in the NARES system was prepared in the prescribed format. Technology inventory of around 200 value-added products and process protocols were prepared. This includes information about 37 products in cereals, 11 products in pulses, 32 products in the horticultural sector, 10 products in the plantation sector, 20 products in tubers,

A. Frontpage of Database

B. Option for Advance Search

C. Display of Detailed Information of Equipment with Print Option

D. Display of Information regarding Value Added Products

Fig. 47. Display of National Database on NARES Technologies in Post-Harvest Sector developed by ICAR-CIPHET

15 products in spices and condiments, 9 products in sugarcane and 10 products in other sectors like honey. Information about 24 milk products, 6 meat products, and 26 fish products and livestock were also collected (Fig. 47).

The design of the database is developed on PHP based web framework which facilitates fast and easy sharing of the post-harvest related information. This system also consists of a Permission Management System which enables easy updating of the information. Any user can retrieve data from the information system. Authenticated users in each major institute will be permitted to add information through the database. An instruction material regarding the guidelines to be followed for adding information in the database was created and circulated among authenticated users for easy usage of the database. A video of the steps to be followed while entering data was also published and circulated among the users. Only the data administrator can approve the information, delete unnecessary information, and modify the database. The developed database is useful for farmers, entrepreneurs, start-ups, and skill development schemes of the Government of India and industries.

Methodology for studying the present status of processing and value addition of cereals, pulses, and oilseeds in Punjab

A preliminary study was conducted to chalk out the strategies for studying the present status of processing and value addition among farmers in Punjab. Thus, an exploratory research methodology was formulated to identify the entrepreneurs/FPO's/SHG's/FPC's who are involved in farming and processing their produce, who procure raw material directly from farmers and process, and who provide custom hiring service of processing to farmers and individual farmers involved in processing. The methodology also aims to study the extent of the adoption of different processing machines and equipment by the farmers. Their opinion about processing and value addition and the additional facilities/ equipment/machinery they feel is required for expanding their business will also be documented in the study. The extent of processing of various cereals, pulses, and oilseed crops and the products developed at the farm level will also be analyzed in the study. A Likert type summated rating scale was developed for identifying and measuring the major constraints faced by entrepreneurs, FPO's/SHG's/FPC's and farmers in processing. The scale thoroughly covers and defines the construct under study and identifies different dimensions of the construct under study. Different items in the scale were carefully identified and inspected through item analysis for the reliability and validity of the measuring instrument. The scale encompasses constraints in terms of aspects related to the technical and skill gap, infrastructure, financial, equipment, and market-related.

Honey, dal and jaggery processing

A Commodity Interest Group (CIG) of 10 progressive beekeepers was instituted and the members of the group were trained in scientific honey processing. They were also guided in the area of the marketing of their produce and were sensitized to tap the potential of direct marketing. Now, the farmers are processing their raw honey in the honey processing unit established at Mahalon village. They are now marketing their produce directly to the consumers under the brand name "Happy Honey" and "Fresh Honey" for a price of Rs. 200/kg. The farmers were also guided for obtaining AGMARK certification.

Machinery and equipment were procured for establishing processing unit at the farmer's field. Pulverisers capacity (70-80 kg/h, 20-25 kg/h), flour mill (50-60 kg/h), mini flour mill (18-20 kg/h), rice mill (400-500 kg/h), oil expeller (70-80 kg/h), destoner(400-500 kg/h), air screen cleaner cum grader(400 kg/h)and foot operated sealing machine were procured for establishment of Agro Processing Center. Farmers were also trained to process spices using the pulveriser. A Memorandum of Understating (MoU) was signed with farmers of Bhartha Khurd village of Nawashahr on 25 May 2019.

A jaggery processing unit was also procured for establishing chemical-free jaggery unit at Rahon village of Nawanshahr. The unit consists of sugarcane crusher (1 t/h), collection tank (750 l), open pan set (3 no's), jaggery moulding frame (size 1'x1'x1') and mould frame tray (size 1'x1'x1'). A Memorandum of Understating (MoU) was signed with farmers and the unit was handed over to them on 17 June 2019.

Balance sheet with Benefit Cost ratio

Inter-vention	Village/ centre of where processing unit is established (if applicable)	Cost of raw material (Rs./kg)	Total quantity procured (kg)	Processed as (i.e. flour, dal etc)	Quantity recovered after processing	Cost of processing/ value addition (Rs./kg)	Selling price (Rs/kg)	Profit (Rs.)	Profit (Rs./kg) over the raw product	Cost-Benefit Ratio
Raw Honey	Mahalon/ Rahon (Nawanshahr)	110	2800	Processed honey	2709	27	240	268835	96.01	2.1307
				Wax	35	By-product	175	6125	175	

Beneficiaries' address with mobile number:

Mohinder: S. Mohinder Singh,
Saini Colony, Mahalon, SBS Nagar,
Punjab-144514 Mob: 094174-56924.

S. Lakhbir Singh,
Machhiwara Road, Near Aman Palace,
V.P.O. Rahon, SBS Nagar, Punjab- 144517
Mob: 070098-54996.

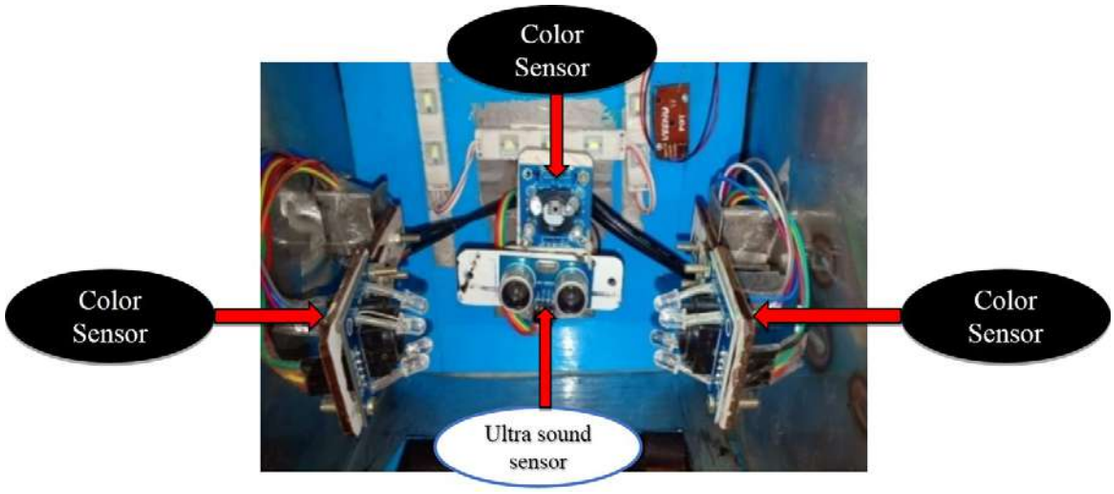
Fig. 48. Handing over of pulverizers to farmers of Bhartha Khurd, Nawanshahr

Fig. 49. Handing over of chemical-free jaggery unit to farmers of Rahon, Nawanshahr

Automatic sorter/grader for pomegranate and tomato

Imaging chamber, roller conveyor, and diversion system were fabricated and interfacing of three color sensors, an ultrasound sensor with a microcontroller board was done. Program for **a.** Capturing the color values at three different places and **b.** Measuring the distance of fruit from the ultrasound sensor was developed. A correlation was established with the distance measured by the ultrasound sensor and the size of the fruit. (i.e. smaller the distance bigger is the size of the fruit and vice- versa).

Prototype of automatic sorter/ grader



Performance evaluation of machine

Roller-cum-belt type conveyor has been designed and manufactured to carry out fruits (Tomato and pomegranate) in singulation from the imaging chamber. The dimensions of roller conveyor are kept in such a way that single fruit will be carried forward and should not drop down between the two adjacent rollers. Dimensional details for roller conveyor are length0.45m, width: 0.2 m, and for belt conveyor are length1.0 m, width: 0.2m, and thickness of the belt: 0.005m. The imaging chamber comprises of three color sensors oriented at 90 degrees with each other and one distance sensor at top of the belt conveyor. Color sensors sense the color values of fruits at three different positions i.e. top and two side positions. The distance of fruit from the sensor is sensed by ultrasound distance finder and is correlated with the size of fruits. With this mechanism/ system it is possible to sort the fruits in five different grades based on the color and size of the fruits. In the diversion system, there are four servo motors that can divert the fruits in four different grades/trays, and another tray is fitted in straight-line with belt conveyor in such a way that materials drop directly without diverting in the tray from belt conveyor as shown in Fig. 50.

Developing methodology for identifying constraints faced by different stakeholders in processing and value addition of cereals, pulses and oilseeds in Punjab

A Likert type (Summated rating) scale was developed for identifying and measuring the major constraints faced by entrepreneurs, FPO's/ SHG's/FPO's and farmers in processing. The steps followed in the scale development were (1) Defining the construct, (2) Identification and operationalization of dimensions under the construct (3) Collection, development, and inspection of items representing each dimension of construct under study (4) Item analysis with the help of experts and a group of respondents during pilot study (5) Reliability analysis and (6) Validity analysis of the scale. The major dimensions identified in constraint analysis were i) Technical and capacity building related constraints, ii) Infrastructure related constraints, iii) Financial constraints, iv) Market-related constraints and v) Equipment related constraints in the case of individual processors. In addition to these dimensions, group related constraints were included in the case of SHG's/FPO's/ processing groups. Under each dimension, six statements were selected finally for constructing a five-point summated rating scale. Responses of

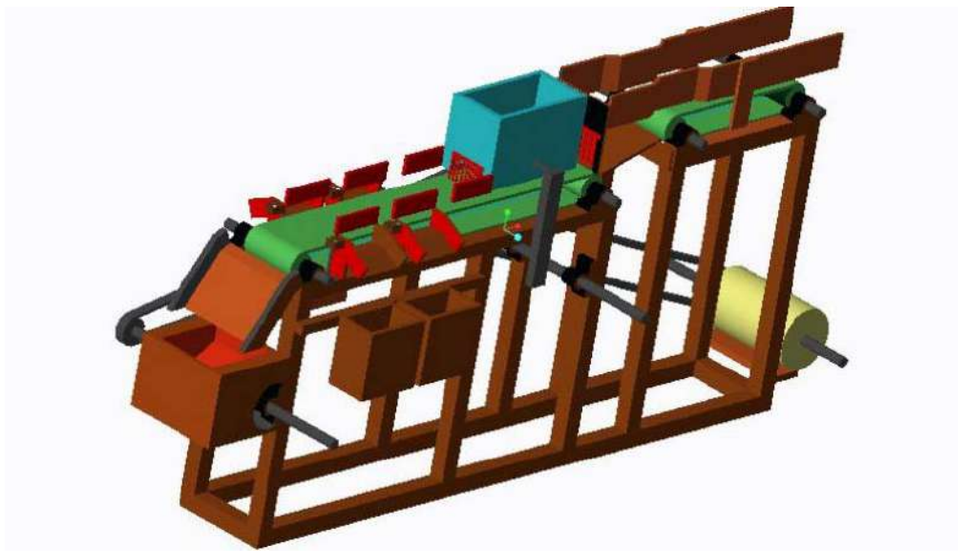


Fig. 50. Fruit sorting system

the stakeholders will be obtained on a five-point continuum ranging from One (1) being the Least Severe to Five (5) being the Most Severe for all the statements. The scale was administered in the target population area with a total of 30 respondents to evaluate its applicability. Thus, the reliability of the scale i.e. the relative absence of errors of measurement in a measuring instrument was tested with the Split Half method, and the coefficient of internal consistency (Spearman's rho) was found to be 0.760 and the Cronbach's alpha coefficient was 0.871. Similarly, the juries' opinion method was used to establish the validity of the scale.

Table 9: Likert type summated rating scale for identifying and measuring the major constraints faced by the stakeholders

	Particulars	Rating				
		Least Severe	Not Severe	Don't know	Severe	Most Severe
Technical and capacity building related Constraints	1. Lack of timely information related to latest processing technologies 2. Inadequate training programmes 3. Non availability of latest technologies in the field 4. Non availability of trained man power/ labour 5. Non availability of raw material year round 6. Others					
Infrastructure related Constraints	1. Inadequate supply of power and electricity 2. Difficulty in maintaining hygienic condition around processing unit 3. Lack of proper roads and transportation facility 4. Lack of proper storage structures in locality/ by own 5. Lack of space and building for processing/ further expansion 6. Others					
Financial Constraints	1. High initial cost of investment 2. Non availability of credit 3. Higher rate of interest for credits 4. Cost of operation is high 5. High payback period for investment 6. Others					
Market Related Constraints	1. Inability to find market for value added produce (lack of demand) 2. Lack of market intelligence 3. Price risk and uncertainty 4. Less knowledge about marketing strategies 5. Lack of appropriate marketing channel 6. Others					
Equipment Related Constraints	1. Non availability of suitable machineries locally 2. Technology not suitable for the situation present in the village 3. Technology developed is not user friendly 4. Maintenance cost is high 5. Facility for repair and maintenance of the machinery is not available 6. Others					
Group related constraints	1. Lack of cohesiveness among members 2. Lack of motivation of members 3. Lack of proper direction 4. Lack of urge for social status 5. Lack of independence in taking decision 6. Others					

Black rice extrudates

Extrudates of black rice (*Chakhao poireiton* variety) were prepared. Twenty experimental runs were made and evaluated for important quality parameters. Expansion ratio (ER) ranged from 2.43 to 3.41, bulk density (BD) ranged from 0.13 to 0.35 g/cm^3, water solubility index (WSI) ranged from 1.48 to 8.19 percent and water absorption index (WAI) ranged from 21.60 to 64.00. Moisture, fat, and ash content ranged from 8.1 to 11.7%, 0.7 to 0.77%, and 0.02 to 0.08% respectively. Pasting properties of the flour of extrudates were also studied using Rapid Visco Analyser (RVA). Final viscosity and set back values of the extrudates were relatively low in comparison to that of the raw materials due to the starch gelatinization that has already occurred during the extrusion process. Total anthocyanin content (TAC) of black rice extrudates ranged from 41.61 to 81.40 mg/100 g, total phenolic content (TPC) ranged from 206.65 to 278.85 mg GAE/100 g and percent RSA of black rice extrudates ranged from 26.46 to 85.11. Percent reduction of antioxidative properties (TAC-35.31, TPC-18.9, and RSA-19.88) was the least when the extrusion was made at feed moisture of 25%, barrel temperature of 130 °C and a screw speed of 250 rpm. Extrusion

Fig. 51. Black rice extrudates

at high temperature and high screw speed reduced the TAC, TPC, and percent RSA of black rice extrudates. However, the extent of reduction is higher at lower feed moisture, higher barrel temperature, and higher screw speed.

Yield of rohu fish waste generation and its anatomical and proximate composition

Anatomical weight composition of Rohu fish was estimated to determine the percentage yield of waste components. Total non-edible tissues (41%) of fish was contributed by head (23.9%) (edible in someplace and inedible in others) followed by scales (4.19%) and fins/trimmings (4.18%) nearly equal and the least by swim

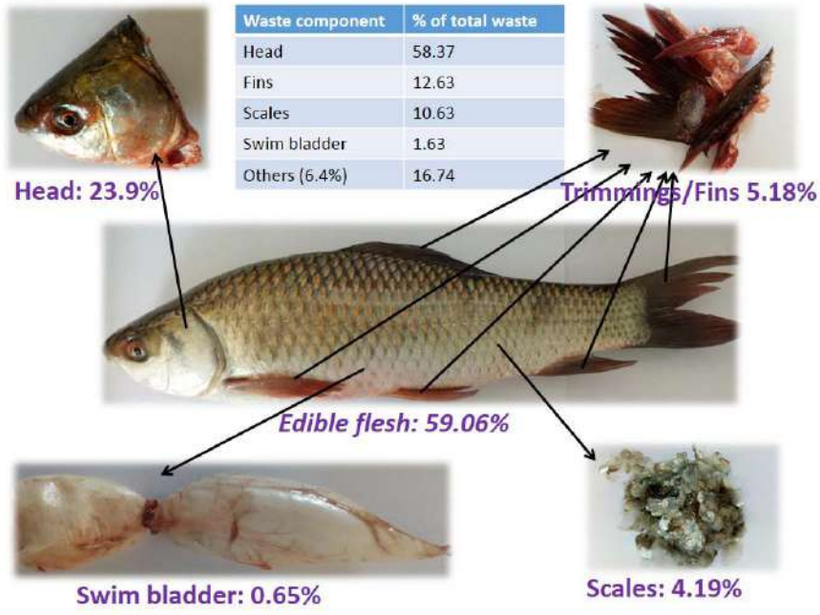


Fig. 52. Anatomical weight composition of Rohu fish

Table 11: Proximate composition of Rohu fish wastes

Waste type	Moisture (%)	Fat (%)	Ash (%)	Protein (%)
Head	58.68±0.40	7.07±2.02	15.23±0.07	17.09±1.15
Trimmings/Fins	62.16±0.50	5.72±0.30	11.75±0.21	18.7±0.46
Scale	63.78±0.13	2.93±0.08	8.78±2.04	22.9±2.1
Swim bladder	60.32±0.00	2.37±0.00	1.23±0.28	34.08±0.50

bladder (0.65%) (Fig. 52). Proximate composition showed the moisture content ranging from 58.68 % (head) to 63.78% (scales); crude protein from 17.09 (head) to 34.08% (swim bladder); crude fat 2.37% (swim bladder) to 7.07 (head) and ash from 1.23 % (swim bladder) to 15.23% (head). Trimmings/ fins had values between these extremes. Rohu fish waste components had the significant quantum of protein in swim bladder (34%), scales (23%), fins (about 19%), and head (17%).

Smart device for detection of insect pest in stored grains

The embedded vision system was developed to detect and count the insects in the stored wheat grain samples. The system is composed of controlling unit viz. Raspberry Pi 4 Model B, The Raspberry Pi camera module V2 (It comes with a Sony IMX219 8-megapixel sensor) and an HDMI display as a hardware component. Python (general-purpose programming language) and Open-CV (Open source computer vision) are used as a software's. After applying the different types of filters, the program can detect the insects/pests in the image as shown in Fig. 53. The developed program can detect and count the storage insect/pest in images of wheat grain samples with 95-100% accuracy.

Up-gradation of woman-friendly semi-automatic fish cleaning-cum-dressing system

A single-phase AC motor (¼ HP, 180 W , 1380 rpm, 50 Hz) was used to increase power and thus torque of the machine. Shaft length was increased from 300 mm to 420 mm for increasing right side clearance to 120 mm. Shaft diameter was increased from 17 mm to 24 mm. The height of the front edge of the working table was causing inconvenience in holding the body of the fish while cutting and therefore, it was reduced from 40 mm to 15 mm.

The water tank was changed from metal to plastic for reducing the weight of the machine to a large extent, making it handier and lowering the cost. Easily washable and detachable two internal parts collect the waste from the water and then pump water to the shower unit through pipes. A cotton bed added with a very fine wire meshed screen was used for filtration of wastewater that separated the solid wastes. The cotton bed absorbed the blood and slime from the water and allowed the filtered water to move towards the storage tank for the pumping back to the shower unit. The water holding capacity of the tank was also increased to 40 L.

Fig. 53. Smart device for detection of insect pest in stored grains (a. Raspberry Pi board with camera V2, b. Captured image of infested grain and c. Image with detected insects/blobs)

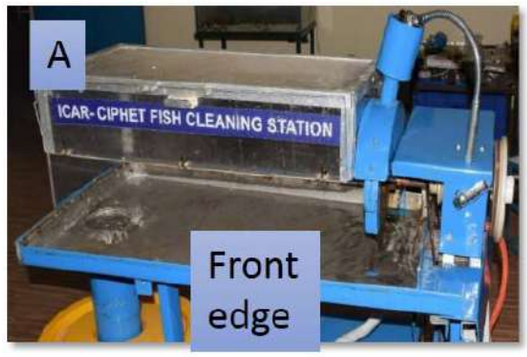
Single phase AC motor (¼ HP, 1380 rpm)

Variable frequency drive (VFD)

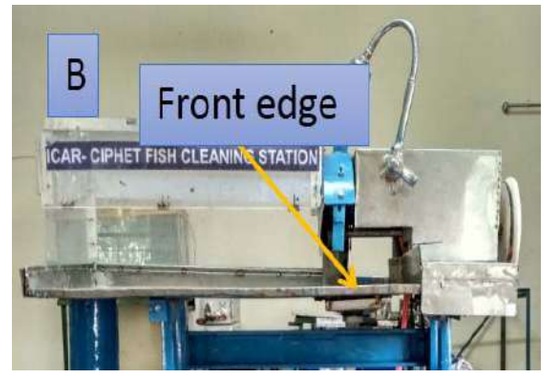
Cutting clearance before modification (A)

Cutting clearance after modification (B)

Bridge for mounting the bearings before modification (A), after modification (B)



Front edge height of the working table was reduced (A) before



Front edge height of the working table was reduced (B) after

Water filtration (old)

Water filtration (updated)

Fish cleaning station before modification

Fish cleaning station after modification

Fig. 54. Up gradation of woman-friendly semi-automatic fish cleaning-cum-dressing system

Development of starter culture for production of Shidal (fermented fish) from Northeast India

Shidal is a very popular traditional fermented fish product of Northeast India which is widely accepted and relished in the region. It is believed that the product has high nutritional and medicinal values. But, the demand for the product in the region can't be fulfilled by the local producers as the production process is too lengthy (5-6 months) and laborious. The study was conducted to shorten this fermentation period by developing a starter culture. *Shidal* was collected from different production centers of the Northeastern region and the product was also prepared in laboratory conditions following the standard method. *Shidal* samples had been collected from different production centres of *Samuguri* and *Batodrawa* of Nagaon district and *Jhargaon* of Morigaon district as well as from different markets of the region *viz Jagiroad* dry fish market, Morigaon district, *Paltan Bazar* fish market, Guwahati, Kamrup district and Nagaon fish market. A total of six numbers of samples were collected from the aforesaid sampling sites and were analyzed for proximate composition, biochemical quality, and microbiological quality (Table 12). All collected samples were found to be of good nutritional quality. Though few colonies of pathogenic bacteria like

Table 12: Biochemical and microbiological quality of *Shidal* collected from production centers & fish markets

Parameters N=3	Shidal samples collected from different production centers & Markets					
	Samuguri production centre	*Batodrawa* production centre	*Jhargaon* production	*Jagiroad* dry fish market centre	*Paltan Bazaar* fish market	Nagaon fish market
A. Proximate Composition						
Moisture, %	36.02±0.90	30.25±0.35	36.74±0.95	33.44 ± 0.88	37.52 ± 0.36	38.16± 0.74
Crude protein, %	31.06±0.25	39.08±0.33	34.25±0.58	38.35 ± 1.67	31.20 ± 1.13	35.40±1.15
Crude fat, %	18.87±0.42	15.77±0.52	21.63±0.89	19.41± 0.42	20.10 ± 0.55	18.05±1.23
Ash, %	13.80±0.18	14.80±0.12	7.05±0.54	8.19± 0.22	10.2 ± 0.95	8.39±0.34
pH	5.8±0.03	5.4±0.02	4.8±0.04	6.0 ± 0.03	6.1 ± 0.02	6.2±0.01
B. Biochemical Quality						
Non protein nitrogen %	3.2 ± 0.34	2.2±0.16	2.5 ± 0.21	5.49±0.24	4.2±0.85	4.48±0.14
Total volatile base N, mg%	116.20±0.77	123.75±4.28	108.24 ± 1.11	223.67±3.28	157.45±1.95	140.33±1.73
Peroxide value (meq O_2/kg of fat)	14.03±0.32	27.22±0.42	25.20±0.56	39.12 ± 0.98	51.96 ±1.34	48.65±0.85
Free fatty acids (% as oleic acid)	20.62±0.17	42.62±0.47	22.56±0.13	64.5 ± 1.63	74.6 ± 0.35	69.55±1.27.
C. Microbiological Quality						
Total plate count (log cfu/g)	5.0± 0.48	5.4±0.15	4.8±0.55	5.4±0.85	6.4±0.61	5.8±0.24
Yeast and mould (log cfu/g)	ND	ND	1.0±0.10	1.2±0.21	1.1±0.06	1.2±0.23
Staphylococcus spp. (log cfu/g)	1.6±0.34	1.8±0.68	2.0±0.65	2.4±0.12	1.8±0.33	2.6±0.55
Escherichia coli (log cfu/g)	<1	<1	<1	<1	<1	<1
Streptococcus spp. (log cfu/g)	<1	1.0±0.12	<1	1.1±0.21	1.2±0.13	1.1±0.08
Salmonella spp. (log cfu/g)	Absent	Absent	Absent	Absent	Absent	Absent

Table 13: Morphological and biochemical characteristics of bacteria isolated from the sample

Sample code	No isolate	Morphological Characteristics		Biochemical test							Genus
		Shape	Colony morphology	Gram staining	Indole test	Methyl red test	Voges Proskauer	Catalase	Oxidase	H_2S production	
SPC	PC1	Short rod	Opaque round	Gram + ve	- ve	-ve	-ve	-ve	-ve	-ve	*Lactobacillus*
	PC2	Pair Cocci	Circular convex	Gram + ve	-ve	-ve	+ ve	-ve	-ve	-ve	*Lactococcus*
	PC3	Short rod	Opaque round	Gram + ve	- ve	-ve	-ve	-ve	-ve	-ve	*Lactobacillus*
	PC4	Coccus	Creamy white round	Gram +ve	-ve	-ve	-ve	+ ve	+ve	-ve	*Staphylococcus*
SFM	FM1	Short rod	White irregular	Gram + ve	-ve	-ve	+ve	+ve	+ve	-ve	*Bacillus*
	FM2	Short rod	Opaque round	Gram + ve	- ve	-ve	-ve	-ve	-ve	-ve	*Lactobacillus*
	FM3	Coccus	Creamy white round	Gram +ve	-ve	-ve	-ve	+ ve	+ve	-ve	*Staphylococcus*

Staphylococcus spp., Streptococcus spp. E. coli were present in the samples, they were within the acceptable limit. For identification of starter culture, the samples collected from the production centers and the fish markets were mixed separately into two single composite samples, both the samples were enumerated and isolated on different specific media. Representative colonies were isolated, purified and biochemically characterized up to the genus level, however, the molecular characterization of the isolates to the species level is under process. Few isolates were identified biochemically as a genus of *Lactobacillus* spp., *Bacillus* spp., *Lactococcus* spp., *Staphylococcus* spp. and are preserved for further studies (Table 13). The DNA extraction protocols from the isolates were standardized and the genomic DNA was extracted from the representative isolates, which was previously identified biochemically to the genus level. The PCR protocols for amplification of the 16s rRNA gene in the representative's isolates is already been standardized in the laboratory using genus-specific primers. The amplified regions of the DNA was purified and sent for sequencing (First base, Malaysia). Biochemical and microbiological quality analysis for *Shidal* collected from different production centres & different fish of the region were done and found to be of acceptable quality. Few isolates were identified biochemically as a genus of *Lactobacillus* spp., *Bacillus* spp., *Lactococcus* spp., *Staphylococcus* spp. and identification of the starter culture.

Fig. 55. Shidal: Fermented fish of Northeast

Solar based multi-commodity cold-storage chamber model using thermoelectric cooling effect

A multi-commodity cold-storage chamber model was developed using Peltier module (TEC1-12706). One chamber (control chamber) was operated with a DC fan (12 V and 0.20A) whereas the other chamber was operated with two Peltier module (Fig. 56). Temperature and humidity sensors (DHT22) were used and displayed in LCD through Arduino Mega 2560. The required power was supplied from 12 V solar battery. Both the chamber has 3-5 kg capacity. The cold chamber could achieve 8 °C

Fig. 56. Multi-cold storage chamber using peltier module

less than the ambient temperature whereas the control chamber could attain 1-2 °C less than the ambient condition. THE theoretical COP of the thermoelectric refrigeration system was found to be 0.55 while the actual COP was 0.123 for load conditions when tested with 2 kg tomato.

Temperature and relative humidity measuring device for real-time monitoring of spray chilling process

A low-cost temperature and relative humidity measuring device was developed (Fig. 57) for real-time monitoring of the spray chilling of palm oil. The device is composed of two components: (i) software platform and (ii) hardware. The process algorithm of the device was programmed in the Arduino integrated development environment (IDE) software. The hardware components include a microcontroller unit (MCU) ATMEGA 2560 (Arduino Mega 2560) connected with other peripheral circuit parts, i.e., three digital humidity temperature sensor (DHT22), liquid crystal display with inter-integrated circuits (LCD I^2C), secure digital (SD) card and real-time clock (RTC) module. DHT 22 has temperature measuring range from –40 °C to +80 °C with ±1 °C accuracy while the

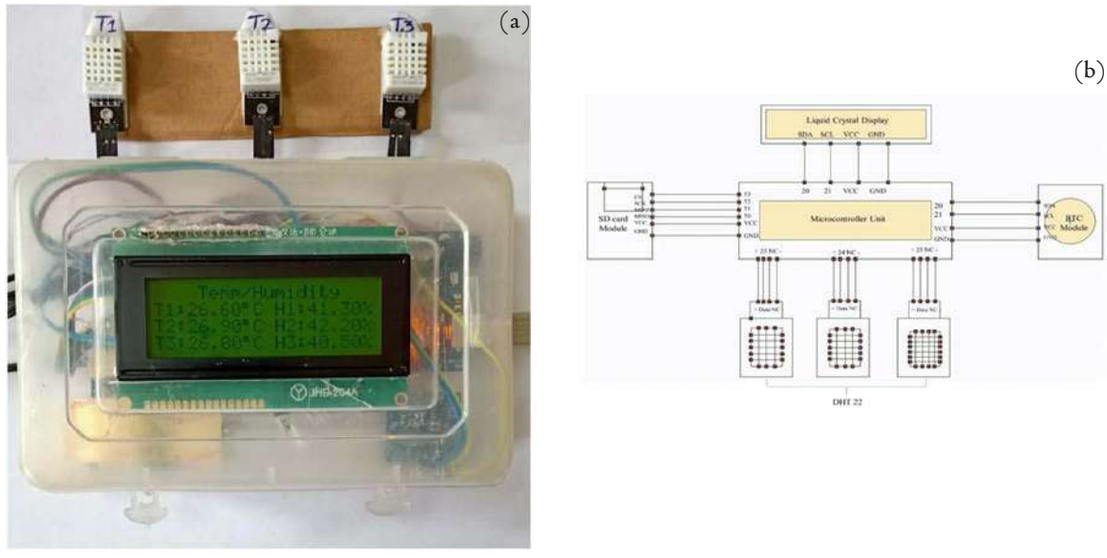


Fig. 57. (a) Developed temperature and relative humidity measuring device (b) Schematic of connection setup

Fig. 58. Temperature and relative humidity measuring device used for real time-monitoring of spray chilling process

relative humidity measuring range varies from 0% to 99.9% with ± 2% accuracy. The schematics of the connection setup are shown in Fig. 58. The sensed parameters from the sensors are displayed automatically on either serial monitor/ computer screen or on the LCD screen and written on the SD card. This data can be saved in an Excel sheet simultaneously. The recorded values of temperature (T1, T2, and T3 in °C) and relative humidity (H1, H2, and H3 in %) with date and time were saved in excel/spreadsheet. Three DHT 22 sensors were placed at three positions of spray chilling chamber, namely, top (near nozzle), middle and bottom (near the inlet of air) to record data with time (Figure 3). The developed device was compared with standard measuring instruments (Testo 608-Hl, Thermo-Hygrometer, Testo India Pvt. Ltd.) and a non-significant variation (0.5%) was observed in temperature and relative humidity data.

Research Highlights of AICRP

Post-Harvest Engineering & Technology

PDKV loading/unloading device

The PDKV loading/unloading device having a sorting table with small inclined belt conveyor and tractor trolley attachment has been developed for unloading onion from tractor trolley and loading into storage structure and unloading from storage structure and loading into tractor trolley or grading machine with capacity 15 – 20 tonnes/day (8 h). Food grade PU belt is used for the loading/unloading device. Wheels are provided to make the unit mobile. This assembly of loading/unloading device, small inclined belt conveyor, and tractor trolley attachment is found to be technically feasible and economically viable. The cost of the machine is approximately Rs. 2.85 lakhs.

Lightweight multi fruit-cum-vegetable grader

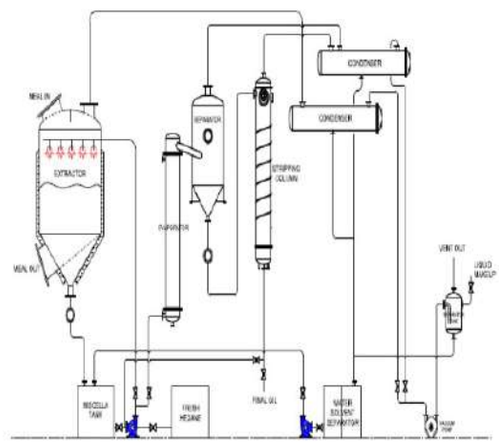
It is used for grading of fruits and vegetables. The capacity of the machine is 500 kg/hour for Citrus (fruit) & 415 kg/hour for Tomato (vegetable). This machine can be operated manually or by solar energy.

Hand compression moulding machine (Batch type)

Hand compression moulding machine consists of a die unit, hydraulic frame, chromium-coated punch, a cylinder made of high grade steel and an electrical unit. It is used for preparation of packaging cups from sugarcane bagasse. The capacity of the machine is 6 cups/day. The cost of the machine is Rs. 1 lakh.

Model pilot plant for solvent extraction of mango kernel oil

It is used to extract oil from Mango Kernel as by-product utilization. The capacity of the machine is 5 kg oil / batch. . The cost of the machine is Rs 22.5 lakh (Approx).



Cashew nut butter making unit

The capacity of the machine is 5 kg/h. The cost of the machine is Rs. 0.5 lakh.

Meat mincer cum bowl chopper

The machine consists of a twin motor that operates both the mincer and the bowl chopper component that are mounted on a common base. The drive shaft of the mincer unit and that of the bowl chopper are aligned such that they operate the screw shaft and rotor shaft of the mincer and bowl chopper respectively. It is used to prepare emulsion based meat products. The capacity of the machine is 50 kg/h. The cost of the machine is Rs. 2.0 lakh.

Electrical impedance meter

The unit consists of two discrete elements: the function generator and a power pack. The function generator affords the user liberty of setting up the frequency of the current applied. The power pack is connected to the function generator and the electrodes used to test the impedance are also connected to it. The power pack measures the voltage and the strength of current that passes through the sample of the meat. The user may calculate the impedance, resistivity and conductivity from the voltage and the strength of the current. Based on the electrical parameters, meat quality is assessed in short time. It is used to assess the impedance of meat and quality of meat. The capacity of the machine is 60 samples / hour. The cost of the machine is Rs. 0.4 lakh.

Storage structure for green gram and paddy for high moisture environment

Material of construction: Galvanized Iron Grade 33 as per ASTM A653-09; Mild steel angle 2 inch; Perforated GI with mesh size 18

- Pulse storage: In green gram storage, it was observed from twelve months data that the designed storage structure showed less infestation (7.67%) of *Callosobruchus chinesis* which is far less than other storage devices like Cloth bag (22.33%), Metallic bin (14.67%) and Plastic container (14.67%).
- Paddy storage: In paddy storage, it was observed from twelve months data that the designed storage structure showed less infestation (3.33%) of *Sitotroga crealella* over other storage devices used for storing paddy. Broken chalk pencil or charcoal can be used as moisture absorbing matter in the central cylinder.

The capacity of the structure is 200 kg. and the cost is Rs. 0.05 lakh.

Control of *Sitophilus oryzae* and *Callosobruchus chinensis* by using visual stimuli

It is used to control the storage insect-pests. The selected colours are: violet, indigo, blue, green, yellow, orange and red.

- In the colour cue preference test of *S. oryzae,* preference was highest in Violet (13.80%), while lowest in Green (2.13%)
- The order of preference of *S. oryzae* across the tested colour was found to be: Violet>Indigo>Blue>Transparent> Yellow>Orange>Red>Green.
- In case of *C. chinensis*, preference was highest in Indigo (16.47%), while lowest in Violet (4.93%).
- The order of preference of *C. chinensis* across the tested colour was found to be: Indigo>Blue>Transparent>Yellow> Green>Orange>Red>Violet

Fig. 1. Acrylic insect experimental set for colour cue preference test

Grain treater for enzymatic pre-treatment to pigeon pea grains

It is used to give the enzymatic treatment to pigeon pea to improve milling efficiency. The capacity of the machine is 100 kg/h. The cost of the machine is Rs. 0.9 lakh.

On-farm solar-assisted dryer for drying of groundnut pods for longer storage

It is used for drying of groundnut pods. The capacity of the machine is 120 kg/h. The cost of the machine is Rs 3.6 lakh.

Tender coconut trimming machine

Trimming machine consists of three trimming knives to perform top trimming, side trimming and bottom cutting of tender coconut. Trimming knife angle has been optimized as 54°, 85°, and 90° for top, side and bottom cutting knives respectively. Linear actuator is attached with the trimming knives for fast and smooth operation. It is used to partially dehusk the tender coconuts in order to reduce the transportation cost and to make it into an attractive pentagonal shape. The capacity of the machine is 110-120 nuts/ h. The cost of the machine is Rs. 0.45 lakh and Rs. 0.9 lakh for mild steel and stainless steel variants respectively.

Foot pedal operated meat mincer

The machine consists of a foot operated chain drive that rotates blades of mincer. The operator can sit comfortably while operating the machine. The mincer is mounted on a stainless steel platform that can be cleaned easily. The

developed pedal operated meat mincer was tested in the laboratory of Khanapara Centre of AICRP on PHET for different parameters and found to be working optimally. It is used for the production of hygienic comminuted meat in places where 24′7 electrical power supply is not available. The capacity of the machine is 30kg/h. The cost of the machine is Rs 0.2 lakh.

Poultry processing cum by-product collection unit

A small smart eco-friendly mobile poultry shop with slaughtering cum by-product collection unit conducive for sale of poultry meat under hygienic conditions has been developed. An e-rickshaw (Battery operated) has been modified to form the mobile processing unit having facilities for carrying out all slaughtering operations like bleeding, defeathering, dressing and storage of carcass under chilling conditions. Besides, it has a carrying capacity of 50 live birds. Further, the machine also has a byproduct collection system under chilling condition thereby promoting effective utilization of by-product and reduced environmental nuisance. All the units in the machine are operated on 12 V DC current supplied using 4 lithium ion battery fitted with the rickshaw. The unit may be a suitable alternative for small poultry vendors / butchers in cities and towns and may also add in providing hygienic and wholesome meat to the consumers at the doorstep besides keeping the city clean. The capacity of the machine is 50 Birds. The cost of the machine is Rs. 1.6 lakh.

Semi-continuous refractance window (RW) dryer

It is thin layer drying equipment for drying of fruit pulp or juice to make fruit leather, powdered fruit products etc. using Refractance Window drying technique. The dryer can accommodate three number of drying trays. It is a semi-continuous dryer which uses water just below its boiling point as the heat source. It is used for drying of fruit purees, juices etc. to produce fruit leathers or powder food. The capacity of the machine is 800 g/h. The cost of the machine is Rs. 0.5 lakh.

Automated manothermosonication (MTS) system

In order to develop an automated manothermosonication (MTS) system, a conceptual design for batch type pressure application system has been designed, fabricated and tested. The MTS treatment operational parameters (temperature, pressure and holding time) were optimized for guava juice using developed pressure application system. Optimization was done on the basis of minimum color change, pH, total plate count, total mold/ yeast and maximum ascorbic acid, total soluble solids, titratable acidity and overall acceptability and found the optimized conditions as: 63.81 °C heating temperature, 184.16 kPa pressure and 6 minutes holding time for complete process. The developed batch type pressure application

system was used for pressure application to juices in combination with temperature and ultrasound treatments for the shelf life extension of juices without adding any preservative. The capacity of the machine is 150 bottles per batch. The cost of the machine is Rs. 0.17 lakh.

Vacuum assisted osmotic impregnation system

Vacuum impregnation (VI) is a mass transfer process between a liquid medium and a solid porous food, promoted by pressure changes in the system that intensifies the capillary flow in porous cells. VI process allows us to incorporate any ingredients in a porous product in order to adapt its composition to certain stability or quality requirements, in a quick and simple way. The conceptual design of vacuum assisted osmotic impregnation system was made in CREO 3.0 (Drawing tools) and the system was fabricated accordingly. The impregnation system consisted of two stainless steel cylinders (one vacuum cylinder and one solution tank), a vacuum pump, a solution pump, heaters, stainless steel pipings, ball valves, a vacuum gauge and an eye-piece. The vacuum cylinder consists of a stainless steel perforated cylinder for placing the fruits to be treated. The developed vacuum assisted osmotic impregnation system may be helpful in efficient application of osmotic pretreatment to the biological material. The capacity of the machine is 10 kg/ batch. The cost of the machine is Rs. 0.65 lakh.

Model retail outlet for hygienic sheep/ goat meat production

The conceptual design of model retail outlet for hygienic sheep/goat meat production is prepared in the form of 2D and 3D architectural design for both stationary and movable model. Most of the food safety parameters achieved as per FSSAI, 2011.

Feature of model retail outlet for sheep/ goat meat:

- Less handling of meat, so less chances of contamination.
- No environmental pollution, as the waste is collected in vehicle itself.

It may be used for the production of hygienic Sheep/Goat meat for the supply to the consumers which will protect the health as well as economic interest of consumer. The capacity of the machine is 8 to 10 carcasses. The cost of the machine is approximately Rs. 16 lakhs.

Automated amylose detection sensor system for assessment of ageing of rice grain

The developed sensor consists of different light sources (red, green and blue LEDs) along with the red LED of 652 nm wavelength that are connected to the ESP8266 (Node MCU)

microcontroller with the help of suitable resistors. A LDR photodiode is used as a light detector for recording the light intensity before and after placing the test solution in the cuvette. A 9 V battery is used as a power source to run the device. All the components are embedded in the outer body which is made of Acrylonitrile Butadiene Styrene (ABS) with the help of 3D printing. Further, an android mobile application was developed to record and analyze the real time data for assessing the ageing of rice as a graphical user interface (GUI). The developed instrument is used for assessing the ageing of rice. The capacity of the machine is 10-12 samples per hour. The cost of developed sensor is Rs. 3000/- for mass production.

Technology for milling of lathyrus

If cleaned and graded lathyrus is passed through PKV mini dal mill with 16:18 (1:1) (w/w) emery roller, at 200 kg/h feed rate and 900 rpm roller speed and further passed through metallic sheller with 200 kg/h feed rate and 430 rpm disc speed, the dal recovery and dehulling efficiency was found to be 76% and 96.71% respectively. The cost of milling is Rs. 74/ quintal.

Edible film coated jaggery

It is used to increase the shelf life of jaggery. The cost of coating is Rs. 860.00 per tonne of jaggery.

100 ml distilled water + edible coating
(0.5% Concentration WPC)
↓
Denaturation at 90 °C (water bath) for 30 minutes
↓
Cooled at room temperature
↓
Add 5% glycerol
(Proper mixing)
↓
Reheated at 50 °C for 10 minutes
↓
Apply on Jaggery samples
↓
Vacuum Packaging in LDPE

Process technology for foxtail millet probiotic beverage

A process protocol has been standardized for the preparation of Foxtail Millet Probiotic Beverage. The foxtail millet grain is first germinated, dried and dehulled to obtain foxtail millet rice. It is then ground to fine flour and the sieved flour was used as a substrate for the preparation of probiotic beverage using Probiotic Lactic Acid Bacteria. The developed probiotic beverage could be stored for 6 weeks under refrigerated temperature.

Simarouba glauca herbal drink powder

Herbal drink powder made from simarouba leaf decoction may be used as nutraceutical drink/ health beverage. It has good amounts of phytochemicals and therefore may be used for many health ailments including cancer and diabetes. Simarouba leaf decoction is extracted by hot water extraction method (@ 80 °C for 30 min). The decoction was further concentrated by vacuum evaporation. This concentrated leaf decoction was mixed with carrier agent (Maltodextrin @10%) and then spray dried (@

210 °C drying temperature and 50 ml/min flow rate) to obtain Simaroubagluca Herbal Drink Powder. It contained: total phenols -166.7mg GAE/g; total flavonoids -272.7 mg Quercetin/g; and antioxidant capacity of 65.43 mg AEAC/g).

Technology for extraction of protein from sunflower oilseed cake

Protein from deoiled sunflower cake was extracted using common salt (NaCl) solution. The extraction process variables namely; pH, NaCl (%) and meal (%) were optimized using RSM to get better protein isolate yield and its protein content. Optimum extraction of protein isolate (30% yield) with 70% concentration was achieved with 10% meal using 9% NaCl at a pH of 9.00. Extracted protein isolate can be used as a source of nutritional and functional proteins by the Food Industry.

Fig. 2. (A) Defatted oil cake; (B) Defatted oil cake powder (C) Protein isolate from Sunflower

Chicken meat nuggets incorporating millet (Kodo millet) and seaweed *(Sargassum sp)*

The developed product is a functional chicken meat product as the kodo millet is used to replace the refined wheat flour as an extender fortifies the product with dietary fibre, and the *Sargassum* added in the product imparts anti-microbial and anti-oxidant properties and thereby promotes functional benefits for health conscious consumers. It is used as functional meat product that ensures that the consumer consumes food laden with dietary fibre and anti-oxidants. The cost of the product is Rs 300 / kg.

Characterization and *in-vitro* studies of collagen- chondroitin sulphate scaffold and keratin biopolymer extracted from animal by-products

The product is a scaffold developed using collagen and chondroitin sulphate derived from chicken skin and bovine trachea respectively, subsequent to liquefying them. The liquids are then crosslinked by addition of a plasticiser, namely glycerol and the homogenous solution is casted onto a petri-plate and cast to dry. The cast is then sterilised, trimmed and stored in ethanol. Chondroitin sulphate collagen scaffolds may be used in the treatment of defects in skin, cartilage, urethra, meniscus and bone. The cost of the Collagen Chondroitin Scaffold (6cm x 6cm) is Rs. 212.

Extraction of pigments from black scented rice (*local Chak-hao*)

Chak-hao is an endangered rice variety grown in Manipur. It is known for its special properties viz. deep purple colour, pleasant aroma and anti-oxidative properties. Some reports claimed it as 'Superfood' given its high nutritional properties.

However its consumption is limited due to limited availability of its products with higher acceptability in the market. In order to maintain its economic value and make it scalable, shelf-stable product need to be introduced. 10 kg black rice paddy gives 7.21 kg whole rice which in turn produced 654 g of rice bran. The bran is stabilised using steam treatment. Extraction is carried out by acidified methanol (0.8% HCl) by keeping in ambient temperature for 24 h. The methanol extracts are concentrated using rotary evaporator (Buchi 6.0) and freeze dried. The lyophilised samples were subjected to antioxidant activity study and anti-diabetic study. GC-MS analysis of the extract was also carried out.

Pectin from pineapple wastes viz, peel, core and pomace

The pineapple (*Ananascomosus*) is the most important horticultural produce of the family *Bromeliaceae* positioning as the important fruit in the world. With the increase in production of processed fruit products, the amount of fruit waste generated is increasing enormously. About 60% of total pineapple fruit is regarded as waste in the form of peel, core, pomace and crown. A valuable by-product that can be obtained from pineapple peel is pectin. Pectins are defined as a group of widely distributed plant cell wall polysaccharides containing galacturonic acid linked at 1 and 4 positions. The wide use of pectin as an ingredient imparts rheological and textural properties to various food products. Work has been carried out to investigate the isolation and optimization of pectin from various pineapple waste biomass such as peel, core and pomace. Acid extraction followed by ethanol precipitation was used to extract pectin. The yields of pectin were found to be 14.21%, 12.75% and 11.24% from pineapple pomace, core and peel respectively. Initial and final moisture content for all sources were also studied. The pineapple wastes were treated separately with different pH (1, 1.5, 2.0, 2.5 and 3.0), extraction temperature (60, 65, 70, 75, 80, 85 and 90 °C) and extraction time (20, 30, 40, 50, 60, 70, 80, 90 and 100 minutes). Maximum yield of pectin was optimized at 1.5 pH, 85 °C extraction temperature and 70 min extraction time.

Protein isolate from pea peel

Protein isolates were produced by wet processing in which low molecular weight water soluble components and the salt soluble proteins were extracted from the powder and then the globular proteins were subsequently isolated by a selective precipitation step at the isoelectric point, neutralized and dried. The precipitates were dried by optimizing parameter of hot air temperature (40, 42 and 44 °C). The schematic diagram of the most frequently used method based on aqueous alkaline extraction followed by isoelectric precipitation is presented by following flow diagram:

Take appropriate amount of flour and add water to it (1:10 ratio)
↓
Adjust the pH (9) and stir it for 1 h
↓
Centrifuge the content at 8000 rpm for 15 min
↓
Collect the supernatant
↓
Adjust the pH of the supernatant to 4.5
↓
Leave it for 2-4 h for precipitation
↓
Centrifuge it after 2-4 h
↓
Collect the precipitate
↓
Wash the precipitate with water to remove traces of acid in precipitate
↓
Neutralize the precipitate
↓
Dry the precipitate/protein isolate

Green pea peel powder


Pea peel protein isolate

Formulation of spinach, mustard greens and fermented bamboo shoot based curry powder for ethnic cuisines of North East India

Procurement of Raw Materials
↓
Sorting, Grading
↓
Cleaning/washing, Cutting
↓
Drying (T1, T2, T3 temperature, by tray drying/ sundrying)
↓
Selection of the best drying combination
Grinding
↓
Mixing/blending in different combinations with different ingredients
↓
Sensory Evaluation
↓
Testing, licencing etc.
↓
Transfer the Technology to the end user

Fig. 3. Spinach, mustard green and bamboo shoot powder

High protein extruded product using defatted peanut flour

An extruded product based on defatted peanut flour is developed using Twin Screw extruder. Optimized process parameters are : Corn flour - 74%, Defatted peanut flour - 26%, Feed moisture content - 13% (wb), Die head temperature - 135 °C and Screw speed – 250 rpm while keeping other parameters as Feeder temperature - 60 °C, Barrel temperature - 100 °C and Feeder speed -12 rpm.

At this combination of process parameters, the extruded sample can be prepared with 18 Nm of machine torque, 114 g/min of mass flow rate, 5.68% (w.b.) of moisture content, 125.06 kg/ m^3 of bulk density, 498.40 kg/m^3 of true density, 2.26 mm/mm of expansion ratio, 521.45 of rehydration ratio, 16.51% of water solubility index, 4.27 g/g of water absorption index, 2.90 g/g of oil absorption index, 19.26% of protein, 66.14% of carbohydrate, 1.31% of fat, 261.14 N of hardness and 64.24 of crispness.

Forced air curing of onion

The forced air curing may replace the traditional curing of onion. Recommended curing parameters are: Curing temperature 40 °C and without foliage onion bulb. The onions can be stored for six month after the forced air curing with 21% more saving of marketable onion as compared to traditional cured onion. The cost of the process is Rs. 7.44/kg.

Coconut milk-based ice cream

Coconut milk-based ice cream formulation was made with coconut milk as the major ingredient along with/without milk powder, refined/ coconut sugar, and vanilla flavour. The processes involve mixing the dry ingredients, stabilizers and emulsifiers, pasteurization of the ice cream mix i.e. dry ingredients, coconut milk, homogenization, ageing at 4 °C, freezing at -5 °C and hardening at -28 °C. The resultant product has 9.2 and 7.5% fat, 7.0 and 4.7% protein content respectively. It is healthy, nutritious, non-dairy and diabetic friendly ice cream. The cost of the product is Rs. 150 / L.

Coconut milk powder and ready-to-cook kheer mix

A methodology has been standardized for the production of coconut milk powder using foam mat drying technology with the addition of sodium caseinate and maltodextrin. The optimized combination obtained was coconut milk with 4% sodium caseinate and 17.5% maltodextrin. The resultant milk powder was used for the preparation of ready-to-cook kheer mix along with vermicelli and coconut sugar (1.5:1.5:1). The amount of water for reconstituting the kheer was standardized as 6:1. The cost of the product is Rs.700/kg for coconut milk powder and Rs.500/kg for kheer mix.

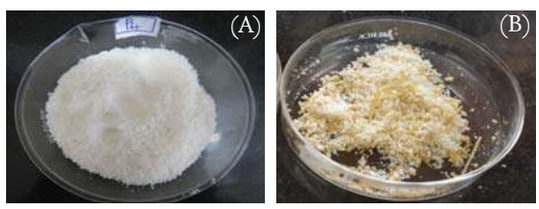


Fig. 4. (A) Foam mat dried coconut milk powder; (B) Ready-to-cook kheer mix

Production of food bio-colour from agricultural wastes /by-products

Pilot-scale fermentation of broken rice is carried out in a tray-type fermenter of 20 kg batch capacity (dry weight) using *Monascus purpureus* (10% inoculum) by solid-state fermentation at 30 °C temperature and 95% humidity. Solid-state fermentation is carried out under optimum cultural condition in a tray-type fermenter. The extraction of the bio-pigment is done by addition of the fermented substrate to ethyl alcohol (1:50) for 24 hours at room temperature. With tray-type fermenter, SSF gives colour value of 41.2 OD Units/g dms (at 500 nm) with 25.8% recovery using static extraction with ethanol at room temperature for 20 minutes. With the aforementioned SSF parameters, the optimization of extraction parameters gives a maximum color value of 44.8 OD Units/g dms (at 500 nm) with 27.5% recovery. The yield of the biopigment (OD Units/g dry matter substrate) is recorded at 500nm. Physicochemical analysis of red bio-pigment is under process. A natural red bio-pigment (monascorubramine) may be developed, replacing synthetic colours, with the utilisation of agricultural by-product/ waste for value addition.

Production of fortified rice analogues

The fortified rice analogues are developed by utilizing the broken rice and broken pigeon pea dhal along with nutrient premixes in a cold extruder. The composite flour with base material as rice flour has been optimized for different levels of moisture content and pigeon pea dhal

flour. The optimized composite flour contained 30% moisture content and 30% of broken dhal flour with a desirability factor of 0.85. Two FSSAI approved nutrient ready mixes (containing Iron, Calcium, Folic acid and Vitamins) namely, N-I and N-II were selected and mixed with the optimized composite flour in an appropriate proportion to further enrich into the fortified rice analogues at different levels to mix with raw rice at 1:50 ratio. It is used for fortification of raw rice using by-products of rice and dhal mills. The cost of fortified rice analogue is found to be Rs.53.50 per kg and after blending with natural rice in the ratio of 1:50, the increase in cost is about Rs.1.00/kg. The benefit cost ratio was worked out to be 1.22.

Radio frequency (RF) processing of chilli powder for enhanced shelf life and microbial safety

RF heating process with an optimized treatment of 100 mm electrode gap and 15 minutes of exposure time retained higher colour values, ascorbic acid, capsaicin content and showed significant reduction in microorganisms. The process of RF heating may used as an alternative to the irradiation treatment for microbial disinfection of low moisture foods such as chilli powder, instant mixes, and spice powders and for enhancing their shelf life.

Shoe polish using karanj oil

Oil extracted from karanj seeds has been used to develop shoe polish. The extracted oil is mixed with bee wax, and colouring agents (black oxide and brown oxide) in a double boiler. The ratio has been optimized. Mixed ingredients are heated for 5 to 10 minutes with proper mixing. The developed polish can be used for polishing shoes or any material made up of leather.

Production of jackfruit chips using vacuum frying

The present study focused on the optimization of pre-treatment, process parameters and packaging material. The performance evaluation of vacuum frying of jackfruit chips using blend of rice bran and palm oil (80:20) was done. Vacuum fried jackfruit chips are healthier and offer attractive physical properties. The formation of acrylamide, a potential carcinogenic agent could be reduced to negligible by this technology. The reduction in oil retention offers less oily taste without compromising natural colour, flavour and nutrients of the products. The cost of production of vacuum fried jackfruit chips and cost benefit ratio were Rs.617.54/- per kg and 2.83:1, respectively.

Plasticulture Engineering & Technology

AICRP on Plasticulture Engineering and Technology is operating with 14 cooperating centres in the country in different agro-climatic zones with coordinating unit at ICAR-CIPHET, Ludhiana. Sanctioned budget of the scheme for 2019-20 was 431.96 lakhs. Currently, total 45 projects are ongoing in which 08 were approved as new projects in the 15th annual workshop, 2019 of the scheme. The role of PET has been instrumental 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 centres.

Achievement of AICRP on PET coordinating unit:

Development of plasticulture park

To demonstrate successful plasticulture technologies developed under the scheme at headquarter, one existing damaged net house of 560 m2 and adjoining area of 1500 m2 were converted in to Plasticulture Park. The main purpose of park is showcase integrated farming using Plasticulture. The park consist of total eight components i.e Shade net house, Modified designed polyhouse, Microclimate control system, Fertigation system, Low tunnel structures,

Table 1: Details Components of Plasticulture Parks

Sr. No.	Name of the structures	Specification	Crops Grown
1.	200 UVS LDPE sheet NV modified design polyhouse Saw shape/ Double Arc	L: 30m, W: 8m, H: 4.5 m, SH: 2m & E-W orientation, Vent area: 12% to 50%. (Size: 240m^2)	Colour capsicum. Tomato, cucumber, Romasco broccoli, Broccoli, Red cabbage,
2.	40 mesh insect net & 50% UVS green net NV shade net structure	L: 30m, W: 8m, H: 3 m, SH: 2m, E-W orientationSize: 240 m^2	Cauliflower, cabbage, nurssary
			
3.	Plastic lined pond	Capacity: 150 m3 Shape: trapezoidal, side slope (2:1), L: 10 m, B:10m , D: 2 m Lb: 8 m & Bt: 8 m	
			

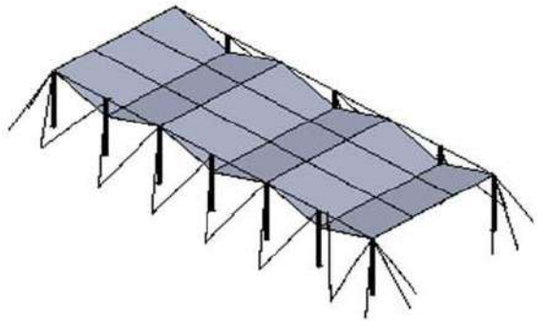
Sr. No.	Name of the structures	Specification	Crops Grown
4.	Compost pit for bio fertilizer	Black plastic lined of 250 micron, Capacity 640m^3	
5.	30µ UVS LDPE Plastic mulching	Silver on black plastic mulching	Bottle guard, okra
6.	Fertigation system	1.5 HP motor, Inline drip system for 1500 m2 area, Sand filter, Disc filter	
7.	Microclimate control system	High pressure fogging line (3 kg/cm^2) with 90 no of foggers, shade net and curtain system with plastic rollups, pressure regulators, filtration, Automatic data loggers, Temp, RH, light intensity recorder, pyrometer, soil moisture and temp recorders	

Training of students on instrumentation and automatim in protected structure in developed facilties

Plastic lined pond, Package of practice of high value vegetable production using plastic mulching and Compost pit for bio fertilizer. These developed infrastructure is used for high value crops cultivation i.e.; Colour capsicum. Tomato, cucumber, Romasco broccoli, Broccoli, Red cabbage, strawberry, Bottle guard, Bitter guard, Okra, Green chilli etc; Till date more than 200 visitors visited park which includes Experts, farmers, students & faculties etc.

Collaborative project of NICRA under AICRP on PET

ICAR-CIPHET is lead centre of the project "Design & development of protective structures for high value crops to reduce damage from hail and frost. One triangular/ sagging type retractable anti hail net models of 150 m2 was designed and installed at ICAR-CIPHET Ludhiana. The hail balls was simulated in lab conditions to decide the slope of roof of the retractable structure for ease in drainage at different terminal velocities, hence slope was provided in range of 25-30 degrees.



Experiment for standardization of low tunnel structures for frost management was planned in September 2019. The crops were selected strawberry at semi-arid region to study effect of different design and geometry over frost occurrence, production and productivity. Type of cladding material used : 17 gsm non woven, 50 µ clear film, 200 µ UVS film and different height of tunnels: 45 cm, 60 cm, 70 cm , 90 cm and 100 cm with Arc type tunnel. Microclimate was monitored throughout the study at all locations with the help of data loggers, temp, RH & light recorders. Non-woven 20 gsm tunnel with 45 cm height found to be best suited for strawberry cultivation in semi-arid climate which resulted maximum production and reduction in frost injury and improvement in post-harvest quality of fruit. Availability of fruit was extended by 50 days upto May 2020.

Achievement of AICRP on PET cooperative centres

Development of vegetable nutrition garden model for urban and peri- urban population using soil-less media

The structure of vegetable nutrition garden model is designed by PAU, Ludhiana centre. A 3 or 5 row rooftop vegetable nutrition garden model could produce fresh vegetables at home. A five row Rooftop vegetable garden model requires net area of 12.6 sq m and a three row Rooftop vegetable garden model requires net area of 8.28 sq m. This model can be installed at Rooftop /Terrace /Front yard /Back yard depending upon the space available. The vegetables tomato, bell pepper, cucumber, coriander, broccoli, spinach, pea, lettuce, fenugreek and chinni sarson are successfully grown. Capacity of developed technology is 50 kg/ month for family of 4-5 persons. This technology is environment friendly besides it maximizes the nutrient use efficiency as leachate can be reused after filtration. The cost of technology is around Rs. 40,000/- and licensed to 4 firms for commercial manufacturing.

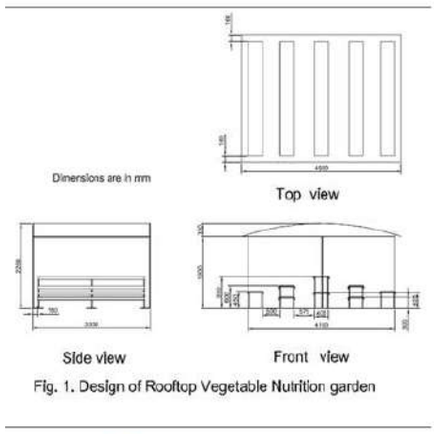


Fig. 1. Design of Rooftop Vegetable Nutrition garden


दैनिक भास्कर
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लुधियाना भास्कर Page 8

पीएयू के तैयार रसोई बगीची मॉडल से छतों पर बिना मिट्टी बिछाए उगाएं सब्जियां

दो सात तक मिट्टी और पानी की ऐसर्च के बाद तैयार किया यह सफल प्रोजेक्ट, छत पर सिर्फ 3 मीटर के दायरे में लगा सकते हैं पांच से सात ये मॉडल

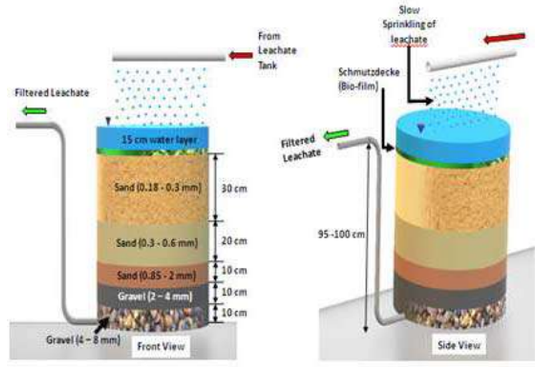
वे सब्जियां उगेंगी रसोई बगीची में


HT Ludhiana 15 NOV 2018

PAU develops model for rooftop gardening using soil-less mediums

PAU, Ludhiana centre has developed nutrient recycling system in soilless cultivation of vegetables under protected cultivation

The Bio sand filter (BSF) disinfection unit pathogens was made from a 125cm diameter 140cm height of plastic tank having 2.54cm inlet and outlet positioned 5cm from top and bottom respectively. The filter was evaluated in terms of flow rates under different filtrates depth viz. 0.2m, 0.3m, 0.4m and 0.5m. The capcity of filter was 1.22 sqm. The optimum flow rate for the slow sand filter to filtrate the leachate should lie in the range 100-300 L m^{-2} h^{-1}, therefore the flow rates of 152.5 L m^{-2} h^{-1} and 267.5 L m^{-2} h^{-1} for the head of 0.4 m and 0.5 m were selected



to standardize the filter for the whole cropping season. The efficacy of the filter in removing the pathogenic microbes was tested and the filter was successfully found to lower the microbes in the leachate solution. The yield per plant was found to be statistically similar in all the three fertigation levels. However, numerically the higher yield of 2.89 kg/plant was found in treatment F_3 (100% Fresh nutrient solution), followed by 2.83 kg/plant in treatment F_2 (90% Fresh nutrient solution with 10% leachate) and 2.76 kg/plant in treatment FI (80% Fresh nutrient solution with 20% leachate). The cultivar multistar recorded significantly higher yield than Punjab Kheera I but it was statistically

at par in result with Kafka. In all the quality parameters increasing trend are observed with respect to fertigation level. When compared with control only F_2 and F_3 treatment recorded improvement in quality characters. With respect to different cultivars, only Multistar and Kafka found be to better in all quality parameters viz. Vitamin C (ascorbic acid or ascorbate), total phenol content, antioxidant capacity, total chlorophyll content and firmness as compared to control.

PAU Ludhiana centre has worked on standardization of Soil-less cultivation of high value vegetables for enhancing water-nutrient productivity, improving nutritional security and increasing profitability of farmers for climate resilient agriculture

The five tomato cultivars viz. V_1:NS 4266, V_2:Punjab Sartaj PAU, V_3:HBY Heemshikhar, V_4:GS 600 and V_5: Heem Sona and three level of nutrient solution F_1:80%, F_2:90% and F_3:100%. The cocopeat slabs of dimensions 1m x 0.25m x 0.15m was used. The better response was recorded when 100 % fresh nutrient solution was used followed by F_2 (90%) and F_1 (80%). Significant response was recorded with V_4:GS 600 in all growth and yield parameters. The recorded yield performace of developed system are treatment F3 (5.80 kg/plant) recorded significantly higher yield as compared to FI (5.39 kg/plant) but recorded statistically at par result with F2 (5.71 kg/plant). Among the different cultivars, variety V4 (5.87 kg/plant) recorded significant fruit yield which was statistically at par in result with VI (5.86 kg/plant) and V5 (5.82 kg/plant). Highest fruit yield was 5.87 kg/ plant recorded with GS 600 variety and lowest fruit yield was recorded with Punjab Sartaj i.e. 5.28 kg/plant.

Development of computer assisted/web based crop nutrition program for commercial nursery and greenhouse production in soilless media

PAU Ludhiana centre has developed web-based program is to assist commercial nursery and greenhouse growers with the acidification of their irrigation water and nutrient solution formulation Programme consist of two part on is acidification only and Nutrient solution formulation . Nutrient solution formulation consist important tabs which are specifically programmed to make desired location specific national formulation for soil less cultivation. There are dedicated tabs featured in programme

to perform specific task which are sample water values tab, target value tab, fertilizer tab and solution fertilizer tab.

Design and development of low-cost multiple use portable polytunnel-cum-polyhouse for higher hills by ICAR-VPKAS, Almora centre. The structure has been designed as location specific conditions and size of polyhouse is 12m x 5.2m x 2.6m. This unique design offers many advatages in hilly terrains where land is small and fragmented in terrace forms. Around four people are required to shift polyhouse and shifting can be done in 2 hrs with ease. The microclimate analysis also carried out and found that structure is maintaining desired microclimate suiting to local conditions. Technology successfully performing in tomato, capsicum crops at farmers' fields

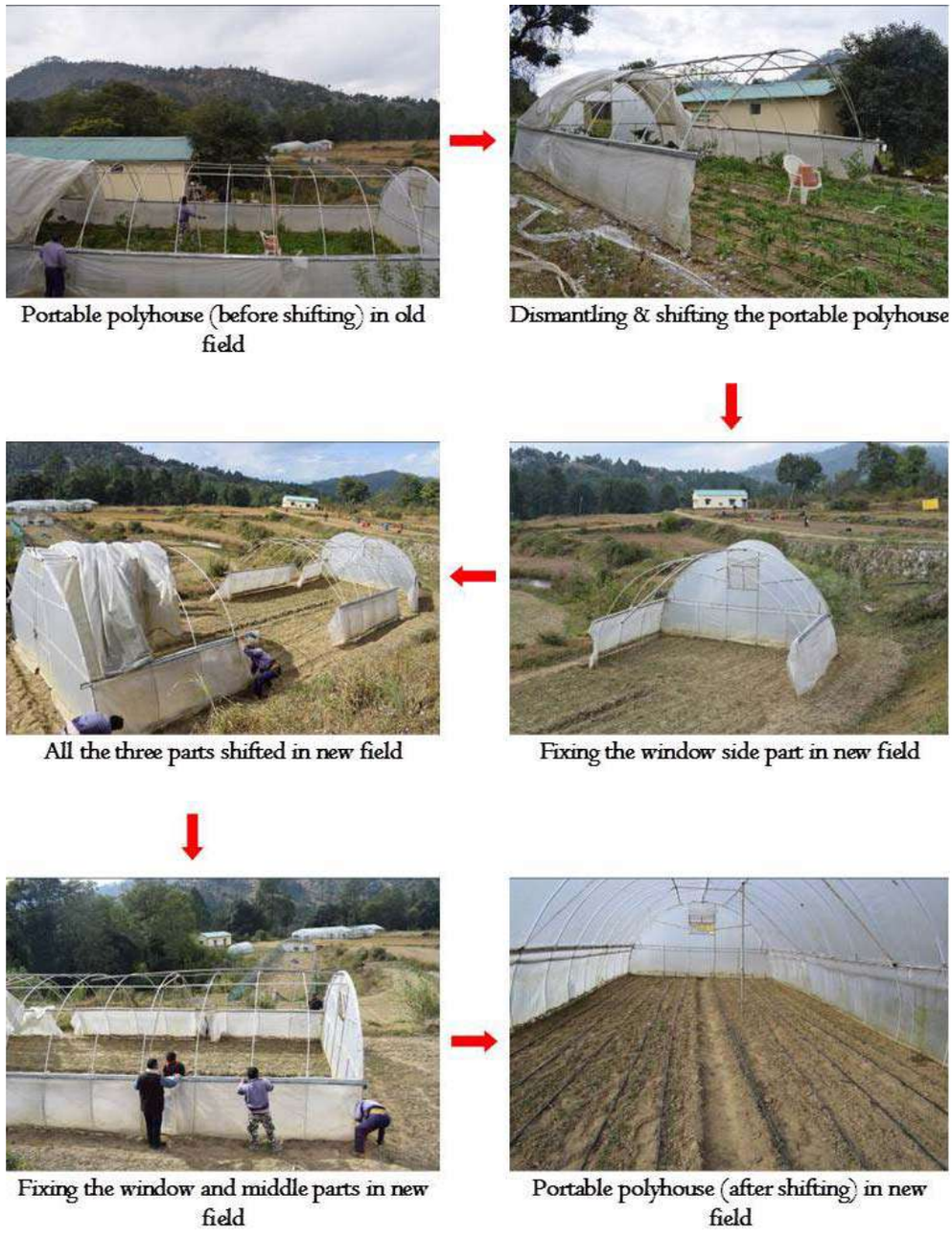


Fig. 1. Shifting of 62.4 m^2 size portable polyhouse from old field to the new field

Design and stadadization of NV multispan bamboo polyhouse for cost-effective soilless cultivation system in *konkan* region by DBSKKV, Dapoli centre

The low cost bamboo polyhouse (Area: 528 sq.m, Gutter height: 4.57m) was designed for 100 km/hr wind speed and erected on farmers field. The transplanting of capsicum was done

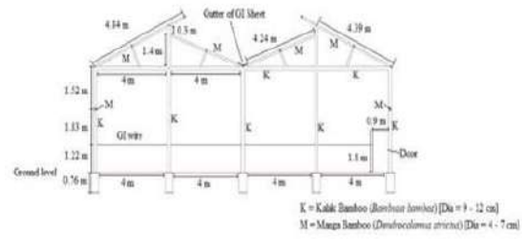


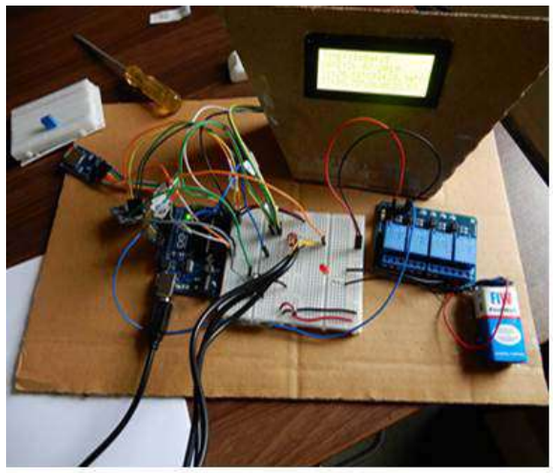
Fig. 2. Bamboo polyhouse (designed wind speed: 100 km/hr, Area: 528 sq.m, Gutter height: 4.57m) erected at farmers field

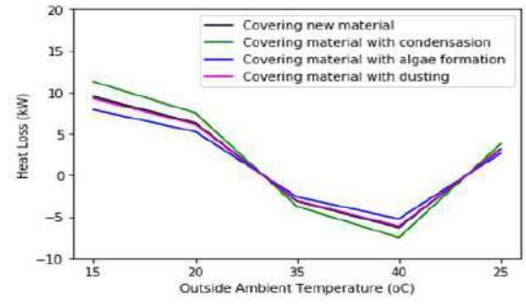
Fig. 3. Transplanting of capsicum (last week of December, 2019) using grow bag and slabs & Full bearing Capsicum crop view

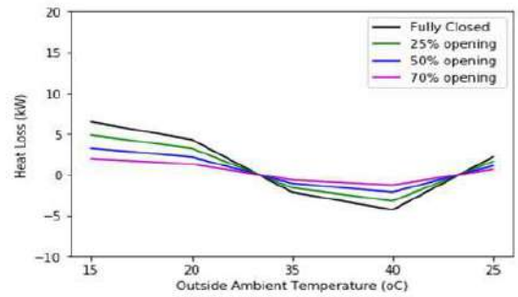
Fig. 4. Harvested capsicum sold at local market

on last week of December, 2019 and harvesting has been started from third week of February, 2020. The structural members such as purlins and rafters were designed for its extreme fiber stress by considering maximum wind pressure, using in top vent deflection, dead load and live load etc. The side columns and middle column were designed by considering its allowable buckling and tensile stress. The maximum wind load was considered in the design of grits. Also, the required minimum depth of foundation was designed for maximum load and soil bearing capacity. Till date 1.8 tone yield was recorded and harvested capsicum sold at local market of Dapoli during lockdown. Soilless capsicum under the polyhouse is managing for fertigation, trellis and pruning, pest and diseases, harvesting and data recording (Environmental & Biometric).

Development of cost-effective indigenous integrated greenhouse controller for naturally ventilated polyhouse by DBSKKV Dapoli centre. One module is developed by inetegratetion and proframming of sensors such as SHT 10, DS18B20, DHT22, MAX6675 thermocouple and DFRobot soil moisture sensor. The LCD was used to display data of hooked sensors and the data were logged and stored in an SD card. The basic thermal modeling for thermal heat loss (conduction, convection, and radiation), moisture production (i.e. real time evapotranspiration) and ventilation for temperature and moisture balances in the greenhouse with changing ambient conditions was done with the objective of judging real time "thermal-environmental status" of the greenhouse. The instantaneous conduction heat loss (rate) through greenhouse roof (material = single layer polyethene, area of the greenhouse covers=549.78 m^2, inside greenhouse temperature=30° C) by considering effects of above factors on conduction heat loss at different ambient conditions. Also, the modeling for conduction heat loss through different per cent (25%, 50% and 75%) opening areas of side curtains of the greenhouse at different ambient conditions (material = single layer polyethene, area of the greenhouse side walls =374.74 m^2, inside greenhouse temperature=30° C) was done.







Optimization of soil less media on growth parameters and fruits yield of organic strawberry (Chandler and Ofra) in eastern Himalayan region by CAU-CAEPHT, Gangtok centre, Four soilless media were used i.e.; Perlite, coco peat, sawdust and rice hull in the trail. Combination of saw dust + rice husk + perlite + coco peat (25: 25: 25: 25) was found best for number of flowers, number of days taken for fruiting, number of fruits, yield per plant and TSS- acid ratio. This may be attributed due to all different nutrient element present in the different soilless media might have contributed as a balanced supply to the plants for its overall growth and development of strawberry plant.

Effect of different colour of shade and growing media on growth and yield of *Anthurium andreanum*

CAU, Gangrok centre has constructed of four different colour (white, green, red & black) shade net houses of area (10ft x 10ft). The tissue cultured Anthurium saplings variety were planted on 29th June, 2019 in plastic pots in soilless media. The experiment consists of 15 different growing media (cocochip, cocopeat, sawdust, wood charcoal, brick pieces, soil and sand). Observation on establishment of plants is under process. Survival percentage of Anthurium andreanumwas highest in red coloured shade net with 97.33% followed by green colour polyhouse 94.67%.

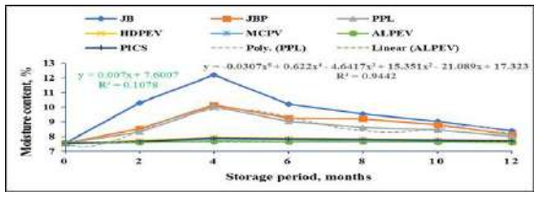
Fig. 5. Anthurium one month old in different coloured polyhouses

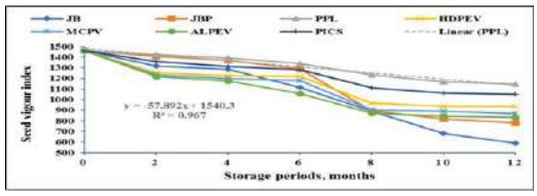
JAU, Junagadh centre standardized off-season okra (Syngenta-1522) cultivation under protected environment for Saurashtra region

Plant growth and yield 197.55 qt/ha were found significantly highest inside the net-cum-polyhouse without ridge vent with silver black plastic mulch over open condition where it very low in offseason. The net profit (Rs.6.70 lakh/ha) could be obtained with B:C ratio of 2.30 by adopting this technology . Recommendations to the farmers of South Saurashtra Agro climatic Zone are recommended to adopt net-cum-polyhouse without ridge vent with silver black plastic mulch (20 µm) for off-season cultivation of okra during winter season.

Effect of packaging on storage behavior of chickpea grain

JAU Junagadh centre have studied effect of packaging on storage behavoiur of chickpea grain (GJG-3) during April, 2018-19. 5.0 kg sample size was used in the experiment with packaging material viz.; Jute bag (JB), Polyethylene lined jute bag (JBP), PP woven laminated bag (PPL), HDPE bag with vacuum (HDPEV) 150 µm, Multilayer coextruded plastic bag with vacuum (MCPV) 150 µm, Polyethylene laminated Aluminium foil bag with vacuum (ALPEV) 150 µm, Perdue improve crop storage bag (PICS). The insect population (262 numbers/500 g), grain damage (91.3 %), weight loss (14.54 %) and Maximum moisture content (12.20 %) was found maximum in chickpea grain stored in JB followed by JBP bag at the end of twelve months of storage period. Maximum protein content in the grain was recorded in HDPE bag (18.96 %) and it was at par with other packaging materials except JB and JBP. Minimum protein content in the grain was found in JB (14.02 %) at the end of storage period. Minimum cooking time of the grain was observed in JB (45.67 min) and maximum cooking time was recorded in ALPEV (74.0 min) followed by MCPV on twelve months of storage. Swelling capacity (0.250 ml/grain) was found maximum in PPL at the end of the storage, where lower in ALPEV, MCPV and HDPE bag than other treatments. Maximum germination (92.0%) and seed vigour index (1146) was recorded in chickpea grain stored in PPL followed by PICS at the end of storage period. Seed qualities like germination and vigour index of the grain was found poor in vacuum packed bags on twelve months of storage. PPL was observed to be best packag terial amongst all treatments for chickpea grain storage up to twelve months.





Package of practice has been developed for improving productivity and production of pigeon pea

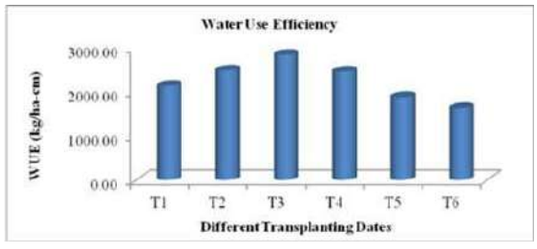
pulses for arid region of Karnataka. Standardized white colour plastic mulch with 100% of RDF and 100% irrigation level for pigeon pea which resulted maximum yield 24 t/ha over current farmer practice of 18t/ha

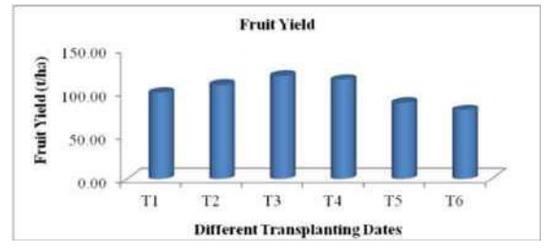
Standardization of fertigation and irrigation with microclimate modelling for capsicum crop under naturally ventilated polyhouse in semi arid region

Polyhouse dynamic model DSSAT (Decision Support System for Agrotechnology Transfer) version 4.6.1 is used for this study for the temperature and Relative humidity based on the energy and mass exchange has been reformulated

based on the type of the polyhouse structure. Network of sensors is used to monitor microclimate and control desired microclimate using provided threshold values by system on GSM mobile. Developed model has been helping in predicting the control action required and accordingly it also generates the actuating signals accordingly. Among the fertigation and irrigation levels 100% RD of nitrogen and 100% RD of phosphorus resulted in maximum yield of 2.94 t/ha.

Modelling growth parameters of tomato crop using DSSAT under naturally ventilated sensor monitored polyhouse is carried out at MPUAT-Udaipur centre. The effect of different transplanting months or time on crop parameters are studied. Developed one small indigenous module based on Arduino platform microcontroller with integrated sensors i.e. DS18B20, DHT22 and SD to record and monitor temperature, light and humidity values. This analysis shows that the suitable temperature for the growing of tomato crop i.e. 29.1°C which gives maximum 2930.54 kg yield/plant. The marketable fruit yield of tomato was found maximum (118.87 t/ha) under treatment (transplanting month September).





Water lifting device for river bed cultivation in hilly region

The low cost lifting device was developed by ICAR-VPKAS, Almora centre. The water lifting device utilize the waste and unused hydraulic energy of flowing river water to lift water from river. Two plunger pump assembly is used to pump the water in developed technology. River current with the help turbine is used as motive power to drive the pumps. Sixteen numbers of blades are used in the turbine. The gear on the turbine drive shaft was consist of 14 teeth and that of pump driven shaft was of 36 teeth. Plunger pump displacement is kept around 5 cm. performance evaluation is carried out and found that the discharge of one-meter height was 10 lpm and at 7 m height discharge was 5 lpm i.e. 7200 liters in 24 hours. • This device will be most useful in areas where spring or/on gravitational flow of energy is available. Use of this technology will increase farmer's income by growing crop in barren land near river bed.

Effect of post-harvest treatments and modified atmosphere packaging (MAP) on vase life of cymbidium orchid of Sikkim

Cymbidium orchids spikes (flowers) for the study were cleansed and sorted to exclude defective and irregular size flowers. The stem-ends of individual spikes trimmed and inserted into a plastic tube containing distilled water (2% sucrose) and packed in corrugated fibre boxes (CFB). Each of the boxes was then wrapped with packaging films as per the treatment and finally hand heat-sealing. The spikes packed in CFB without wrapping with packaging films was served as the control. All treatments were stored at room temperature(22°C-24°C). The parameters to be recorded on total water uptake, weight loss (g), determination of internal O2 and CO2 andvase-life (days). The experiment was layout following CRD consisting of four treatments viz. T1 - Control (without MAP), T2 - polypropylene film (25µ), T3 - LDPE (50µ), and T4 - Silpoullin film (35 GSM) with five replications and one spike per replication. Results of the study revealed that maximum vase life of spike (20 days), opening of florets (86.89 %) and no weight loss of flower at the time of opening of packaging in T2 - polypropylene film (25µ) as compare to other treatments.

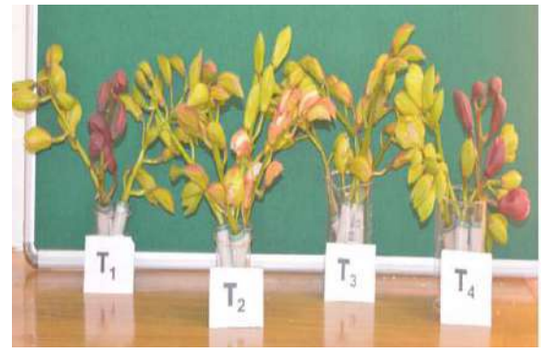


Fig. 6. Orchid spikes before packaging

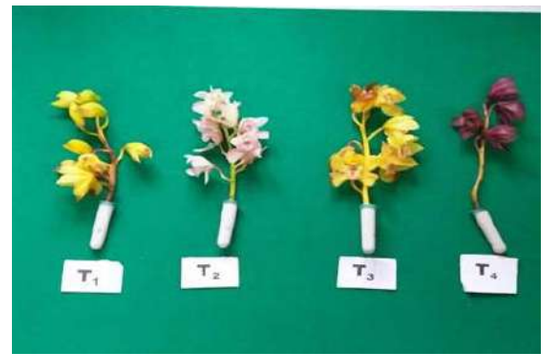
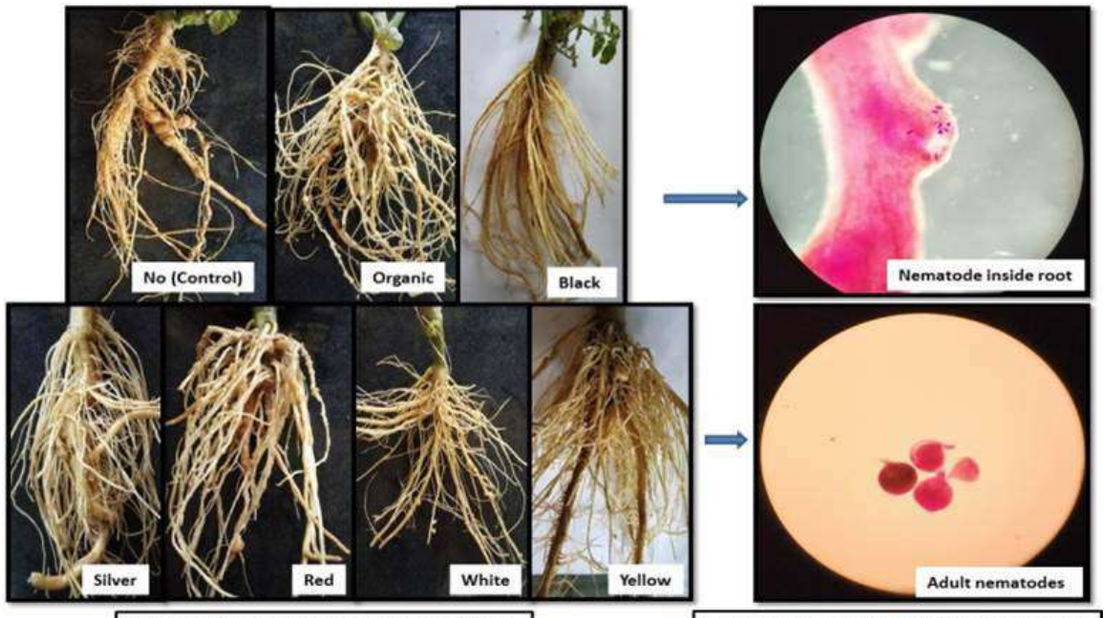


Fig. 7. Orchid spikes after packaging

First of kind unique study on assessment of soil microbial activities and post-harvest quality of tomato cultivated under plastic and organic mulches in arid regions was carried out by CIPHET Abohar centre

Effect of various plastic (black, silver, red, white and yellow) and organic mulches on agriculturally important microorganisms such as Phosphorus, Potassium, Zinc solubilizing bacteria and iron and sulfur metabolizing bacteria in tomato rhizosphere were examined. Highest population



Effect of various mulches on Nematode infection

Microscopy images of root infected nematodes

of beneficial P-solubilizing bacteria (68.5 ± 8.95× 10^{-6}) was found in black mulch treatment followed by white mulch. Wilted plants roots and soil near root was analyzed for the nematode infection (%), root knots, and nematode population in the soil. Maximum number of plants infested with nematode infection was found in organic treatment (38.33 %) while lowest infection was found in black mulch treatment (16.67%), followed by white mulch treatment (21.67%). In terms of nematode population, lowest population of nematode was found in white mulch treatment, i.e. 60/100 gram of soil, followed by black mulch treatment (84.5/100 gram of soil). The results of study provided actual soil microbes conditions under different color mulch which responsible for good plant growth.

Phase change materials based mobile cool chamber for transportation of fruits and vegetables by CIPHET Abohar centre

Overall dimensions of the chamber are length, width and height of the cool chamber are 1.46 m, 0.93 m and 0.39 m respectively. Performance of PCM based mobile cool chamber was evaluated under no load and full load conditions. Results indicated that under no load condition and providing PCM panels, inside temperature was lower by 13 to 20°C than the outside temperature (varied form 28 – 46°C). When no PCM panels were provided, inside temperature increased by 3 to 13°C above the outside temperature (varied form 32 – 41°C). About 25 kg of radish and 18 kg of palak were kept in the cool chamber and performance of the chamber in maintaining the freshness of these commodities was evaluated. Vegetables kept in a cool chamber for four consecutive days were fresher than those kept outside the chamber. Daily average physiological loss in weight (% PLW) in radish was 9.98 and 1.98 % when kept outside and inside the chamber, respectively. Similarly, daily average PLW in *palak* was 11.19 and 1.37 % when kept outside and inside the chamber, respectively. The cost of system is around Rs. 100000/- and under developmental stage.

Pabda hatchery

ICAR-CIFA has designed and developed a Pabda hatchery unit under its AICRP on PET center located at Bhubaneswar. Fishes of genus Ompok, widely called as 'butter catfish', and in India and neighboring countries commonly known as 'Pabda'. It is valued as medium-sized silurid catfish having high consumer preference in many parts of India. The developed system consists of two major parts i.e. Hatching/ incubation unit; and Brood acclimation-cum-Latency stage nurture-cum Hatchling rearing tanks. Diameters of the pools are of 1.2 m, 1.1 m and 1.0 m having a water height of 0.20 m. The overall height of the hatching/ incubation unit is 1.55 m. Four Product description numbers of RPVC duck-mouths are fitted at the bottom of the hatchery to get required water flow or keep eggs in suspension in water, as per need. Size of largest tank is 3.0 x 1.1 x 0.60 m and smallest is of 2.8 x 0.9 x 0.6 m; to allow fittings of one inside another during transportation. For maintaining water level based on purpose of use, outlets fitted with individual full-way valves are provided. The system is suitable for acclimation of 8-10 kg brooders of pabda and also for nurturing of injected brooders of 5-6 kg. The system can also be used for rearing of hatchlings and about 10,000–15,000 nos. of early fry can be produced in a single cycle.

Animal shelter for cold and temperate region

Designed and developed animal shelter is 9.75 m x 4.75m x 2.59m .Microclimate analyss of developed shed was carried out and temperature found in the range of 25-36ÚC which is suitable for animal growth. Head load generated by animal was also calculated. Loading considerations of the animal shelter found to be satisfactory (Total dead load = 248 N/m^2; Dead Load of Purlins = 31N/m^2; Spacing of Truss = 2.3 m; Live Load= 350N/m^2; Wind Load=5599.58 N). Weight gain was more inside shelter as compare conventional practice. The animals mostly spent time outside the shed during September when the temperature fluctuations were more (Day temperature was more compared to night) and animals were not sheared. After shearing animals started going inside the shed during late night hours. After 15th Oct animals seemed comfortable in the shed during night hours and spent night hours within the shed. No morbidity and mortality was observed in the experimental animals. Thirty (30) animals (sheep) were divided randomly into two groups with average body weight of 15.8 kgs and one group was housed in conventional housing and another group in developed structure during the night hours and this experiment was carried during two (2) months of December and January. Weight gain was found in the developed shelter as compare to conventional practice. However improvements in design and ventilation is required for enhancing performance which is under progress.

Plastic feeders for medium and small sized adult goats and post weaned kids

ICAR-CIRG centre has developed FRP plastic feeders for goat husbandry. FRP plastic of 2-3mm thick green & blue sheets was used in the fabrication and PVC pipes was used as building material. The feeding trough materials type and dimension did not influence the animal behaviour. The color of FRP sheets had influence on buck's behaviour. The hayracks plastic strips with green color induced nibbling/biting, whereas blue color strips are safe while using in feeders. The green color may appear that goats may realise the green with similarity color of green fodders. The wastage for concentrate feed is almost nil and 2-5% wastage in case of dry and green fodders for all categories of goats.

ICAR sponsored winter school

A 21 day ICAR Sponsered Winter School on Design, Innovations and Applications of Plasticulture Technologies in Agriculture, Horticulture and Pisciculture Production and Post-Harvest Management for Doubling the Farmer's Income during 05-25, Nov. 2019. Total 18 participants which includes Asst proff. Scientist and professor from six states were participated in the training programme. Honourable DDG Engg Dr K Alagusundaram alongwith ADG Engg ICAR New Delhi inaugurated the winter school.

Research Highlights of Consortium Research Platform on Secondary Agriculture

The aim of this project is to accelerate the pace of technology development, demonstration, training, and commercialization in the domain of value addition to different agriculture produce for enhanced income to farmers and harness the un-trapped potential of the vast number of products which could be obtained from main commodities and by-products using high end effective technologies.

The project has following objectives:

a. To develop value chain for selected commodities in the production catchments.

b. To develop technologies and establish pilot plants for high value and low volume products.

c. To isolate and characterize high value bio-molecules from crop residues and processing by-products.

d. To develop rapid detection protocols and kits for food safety & quality assurance and establishment of accredited food testing laboratories.

This platform has 5 projects running at 4 centers as below:

S. No	Name of centre	Project Name
1	CIPHET, Ludhiana	Value Addition of Makhana and Its By-products
2	CIPHET, Ludhiana	Establishment of Modern Agro-Processing Centre of Fruits and Vegetables
3	FRI Dehradun	Value addition to guar gum and its byproducts
4	IGKV Raipur	Establishment of Agro-processing centre for value addition of small millets
5	AEC&RI, TNAU, Kumulur	Establishing APC on Millets, Pulses, Fruits and Vegetables

Progress of the centers is as below:

I. Project name: Value addition of makhana and its byproducts

Progress:

a. Development of continuous makhana seed washer

A machine for continuous washing of makhana seeds was developed and fabricated. The machine

Fig. 1. Continuous makhana seed washer

consists of 9 emery discs of 225 mm diameter and 20 mm width. The distance between two discs is 75 mm. The discs are mounted on a shaft. The disc assembly is placed in a cylinder. The clearance between outer periphery of the disc and cylinder is 25 mm. The upper half of the disc is made of mild steel sheet whereas screen of 7×25 mm slotted opening is fitted at the bottom half of the cylinder. A water pipeline is provided over the top of cylinder with water pipelines.

The discs rotate at 200 rpm using an electric motor of 1 hp. The machine can wash about 120 kg raw makhana seeds in one hour.

b. Hand tool for stirring makhana seeds during initial roasting

The initial roasting of makhana seeds is done after washing and drying. At present this operation is performed manually. About 2-3 kg seed is placed in an open pan. The pan is heated by burning wood. Stirring of the seeds is done continuously during roasting operation. About 6-9 bamboo sticks of about 10 mm diameter and 450 mm long are fastened together to make a stirrer and stirring of the seeds is done using this tool during roasting. Such stirrer worn out in 2-3 days operation. Handle of the stirrer is rough and therefore uncomfortable during operation.

Therefore, a hand tool was developed for stirring of makhana seeds during initial roasting in open pan. The tool consists of 9 fingers made of mild steel wire of 5 mm diameter and 450 mm long. The fingers are joined together at one end with a handle of 65 mm diameter whereas the other end in free in arc shape of 225 mm. A handle of 300 mm length and 80 mm diameter is attached with the fingers. The fingers are tied using a tie rod at 150 mm distance from the bottom of handle. This tool was evaluated for initial roasting of the makhana seeds in open pan. The tool was found very comfortable, durable and easy to operate. About 600 kg makhana seed was roasted in open pan using this tool. The fingers remain intact in the whole operation. A total 10 tools were distributed to the trainee farmers for field evaluation.

c. Storage study of roasted makhana seeds

The moisture content of makhana seeds is about 25% immediately after initial roasting. The roasted seeds are kept for about 48 hours after roasting for tempering. The moisture content of the seeds reach to 20-22% after 48 hours and then second roasting of the seeds is done for popping. The initial roasted seeds have to be popped within 5-7 days after roasting, if seeds are placed in jute bags. The popping efficiency is reduced drastically after 7 days. Therefore a study was conducted to investigate the effect of packaging material and storage duration on popping efficiency of roasted makhana seeds. The experimental plan was as below:

Packaging materials: LDPE (25 ì); LDPE (80 ì); Silver laminate; Biaxial oriented poly propylene laminate (BOPP); Poly propylene

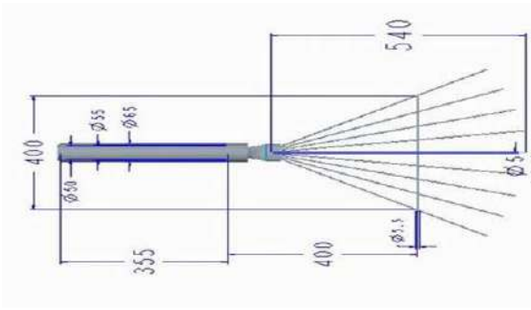


Fig. 2. Hand tool for stirring makhana seeds during initial roasting

Sample size: 2 kg roasted seed

Date of storage: 25 November 2018

Storage period: 180 days (popping after every 10 days)

Observations: Weight of seeds; Popping efficiency; total recovery; popped makhana recovery; colour

The roasted makhana seeds were procured from Saharasa (Bihar) of different size grades. Samples of 2 kg were packed into the selected packaging material and sealed. The sealed packets were stored at normal room temperature. Control samples were also stored in the jute bags.

- Popping of control samples did not take place after 10 days of storage.
- No change in weight of samples was observed even after 90 days storage.
- Total recovery of makhana (unpopped + popped + broken) varied between 54-58% during the storage period.
- The popped makhana recovery varied between 35 to 45%. The recovery was not dependent on storage periods or type of packaging material.
- The popping efficiency varied between 79 to 90%. The popping efficiency was not dependent on storage periods or type of packaging material.
- The expansion ratio of the makhana varied between 2 to 2.6.
- No appreciable change in popping quality has been observed up to 180 days of storage.
- The study suggests that the packaging of roasted makhana seeds may be done in any packaging material having moisture barrier property. The suitability of packaging material will depend upon their strength.

d. Value added products from unpopped makhana

Makhana flour for the preparation of value added products is obtained by grinding unpopped to the powdered form. When the roasted makhana is passed through makhana decorticating machine, some of the roasted seeds don't get popped but the hull/seed coat gets separated. This un-popped makhana is known as thurri which is used as the basic ingredient in the value addition.

Ladoo

For the preparation of makhana ladoo, ghee was heated in a kadai or heavy-based pan over low flame. The flour was added to the pan, mixed well and roasted over a low flame until it turns golden brown. The mixture was transferred to a large plate and it was cooled for approximately five minutes. When the mixture was slightly warm, jaggery/sugar syrup/honey was added and mixed. Then the mixture was shaped into ladoos, cooled and packed into polyethylene package (Table 1).

Unpopped makhana

Makhana flour

Fig. 3. Unpopped makhana and its flour for ladoo preparation

Ingredients and type of ladoo prepared from unpopped makhana flour

Different makhana ladoos	Ingredients
A) Makhana ladoo (jaggery)	· Makhana turri flour (100 g) · Ghee (40 g) · Jaggery (80 g)
B) Makhana ladoo (chasni/sugar syrup)	· Makhana turri flour (100 g) · Ghee (40 g) · Sugar syrup (120 g)
C) Makhana ladoo (40% honey)	· Makhana turri flour (100 g) · Ghee (40 g) · honey (40 g)
D) Makhana ladoo (50% honey)	· Makhana turri flour (100 g) · Ghee (40 g) · honey (50 g)
E) Makhana ladoo (60% honey)	· Makhana turri flour (100 g) · Ghee (40 g) · honey (60 g)

The process for development of ladoo from unpopped makhana flour is presented below:

Heat desi ghee on heavy bottom pan
↓
Add flour
↓
Roast on a low flame till roasted color and flavor develops
↓
Keep for some time to allow cool
↓
Add sugar syrup (two thread consistency)/jaggary/honey
↓
Moulded to round shape balls
↓
Packaging

Fig. 4. Flow sheet for the preparation of makhana ladoo

Jaggary ladoo

Sugar syrup ladoo

40% honey

50% honey

60% honey

Fig. 5. Different makhana ladoos

Table 1: Sensory evaluation (hedonic scale) of different makhana ladoo

S. No	Sample	Appearance / Colour	Texture	Odour/ Aroma	Flavour	Taste	Overall Acceptability
1.	Makhana ladoo (jaggery)	8.3	8.05	8.1	8.28	8.5	8.25
2.	Makhana ladoo (chasni/ sugar syrup)	7.5	7.2	7.18	7.35	7.35	7.32
3.	Makhana ladoo (40% honey)	7.6	7.33	7.33	7.25	7.23	7.35
4.	Makhana ladoo (50% honey)	7.75	7.38	7.33	7.78	7.55	7.62
5.	Makhana ladoo (60% honey)	7.88	7.75	7.75	8.05	8.30	7.95

Gluten free ribbon pasta from unpopped makhana

The availability of the gluten-free products is limited and consequently, celiac patients have difficulty finding gluten-free foods. Protein content of makhana is high and comparable to cereal crops but has no gluten content. The present invention relates to the process for the development of gluten free ribbon pasta without the use of wheat flour or semolina. Experimental design Response surface methodology (RSM) was adopted to design the experimental combinations for developmentof the nutritious pasta samples for this study.The independent variables included theproportion of makhana turri flour, water chestnut flour and potato flour. Carrot juice was added to replace water and also to improve the antioxidant activity of pasta. Response variables are protein content, ash content, total phenols, antioxidant activity,cooking time, rehydration ratio, overall acceptability and colour quality ('L', 'a', 'b' and 'YI' value).

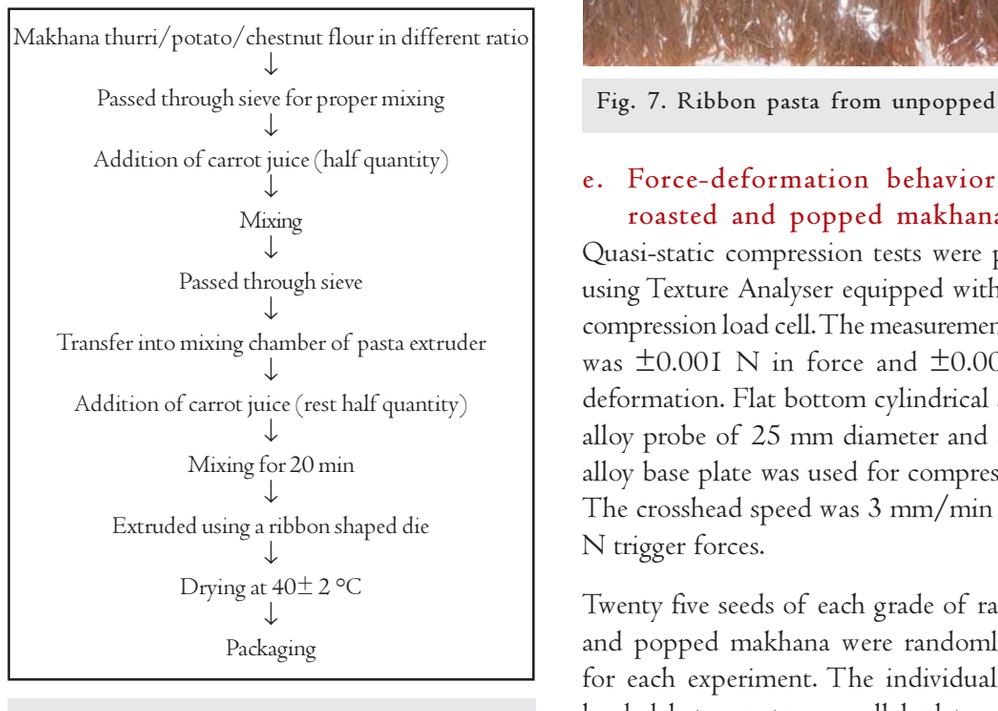


Fig. 6. Flow sheet for the preparation of ribbon pasta from unpopped makhana

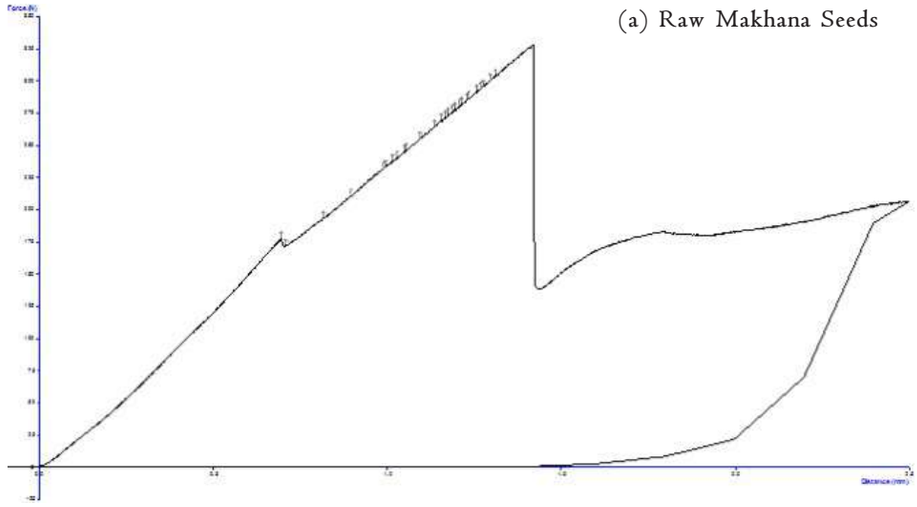
Fig. 7. Ribbon pasta from unpopped makhana

e. Force-deformation behavior of raw, roasted and popped makhana

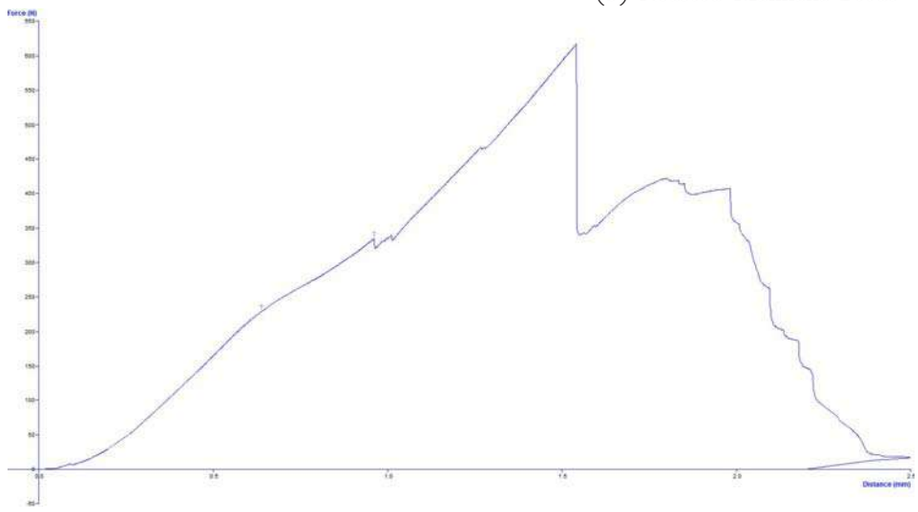
Quasi-static compression tests were performed using Texture Analyser equipped with a 500 N compression load cell. The measurement accuracy was ±0.001 N in force and ±0.001 mm in deformation. Flat bottom cylindrical aluminum alloy probe of 25 mm diameter and aluminum alloy base plate was used for compression tests. The crosshead speed was 3 mm/min with 0.05 N trigger forces.

Twenty five seeds of each grade of raw, roasted and popped makhana were randomly selected for each experiment. The individual seed was loaded between two parallel plates of texture analyzer and compressed until the seeds failed. The slow speed allowed each seed to be

(a) Raw Makhana Seeds



(b) Roasted Makhana Seeds



(c) Popped Makhana

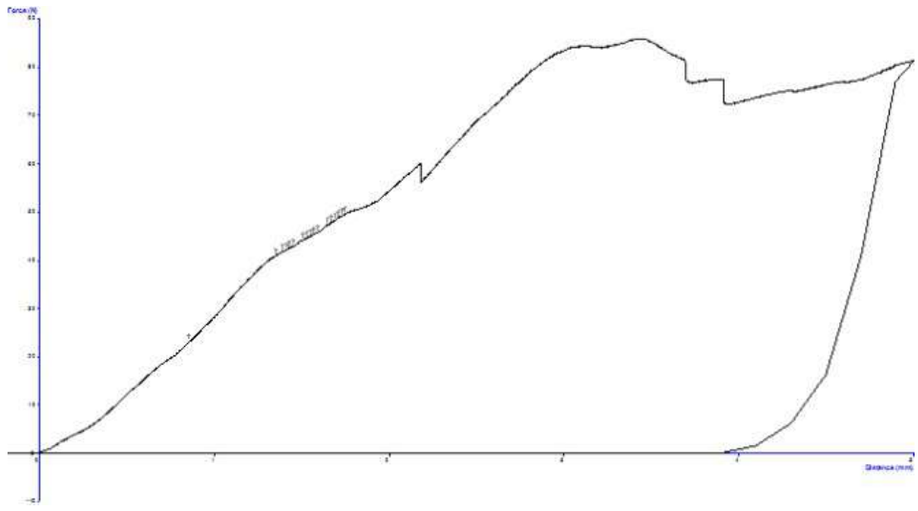


Fig. 8. Force deformation behavior of (a) raw makhana seeds; (b) roasted makhana seed; (c) Popped makhana

compressed for an appreciable time before failure. The bio-yield point was detected by an increase in deformation at either reduced or no change in force in the force-deformation curve.

Typical force-deformation behaviors of raw makhana seed at 31% moisture content, roasted makhana seeds at 21% moisture content and popped makhana at 6% moisture content are shown below. Increasing the load manifested in yielding of seeds, that is reflected as decrease in force with increase in deformation. Further increasing the load resulted in failure of seeds and rupture was observed. The force and deformation at bio-yield point of popped makhana was significantly lower ($p<0.01$) than those of raw makhana and roasted makhana seeds. The popping resulted into expansion of starch and therefore the bio-yield force decreased considerably.

The high moisture content of raw makhana seed did not result into ductile behavior indicating that seed coat plays critical role in the failure of raw seeds. In case of roasted seed, the force at bio-yield point was double to that of raw seeds. Gelatinization of kernel powder during roasting and further drying during tempering, resulted into increased hardness of kernel. Further the moisture content of the hull and kernel was also reduced. The combined effect of these might have resulted into increase in bio-yield force of roasted seeds. In case of popped makhana, the expansion ratio was around 2. Thus the popped kernel becomes very soft, though the plastic flow was not observed. It indicates that the popping increases the volume but integrity of the kernel is affected less.

Project name: Establishment of modern agro-processing centre for fruits and vegetables

Progress:

a. Effect of drying temperature on physico-chemical properties and drying kinetics of rose petals in a tray dryer

The dried petals of rose (*Rosa indica* L.) are used in pharmaceutical industry, particularly in Ayurvedic system of medicine. The sun drying is

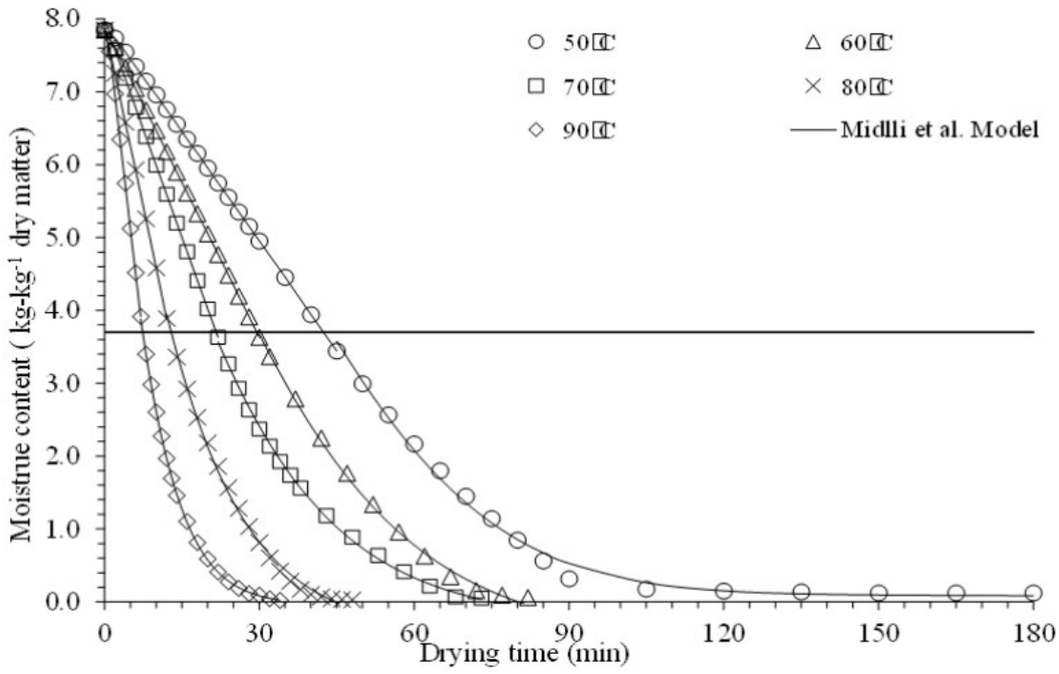


Fig. 9. Moisture content variations of rose petals with drying time for different drying temperatures (– is the predicted values by Midilli et al. model in falling rate period)

Fig. 10. Rose petals dried at different temperatures

commonly practiced in India for drying rose petals, which lead to poor product quality. Therefore the present study was conducted to study the effect of drying air temperature on physicochemical properties of rose petals. The drying data were applied to six well known semi-empirical mathematical models namely Newton, Page, Modified Page, Midilli & Kucuk, Henderson & Pabis and Logarithmic models to suggest suitable model. The petals were dried in a tray dryer at 50-90°C air temperatures. The drying of rose petals continued till the change in weight of petals was less than 0.001 kg water-kg^{-1} dry matter for drying kinetics study. In another experiment, the drying of petals continued till the moisture content of the petals reached to 10-12% (db) to for determine the effect of drying temperature on chemical properties.

The drying of rose petals took place in constant rate period followed by falling rate period. The moisture content of petals decreased from initial moisture content of 7.85±0.13 kg water-kg^{-1} dry matter to critical moisture content of 3.70±0.20 kg water-kg^{-1} dry matter in constant rate period of drying. The experimental and predicted drying curves of rose petals at 50, 60, 70, 80 and 90°C air temperatures are as below:

The increase in drying temperature resulted into decrease in drying time until equilibrium moisture content were reached. The moisture content of rose petals reached to about 12% (db) in 150 min when dried at 50°C whereas drying at 90°C took only 28 min for reducing the moisture content to 11.6% (db). Further, the drying of rose petals took place in constant rate period (CRP) initially and then in falling rate period (FRP) at all drying temperatures. On the basis

of standard error estimates, mean relative deviation modulus, and pattern of residual values, the Midilli et al. model was found suitable to describe the drying kinetics of rose petals.

The bulk density, true density and porosity of rose petals decreased significantly after drying. The petals become darker after drying. The drying at higher temperatures affected the physical properties significantly. The DPPH value of fresh rose petals was equivalent to the strawberry. The vitamin-C content, DPPH antioxidant capacity, TSS and pH of fresh petals were 13.89 mg/100 g, 76.33%, 5° Brix and 5.49, respectively and decreased with drying temperature. The increase in drying air temperature resulted into significant decrease in chemical constituents. The study showed that the drying of rose petals should be done at drying air temperature of 70°C or less.

b. Process for Preparation of Rose Petal Jam

Jam is conventionally produced using fruits including fruit juices, fruit pulp, fruit juice concentrate or dry fruit by boiling its pieces or pulp or puree with sweeteners namely sugar, dextrose, invert sugar or liquid glucose to a suitable consistency. The present process relates to the preparation of rose petals jam without any fruit or vegetable or their powder or essence of rose or of any other flower. The *gulkand*, which is popularly prepared and consumed in India, is prepared from rose petals by putting the alternate layers of rose petals and sugar in a container and placing this under sun for about 28-30 days, which is a lengthy process moreover does not yield a product like jam. The objective of this study was more specifically was to develop a process for preparation of rose jam from petals with sugar and permitted food additive that could meet the FSSAI standard for jam to the maximum possible extent and result a product like jam with good sensory acceptability without using any fruit or vegetable or their powder or essence of rose or of any other flower. The resultant developed rose petal jam following the evolved process is free from any fruits, vegetables or any kind of essence with good flavour and taste and the process is also have good techno-economic feasibility and easy adoptability and can be prepared in few hours.

Freshly harvested rose for the production of jam were considered for the study to take the rose petals after removing the sepals, stamen and pistil part of rose flowers. Thereafter gentle washing of rose petals in potable water is done and surface water is removed. Fine grinding of the petals is done with sugar. The rose paste is then heated with sugar up to get the desired consistency, textural profile of the jam and total soluble solids, almost similar to the maximum possible extent as specified for jam by FSSAI. After achieving the total soluble solids to a certain level, food additives are added followed by heating till the desired consistency (68-70 °Brix) of the end product. After completing the heating process, prepared rose petal jam is to be hot filled in sterilized glass jars for marketing or storage at ambient temperature in cool and dry place.

Fig. 11. Rose petal jam

Project name: Value addition of guar gum and its byproducts

Progress:

a. Hydroxypropylation of guar gum

Biopolymers comprise rich source of starting materials which were modified in desired manner

for specific applications without compromising their ecofriendly behavior. Hydroxypropyl guar gum (HPGG) is reported to be one of the most important non- ionic derivatives due to its better solubility and thermal solubility in comparison to native guar gum. HPGG is reported to have applications in diverse fields and industrial applications.

b. Cross-linking of guar gum

Cross-linking is a stabilization process in polymer chemistry which leads to multidimensional extension of polymeric chain resulting in network structure. Cross linking changes a liquid polymer solution into 'solid' or 'gel' by restricting the ability of movement. Cross linked polymers are important derivatised products since they are mechanically strong and resistant to heat wear and attack by solvents. A number of polysaccharides like chitosan, dextran, guar, starch, cellulose and alginate have been cross-linked with epichlorochydrin and used in different industries due to compatibility, biodegradability as well as excellent viscosifying properties.

c. Analysis of cross-linked products

The cross-linked products were analysed to determine degree of cross linking by methylene blue absorption method. The cross-linking was also confirmed by FTIR spectral analysis. The utilisation aspects of cross-linked products were also determined by dye absorption capacity using methylene blue.

Project Name: Establishment of APC for value addition of small millets

Progress:

a. Two millet processing line is installed, one at Centre of Excellence on NTFP & MAP at University Campus, Raipur and one at Krishi Vigyan Kendra, Jagdalpur.

b. Four millet processing line is in pipe-line for installation at four different Krishi Vigyan Kendra of the State.

c. The process technologies for multi grain flour, ragi malt, ragi flour, little millet rice and kodo rice has been validated, demonstrated and transferred to KVKs and Self Help Groups.

d. Hands–on-training and demonstration on millet processing and value addition are now regular activities of the developed millet processing centre.

e. The millet processing centre is available for custom hiring

f. The process technologies for the preparation of ragi based extruded products have been validated and demonstrated.

Awards and Recognitions

Dr. D. N. Yadav	Member (2020-2022) of Scientific Panel on Cereals, pulses & Legumes and their products (including bakery)	FSSAI, New Delhi.
Dr. K. Bembem	Best Paper Presentation Award	2nd National Conference on Technological and Emerging Aspects in Agriculture and Community Sciences at Society of World Environment, Food and Technology, New Delhi
Dr. Manoj Mahawar	Young Engineer Award 2019-20	Under the category of Agricultural Engineering given by The Institution of Engineers (IEI), India
Dr. R. K. Singh	Eminent Scientist Award	Institute of Environment and sustainable development, Banaras Hindu University, Varanasi.
Dr. R. K. Singh	Award of Honour	8th Asian Australasian Conference on Precision Agriculture held at Punjab Agricultural University, Ludhiana
Dr. R. K. Vishwakarma	Fellow	Agri-innovation foundation fellow Lucknow
Dr. Th. Bidyalakshmi Devi	Silver medals in 100m race, long jump, badminton (Single) and bronze medal in Shot-put.	ICAR Zonal Tournament-2019 (North Zone) held at ICAR-IIPR, Kanpur during 12-14th December, 2019
Dr. Yogesh Kumar	All India Best Publication Award	National seminar on doubling income through sustainable and holistic agriculture, Society of Advancement of Human and Nature (Dr YS Parmar University of Horticulture and Forestry)

Director ICAR-CIPHET and Senior Administrative Officer, ICAR-CIPHET receiving Award for work in Hindi on 28th August, 2019

Dr. Manoj Mahawar received 'Young Engineer Award 2019-20' under the category of Agricultural Engineering given by The Institution of Engineers (IEI), India

Dr Yogesh Kumar received All India Best Publication Award from Society of Advancement of Human and Nature (Dr YS Parmar University of Horticulture and Forestry)

Felicitation of participants of ICAR-CIPHET for outstanding performance in Games organized by CGEWCC, Ludhiana

Intellectual Properties (Licensing and Patents)

Technology Licensed

S. No.	Title	Firm	Licensing Fee (Rs.)	Date of Licensing
1.	Mechanized system for popping and decortications of makhana seeds	M/s Unitech Technocrats, H.P.	150000.00	28 March, 2019
2.	Live fish carrier system and method of transportation of live fish therein	M/s E Magic Electric, Vill- Nangal Fateh Khan, PO - Patara, Jalandhar, Punjab-144 101	280000.00	16 April, 2019
3.	Processing of aonla for manufacturing of value added products	Mr. Virsa Singh s/o Sh. Jaswant Singh, Ward no. 2, Garden colony, Patti, Dist- Tarn Taran, Punjab-143416	15000.00	10 May, 2019
4.	High volume low speed (HVLS) fan	M/s Chana Mechanical Engg., Sherpura Road, Jagraon-142 026 (Ludhiana), through its Proprietor Mr. Karnail Singh Chana	20000.00	09 September, 2019

Licensing of mechanized system for popping and decortications of makhana seeds to M/s Unitech Technocrats, H.P. on 28.03.19

Licensing of live fish carrier system and method of transportation of live fish therein to M/s E Magic Electric, Jalandhar on 16.04.19

Licensing of processing of aonla for manufacturing of value added products to Mr. Virsa Singh from Tarn Taran on 10.05.19

Licensing of high volume low speed (HVLS) Fan to M/s Chana Mechanical Engg., Jagraon on 09.09.19

Patents Granted (2019)

S. No.	Title	Patent Number	Date of Grant	Inventors
1.	Method of predicting maturity stage and eating quality of mango	309470	19.03.2019	Dr. S.N. Jha Dr. K. Narsaiah Dr. Pranita Jaiswal Dr. Ramesh Kumar
2.	Autoclavable microencapsulation system with multistage breakup two fluid nozzle for clean production of microcapsules	324943	13.11.2019	Dr. K. Narsaiah Dr. S.N. Jha Dr. M.R. Manikantan

Patents Filed (2019)

S. No.	Application Number	Title	Date of Filing	Inventors
1.	201911012570	Microbial method for production of protein isolate/concentrate from oil-seed cakes/meals	29.03.2019	Dr. D. N. Yadav Dr. Sangita Bansal Dr. R. K. Singh Dr. S. N. Jha
2.	201911021833	Indigenous pilot plant for production of protein isolates / concentrate from de-oiled cakes/meals	01.06.2019	Dr. D.N. Yadav Dr. S.K. Nanda Dr. R.K. Gupta
3.	201911032375	Method for detection of papaya seed powder adulteration in black pepper seed powder	09.08.2019	Dr. Manju Bala Dr. Swati Sethi Dr. Surya Tushir Dr. Mridula Devi Dr. R.K. Gupta Dr. R.K. Singh
4.	201911036120	Process for preparation of fat free flavoured makhana	07.09.2019	Dr. Mridula Devi Dr. R.K. Vishwakarma Dr. Ranjeet Singh Dr. R.K. Singh Dr. S.N. Jha
5.	201911049376	Process for producing low-fat, high-fibre processed meat products using food industry by- products	02.12.2019	Dr. Yogesh Kumar Dr. K. Narsaiah Dr. R.K. Singh Dr. Sandeep Mann Dr. R.K. Vishwakarma

Infrastructure Development (2019)

Work	Campus
Renovation of workshop building	Ludhiana
Renovation of workshop building	Abohar
Development of guest house-2 park	Ludhiana
Installation of interlocking tiles (park)	Ludhiana
Installation of interlocking tiles (residential quarters)	Ludhiana
Installation of optic-fibre cable for Wi-Fi in whole campus	Ludhiana
Development of way from divisional building to APC building	Ludhiana
Installation of vertical blinds in all divisional buildings rooms	Ludhiana
Repair of Type-III quarters	Ludhiana
Repair of Type-V (E1) quarter	Ludhiana
Repair of security cabins	Ludhiana
Foundation work for Type-II quarters	Ludhiana
Installation of 5 new electric light poles	Ludhiana
Installation of 22 flood lights	Ludhiana
Earthing work for Makhana processing plant	Ludhiana
Plantation of 127 Sheesham (Indian Rose; *Dalbergia latifolia*) trees	Ludhiana
Plantation of 11 Ficus plant	Ludhiana
Plantation of 6 Ashoka (*Saraca asoca*) trees	Ludhiana
Development of foundation work for transformer	Ludhiana
Repair of water supply line to residential quarter	Ludhiana
Repair of ladies toilets (3) divisional block (work awarded)	Ludhiana
Repair of gents toilets (3) divisional block (work awarded)	Ludhiana
Repair of divisional block (work awarded)	Ludhiana
Repair of PET office (3) divisional block (work awarded)	Ludhiana
Repair of administrative block (work awarded)	Ludhiana
Repair of gents toilets (3) divisional block (work awarded)	Ludhiana
Repair of type-IV (old) quarter (work awarded)	Ludhiana

Renovated Workshop Building at ICAR-CIPHET, Ludhiana

Post-Harvest Machinery and Equipment Testing Centre (PHMETC)

The Post-Harvest Machinery and Equipment Testing Centre (PHMETC), ICAR-CIPHET, Ludhiana has tested 32 machines during 1 January - 31 December, 2019 earning a total testing fees of Rs. 31,90,843 (Rupees Thirty One Lakh Ninety Thousand Eight Hundred Forty Three).

S.No.	Machine Name	Test Report No.	Testing Fee (Rs.)
1.	Mini Rice Mill	PHMETC/CIPHET-01/32/2019	114070.00
2.	Mini Flour Mill	PHMETC/CIPHET-02/33/2019	54670.00
3.	Mini Oil Mill (2 hp)	PHMETC/CIPHET-03/34/2019	317020.00
4.	Mini Oil Mill (1 hp)	PHMETC/CIPHET-04/35/2019	201740.00
5.	Mini Rice Mill (Dehusker)	PHMETC/CIPHET-05/36/2019	103700.00
6.	Mini Rice Mill (Dehusker)	PHMETC/CIPHET-06/37/2019	114070.00
7.	Mini Rice Mill (Dehusker)	PHMETC/CIPHET-07/38/2019	103700.00
8.	Flour Mill (18 inch) - Horizontal	PHMETC/CIPHET-08/39/2019	107470.00
9.	Flour Mill (14 inch- Vertical Type)	PHMETC/CIPHET-09/40/2019	54670.00
10.	Flour Mill (16 inch- Vertical Type)	PHMETC/CIPHET-10/41/2019	107470.00
11.	Flour Mill (18 inch- Vertical Type)	PHMETC/CIPHET-11/42/2019	107470.00
12.	Rawa Machine	PHMETC/CIPHET-12/43/2019	107470.00
13.	Dalia / Rawa Machine (Steel Plate Type)	PHMETC/CIPHET-13/44/2019	107470.00
14.	Vermicelli/Sevai Machine	PHMETC/CIPHET-14/45/2019	52910.00
15.	Flour Mill (Pulverizer- 1 hp)	PHMETC/CIPHET-15/46/2019	97700.00
16.	Flour Mill (Pulverizer- 2 hp)	PHMETC/CIPHET-16/47/2019	97700.00
17.	Flour Mill (Pulverizer- 3 hp)	PHMETC/CIPHET-17/48/2019	97700.00
18.	Flour Mill (Pulverizer- 5 hp)	PHMETC/CIPHET-18/49/2019	97700.00
19.	Combined Rice and Flour Mill	PHMETC/CIPHET-19/50/2019	181012.00
20.	Pulveriser Machine (Stainless Steel)	PHMETC/CIPHET-20/51/2019	70400.00
21.	Chilli Masala Pulveriser Machine (3hp)	PHMETC/CIPHET-21/52/2019	70400.00
22.	Chilli Pounding Machine (2 Bar)	PHMETC/CIPHET-22/53/2019	47300.00
23.	Sugarcane Juice Machine	PHMETC/CIPHET-23/54/2019	47300.00
24.	Chilli Pounding Machine (3 Bar)	PHMETC/CIPHET-24/55/2019	70400.00
25.	Chilli Masala Pulveriser Machine (7.5 hp)	PHMETC/CIPHET-25/56/2019	41800.00
26.	Papad Rolling Machine	PHMETC/CIPHET-26/57/2019	43780.00
27.	Flour Mill	PHMETC/CIPHET-27/58/2019	97700.00
28.	Arecanut Dehusker V-1	PHMETC/CIPHET-28/59/2019	91700.00
29.	Arecanut Dehusker V-6	PHMETC/CIPHET-29/60/2019	91700.00
30.	Mini Rice Mill	PHMETC/CIPHET-30/61/2019	114070.00
31.	Flour Mill (14 inch- Vertical Stone Type)	PHMETC/CIPHET-31/62/2019	64511.00
32.	Mini Rice Mill (Tractor operated)	PHMETC/CIPHET-32/63/2019	114070.00

HRD Programmes Organized

S.No.	Programme Title	Type	Number of Participants
1.	The XV Annual Workshop of AICRP on PET	Workshop	
2.	Novel Agro-Processing Technologies for Enhancement of Income in Production Catchment (26 November-03 December, 2019)	Model Training Course	14
3.	Post-Harvest Management of Agriculture Produce (7-11 January, 2019)	Farmers training	20
4.	Dehydration of onion, garlic and ginger (11-13 June, 2019)	Entrepreneurship Development Program	2
5.	Processing of aonla for manufacturing of value added products (6-10 May, 2019)	Entrepreneurship Development Program	1
6.	Processing and Value Addition of Mango (15 -17 July, 2019)	Entrepreneurship Development Program	6
7.	Processing of Aonla for manufacturing of value added product (06-10 May, 2019)	Entrepreneurship Development Program	1
8.	Dehydration of onion, garlic and ginger' (11-13 June, 2019)	Entrepreneurship Development Program	2
9.	Application of mulching technology for quality production of winter season vegetable crops (09-11 October, 2019)	Entrepreneurship Development Program	20
10.	Multifoods based nutri-pasta (June 04-06, 2019)	Entrepreneurship Development Program	3
11.	Minimal Processing of Fruits and vegetables (June 07-09, 2019)	Entrepreneurship Development Program	3
12.	Processing and value addition of rose petals (July 8-10, 2019)	Entrepreneurship Development Program	4
13.	Quick cooking wheat dalia (August 2-5, 2019)	Entrepreneurship Development Program	1
14.	Processing and value addition of rose petals (August 8-10, 2019)	Entrepreneurship Development Program	4
15.	Beetroot processing and value addition (October 16-18, 2019)	Entrepreneurship Development Program	3
16.	Minimal Processing of Fruits and vegetables (December 22-24, 2019)	Entrepreneurship Development Program	12
17.	Beetroot processing and value addition (December 26-28, 2019)	Entrepreneurship Development Program	12
18.	Green chilli processing and value addition (December 29-31, 2019)	Entrepreneurship Development Program	12
19.	Gluten free maize based food products (30 April, 2019)	Entrepreneurship Development Program	15

S.No.	Programme Title	Type	Number of Participants
20.	Groundnut/Soybean Processing (15 January, 2019)	Entrepreneurship Development Program	01
21.	Groundnut/Soybean Processing (16-17 January 2019)	Entrepreneurship Development Program	30
22.	Design and Manufacturing of Agro Processing Machines (06 July 2019)	Entrepreneurship Development Program	01
23.	Green Chilli Processing (12-14 March, 2019)	Entrepreneurship Development Program	5
24.	Processing of pulses (11-12 June, 2019)	Entrepreneurship Development Program	2
25.	Food Processing and Value Addition (18-22 February, 2019)	Farmers Training	25
26.	Processing & Value Addition of Cereal, Pulses and Oilseed Crops (25 February-01 March 2019)	Farmers Training	25
27.	Post-Harvest Management of Vegetables and Fruits (11-15 March, 2019)	Farmers Training	25
28.	Post-Harvest Management of Agricultural produce (12-14 March, 2019)	Farmers Training	15
29.	Post-Harvest Management of Agricultural Produce (05-09 May, 2019)	Farmers Training	20
30.	Post-Harvest Management of Agricultural Produce (19-23 August, 2019)	Farmers Training	20
31.	Post-Harvest Management of Agricultural Produce (26-30 August, 2019)	Farmers Training	20
32.	Post-Harvest Management of Agricultural Produce (16-20 December, 2019)	Farmers Training	25
33.	Post-Harvest Management of Agricultural Produce (1-3 October, 2019)	Farmers Training	31
34.	Post harvest management of fish (15-17 October, 2019)	Farmers Training	50
35.	Post harvest handling and processing of freshwater fish (26-28 December 2019)	Farmers Training	68
36.	Post harvest management of maize (27-29 November 2019)	Farmers Training	50
37.	Agribusiness Entrepreneurship Development through Agro Processing (24 September, 2019)	Sensitization program	55
38.	Agribusiness Entrepreneurship Development through Agro Processing (25 September, 2019)	Sensitization program	45

Students Training

Name of College/ University	No. of students	Degree	Duration
Chhattisgarh Agricultural Engineering College, IGKV, Dhanora , Risali, Bhilai, Durg, Chhattisgarh	10	B. Tech. (Agril. Engg.)	01-30 Apr, 2019
College of Agricultural Engineering, Dr. RPCAU, PUSA, Samastipur, Bihar	01	B. Tech. (Agril. Engg.)	05 Feb. - 07 Jun, 2019
College of Agricultural Engineering, Dr. RPCAU, PUSA, Samastipur, Bihar	03	B. Tech. (Agril. Engg.)	07 Feb. - 09 Jun, 2019
Swami Vivekananda College of Agricultural Engineering and Technology, IGKV, Raipur, Chhattisgarh	13	B. Tech. (Agril. Engg.)	1-30 Apr, 2019
Kalinga University, Village Kotni, Near Mantralaya, Naya Raipur, Chhattisgarh	7	B. Tech. (Agril. Engg.)	15 Apr - 14 May, 2019
Bhartiya College of Agricultural Engineering (affiliated to IGKV), Raipur, Pulagaon Chowk, Durg , Chhattisgarh	2	B. Tech. (Agril. Engg.)	15 Apr - 14 May, 2019
College of Agricultural Engineering and Technology, Orissa University of Agriculture & Technology Bhubneswar, Odisha	3	B. Tech. (Agril. Engg.)	01-31 May, 2019
College of Agricultural Engineering and Technology, Orissa University of Agriculture & Technology Bhubneswar, Odisha	3	M. Tech. (Agril. Engg.)	15 May - 14 Jun, 2019
Amity Institute of Food Technology, Amity University, Sector-125, Noida, Uttar Pradesh	2	B. Tech. (Food Tech.)	27 May - 30 Jun, 2019
Dr. D. Y. Patil College of Agricultural Engineering and Technology, (Affilated to M.P.K.V., Rahuri) Talsande, Hatkanangale, Kolhapur, Maharashtra	4	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
Dr. Annasaheb Shinde College of Agricultural Engineering and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra	5	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
College of Agricultural Engineering & Technology, Dr. Punjab Rao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra	2	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
College of Agricultural Engineering & Technology, Dr. B.S. Konkan Krishi Vidyapeeth, Ratnagiri , Maharashtra	2	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
College of Agricultural Engineering and Technology, Sangulwadi (Affiliated to Dr.B.S.K.K.V.), Sindhudurga, Maharashtra	4	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh, Gujarat	2	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
Sriram College of Agricultural Engineering, Solapur, Maharashtra	4	B. Tech. (Agril. Engg.)	15 May - 14 Jun, 2019
Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS) Allahabad, Uttar Pradesh	2	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
College of Agricultural Engineering and Technology, Anand Agricultural University, Dhola-kuva, Dahod Road, Godhra, Gujarat	5	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
College of Agriculture Engineering & Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra	2	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
College of Technology & Engineering, Department of Soil and Water Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan	5	B. Tech. (Agril. Engg.)	01-30 Jun, 2019

Name of College/ University	No. of students	Degree	Duration
College of Agriculture Engineering & Technology, (Affiliated to Dr. Balasaheb Sawant Konkan Krushi Vidyapeet, Dapoli), Saralgaon, Thane, Maharashtra	3	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
College of Dairy and Food Science Technology, Maharana Pratap University of Agricultural and Technology, Udaipur, Rajasthan	3	B. Tech. (Agril. Engg.)	01-30 Jun, 2019
Acharya N.G. Ranga Agricultural University, Dr. NTR College of Agricultural Engineering, Bapatla-522101, Guntur District, Andhra Pradesh	10	B. Tech	01 Jun - 15 Sep, 2019
Department of Biotechnology, Thapar Institute of Engineering & Technology (Deemed to be University) Patiala -147 004 (Punjab)	02	B. Tech	1 Jul - 31 Dec, 2019
SV College of Agricultural Engineering, and Technology & Research Station, Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya, Raipur – 492 012 (Chhattisgarh)	09	B. Tech	01 - 30 Sep, 2019
Department of Biotechnology, Thapar Institute of Engineering & Technology (Deemed to be University), Patiala-147 004 (Punjab)	01	B. Tech	01 Jul - 31 Dec, 2019
Vision Institute of Technology, Hathipur, Maharajpur, NH-2, G.T. Road, Kanpur- 209402	01	B. Tech	15 Apr - 14 May, 2019

Training on post-harvest management of fish at College of Fisheries, AAU, Assam under SCSP Plan by ICAR-CIPHET

Organization of ICAR-Summer School cutting edge epitome of processing, value addition, and waste utilization of horticultural crops for augmenting farmer's income during 1-21 October, 2019

Organization of ICAR-Winter School on 'Design, innovation and application of plasticulture technologies in agriculture, horticulture and pisciculture production and post-harvest management for doubling the farmers' income' during 5-25 November, 2019

Training on post-harvest handling and processing of fresh water fish at College of Fisheries, Kawardha, CKV, Durg under SCSP Plan by ICAR-CIPHET during 26-28 December, 2019

Training on post-harvest management of maize at College of Fisheries, AAU, Assam under SCSP Plan by ICAR-CIPHET

Entrepreneurship Development Program (EDP) on minimal processing of fruits and vegetables during 7 - 9 July, 2019

Entrepreneurship Development Program (EDP) on processing and value addition of rose petals during 08 - 10 August, 2019

Entrepreneurship Development Program (EDP) on beetroot processing and value addition during 16 - 18 October, 2019

Training on gluten free maize-based food products on 30 April, 2019

Entrepreneurship Development Program (EDP) was conducted on processing and value addition of mango during 15 - 17 July, 2019

ICAR- Central Institute of Post-Harvest Engineering & Technology, Ludhiana, Punjab

Model Training Course

on

Novel Agro-Processing Technologies for Enhancement of Income in Production Catchment

(26th November – 03rd December 2019)

(Sponsored By: Directorate of Extension, MoA & FW, Govt. of India)

Sitting (L to R) : **Gopinath Kar, Suraj Namdas, Surya Tushir, D. V. Singh, S. K. Tyagi, Sandeep Mann, Sandeep P. Dawange, Ravinder Singh Dhanda, Uday Singh, Alok Kumar**

Standing (L to R) : **Rajiv Sharma, Surendra Delki, Krishna Murari, Om Dutt Sharma, Tirath Kumar, Tirjyak Kumar Das, Mrs. Ashwini Sapkal, Mrs. Deepali Jadhav, Dr. Khusboo Rana, Lal Chand Beniwal, Yogesh B. Kalnar, Renu B., K. Bembem**

Krishi Vigyan Kendra (KVK) ICAR-CIPHET, Abohar

CRM Activities

Sr. No.	Name of Training	Date	Duration	Participant	Male	Female
1	Crop Residue Management Awareness camp at Govt. Sen. Sec. School, Gobindgarh	5-10-2019	01 Day	60	25	35
2	Crop Residue Management Awareness camp at Govt. Sen. Sec. School, Balluana	10-10-2019	01 Day	150	-	150
3	CRM Awareness Campaign in Buraj Muhar	15-10-2019	1 Day	51	51	-
4	CRM Awareness Campaign in Bahawal Bassi	25-10-2019	1 Day	29	29	-
5	CRM Awareness Campaign in DAV College Abohar	14-11-2019	1 Day	131	77	54
6	CRM Awareness Campaign in Fazilka Block Level Villege Behak Khas	19-11-2019	1 Day	75	75	-
7	CRM Awareness Campaign in Jalalabad Block Level Villege Kahnewal	21-11-2019	1 Day	64	53	11

In-situ crop residue management demonstration

Name of village	No. of demonstration
Bahawal Basi	41
Buraj Muhar	

Kisan Mela on Jal Shakti Abhiyan on 04-09-2019 at Ladhuka Mandi

Training on disease management in kharif crop 30-07-2019

Training on beekeeping on 07-09 Aug 2019

Training integrated pest management in kharif crop on 27-09-2019

Training on integrated nutrient management in kharif crop on 27-09-2019

Training on management on fruit droping in citrus fruit on 23-10-2019

Training on management of drip irrigation in fruit crops 07-11-2019

Training on soil health management of sustainable production & celebrated World Soil Health Day 05-12-2019

Training on disease management of rabi crops & celebrated Kisan Diwas 23-12-2019

Kisan Mela on Jal Shakti Abhiyan on 04-09-2019 at Ladhuka Mandi

Training on seed treatment on 12-06-2019

Awareness Campaign Programme on CRM at Fazilka Block Level Villege Behak Kahs on 19-11-2019

Awareness Campaign Programme on CRM at Jalalabad Block Level Villege Kahnewal on 21-11-2019

Major Events Organized by Agro Business Incubation Centre

S No	Name of Programme (Training/workshop/ Seminar etc.) Organized	Date of Programme	Participants (No)
1	Training on Groundnut/Soybean Processing	15 Jan 2019	01
2	Awareness cum training program on Groundnut/Soybean Processing	16-17 Jan 2019	30
3	Training on Gluten free maize based food products	30 April 2019	15
4	Training on Design and Manufacturing of Agro Processing Machines	06 July 2019	01

Outreach Activities

S No	Programme Organized	Date	Number of Participants	Venue of Event
1	Sensitization Program on Agribusiness Entrepreneurship Development through Agro Processing	24.09.2019	55	Ayali Khurd, RSETI, Ludhiana
2	Sensitization Program on Agribusiness Entrepreneurship Development through Agro Processing	25.09.2019	45	Govt. Sr. sec. School Ayali Khurd, Ludhiana

Sensitization program on agribusiness entrepreneurship development through agro processing organized at Ayali Khurd, RSETI by ICAR-CIPHET Ludhiana on 24 September, 2019

Sensitization program on agribusiness entrepreneurship development through agro processing organized at Government Senior Secondary School, Ayali Khurd by ICAR-CIPHET Ludhiana on 25 September, 2019

Mera Gaon Mera Gaurav (My Village My Pride)

The Mera Gaon Mera Gaurav (My Village My Pride) Scheme of Government of India was actively done by forming nine teams of scientists from both of its campuses.

Institute/SAU summary under MGMG

No. of Teams formed	No. of Scientists	No. of Villages Adopted	No. of Blocks Covered	No. of Districts Covered	Bench Mark Survey Conducted (Number of Villages)
9	31	35	8	4	15

Activities

S. No.	Name of activity	No. of activities conducted	Number of Farmers Participated/benefitted
1.	Visit to village by teams	8	225
2.	Interface meeting/ *Goshthies*	8	200
3.	Trainings conducted	-	-
4.	Mobile based advisories	1	25
5.	Literature support provided	25	300
6.	Awareness created	30	375
7.	Linkages developed with other agencies	2	80

Swachh Bharat Abhiyan

Under Swachh Bharat Abhiyan, various activities such as cleanliness drive, awareness program, digitization of office records, disposal of old files and items, beautification of the institute campus and displaying banners showing the importance of swachhta have been performed well. "Swachh Bharat Abhiyan-Swachhta Hi Sewa" and "Swachhata Pakhwada" were celebrated in the institute.

Swachhata Hi Sewa (11th September-2nd October 2019)

Under the theme '*Single-use plastic waste management*', Swachhata Hi Sewa was celebrated from 11th September, 2019 to 2nd October, 2019 in both the campuses. The movement was initiated with the pledge taking ceremony. The awareness program was organised to spread knowledge regarding the detrimental effects of single-use plastic on human beings, wildlife and environment in Govt. Sen. Sec. School Kera khera village (Abohar), Guru Nanak Khalsa College (Abohar), Punjab Govt. Senior Secondary School, Ayali Khurd (Ludhiana), and in many other villages namely, Nurpur Bet (Ludhiana), Malkpur bet (Ludhiana), Killan Wali (Abohar) and Govindgarh (Abohar). Various activities were performed in campus, schools, colleges, near-by areas, villages, etc.

Single use plastic waste collection mega drive

Participation in swachchta hi sewa programme-2019

Celebration of Farmers' Day

Sensitization of school children of nearby villages on the importance of cleanliness

Landscaping work at Ludhiana campus

Wall painting work at Ludhiana campus

Interlocking Tiles work at Ludhiana campus

Plantation work at Ludhiana campus

Plantation by Director, ICAR-CIPHET Dr. R. K. Singh in presence of Dr. S. P. Kimothi, ADG (TC) at NASC Complex, New Delhi

Participation in Conferences/Symposia/ Workshops/Meetings

S.No.	Scientist	Participation	Venue
1.	Vikas Kumar, Scientist	Winter School on 'Recent advances in fish processing, value addition and fish waste management' (7-27 January, 2020)	College of Fisheries, CAU, Lembucherra, Tripura (W)
2.	Dr. Deepika Goswami, Scientist	Winter School on 'Technological advances in functional food ingredients and validation of their claims' (6-26 December, 2019)	ICAR-NDRI, Karnal, Haryana
3.	Dr. Mridula D., Principal Scientist	Management Development Programme on 'Leadership development (pre-RMP Programme)'(11-22 June, 2019)	ICAR-National Academy of Agricultural Research Management (NAARM), Hyderabad, Talangana
4.	Dr. Mridula D., Principal Scientist	Training Workshop for Vigilance Officers of ICAR Institutes (31 October - 01 November, 2019)	ICAR-National Academy of Agricultural Research Management (NAARM), Hyderabad, Talangana
5.	Dr. Bhupendra M Ghodki, Scientist	Short Term Course on PLC and Micro-controllers (26 August - 06Sept 2019)	NITTTR, Chandigarh
6.	Dr. DN Yadav	Management Development Programme on Leadership Development (a pre-RMP Programme) July 11-22, 2019	NAARM, Hyderabad
7.	Dr. D N Yadav	Workshop on Preparation of EFC/PIB Proposal (Oct 30-Nov 1, 2019)	ISTM, New Delhi
8.	Dr. D N Yadav	National Workshop on "Production, Processing and Value addition of Nutri-Cereal in India" and presented a technical paper on "Development of Processing Machinery/Equipment for Nutri-Cereal" (September 16, 2019)	CCSHAU, Hisar
9.	Dr. D N Yadav	National Conference on Capacity Building of Sustainable Food value Chain for Enhance Food Safety and Quality (Aug 21-22, 2019)	National Productivity Council, New Delhi
10.	Dr. Dukare, A. S.	International conference on "Current Trends in Microbiology and Microbiome Research: a global perspective (CTM-2019) (11th & 12th October, 2019)	Department of Microbiology, Maharshi Dayanand University, Rohtak (Haryana)
11.	Dr. Bhushan Bibwe	National Conference on Identification, convergence, implementation & extension of science-tech-research for sustainable development (20-21 April 2019)	SVPUA & T Meerut
12.	Dr. Bhushan Bibwe	International Conference on Innovative Horticulture and Value Chain Management – Shaping Future Horticultural (28-31 May, 2019)	GBPUA&T, Pantnagar, Uttarakhand

S.No.	Scientist	Participation	Venue
13.	Dr. Bhushan Bibwe	National Workshop on "Horti-produce transport in India- Present status and issues for reduction in post-harvest losses" (8th January 2019)	NASC Complex, New Delhi
14.	Dr. Pankaj Kumar	53rd Annual Convention of Indian Society of Agricultural Engineers (ISAE) (28-30 January 2019)	Institute of Agricultural Sciences, Banaras Hindu University, UP
15.	Dr. Pankaj Kumar	National workshop of approved Test Centres (25 November 2019)	CCS Haryana Agricultural University, Hisar, Haryana
16.	Dr. Pankaj Kumar	Agricultural and Food Processing Machinery Manufacturers' meet (27 November 2019)	Junagadh Agricultural University, Junagadh, Gujarat
17.	Dr. Manju Bala	Noble Prize lecture Series India 2019 (12.09.2019)	PAU, Ludhiana
18.	Dr. K. Bembem	2nd National Conference on Technological and Emerging Aspects in Agriculture and Community Sciences	Society of World Environment, Food and Technology, New Delhi
19.	Dr. Bidyalakshmi	Oral presentation on "Design Consideration of sensor based smart solar dryer for precision drying" on 8th Asian Conference on Precision Agriculture (ACPA) (14-17 October, 2019)	PAU, Ludhiana
20.	Dr. Bidyalakshmi	Oral presentation on "Design of Sensor Based Solar Dryer with Phase Change Material as Thermal Storage" on 54th annual convention of ISAE and International symposium on "Artificial Intelligence Based Future Technologies in Agriculture" (07-09 January, 2020)	Hyatt Regency, Pune
21.	Dr. Bidyalakshmi	Delivered invited talk on "Infra-red spectroscopy: Non destructive analytical technique" in National conference on "Advances In Biotechnological Researches In Plants, Animals And Microorganisms During Last 10 Years" (14-15 December, 2019)	M.N. College and Research Institute, Bikaner (Affiliated to Maharaja Ganga Singh University, Bikaner and Recognized by Govt. of Rajasthan)
22.	Dr. P. N. Guru	Presented paper and delivered invited talk on "Insecticide usage pattern and farmers' perception on insecticide usage in capsicum (*Capsicum annuum* L. var. frutescens)" In: International conference on environmental ethics, resource management and regional development: issues, challenges and prospects (29-30 November, 2019)	Dr. BR Ambedkar Govt. college, Sri Ganganagar (Rajasthan) India
23.	Dr. P. N. Guru	Attended 3 days' workshop on Preparation of Expenditure Finance Committee/ Standing Finance Committee (WPEFC/SFC) (30 October - 01 November, 2019)	ISTM-DoPT, New Delhi

Director, ICAR-CIPHET delivered lecture on processing and value addition of nutri cereals at HAU, Hissar

Director, ICAR-CIPHET sensitizing ICAR Headquarter staff on adverse environmental impact of single-use plastics

Participation in Exhibitions/Mela

Sr. No.	Exhibition/ Mela	Venue
1.	106th Session of the Indian Science Congress 2019 (3-7 January, 2019)	LPU, Phagwara (Punjab)
2.	14th Agri Science Congress (20-23 February, 2019)	IARI, New Delhi
3.	Coastal Agri. Expo 2019 (02-04 March, 2019)	ICAR-CCARI, Old Goa
4.	Kisan Mela (15-16 March, 2019)	PAU, Punjab
5.	Kisan Mela (21-22 September, 2019)	PAU, Ludhiana
6.	Pashu Palan Mela (21-22 September, 2019)	GADVASU, Ludhiana
7.	Food Industry and Craft Mela (20 October, 2019)	PAU, Ludhiana
8.	IIMR Foundation Day Exhibition(15 November, 2019)	IIMR, Ladowal, Ludhiana

Major Events Organized

Sr. No.	Event	Date	Duration
1.	Live Telecast of Hon'ble Prime Minister Sh. Narender Modi on FMD & Swachhta Hi Sewa	11-09-2019	1 Day
2.	Gandhi Jayanti & Swachhta Abhiyan	02-10-2019	1 Day
3.	World Soil Health Day	05-12-2019	1 Day
4.	Kisan Diwas	23-12-2019	1 Day
5.	Jal Shakti Abhiyan at Lamochar Kalan	26-07-2019	1 Day
6.	Kisan Mela on Jal Shakti Abhiyan At Ladhuka Mandi Jalalabad	04-09-2019	1 Day
7.	Carrot Grass *(Parthenium hysterophorus)* Awareness Week	16-08-2019 - 22-08-2019	7 Days
8.	Swachhta Hi Sewa	11-09-2019 - 02-10-2019	21 Days
9.	Vigilance Awareness Week	28-10-2019 - 02-11-2019	7 Days
10.	International Yoga Day	21-06-2019	01 Day
11.	Tree Plantation Awareness Camp	27-09-2019 - 28-09-2019	02 Days
12.	Constitutional Day	26-11-2019	01 Day
13.	Communal Harmony Week	19-11-2019 - 25-11-2019	7 Days
14.	राजभाषा हिन्दी पखवाड़ा	14-09-2019 - 28-09-2019	15 Days
15.	हिंदी कार्यशाला	29-06-2019	1 Day
16.	हिंदी कार्यशाला	30-09-2019	1 Day
17.	हिंदी कार्यशाला	30-12-2019	1 Day

राजभाषा हिन्दी पखवाड़ा (14–28 सितम्बर, 2019)

प्रत्येक वर्ष की भांति, संस्थान के दोनों परिसरों में दिनांक 14 से 28 सितम्बर, 2019 तक राजभाषा हिन्दी पखवाड़ा मनाया गया। मुख्य संस्थान लुधियाना में समारोह का उद्घाटन दिनांक 13 सितम्बर 2019 को मुख्य अतिथि माननीय डॉ. सुरेन्द्र कुमार, पूर्वकुलपति, गुरू कुल कांगड़ी विश्वविद्यालय, हरिद्वार, उतराखंड के कर कमलों द्वारा किया गया। इस अवसर पर वैज्ञानिक एवं स्टाफ सदस्यों को सम्बोधित करते हुए उन्होने हिन्दी के प्रचार–प्रसार के लिए दिनचर्या में सरल शब्दों के प्रयोग पर जोर दिया। संस्थान के निदेशक डॉ. आर के सिंह ने अपने संबोधन में बताया कि हिन्दी पखवाड़े को त्यौहार के रूप में मनाने से हिन्दी सशक्त एवं सामर्थ्यवान होगी। निदेशक महोदय ने संस्थान के समस्त वैज्ञानिकों से अनुरोध किया कि वे अपने शोध–पत्रों को हिन्दी भाषा में प्रकाशित करने पर जोर दें।

राजभाषा हिन्दी पखवाडा समारोह के अन्तर्गत विभिन्न संयोजकों एवं सह–संयोजकों के सहयोग से दस प्रतियोगिताएँ जैसे हिंदी टिप्पण एवं प्रारूप लेखन प्रतियोगिता, प्रार्थना पत्र प्रतियोगिता, कंप्यूटर पर यूनिकोड में हिंदी टाइपिंग प्रतियोगिता, हिंदी निबंध प्रतियोगिता, हिंदी काव्य पाठ प्रतियोगिता, प्रश्न मंच प्रतियोगिता, एक दिवसीय (हस्तलिखित) पोस्टर प्रतियोगिता, तत्काल भाषण प्रतियोगिता, वाद विवाद प्रतियोगिता, प्रश्नोत्तरी प्रतियोगिता, लघु गीत–संगीत प्रतियोगिता आयोजित की गई।

राजभाषा हिन्दी पखवाड़ा का आयोजन (14–28 सितम्बर, 2019)

राजभाषा हिन्दी पखवाड़ा का आयोजन (14–28 सितम्बर, 2019) : पारिपोषित वितरण

Communal Harmony Week (19-25 November, 2019)

Communal harmony campaign and the fund raising week was organized during November 19-25, 2019 and the flag day on November 25, 2019 at ICAR-CIPHET, Ludhiana. It is celebrated to promote the values of communal harmony and national integration among the people of the country.

International Yoga Day (21st June, 2019)

Fifth international day of yoga was celebrated on 21st June (Friday) 2019 at ICAR-CIPHET, Ludhiana. Staff and trainee students from different engineering colleges from different parts of the country participated in this programme. Yoga expert, Dr. Shiv Kumar Sharma, M.D. (A.M.) taught yoga exercises as well as explained health benefits associated with them. Dr. K. Narsaiah I/c Director highlighted the importance of yoga day and urged all the participants to make it as a part of their daily routine to lead healthy and happy life. Dr. Manju Bala, Chairperson, yoga day organizing committee, thanked all the participants. Programme was coordinated by Dr. Yogesh Kumar, Scientist.


आरोग्य भारती लुधियाना
विश्व योग दिवस
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हिंदी कार्यशालाएं

- सीफेट, लुधियाना में 29 जून 2019 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में संस्थान के अधिकारियों के हिंदी में वक्तव्यों/प्रस्तुति के अतिरिक्त डॉ. राजिंदर सिंह साहिल, सह–प्राध्यापक (हिंदी), गुरु हरगोबिन्द खालसा कॉलेज, गुरुसर, सधार, लुधियाना, ने "हिंदी में सरकारी पत्र व्यवहार" एवं "हिंदी को राष्ट्रभाषा लागू करने में वैचारिक कठिनाईयां", विषयों पर अपनी प्रस्तुति देकर सभी को लाभान्वित किया।

- सीफेट, लुधियाना में 30 सितम्बर 2019 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में संस्थान के अधिकारियों के हिंदी में वक्तव्यों/प्रस्तुति के अतिरिक्त डॉ. शिव कुमार शर्मा, एम. डी. (ए.एम.), ऋषि नगर, लुधियाना ने "वर्तमान परिवेश में हिंदी भाषा का महत्व" एवं "तनाव प्रबंधन में भाषा की उपयोगिता" विषयों पर अपनी प्रस्तुति देकर सभी को लाभान्वित किया।

- सीफेट, लुधियाना में 30 दिसंबर 2019 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में संस्थान के अधिकारियों के हिंदी में वक्तव्यों/प्रस्तुति के अतिरिक्त डॉ. (श्रीमती) किरण साहनी, सहायक निदेशक (राजभाषा) एवं सदस्य सचिव (न.रा.का.स.), लुधियाना ने 'मानक हिंदी वर्तनी और अभ्यास' एवं "हिंदी भाषा विज्ञान और सदाचार" विषयों पर अपनी प्रस्तुति देकर सभी को लाभान्वित किया।

Constitutional Day (26 November, 2019)

"The Constitution Day" was celebrated at both campuses of ICAR-CIPHET, Ludhiana and Abohar on November 26, 2019, to spread awareness about the Indian Constitution. It was marked by the conduct of 'special sessions' at both the campuses on the thematic area of constitution, the preamble, and the directive principles which was attended by the respective official staff of the institute. In continuation of this monthly programme, a lecture was also organized on the "Fundamental Duties Article 51-A of the Indian Constitution" on December 23, 2019. All the staff of the institute and nearby farmers attended the lecture.

Independence Day

ICAR-CIPHET on the Eve of 15th August, 2019

Organization of 150th Birth Anniversary of Mahatma Gandhi

Drawing competition

Essay competition

Inter-school quiz competition

Final award ceremony

Speech on the life of Mahatma Gandhi by award winning participant

Award ceremony

Foundation Day

Welcome of Chief Guest Dr Gajendra Singh by Dr R K Singh, Director, ICAR-CIPHET

Plantation by Chief Guest Dr Gajendra Singh and Director, ICAR-CIPHET

31st Foundation Day of ICAR-CIPHET

Participation in ICAR North Zone Sports Tournament during 12-14 December, 2019


I
II
III


YONEX

Distinguised Visitors

Visit of Dr. K. Alagusundram, DDG, Agricultural Engineering, ICAR-New Delhi to ICAR-CIPHET to review the progress of ongoing research work and infrastructure development

Visit of Dr. S. N. Jha, ADG, Agricultural Engineering (PE), ICAR-New Delhi and Dr. S. M. Ilyas, Former Director, ICAR-NAARM, Hyderabad

Research & Administrative Meetings

Research Advisory Committee (RAC)

Research Advisory Committee (RAC) of CIPHET was constituted by ICAR (Council's order no. F.No.-A.Engg/4/2/2018-IA-II (AE) dated 07.02.2018) for a period of three years with effect from 31.01.2018 to 30.01.2021.

Chairman	Prof. Anwar Alam, Former DDG (Engg.) ICAR
Members	Dr. Nabarun Bhattacharya, Director, C-DAC, Kolkata Dr. Vasudeva Singh, Former Cheif Scientist, CSIR-CFTRI, Mysore Dr. S. Ganapathy, Prof. & Head, TNAU, Coimbatore Dr. S. K. Dash, Dean, COAE&T, OUAT Dr. R. K. Gupta, Former Director, ICAR-CIPHET Dr. S. D. Kulkarni, Former PD, SPU, ICAR-CIAE, Bhopal
Ex-Officio Member	Dr. S. N. Jha, ADG (PE), ICAR
Member Secretary	Dr. K. Narsaiah, National Fellow & Principal Scientist, ICAR-CIPHET

- The 21st Research Advisory Committee (RAC) meeting of CIPHET was held on 05-06 February, 2019 at ICAR-CIPHET, Ludhiana.

Institute Research Council (IRC)

Chairman	Dr. R. K. Singh, Director, ICAR-CIPHET
Experts	Dr. S. M. Ilyas, Former Director, ICAR-NAARM, Hyderabad Dr. S. N. Jha, ADG (PE), ICAR
Member Secretary	Dr. D. N. Yadav, Principal Scientist, ICAR-CIPHET

- The 29th Institute Research Council (IRC) meeting of CIPHET was held on during May 28-29, 2019. During the 29 th IRC, 13 new project proposals (RPP I), 24 on-going projects (RPP II), 12 completed projects (RPP III) and 2 proposal for further refinement and commercialization of technology (RPP IV) were presented.

Institute Management Committee (IMC)

Chairman	**Dr. R. K. Singh, Director, ICAR-CIPHET**
Members	Dr. S. N. Jha, ADG (PE), ICAR Dr. M. K. Garg, Prof. CCSHAU, Hisar Dr. R. K. Jhorar, Dean, CCSHAU, Hisar Sh. R. S. Dhillon, Farmer Dr. H. S. Oberoi, Head, PHT Division, ICAR-IIHR, Bangaluru Dr. A. K. Thakur, Principal Scientist, ICAR-NIRJAFT, Kolkata Er. Amanpreet Singh, Respresentative of Director of Agriculture, Govt. of Punjab
Member Secretary	SAO, ICAR-CIPHET

- The 35th meeting of Institute Management Committee of ICAR-CIPHET was held on 28 March, 2019 at ICAR-CIPHET, Ludhiana

Women Complaint Committee

In compliance of the Council letter F. No. 24(14)/2008-CDN, the Director, ICAR-CIPHET has constituted Women Complaint Committee to deal with complaints regarding sexual harassment of women at the work place (F.No.8 (85)/2006-Cdn dated 05.12.2017.

Chairperson	**Dr. Mridula D., Principal Scientist, ICAR-CIPHET**
Members	Dr. Renu Balakrishnan, Scientist, ICAR-CIPHET Dr. Ranjeet Singh, Senior Scientist, ICAR-CIPHET
Member Outside	Dr. Sandhya Singh, Asstt. Research Engineer, PAU, Ludhiana

Women Cell

Chairperson	**Dr. Manju Bala, Principal Scientist, ICAR-CIPHET**
Members	Dr. Poonam Chaudhary, Scientist, ICAR-CIPHET Mrs. Sunita Rana, LDC, ICAR-CIPHET
Member Secretary	Mrs. Sonia Devi, Tech. Asstt., ICAR-CIPHET

- The Director, ICAR-CIPHET has constituted Women Cell to look after the concerns of women officers and staffs and their guidance (F.No.9 (16)/2014-Cdn 2611-2617 dated 18.12.2017.

Institute Joint Staff Council (IJSC)

Official Side

Chairman	**Dr. R. K. Singh, Director, ICAR-CIPHET**
Members	Dr. D. N. Yadav, Principal Scientist Dr. Sunil Kumar, Principal Scientist Dr. Deepika Goswami, Scientist Senior Administrative Officer Finance & Accounts Officer

Staff Side

Members	Sh. Ashwani Kumar, UDC Sh. R. K. Raheja, UDC Sh. H. S. Sekhon, Tech. Officer Sh. Vishal Kumar, Senior Tech. Asstt. Sh. Sukhbir, SSS Sh. Manoj Kumar, SSS

- A new Institute Joint Staff Council (IJSC) has been constituted by the Director (F. No. 9(43)/2015-Cdn dated 11.02.2019) for a period of three years.

Personnel

Director
Dr. R. K. Singh (Acting)

Project Coordinator, AICRP (PHET)
Dr. S. K. Tyagi (Acting)

Project Coordinator, AICRP (PET)
Dr. R. K. Singh

ICAR-CIPHET, Ludhiana

Principal Scientist
Dr. S. K. Tyagi
Dr. K. Narsaiah
Dr. Mridula D.
Dr. D. N. Yadav
Dr. Sandeep Maan
Dr. R. K. Vishwakarma
Dr. Manju Bala
Dr. A. U. Muzaddadi
Dr. R. C. Kasana

Senior Scientist
Dr. Ranjeet Singh

Scientist
Dr. Yogesh Kumar
Dr. R. K. Anurag
Dr. Deepika Goswami
Smt. Leena Kumari
Smt. Surya
Dr. Swati Sethi
Er. Chandan Solanki
Er. Dhritiman Saha
Er. A. A. Bashir
Er. Navnath Indore
Sh. Vikas Kumar
Dr. Khwairakpam Bembem
Dr. Renu Balakrishnan
Er. Kalnar Yogesh
Dr. Pankaj Kumar
Dr. Poonam
Er. Sandeep Dawange
Dr. Thingujam Bidyalakshmi
Dr. Guru P. N.
Dr. B. M. Ghodki

Administrative Staff

Senior Administrative Officer
Sh. H. L. Meena

Assistant Administrative Officer
Sh. B. C. Katoch

Assistant Finance and Accounts Officer
Sh. Manni Lal

Private Secretary
Sh. S. S. Verma

Assistant
Sh. Kunwar Singh
Sh. Avtar Singh
Sh. Tarsem Singh Purba
Smt. Jasvir Kaur

Upper Division Clerk
Sh. Gurdial Singh
Sh. Ashwani Kumar
Sh. R. K. Raheja
Sh. Iqbal Singh

Lower Division Clerk
Smt. Sunita Rana
Sh. R. K. Yadav
Sh. S. K. Gaur

Technical Staff

Technical Officer
Dr. Mukund Narayan
Sh. Gurdeep Singh
Sh. H. S. Sekhon (Driver)

Senior Technical Assistant
Sh. Beant Singh (Driver)
Sh. Vishal Kumar
Sh. Hardeep Singh
Smt. Sonia Rani
Sh. Jaswinder Singh
Sh. Jagtar Singh
Sh. Lakhwinder Singh
Sh. Bhajan Singh
Sh. Jaswant Singh
Sh. Rajiv Sharma

Senior Technician
Sh. Satwinder Singh
Sh. Sarup Singh

Technical Assistant
Sh. Pradip Kumar
Sh. Yashpal Singh
Smt. Pragya Singh

Supporting Staff

Skilled Support Staff
Sh. Sukhbir
Sh. Manoj Kumar

ICAR-CIPHET, Abohar

Principal Scientist
Dr. Ramesh Kumar
Dr. Sunil Kumar

Scientist
Dr. Prerna Nath
Dr. Kale Sakharam
Dr. Bibwe Bhushan
Dr. Dukare Ajinath
Dr. P. K. Kannaujia

Administrative Staff

Assistant Administrative Officer
Sh. Pawan Kumar

Assistant
Sh. Mohan Lal

Lower Division Clerk
Sh. Ajay Kumar

Technical Staff

Chief Technical Officer
Sh. V. K. Saharan

Assistanr Chief Technical Officer
Sh. Prithvi Raj
Sh. Rajesh Kumar

Senior Technical Assistant
Sh. Ganpat Ram (Driver)
Sh. Devinder Kumar
Sh. Pawan Kumar
Sh. Dalu Ram

Supporting Staff

Skilled Support Staff
Sh. Surinder Kumar

Personalia (Promotion/Joining/Transfer)

Promotion

Sh. Hardeep Singh, Technical Assistant (Turner) promoted as Sr. Technical Assistant (Turner) w.e.f. 10.12.2017 at ICAR-CIPHET, Ludhiana.

Smt. Sonia Rani, Technical Assistant (DEO) promoted as Sr. Technical Assistant (DEO) w.e.f. 10.12.2017 at ICAR-CIPHET, Ludhiana.

Sh. Prithvi Raj, Sr. Technical Officer promoted as Assistant Chief Technical Officer w.e.f. 01.01.2018 at ICAR-CIPHET, Abohar.

Sh. Rajesh Kumar, Sr. Technical Officer promoted as Assistant Chief Technical Officer w.e.f. 01.01.2018 at ICAR-CIPHET, Abohar.

Sh. Dalu Ram, Technical Assistant (Fitter) promoted as Sr. Technical Assistant (Fitter) w.e.f. 31.01.2018 at ICAR-CIPHET, Abohar.

Sh. Jaswinder Singh, Technical Assistant (Machinist) promoted as Sr. Technical Assistant (Machinist) w.e.f. 10.03.2019 at ICAR-CIPHET, Ludhiana.

Sh. Jagtar Singh, Technical Assistant (Electrician) promoted as Sr. Technical Assistant (Electrician) w.e.f. 23.03.2019 at ICAR-CIPHET, Ludhiana.

Sh. Beant Singh, Sr. Technical Assistant (Driver) promoted as Technical Officer (Diver) w.e.f. 04.03.2019 at ICAR-CIPHET, Ludhiana.

Sh. Vishal Kumar, Sr. Technical Assistant (DEO) promoted as Technical Officer (DEO) w.e.f. 22.07.2019 at ICAR-CIPHET, Ludhiana.

2nd financial up-gradation under MACP Scheme granted to Sh. Surinder Kumar, SSS at ICAR-CIPHET, Abohar w.e.f. 01.09.2018.

2nd financial up-gradation under MACP Scheme granted to Sh. Sukhbir, SSS at ICAR-CIPHET, Ludhiana w.e.f. 01.09.2018.

2nd financial up-gradation under MACP Scheme granted to Sh. Manoj Kumar, SSS at ICAR-CIPHET, Ludhiana w.e.f. 04.03.2019.

Release of Technical Bulletin on Livestock Processing Technology by honorable DDG (Agril. Engg.) Dr K Alagusundaram; ADG, Dr KK Singh; Director, ICAR-CIPHET, Dr RK Singh and Head, Dr K Narsaiah at ICAR-CIPHET

Major Publications

Institute Publications

Annual Report, 2018-2019

Annual Progress Report of Krishi Vigyan Kendra (2018-2019), Abohar (Fazilka), pp. 1-29.

Prasanskaran Pragati (Hindi) (Varsh 2, Ank 1: January-June 2018)

Prasanskaran Pragati (Hindi) (*Varsh 2, Ank* 2: July-December 2018)

Technical bulletin

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