Significant Achievements of Division of Food Science and Postharvest Technology - 2023-24

Research

Dr. Dinesh Kumar

- This study aimed to investigate the influence of different maturity stages (unripe, half-ripe, and ripe fruit) at harvest on the antioxidant activity of mangoes. Harvest I and Harvest II significantly reduced the loss of functional components, maintained higher antioxidant enzyme activities and kept a stronger ability to scavenge free radicals
- Pomello (*Citrus grandis* (L.) undergo systematic changes during fruit development, though some tissues exhibited fluctuating trends depending on the growing season. Specifically, the highest levels of total phenolic and flavonoid content were found in the fruit membrane, the fruit flavedo had the greatest antioxidant capacities and FRAP activities, and the fruit albedo had the most naringin. Additionally, the pomelo juice contained the highest DPPH free radical scavenging activity and tannin content. These patterns suggest a potential bias in how these compounds accumulate during fruit development. From the GC-MS analysis, we identified a total of 111 compounds, with 91 common to both growing seasons. Overall, these findings could provide valuable insights for the food processing industry to produce high-quality foods and incorporate health-beneficial products and components into daily diets.
- Chickpea flakes were developed with varying amounts (0–30%) of apple pomace (AP). Adding up to 20% AP to extruded snacks and baked scones did not significantly alter ($P < 0.05$) the proximate composition of the final products, except for the starch content in baked scones. At this level of AP incorporation, the fiber content, phenolic content, and antioxidant capacity (including DPPH radical scavenging activity, ferric reducing antioxidant power (FRAP), and β-carotene/linoleic acid system) all increased compared to products without AP. Chlorogenic acid and quercetin were the primary phenolic compounds identified in the products.
- The north-eastern citrus varieties namely *Citrus Hystrics*, Chase rough lemon (*Citrus jambhiri*), Elaichi lemon (*Citrus limon*) and Jora Tenga (*Citrus medica*) were assessed for flavonoid glycosides mainly naringin and hesperidin and found that hesperidin (11.45-43.50 ppm) is the predominant flavonoid than naringin (4.77-18.05 ppm) and are present in varying concentration.

Charanjit Kaur

- The effect of different ratios of PEP-TS on mechanical properties (water barrier, tensile strength, elongation, and contact angle) was evaluated and compared with control PEP. Films with PEP-TS (3:1) demonstrated improved mechanical strength and antioxidant activity over PEP. Composite films with high ratio of PEP (3:1) improved the contact angle and hydrophobicity of the composite films
- Ascorbic acid infusion in peeled garlic was found to accelerate Maillard reaction and shorten the process from 18 to 12 days. The functional quality of modified process was higher than black garlic developed through conventional process. Purple skinned cultivars were found more suitable for development of white. Specifically, ‘Bhima purple’ seems an ideal candidate in this category.

Ram Asrey

- Role of UV-C light (1.6, 2.0, and 2.4 kJ m^{-2}) on physicochemical parameters, antioxidative compounds, and defense-related enzymes in cold-stored guavawas explored. The results demonstrated that UV-C (2.0 kJ m^{-2}) significantly delayed weight loss (8.12%), firmness

loss (3.94 N), and decay incidence (9.63%) in guava fruits. Also, the UV-C treatment enhanced bioactive compounds such as total phenols (251.42 mg GAE 100 g^{-1} FW), flavonoids (80.86 mg CE 100 g^{-1} FW), ascorbic acid (160.20 mg 100 g^{-1} FW), and antioxidant capacity (4.17 µmol TE g^{-1} FW) as compared to control.

- Ozone + 0.3% guar gum treatment extended the shelf life of stored papaya by up to 8 days (2 days more than untreated fruits) without compromising their quality under ambient conditions. The findings suggest practical implications for the fruit industry, catering to both economic and environmental sustainability goals.

Shruti Sethi

- Efficacy of ornamental plant extracts (leaf and petal of rose and marigold) against postharvest fungi was assessed. *In vitro* studies revealed that extracts at a total phenolic concentration of above 150 mg GAE mL^{-1}, inhibited the growth of *Colletotrichum gloeosporioide*s, *Rhizopus stolonifer* and *Aspergillus niger*, with rose leaf extract showing the highest inhibition percentage followed by marigold petal extract.
- *In-vivo* experiments demonstrated that higher phenolic concentrations (200 mg GAE mL^{-1}) outperformed lower concentrations, with marigold petal extract remarkably reducing lesion diameter and decay percentage across all fungal strains. Rose leaf and marigold petal extracts, particularly at 200 mg GAE mL^{-1}, emerged as natural alternatives for controlling postharvest fungal infections in guava fruits.
- Experiments were carried out to maximise the extraction of chlorophyll from pea pod pomace using ultrasonication, and enzyme-assisted extraction. Addition of cellulase enzyme at concentration of 49.975 IU/g delivered maximum chlorophyll recovery of 43.15 mg/100g. Storage temperature of the stabilized chlorophyll below 25°C under dark conditions at pH 7.0 is the best to get maximum stability of the pigment for its effective utilization as a natural green colourant.
- Accelerated dissipation of pesticides with increasing doses of irradiation from 0.25 to 1.0 kGy was observed in apple with significant decline in their half life. Among the chemical treatments, peroxyacetic acid, oxalic acid and sodium hypochlorite significantly influenced the dissipation of pesticide residues by 70 to 98%.

Shalini Gaur Rudra

- Low calorie osmodehydrated persimmon candy.
- Modified starch based edible coating from mango kernels.
- Naturally coloured gluten free multimillet pasta and eggless cake mix.
- Effect of pre-treatments on the nutritional and physic-chemical profile of fingermillet varieties KMR-340 and MR-1.
- Value added products development from Hull-less Barley BHS325.

Alka Joshi

- Overripe banana (*Musa* x *paradisiaca* L.) is a rich source of sugar which can be used as a natural sweetener in foods. Keeping its high perishability, sugar and mucilaginous texture in view, foam mat drying was standardized by comparing four different foaming agents *i.e*., egg albumin, casein, soy and whey protein isolates. For product optimization, a three-factor three-level Box Behnken Design (BBD) was used. The optimized formulation was comprised of 26% banana flour with 200 rpm screw speed and 16% feed moisture. The proximate composition of extruded snacks showed that the developed snack is a fair source of dietary fiber with a slightly sweet tinge of overripe banana flour without any added sugar.

- The specifications desired by industries for processing traits are: fruit weight> 50 g, a/b ratio >2, TSS >5-6º Brix, fruit firmness > 4.0N, Acidity > 0.4 and pH of the fruit should be less than 4.5. Screening of tomato genotypes done through multicriteria decision making and further, their processability was validated with commercial checks for tomato puree (~12º Brix) and tomato paste preparation (~25º Brix).
- GABA has received much attention as a health-promoting functional compound. Six tomato genotypes namely 'H-81', H-684','H-162', 'H-507', 'H-572', 'H-561' and Candy were harvested at seven different maturity stages. On average the GABA content was significantly higher in green tomatoes in comparison with all other stages.

Neelam Upadhyay

- Method for formulation of poshak-prash was optimized based on sensory evaluation and texture profiling. The optimized product was compared with control for proximate analysis, physico-chemical analysis, textural study and tribology. The data analysis of metabolomics profile and cell line studies of developed product are in process.
- The levels of different ingredients for formulation of gluten-free flour are optimized. The flours are characterized for proximate composition and analyzed for sensory evaluation. Rheological studies are conducted, but needs to be repeated for validation of results.
- Protocol for formulation of beverage from millet (ragi) has been standardized. The beverage is characterized for proximate composition and physico-chemical analysis.
- Two different varieties of kodo millet were analyzed for physico-chemical parameters like proximate composition, antioxidants, phenolics, fatty acid profiling, textural study, etc. The control samples were compared with different treatments (i.e. steaming, roasting, germination).

Bindvi Arora

- Process of extrusion functionalization of pea pod powder to be used as an ingredient in instant noodles was optimized. Extrusion modifies the protein structure in pea pod powder without compromising the antioxidant capacity of the final product. The properties of noodles with functionalized pea pod powder were comparable to those of control noodles without pea pod powder.
- Effect of food acids and chelating agents on emulsification properties of extruded chick pea powder was studied to functionalize chickpea powder as a clean label emulsifier. Chickpea powder extruded with 1% citric acid demonstrated enhanced emulsion activity and emulsion stability for 2:3 oil in water emulsion.
- Overripe banana incorporated corn puffs were developed to be used as snack or breakfast cereal. The process parameters comprising 26% banana powder, 16% feed moisture and screw speed 200 rpm was optimized. The developed snack is a rich source of dietary fiber, and inclusion of overripe banana contributed as a natural sweetener.
- Puffed extruded snack with added tomato pomace powder was optimized to enhance the antioxidant potential of savory snack foods and utilize tomato pomace, a by-product of the tomato processing industry. The developed product demonstrated enhanced antioxidant potential and increased lycopene content.
- Green leafy vegetable based reconstitutable powder was made ready to commercialize and was submitted to ITMC for approval.

Anamika Thakur

- Page 'n' and 'lnK' values at drying temperatures of 50, 60 and 70°C of pomegranate peel was -0.415, -0.392, 0.490, respectively and 2.222, 2.038, 2.352, respectively. The surface area (s) and volume (v) of the peel slices were calculated to be 3 mm^2 and 1.5 mm^3,

respectively. The moisture diffusivity (D) value at drying temperatures of 50 °C, 60 °C and 70 °C was found to be $2.73x10^{-3}$ m^2/s, $3.16x10^{-3}$ m^2/s and $5.25x10^{-3}$ m^2/s, respectively. ctivation energy was 39 kJ/mol. Cellulose content at 50, 60 and 70°C was 542, 611 and 695 mg/100g, respectively.

- The primary constituents of wet pummelo peel waste, similar to other citrus fruits encompass bioactive substances such as flavonoids, polyphenols, β- carotene (antioxidants) minerals such as K and P, soluble sugar, vitamins (vit.C, B1,B12) water, lipids, hemicellulose, cellulose. Hence, pummelo peel was used for extraction of nanocellulose using chlorine free method. Nanocellulose yield was 19.34%.

- The moisture diffusivities of whole chickpea and kernel varied from $7.36x10^{-4}$ $m^2.s^{-1}$ to 1.299 $x10^{-3}$ $m^2.s^{-1}$ for whole chickpea and from 0.0436 to 0.0833 $m^2.s^{-1}$ for kernel. Activation energy for hydration of whole chickpea was found to be $60.634 kJ.mol^{-1}$ and of kernel was 26.763 $kJ.mol^{-1}$. Heat treatment at 450W (18 W/g) power level for 3 min was inferred as the most suitable for making flakes.

- The maximum value of greenness of flakes was found at treatment combination of 450W (18 W/g) power level for 3 minutes. Broken content and trypsin inhibitor activity was also very less at this power- time combination. Hence, based on these parameters, heat treatment at 450W (18 W/g) power level for 3 minutes was inferred as the most suitable for making flakes.

Publications

S. No.	Publication	NAAS Score
1.	**Kumar, D.,** Ladaniya, M. S., Gurjar, M., Kumar, S., Mendke, S and Ghosh, D. (2023) Elucidation of flavanones, phenols and antioxidant capacity influenced by drying methods from physiologically dropped underutilized Citrus grandis fruits. *Frontiers in Plant Science* 14. https://doi.org/10.3389/fpls.2023.1193635	11.60
2.	Anand Vishnu, Ksh Vikono, Kar V, Varghese E, Vasudev, S, **Kaur Charanjit** (2024)**.** Encapsulation efficiency and fatty acid analysis of chia seed oil microencapsulated by freeze-drying using combinations of wall material. *Food Chemistry* 430: 136960.	15.23
3.	Vathsala V, Singh, S.P, Bishnoi M Varghese E, Saurabh, V, Khandewal A, **Kaur Charanjit** (2024). Ultrasound-assisted extraction (UAE) and characterization of citrus peel pectin: Comparison between pummelo (Citrus grandis L. Osbeck) and sweet lime (*Citrus limetta* Risso). *Sustainable Chemistry and Pharmacy* 37: 101357	12.0
4.	Vathsala V, Saurabh V, Choupdar, G.K, Upadhyay, N Singh S.P, Dutta A, **Kaur Charanjit** (2023) Black garlic particles as a natural pigment and emulsifier in a Pickering emulsion based low fat innovative mayonnaise: Improved rheology and bioactivity. *Food Research International* 173 : 113484	14.4
5.	Vivek Saurabh, V. Vathsala V, Yadav S.K, Sharma N, Varghese E, Saini V, Singh S.P, Dutta A, and **Kaur Charanjit** (2023) Extraction and characterization of ultrasound assisted extraction: improved functional quality of pectin from jackfruit (Artocarpus heterophyllus Lam.) peel waste." *Journal of Food Measurement and*	9.4

	Characterization 17.6 (2023): 6503-6521.	
6.	Ksh Vikono, Anand V, Rana, V.S, Mishra J, Kumar M, **Kaur Charanjit (2023)** Unleashing the bioactive potential of Capsicum chinense cv Bhut Jolokia: a comparison of microwave-and ultrasound-mediated extraction techniques for lipophilic capsaicin. *Natural Product Research* (2023): 1-10.	8.20
7.	Ksh Vikono, Anand V, Rana, V.S, Mishra J, Varghese E, Upadhyay, N., **Kaur Charanjit** (2023) Extraction of capsaicin from Capsicum chinense (cv Bhut Jolokia) using supercritical fluid technology and degradation kinetics. Chemical papers DOI: 10.21203/rs.3.rs-3014699/v1	8.20
8.	Menaka, M. Asrey, R., Meena, N.M., Vergheese, E., Sethi, S., Vinod, B.R., Ahamad, S., Goswami, A.K. (2024). Effect of melatonin on biochemical changes, antioxidant system and oxidative membrane damage of Indian guava (cv. Barafkhana) during cold storage. *South African J. Botany*. DOI: 10.1016/j.sajb.2024.04.007	9.10
9.	Pooja B.K., **Sethi, S.,** Joshi, A., Varghese, E., Kaur, C., Kumar, R., Shridhar (2023). Ultrasound assisted extraction of chlorophyll from pea pod waste: Optimization, kinetics and stability study. *Food Analytical Methods* DOI: 10.1007/s12161-023-02502-8	8.90
10	Singh, A.K., Banerjee, T., **Sethi, S.**, Tippannanavar, M., Joshi, A., Kumar, R., Dhiman, M.R., Sharma, R.M., Asrey, R., Pandey, R. (2024) Fungicide residue degradation in hot water treated apple. *Erwerbs-Obstbau* https://doi.org/10.1007/s10341-024-01041-8	7.30
11	Sulaimankhil, S., **Sethi, S.**, Varghese, E. (2024) Influence of staggered hexanal treatment on post-storage fruit physiology, functional quality and enzyme activity of 'Royal Delicious' apple. *Erwerbs-Obstbau* DOI: 10.1007/s10341-023-01027-y	7.30
12	Abarna, S., Joshi A., **Sethi, S.**, Tomar, B.S., Kumar, R., Varghese, E. (2023). Betalains stability and antioxidant activity of beetroots: As a function of maturity stage. *Sugar Tech* doi.org/10.1007/s12355	7.90
13	Singh, A.K., **Sethi, S**., Asrey, R., Kumar, R. (2023) Influence of hot water treatment on nutritional quality attributes of cold stored apple (*Malus* × *domestica*). *Indian Journal of Agricultural Sciences* 93 (9): 1025	6.40
14	Nayak, S.L., **Sethi S.**, Lata Nain, Dubey, A.K., Bhowmik, A. (2023). Changes in microstructure, enzymatic activity and functional quality of citrus juice sacs upon granulation. *National Academy Science Letters* DOI: 10.1007/s40009	7.10
15	Abarna, S., Joshi A., **Sethi, S**., Kaur, C., Tomar, B.S., Kumar, R., Varghese, E. (2023). Beetroot betalain and antioxidant potential: A function of maturity stage. *National Academy Science Letters* DOI: 10.1007/s40009	7.10
16	Pooja B. K., **Sethi S,** Bhardwaj R, Chawla G., Kumar R, Joshi, A, and Bhowmik A. Isoelectric precipitation of protein from pea pod and evaluation of its physicochemical and functional properties. *Vegetos* DOI: 10.1007/s42535-023-00667-5.	5.68
17	Arora, B., **Sethi, S**., Joshi, A., Narola, A. (2023) Optimizing pre-drying treatments of kale leaves for enhanced processing quality *Pantnagar J*	4.86

	Res. 21(3): 444-452.	
18	**Sethi, S**., Joshi, A., Kumar, M., Raghavendra, H. R., Pooja, B. K., Nayak, S. L., Chauhan, O. P. (2023). Phenolic and antioxidant capacity retention of potato peel waste as a function of cultivar, pretreatment and drying procedure. *Defence Life Science Journal*, 8(1): 71-82. DOI: 10.14429/dlsj.7.18208.	-
19	Lekshmi S. G., **Sethi, S**., Pooja B. K., Nayak, S.L., Menaka M. (2023) Ornamental plant extracts: Application in food colouration and packaging, antioxidant, antimicrobial and pharmacological potential – A concise review *Food Chemistry Advances*. doi.org/10.1016/j.focha.2023.100529.	-
20	Nayak, S.L. , **Sethi, S**., Saha, S., Dubey, A. K., Bhowmik, A. (2023) Microfluidization of juice extracted from partially granulated citrus fruits: Effect on physical attributes, functional quality and enzymatic activity *Food Chemistry Advances* 2: 100331	-
21	Thakur, R., **Rudra**, **S.G.,** Dikshit, H.K., Dash, S., Bhardwaj, R., Vinutha, T., Kumar, S., Chopra, S. (2023). Baked Crisps from Indian Biofortified Lentils: Effect of Seed coat on Rheology, Texture and Composition, ***Applied Food Research, Elsevier*** *Publications* doi: https://doi.org/10.1016/j.afres.2023.100380	-
22	Sreenatha A, **Rudra**, **S.G.,** Kumar, A., Dahuja, A. and Sharma, P.K. (2023). Variation in physico-chemical and functional properties of pre-treated finger millet grains and flours. ***The Pharma Innovation Journal*** 12(12): 3101-3109.	5.23
23	Chinnaswamy, S., **Rudra, S.G.**, Reddy, V.R., Awasthi, O.P., Kaur, C. (2023). Shelf life extension of Grewia berries using layer-by-layer edible coatings ***Vegetos***, 36 (4), 1326-1336.	5.27
24	**Thakur, A.** and Kar, A. (2023). Waste to wealth: Chlorine free extraction of nanocellulose from waste husk of rice. *The Pharma Innovation Journal* 12(3): 4371-4375	5.33
25	**Thakur**, **A**., Dutta, I. Kumar, D., Tiwari, U. (2024). Determination of Drying kinetics and Cellulose content of Punica Granatum L. Peels. *AMA- Agricultural Mechanization in Asia, Africa and Latin America* 55(3): 17355-17367.	6.30
26	**Thakur, A.**, Raina, M., Kumar, D., Tiwari, U. (2024). Determination of Soaking Kinetics of Green Chickpea Whole seed, kernel and hull var. Pusa 112. *AMA- Agricultural Mechanization in Asia, Africa and Latin America* 55(3): 17355-17367.	6.30

Trainings/ Seminar Organized

S.No.	Title of Training	Duration	Dates
1.	Agripreneurship Development Programme on Value Addition Technologies from Millets	5 days	20-24 March, 2023
2.	Waste utilization of custard apple peel and seed	2 days	26 and 28 March, 2023

3.	Agripreneurship Development Program: Processed Food Products from Millets	5 days	4 to 8 Dec 2023
4.	Agripreneurship Development Program: Novel Processing Techniques for Horticultural and Arable Crops	6 days	15 to 20 January, 2024
5.	Processing and Value Addition of Agri-Produce (conducted in Sitarganz, Uttarakhand)	2 days	14-15 March, 2024
6.	Preservation of ber fruits and visit to processing units	2 days	13-15 March, 2024
7.	Seminar on Introduction to Intellectual Property Rights and The Basics of Patent Law under 'IPR awareness programme'	1 day	9th November, 2023

List of Externally funded projects

S.N.	Title of the project	Funding agency (PI/Co-PI)	Fund
1.	Development of healthy crisp from fruits and vegetables	MOFPI PI-Shalini Gaur Rudra and Alka Joshi	24.24 lakh
2.	Enhancing lively hood of rural women through technological intervention of postharvest handling and value addition of custard apple and ber fruits	DST PI- Ram Asrey	21.43 lakh
3.	Bio- efficacy evaluation of UPH2121 on stored potato under controlled condition (Consultancy Research Project)	United Phosphorus Ltd. New Delhi PI- Ram Asrey	12.74 lakh
4.	Impact of Bensulf SUPERFAST (90% Sulphur) on Bio-efficacy & storage quality of Onion	Mahadhan AgriTech Limited, Pune PI- Ram Asrey	11.99 lakh
5.	Optimization and characterization of beverage from minor millets and exploring the nutritionally important bioactives for women health using integrated omics approaches'	DST SHRI PI-Neelam Upadhyay and C Kaur	30.76 lakh