

खाद्य विज्ञान एवं प्रौद्योगिकी विभाग



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दिनांक /Dated: 31.08.2023

डॉ. नीलम उपाध्याय

वैज्ञानिक (वरिष्ठ वेतनमान)

Dr. Neelam Upadhyay

Scientist (Senior Scale)

Brief summary of research work

This gives me immense pleasure to nominate Ms. Swati Tiwari for this very prestigious award. The justification which rationalizes her contention for this award is given below indicating the requirement, genesis and outcome of the research work carried out by her. I tenaciously believe that this work is need of the hour and Ms. Swati has done a great job during her research. The brief summary of research work is as under:

Fruits and vegetables are abundant in bioactive components and accessory group of compounds such as carotenoids and other phytonutrients, especially, their peels and pomace waste. However, such bio-waste is normally discarded as such and thus pose an environmental threat, besides discarding the nutrients associated with it. Carrot, is an important root vegetable and a major source of carotene. During carrot juice processing, 50% of the raw material is left as carrot waste or pomace and is mostly used as feed or is disposed off. However, being a good source of carotenoids it can potentially be introduced into food chain. But, the problem lies with its usage as it contains carotenoids bound to fibers present in carrot waste which decrease the micellization of carotenoids, in turn decreasing its bioaccessibility. Further, carotenoids could be efficiently extracted from carrot bio-waste using organic solvent, but these are reported to pose adverse health effects on account of their petrochemical nature. Thus, employing green bio-refinery approach for extraction of carotenoids could increase both extractability of carotenoids and also its bioavailability.

With this background, in the present study, carotenoids from carrot bio-waste was extracted in green solvent (vegetable oil i.e. flaxseed oil) by employing ultrasonication and high shear dispersion techniques. It was observed that high shear dispersion technique showed significantly higher extractability of carotenoids over ultrasonication. The extracted carotenoids showed significantly higher total carotenoid content, β -carotene content, antioxidative properties and color value than the control (i.e. vegetable oil). The carotenoids extracted in flaxseed oil could be used as a functional colourant on account of being rich in

β -carotene and omega-3 alpha-linolenic acid. However, it could only be used in the food products which contain fat/ oil as a continuous phase like mayonnaise, bread spreads, etc.

Further, for increasing the horizon of applications of extracted natural functional (omega-3 and carotenoids- rich) colourant, the emulsion based delivery system was prepared using natural emulsifiers namely, Whey protein concentrate, gum Arabic and lactose as filler using 33 factorial experiment of CRD and three way ANOVA of SAS and high shear dispersion technique. The prepared emulsion was freeze dried so as to obtain the powder rich in carotenoids and alpha-linolenic acid. The developed powder was employed as a functional ingredient in milk based flavoured drink which showed superior functional properties than the control milk-based flavoured drink.

The study concluded that carrot bio-waste could be an efficient source of carotenoids which could be extracted profitably using flaxseed oil as a natural organic-solvent-free ingredient and further its emulsion could also be prepared using natural emulsifiers. Both, functional colourant in extract, emulsion and dried form could be used in food systems to provide aesthetic appeal to the product and also improve its bio-functionality.

Usability of research

- This research aid with finding the efficacy of carotenoids as natural colorant: Synthetic food colours though not banned in most of the countries but are threat to food safety. Therefore, pigments extracted from horticultural waste are the most suitable alternatives. Thus, carotenoids extracted in this work can be effectively used as natural colorant in variety of food products.
- This work will provide links for novel formulations as a source of β -carotene: Owing to pro-vitamin A activity β -carotene, a sub-category of carotenoids have important place in the pigments extracted from horticultural commodities. Carrot contains 90% of carotenoids as β -carotene, therefore this type of research is highly suitable to extract these valuable nutraceutical. Also, in the scenario when vitamin A deficiency is one of the most prevalent deficiency around globe and in India.
- This work is based on environment friendly approach: Carrot bio-waste is the major solid residue produced from carrot juice processing industry which contains at least 50 % of the carotenoids. Thus, utilizing such valuable and underutilized carotenoid source can be highly beneficial to maintain the concept of novel circular economy and decreasing the environmental burden of waste disposal.
- This work is focused to emphasize the reduction of usage of organic solvent: Earlier more emphasis on the extraction of natural pigments was given using organic solvents. Such protocols leave residual solvents after processing which again possess various adverse health effects including hindering in normal cellular metabolisms thereby cellular degeneration, CNS depressant, and chronic encephalopathy etc. Thus, in future also optimizing and working on techniques that can replace the organic solvents with vegetable oils for the extraction of natural pigment can be a breakthrough.
- Applicability of natural colourant extracted in flaxseed oil and also its delivery system: Both of these were shown to be efficiently used in model food systems revealing significantly higher ($P < 0.05$) bio-functional properties and sensory attributes.

Outcome of research

Technology:

- **Lipid and water soluble yellow natural colouring ingredient from bio-waste**
 - o beta-carotene and alpha-linolenic acid rich natural colourant (liquid)
 - o Freeze dried powder (beta-carotene and alpha-linolenic acid rich)
 - o Flavoured milk containing functional natural colourant (beta-carotene and alpha-linolenic acid rich)

Publications:

3 research papers in high impact journals:

- Tiwari, S., Upadhyay, N., Singh, A. K., Meena, G. S., & Arora, S. (2019). Organic solvent-free extraction of carotenoids from carrot bio-waste and its physico-chemical properties. Journal of food science and technology, 56, 4678-4687.
- Tiwari, S., Upadhyay, N., & Malhotra, R. (2021). Three way ANOVA for emulsion of carotenoids extracted in flaxseed oil from carrot bio-waste. Waste Management, 121, 67-76.
- Tiwari, S., Upadhyay, N., & Singh, A. K. (2022). Stability assessment of emulsion of carotenoids extracted from carrot bio-waste in flaxseed oil and its application in food model system. Food Bioscience, 47, 101631.



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