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Development, organoleptic, chemical, and microbial analysis of a complementary food premix based on makhana, chickpeas, and steamed rice flour

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Abstract
The formulation for preparation of premix was carried out by using different variation in makhana powder and steam rice flour whereas chickpea flour which is constant T_0, T_1, T_2, T_3, T_4 *viz.*, 100:00, 40:15:15, 35:20:15, 32:21:15, 30:21,15 respectively. Further premix power were prepared and it then allow for organoleptic evaluation with semi trained panel in that T1 is got more score in terms of texture, consistency and taste received highest sensory score (8). chemical properties of preimix *viz*, moisture, fat, protein, carbohydrates, ash Result obtained for chemical composition of premixed revealed that moisture content was 7.85%, fat 6.10%, protein 10.35%, carbohydrates 72.40%, crude fiber 3.5%, and ash 1.5%. with calories of 385.9 kcal. Later, sample is treated for microbial analysis on storage studies of 1, 4 and 8 days with parameter evaluated TPC and Yeast and Mould count results shows for TPC (CFU/g) for Day 1, 4 and 8 are 3.2 x 10^3, 3.6 x 10^3, 4.0 x 10^3 and Yeast & Mold Count (CFU/g) 1.6 x 10^3, 2.1 x 10^2, d3.5 x 10^2 and coliform count (CFU/g) <10(ND). Overall, it can be concluded that supplementation of makhana power up to 40% in preparation of premixed with good sensory attributes and nutritional value can be prepared.

Keywords: Makhana, chickpeas, steam rice flour, premix, organoleptic evaluation, microbiological analysis, yeast and mould, coliform, TPC, chemical analysis

Introduction
The growing global trend toward health-conscious eating habits has sparked a significant shift in consumer preferences, with increasing demand for functional foods that offer not just basic nutrition but also additional health benefits. Among these, the focus on digestive health, immunity, and overall well-being has driven research and innovation in food products. Prebiotics, substances that stimulate the growth or activity of beneficial gut bacteria, have become a key area of interest. These non-digestible compounds play a crucial role in maintaining a balanced gut microbiota, enhancing nutrient absorption, and supporting immune function. As awareness grows about the link between gut health and overall wellness, the development of prebiotic-rich food products is gaining immense popularity (Gomez-Cabrera *et al.*, 2012) [11]. One promising innovation in this space is the development of prebiotic flour premixes that offer not only functional benefits but also convenience, versatility, and accessibility.

These premixes combine nutrient-dense ingredients with prebiotic properties, making them an ideal solution for modern consumers looking for an easy way to incorporate digestive health benefits into their diets (Ziegler & Hamaker, 2017). This focuses on the formulation of a prebiotic flour premix made from makhana powder, steamed rice flour, chickpea powder, sugar powder, and dry fruit powder. Ingredient is selected for its nutritional value, sensory appeal, and health benefits, ensuring a product that addresses the demand for both functional foods and convenient meal options (Cheng *et al.*, 2015) [17].

Makhana, also known as foxnut or lotus seed, has been a staple in Asian cuisine, particularly in India, for centuries. Traditionally used in snacks, desserts, and medicinal preparations,

makhana is rich in carbohydrates, proteins, essential amino acids, and various micronutrients. One of makhana's standout features is its potential prebiotic effect. The starch in makhana is resistant to digestion in the upper gastrointestinal tract, allowing it to reach the colon, where it serves as a food source for beneficial gut microbiota. By incorporating makhana powder into the premix, the product harnesses this prebiotic potential, promoting digestive health while providing a nutritious, energy-dense option for consumers (Rathi *et al.*, 2017; Chauhan & Sharma, 1990; Li *et al.*, 2020) [13].

Steamed rice flour, a common ingredient in many Asian and global culinary traditions, offers a unique functional profile, particularly when used in functional food formulations. Its light texture and neutral taste make it an excellent choice for a wide variety of recipes, from porridges to baked goods. Steamed rice flour is known for its enhanced digestibility compared to raw rice flour, making it an ideal option for individuals with sensitive digestive systems. It also provides a gluten-free alternative to wheat flour, catering to consumers with gluten intolerance or those following specific dietary patterns like celiac disease or gluten sensitivity. The addition of steamed rice flour in the premix helps achieve a smooth consistency and pleasant mouthfeel while contributing to a balanced macronutrient profile (Lu & Cheng, 2013; Lee *et al.*, 2006) [18].

Chickpeas, or garbanzo beans, are another nutritional powerhouse. Rich in plant-based protein, dietary fibre, and essential micronutrients like folate, iron, and magnesium, chickpeas offer numerous health benefits. Their high fibre content, both soluble and insoluble, promotes healthy digestion and helps regulate blood sugar levels. Chickpeas also contribute to satiety, making them an excellent choice for those looking to manage their weight or control blood glucose levels. In the prebiotic flour premix, chickpea powder enhances the protein and fibre content, supporting gut health and contributing to the product's overall nutritional balance. Additionally, chickpeas improve the flavour and texture of the premix, making it more appealing to a wider range of consumers (Martínez-Villaluenga *et al.*, 2009; Babio *et al.*, 2009; Haug & Lantzsch, 2017) [19, 20]. While the primary focus of the premix is its prebiotic benefits, the inclusion of sugar powder and dry fruit powders plays a crucial role in enhancing the product's sensory attributes. Sugar powder, used in moderation, provides a mild sweetness that helps balance the flavours of the other ingredients. This makes the premix more palatable, especially for those looking for a quick and enjoyable food option.

The almonds and cashew nut powders, such as those made from dates, almonds, and cashews, not only contribute natural sweetness but also offer additional vitamins, minerals, and antioxidants. These dry fruits are rich in healthy fats, fibre, and micronutrients like vitamin E, magnesium, and potassium, which support heart health, brain function, and overall immunity. By incorporating these dry fruit powders, the premix becomes a well-rounded and nutrient-dense product that addresses both taste and health needs (Sánchez & Díaz, 2019; Hammad *et al.*, 2020; Amiri & Mirzaei, 2016) [21, 22, 23]. The modern lifestyle, characterized by fast-paced schedules and a reliance on convenience foods, has created a gap in the market for nutritionally balanced, easy-to-prepare meals. Many convenience foods are often devoid of significant nutritional value, leading to a rise in chronic health conditions like obesity, diabetes, and digestive disorders. The prebiotic flour premix offers a solution to this issue by providing a quick, convenient, and nutritious option for individuals seeking to improve digestive health, boost immunity, and maintain overall well-being. This premix can be used to prepare a variety of foods, including instant porridges, protein bars, snacks, and baked goods, making it adaptable to various dietary preferences and lifestyles (Popkin *et al.*, 2012; Fardet *et al.*, 2018) [12, 14].

Materials and Methods

This study was conducted in the Department of Food Plant Operation, Food Chemistry and Nutrition and Food Microbiology at K.K. Wagh College of Food Technology, affiliated with Mahatma Phule Krishi Vidyapeeth, Nashik, Maharashtra. The research focused on developing a novel product using a premix using a composite blend of rice flour, chickpea flour, makhana flour, sugar, and dry fruits (almonds and cashews). The raw materials, including rice flour, chickpea flour, makhana flour, sugar, almonds, and cashews, were sourced from local markets and confectionery outlets in Nashik.

Methodology

Standardization of Formula for preparation of premix

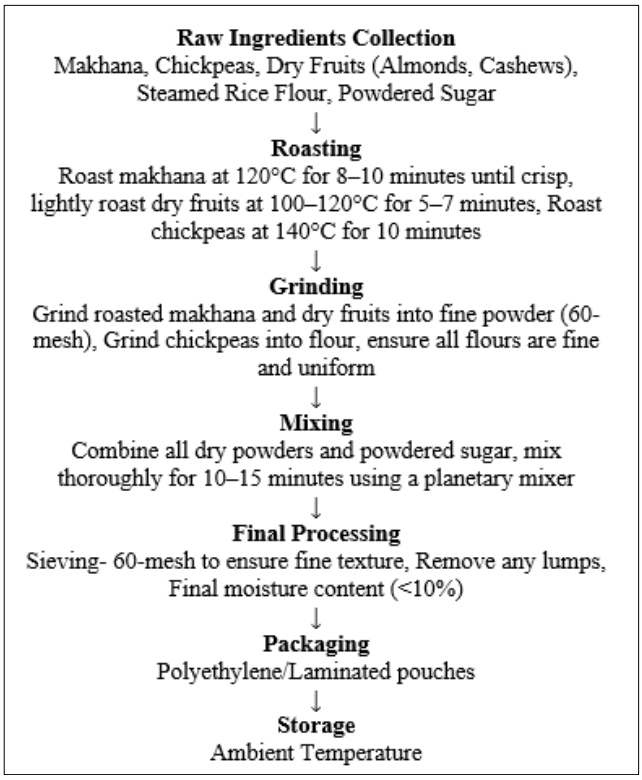
For standardization of formula various combinations of the ingredients used in the formulation included makhana powder, steamed rice flour, chickpea powder, powdered sugar, and dry fruits powder. Makhana seeds were cleaned, roasted, and ground into a fine powder. Steamed rice flour was prepared by soaking rice, steaming it until partially cooked, drying it, and then grinding it into a smooth flour. Chickpeas were roasted to enhance digestibility and flavour, then ground into a fine powder. Dry fruits such as almonds and cashews were finely powdered after proper cleaning and drying. Powdered sugar was prepared by grinding refined sugar to a fine consistency. All the individual ingredients were weighed accurately according to the desired proportion and mixed thoroughly using a blender to ensure uniform distribution. The final premix was packed in to moisture-proof, air-tight containers and stored at room temperature for analysis.

Table 1: Standardization of Formula (ingredients for per 100gm) for preparation of premix

Trials	Chickpeas Powder	Sugar Powder	Makhana Powder	Steamed Rice Flour	Dry Fruits
T_0	25 g	15 g	00 g	00 g	5 g
T_1	15 g	18 g	40 g	15 g	12 g
T_2	15 g	18 g	35 g	20 g	12 g
T_3	15 g	18 g	32 g	21 g	12 g
T_4	15 g	18 g	30 g	21 g	12 g

Preparation of Premix

A nutritious makhana-based premix powder was developed by combining makhana (foxnut) powder, chickpea flour, steamed rice flour, powdered sugar, and dry fruits powder. The process began with manually cleaning and dry-roasting makhana seeds to enhance their nutty flavor and crispness before grinding them into a fine powder. Chickpeas were similarly sorted, washed, and roasted to reduce anti-nutritional factors and then milled into flour. For the steamed rice flour, raw rice was soaked, steamed to partially gelatinize the starch, dried, and ground into a fine, sieved flour. Dry fruits were lightly roasted for aroma and shelf-stability before being powdered. All ingredients were precisely weighed, thoroughly mixed in a sanitized stainless steel vessel to ensure uniformity, and the final premix was stored in moisture-proof, airtight containers at ambient temperature to preserve its quality, texture, and nutritional value for use in ready-to-eat health food applications.



Flow Chart 1: Processing technology for preparation of Premix

Result and Discussion

Sensory evaluation of Premix: The sensory evaluation were carried out of premix data with respect to colour, taste, flavour, texture, appearance, and overall acceptability are depicted in Table No. 2 It can be revealed from the above Table 2 that the sensory evaluation scores given by the semi trained panelist showed that the textural scores were significantly decreasing from control sample to sample T3. Appearance of control sample and sample T1 was having similar score for appearance. When the data analysed statistically it was found that control sample and sample T1 was significantly superior to the rest of the samples.

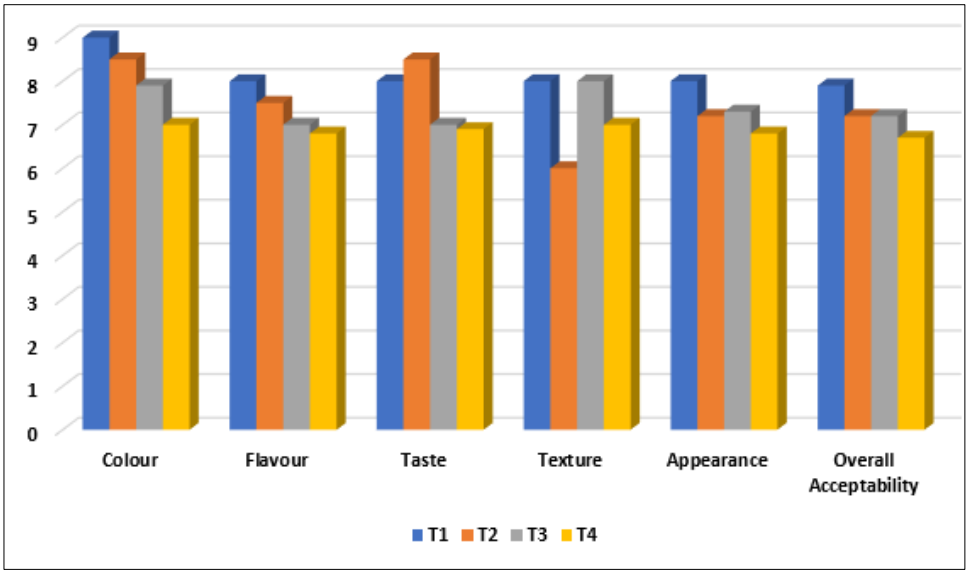
Parameter for 9-point Hedonic scale

Table 2: Nine-point hedonic liking preference scale

Dislike extremely	Dislike very much	Dislike moderately	Dislike Slightly	Neither like nor dislike	Like slightly	Like Moderately	Like very much	Like extremely

Table 3: Mean sensory values for the Premix

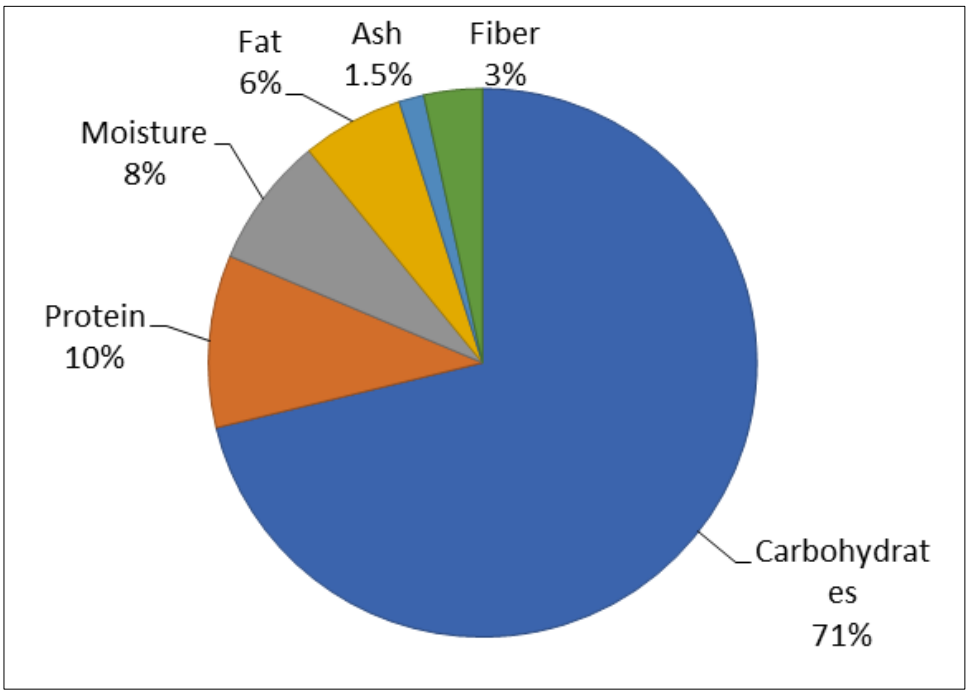
Sample	Colour	Taste	Flavour	Texture	Appearance	Overall Acceptability
T_0	8	7	8	9	8	8
T_1	9	9	8	9	9	8
T_2	7	6	7	8	7	7
T_3	6	7	6	7	6	6



Graph 1: Graphical Representation of Sensory evaluation chart

Table 4: Tabular Representation of Chemical Analysis

Chemical Analysis of Premix						
Parameters						
Moisture	**Fat**	**Protein**	**Carbohydrates**	**Fibre**	**Ash**	**Calorific Value**
7.85%	6.10%	10.35%	72.40%	3.5%	1.5%	385.9 kcal



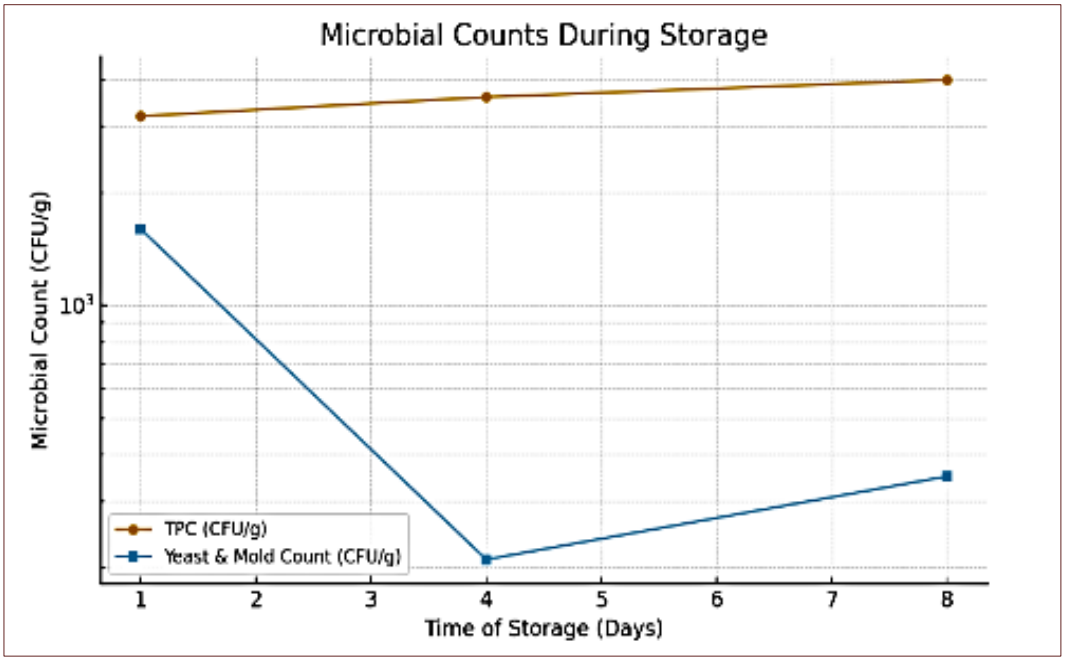
Graph 2: Graphical Representation of Chemical Analysis

The chemical composition of the sample was analysed for major nutritional constituents, including moisture, fat, protein, carbohydrates, ash, and crude fibre. Revealed that moisture content was 7.85%, fat 6.10%, protein 10.35%, carbohydrates 72.40%, crude fiber 3.5%, and ash 1.5%. with calories of 385.9 kcal.

Microbial Analysis

Table 5: Tabular Representation of Microbial Analysis

Storage Days	TPC	Yeast & Mould	Coliforms	Desirable Limits
	(CFU/g)			
1	3.2×10^3	1.6×10^3	<10(ND)	TPC<1.0×10^4
4	3.6×10^3	2.1×10^2	<10(ND)	Y&M<1.0×10^3
8	4.0×10^3	3.5×10^2	<10(ND)	Coliforms<1.0×10^2



Graph 3: Graphical Representation of Microbial Analysis

Plate 1: Microbial Count Plate

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