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Designing of packaged button mushroom-based functional foods: Gluten-free noodles and gluten-cum-oil free soup as vehicles for *in vivo* delivery of target bioactive molecules

Shumaila Belal, Dipshikha Tamili, Paramita Bhattacharjee*

Department of Food Technology & Biochemical Engineering, Jadavpur University, Kolkata-700 032, India

Abstract

Button mushrooms (*Agaricus bisporus*), widely consumed for their high protein content are also rich in important antioxidants-cum-biotherapeutic molecules such as serotonin and melatonin [1,2,3]. Their fruiting bodies are also valuable sources of lovastatin and ergosterol, known for their potent hypocholesterolemic effects [4,5]. However, button mushrooms till date remains largely unexplored for the aforesaid bioactives. In view of increasing consumer preference for instant foods, two mushroom-based functional food products, *viz*. gluten-cum-oil free mushroom noodles and soup were developed as natural delivery matrices for the above-mentioned bioactives with judicious usage of food additives under minimal processing conditions employing green technology (subcritical processing) to preserve their bioactive integrity and remove the endogenous toxin present in button mushroom, agaritine [6,7,8,9]. Multi-criteria decision tree-TOPSIS approach, incorporating three input and five output variables was employed to obtain the optimal combination of amounts of ingredients used and microwave drying time of noodle formulation; while the Taguchi L9 orthogonal array design was used to optimize the parameters for formulation of the mushroom soup, considering four significant parameters (amounts of ingredients used and processing conditions) at three levels [10]. Both the newly developed food products exhibited appreciable antioxidant activities, while maintaining their respective desirable characteristics in terms of proximate composition, physicochemical properties, cooking indices (for noodles), EDAX profile, thermal stability, and microstructure [11]. *In vitro* release kinetics of the mushroom noodles and soup using standard dissolution apparatus exhibited substantial release of all the target biomolecules (L-tryptophan, serotonin, melatonin, lovastatin and ergosterol) in the simulated gut buffers within 2 h. *In vivo* feeding trials for the formulated products were conducted on male Sprague Dawley rats (mushroom noodles) and male Wistar Albino rats (mushroom soup) of similar body weight. The findings of the *in vivo* studies were in consonance with those of the *in vitro* studies, demonstrating effective gastrointestinal absorption and systemic bioavailabilities of the target biomolecules from either food matrix. Serum levels of L-tryptophan, serotonin, and melatonin increased approximately 95%, 20%, and 44%, respectively, within 30 min post-consumption of noodles and decreased post 50 min [13]; while, the peak serum concentrations of the hypocholesterolemic biomolecules**,** lovastatin and ergosterol, were observed 1.5 h after the oral gavaging of the soup, confirming efficient release and absorption of these bioactives through the food matrix. The packaged functional food products showed appreciable stability with shelf-life of approximately 40 weeks (noodles) and 57 weeks (soup). Thus, the studies establish the newly developed mushroom-based gluten-cum-oil free noodle and soup to be potential functional food products and efficient delivery vehicles for these biotherapeutics and thus putative substitutes of synthetic drugs of L-tryptophan, melatonin and lovastatin.

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* Corresponding author *E-mail address:* paramita.bhattacharjee@jadavpuruniversity.in