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Utilization of Freeze-dried *Moringa oleifera* Leaves Powder in Production of Paneer

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ABSTRACT: Dairy products are known for their positive health benefits and are consumed all over the world. The supplementation of plant powder as sources of beneficial nutritional components to food has recently gained a lot of interest. Minerals and phenolic compounds, which are beneficial components, are very low in milk and fermented foods. *Moringa oleifera* is rich in polyphenols and flavonoid compounds. Its inclusion in milk could be an excellent method to improve the nutritional value of dairy products. The present investigation was aimed to formulate paneer with different concentrations of freeze dried *Moringa oleifera* leaf powder (MLP). Formulations were: control MP_0, 0.5% MP_1, 1% MP_2, 1.5% MP_3 and 2% MP_4. On the basis of the study, it is concluded that MP_2 (1% MLP) had gained higher nutritional value and better sensory acceptance than control. However, sensory acceptance was significantly modified after the incorporation of freeze dried *Moringa oleifera* leaf powder in product formulation.

Keywords: *Moringa oleifera* leaf powder, paneer, sensory properties, freeze drying, nutritional value.

INTRODUCTION

Micronutrient deficiencies often cause malnutrition, that is a crucial health problem which is characterized by a low or high quantity of nutrients, quoted Ortiz *et al.* (2016). It impacts the life's quality and epidemiological parameters, which will generate several diseases either infectious or chronic diseases. It will often affect children, women of reproductive age, poor pregnancy outcomes and physical development, researched Mandelbaum (2004); Method and Tulchinsky (2015). As a consequence, it leads to premature death, disability, and reduces work load capacity, researched Black *et al.* (2013); Rogol *et al.* (2021); Yamashiro (2021). Up to 3–3.5 million of children aged under 5 years old die every year and women of reproductive age, because of undernutrition they are at risk for fetal growth restriction, sub-optimum breastfeeding, stunting, wasting, and deficiencies of vitamin, iodine, zinc, iron, rickets, osteomalacia, and thyroid deficiency. Therefore, itis essential to adopt the appropriate nutrients quality and quantity in our daily diet to improve human health, sustained economic growth and national development, researched Mishra (2011); Holdoway *et al.* (2021).

According to Bhagwat *et al.* (2014), food fortification is considered as one of the preventive approaches against micronutrient deficiencies. Research studies have been carried out to develop food fortification in developed countries, Akhtar *et al.* (2010); Mishra (2011). In order to evaluate the food fortification, more research studies are required to study the different types of fortification.

Paneer, an indigenous variety of soft cheese which is obtained by heat and acid coagulation of milk at high temperatures. It is very popular in Indian subcontinent and it forms a base material for the preparation of a large number of culinary dishes, stuffing material for various vegetable dishes, snacks, and sweetmeats. According to Shrivastava and Goyal (2007), paneer is of great value in diet because it is rich in proteins, fat, minerals, and vitamins, but it is devoid of vitamin C, iron and dietary fibre like other dairy products.Plant extracts in dairy foods might improve the physicochemical and sensory properties, which has a positive effect on consumers researched, Ozmen Togay *et al.* (2022).

Moringa oleifera Lam. is an indigenous edible plant, commonly referred to as "The Miracle Tree" due to its nutritional and medicinal properties, researched Palada (1996); Fuglie (1999); Ashfaq *et al.* (2012); Gonzalez Burgos *et al.* (2021). It is one of the useful trees, as every part of the tree can be used for food, medicinal or industrial purposes Khalafalla *et al.* (2010). The *moringa* leaves are highly nutritious especially in micronutrients like Ca, Fe, etc., Shiriki *et al.* (2015); Mounika *et al.* (2021); Bailey Shaw *et al.* (2021) founded. Nambiar and Seshadri (2001) founded, that *M. oleifera* leaves acts as a good source of Vitamin A and it would help for overcoming Vitamin A deficiency. *M. oleifera* leaves has the ability to counteract malnutrition cases, since infants and breast-feeding mothers are at risk of deficiency in nutrition. It is also referred as "Mother's Best Friend" because it has the ability to improve

woman's milk production, so it is indeed a "Natural Gift of Nature", quoted Siddhuraju and Becker (2003); Anwar *et al.* (2007). Zongo *et al.* (2013) envisaged that consuming 10 g of *M. oleifera* leaf powder on daily basis can help malnourished children to recover their body weights and enhance health benefits within a short span of time. Moreover, consumption of *M. oleifera* helps in strengthening the neural response, which will enhance the immune functions and improves health because of the large amounts of microelements and polyphenol antioxidants, founded Bamishaiye *et al.* (2011).

Saini *et al.* (2014) demonstrated, the potential bioactive properties of *moringa* leaves and also shown the enrichment of carotenoids, tocopherols along with iron bioavailability in animal models. Kumar and Pari (2003) reported that *M. oleifera* showed anticancer activities, prevention of cardiovascular and liver diseases. Teixeira *et al.* (2014) showed, that the *moringa* leaf flour contained 28.7, 7.1 and 44.4% of crude protein, fat and carbohydrate, respectively. Research studies conducted on ethanolic extract from *moringa* leaves where the results showed that the plant extract is a potential source of dietary antioxidants, Arabshahi *et al.* (2007) founded. It can also enhance the shelf-life of fat containing foods due to the presence of antioxidant compounds researched Dillard and German (2000). According to Madukwe *et al.* (2013), usage of dry *moringa* leaf powder provides effective treatment of anemia. Mukunzi *et al.* (2011) reported that *M. oleifera*can be used to improve the nutritional and sensory properties of food by incorporating its extract into food products.

The food industry might offer traditional dairy products fortified with sustainable plant sources, such as the different parts of *M. oleifera*, promoting the consumption of this plant. However, the prospective applications of moringa in the field of food fortification are unknown, founded Yadav and Srinivasamurthy (2020). To that end, the objective of this paper is to develop fortified dairy products that offer the necessary nutrients to counteract malnutrition issues, along with pleasant sensory attributes and that would capture the attention of the consumer.

MATERIALS AND METHODS

A. Procurement of ingredients

Standardized milk was purchased from local dairy and it was used as the base material for preparation of paneer.

B. Procurement and storage of M. oleifera

M. oleifera was procured from the local market. They were cleaned by tap water and shade dried with good ventilation for almost two weeks. The dried *M. oleifera* leaf samples were blended and passed through a sieve (20 mesh). The powdered leaf samples *M. oleifera* were kept in sealed air-tight containers and stored in darkness until their treatment.

C. Conventional solid-liquid extraction

Conventional solid-liquid extraction was carried out as described by Abubakar and Haque (2020) with some modifications. First, 2g of dried powdered leaves of *M. oleifera* was extracted with distilled water (100%). The maceration was carried out for 3× 24h at room temperature (28±2ºC) with occasional shaking. The process is repeated 3 times. The extracts were centrifuged for 15min at 5000 rpm to remove solids. Next, the solvent was evaporated using rotary evaporator under vacuum at 40ºC. The final extracts were freeze dried and used for further analysis.

D. Preparation of freeze dried M. oleifera leaf powder based paneer

Paneer was prepared from standardized milk with slight modification using the method given by Singh and Kanawjia (1991).

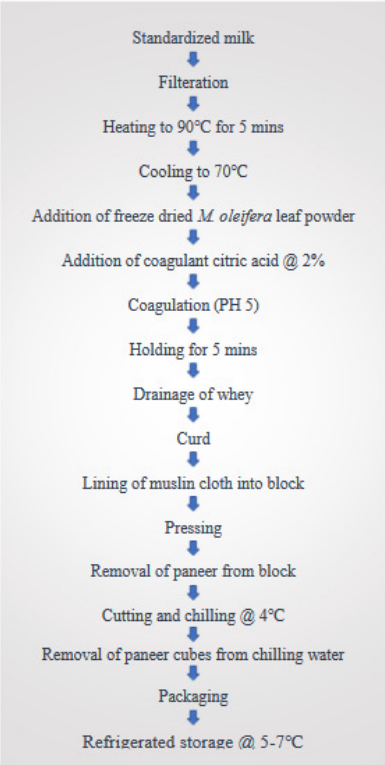

Fig 1. Flow diagram for preparation of Paneer incorporated with freeze dried *moringa* leaf powder.

E. Packaging and storage of paneer

Control, 0.5%, 1%, 1.5%, 2% freeze dried *moringa* leaf powder incorporated paneer sample of 100 g were prepared and packed in LDPE bag and stored at 4±1°C.

F. Sensory evaluation

Sensory evaluation of control and freeze dried *M. oleifera* leaf powder based paneer samples was carried out using 9-point hedonic scale. Twenty panelists were selected includes students and staff of our college who were regular consumers of paneer. Color and appearance, body and mouthfeel, flavor and overall acceptability were the sensory parameters evaluated by sensory panelists. The evaluation was divided into 3 sections as visual characteristics (color and appearance), flavor and texture (body) evaluations. Visual analysis of freeze dried *M. oleifera* leaf powder based paneer samples was followed by texture and flavor evaluations.

G. Statistical Analysis

One-way analyses of variance (ANOVA) followed by a Duncan post hoc test were applicable and used to analyze the level of statistical significance of the growing regions on the levels of total phenolic, total flavonoid and antioxidant content. $P<0.05$ were considered statistically significant.

RESULTS AND DISCUSSION

A. Sensory evaluation of freeze dried M. oleifera paneer

All the sensory parameters *viz.* appearance and body, color and flavor, texture and overall acceptability were found to be significantly difference (P<0.05) in paneer incorporated with freeze dried *moringa* leaf powder. The sensory attributes of freeze dried MO powder incorporated in paneer was shown in (Table 1).

Table 1: Sensory characteristics of control and freeze dried *M. oleifera* leaf powder based paneer.

Sr. No.	Concentration	Sensory attributes of *M. oleifera* paneer					
		Appearance	Body	Color	Texture	Flavor	Overall Acceptability
1.	MP_0	8.3±0.19^{a}	8.1±0.19^{a}	8.2±0.15^{a}	8.3±0.21^{a}	8.3±0.19^{a}	8.5±0.14^{ab}
2.	MP_1	8.2±0.15^{a}	7.9±0.17^{a}	8.3±0.14^{a}	7.9±0.19^{a}	8.1±0.19^{b}	8.0±0.16^{b}
3.	MP_2	8.7±0.10^{a}	8.3±0.21^{a}	8.4±0.15^{a}	8.4±0.15^{a}	8.2±0.22^{a}	8.7±0.12^{a}
4.	MP_3	6.2±0.18^{b}	5.7±0.31^{b}	5.9±0.20^{b}	6.0±0.19^{b}	6.1±0.29^{b}	6.0±0.22^{c}
5.	MP_4	5.3±0.33^{c}	5.8±0.27^{b}	5.7±0.21^{b}	5.6±0.16^{b}	5.9±0.27^{b}	4.9±0.17^{d}
6.	F value	49.820**	28.170**	64.143**	52.555**	26.298**	94.891**

Values followed by different letters are significantly different at P<0.05, MP_1= Control, MP_2=0.5%, MP_3=1%, MP_4=1.5%, MP_5= 2%

It is clear from the Table 1 that there was a significant different between the color concentrations in the developed paneer. These results were agreement to Saricoban and Yilmaz (2010); Zhang *et al.* (2018) who reported that change of color in yoghurt which fortified with *moringa*, due to increase of dietary fiber present in leaves. The developed paneer sample of MP_2 had the highest score of (8.7) for color and appearance followed by MP_1 (8.2), MP_0 (8.3), MP_3(5.9) and MP_4 (5.7).

Based on the type of acid used, there was a significant difference in flavor of the treated paneer. There was a gradual and significant (P<0.05) decrease in flavor and texture of 1.5% and 2% *MO* treated paneer. The mean score for flavor sample MP_0, MP_1, MP_2, MP_3, MP_4 were 8.3, 8.1, 8.2, 6.1 and 5.9 respectively. The flavor acceptability of paneer samples decreased as dominance of bland flavor and bitterness smell of freeze dried *M. oleifera* leaf powder which was not accepted by panelist at higher level of *M. oleifera* leaf powder fortification. The main score for body and texture of paneer sample MP_0, MP_1, MP_2, MP_3 and MP_4 were 8.3, 7.9, 8.4, 6.0 and 5.6 respectively. Bermudez Beltran *et al.* (2020) observed that the addition of 2% *M. oleifera* leaf powder to the cape gooseberry Petit Suisse cheese increased its nutritional value but decreased the sensory acceptance of the product.

The Overall acceptability of 1% MP_2 paneer was significantly higher than control sample. These results were agreement to Hassan *et al.* (2017) who found that white cheese enriched with 1% of *M. oleifera* leaf powder showed the best sensory acceptance in terms of appearance, texture and taste in comparison with the control sample.

Sensory evaluation as well as overall acceptability results of the paneer samples showed that MP_2(1% *M. oleifera* leaf powder) was the most acceptable sample as it scored highest among all samples with respect to color, body, texture and overall acceptability.

CONCLUSIONS

A method was standardized for manufacture of paneer containing freeze dried *M. oleifera* leaf powder as an ingredient. It makes it a complete food as paneer is naturally devoid of vitamin C, iron and dietary fibre like milk and milk products. *M. oleifera* leaf powder being a good source of iron and dietary fibre can be utilized in paneer. So, the developed product exhibited significant (p>0.05) sensory scores in paneer. The result revealed the possible application of Moringa leaf powder (1%) as a natural source of anti-oxidant property in development of dairy products with potential health benefits.

FUTURE SCOPE

The application of *Moringa oleifera* in medicine has witnessed its long tradition in human benefits. Recent research studies have confirmed that it has a potential to be used in the food applications where its biological behaviour plays important role. It contains various phenolics and flavonoids compound which can be utilized for the preparation of nutraceutical foods. Thus, it can be boom to the food and pharmaceutical industries. *Moringa oleifera* is still unexplored for its food application especially in dairy sectors. This review gives insight on health benefits which determines the utilization of *Moringa oleifera* in food applications. Therefore, the need of the hour is to explore the *Moringa oleifera* by researchers and scholars with the aim to achieve food safety and nutritional security.

Credit authorship contribution statement. Saranya: Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing. Perasiriyan: Writing - review & editing. Rita Narayanan, Mangala Gowri & Sujatha: Conceptualization, Methodology, Resources, Writing - review & editing, Supervision, Project administration, Funding acquisition.

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Conflict of Interest. None.

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