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Standardisation, Formulation and Quality Evaluation of Makhana Flour Incorporated Recipes

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Abstract

Makhana has many medicinal properties, hence they are used against many human disorders. It is used as an important source of natural antioxidants with antidiabetic properties. Makhana are processed into flour and used in selected recipes after formulation and standardisation, and the stability of the flour was assessed. The nutrient content, phytochemicals, physicochemical properties, and shelf life of the flour were studied. The nutrient analysis of the recipes revealed that all three various products of Makhana flour incorporation contributed significantly to the overall carbohydrate, protein, potassium, calcium, iron, and magnesium content. The microbial analysis showed that the Makhana flour was stable up to 30 days of storage in a glass container. The overall acceptability was higher in standard and Makhana flour incorporated tacos. The present study highlights the potential of Makhana flour as a valuable ingredient for the development of nutritious and healthy recipes.

Keywords: Healthy Makhana Recipes, Makhana, Nutritional Properties, Storage Stability

1. Introduction

Makhana *(Euryale ferox Salisb)* are popularly called Black Diamond when raw and are famously known as white balls when they pop. Makhana are botanically known as *Euryale ferox Salisb*. This crop is an aquatic emergent macrophyte. Makhana is such a cash crop which is cultivated normally without the application of any chemical fertilisers or manures. It is grown in both field and pond conditions[1]. *Euryale ferox Salisb* belongs to the family Nymphaeaceae (water lily family), commonly known as Makhana, Gorgon nut, or Foxnut, grown in stagnant perennial water bodies like ponds, Oxbow lakes, and swamps. The Makhana are roasted and known as the popped seeds of Euryale ferox Salisb[2]. Makhana is an organic, nutritional, non-cereal edible crop. Makhana is a good source of carbohydrates, protein and minerals. In recent years price of Makhana has increased due to an increase in demand from domestic as well as foreign markets. The crop has been recognised as an important crop in the state of Bihar and has the potential to alleviate the poverty of a section of people involved in its cultivation[3]. Makhana *(Euryale ferox Salisb)* is one of the most common dry seeds utilised by people because of its low fat, high carbohydrates, protein, and minerals. It is a good source of unique proteins and carbohydrates. Kernels of Euryale are the major source of glutamine, arginine, leucine, and isoleucine and a fair source of cysteine and methionine and other amino acids which act as antioxidants as well as precursors of other long-chain amino acids for normal health functions[4].

Antioxidant activity of foxnut related to medical conditions such as proteinuria inhibition or diabetic nephropathy is the most important activity of Makhana. As a significant source of natural antioxidants is foxnut has been used to treat diabetes, hyperlipidemia and used as functional foods and dietary additives. They contain kaempferol, a flavonoid which has an anti-inflammatory effect and is a free radical scavenger. There are potent antioxidants that can eliminate free radical intermediates, stop chain reactions, and function as a fighting agent. The most important amino acids present in foxnut are leucine, isoleucine, methionine, cysteine, arginine, and glutamine[5].

Hence, the present study was undertaken to standardise, formulate Makhana flour incorporated

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recipes, test the sensory attributes, and analyse their physicochemical and phytochemical properties, nutrient composition and shelf life of Makhana flour.

2. Materials and Methods

2.1 Selection of Makhana

In the present study, good quality Makhana *(Euryale ferox salibs)* was purchased through online shopping. The Makhana were cleaned to render them free from dust and impurities.

2.2 Processing of Makhana Flour

About 200 g of Makhana was dry roasted on a medium flame for 2-3 min or until it dried completely. Then the Makhana was transferred to a blender and blended into a fine powder. Finally, sieved the flour and stored it in an air-tight glass container. The flow chart for the preparation of Makhana flour is given in Figure 1.

2.3 Processing of Makhana Flour Tacos

Ingredients such as wheat flour, salt, Makhana flour and oil and these ingredients are mixed well. Add water and knead to make dough. Cover and rest the dough for 30 minutes. Make a small ball and then roll it into a flat shape. Cook till done on a tawa. Take a pan and add oil, mustard seeds, cumin seeds powder, curry leaves, tomato, salt, onion, chilli, ginger, garlic and Paneer. Then cooked until done. Add the stuffing rolled into a round roll. Then cook on a medium flame until a golden brown colour is obtained.

2.4 Processing of Makhana Flour PEDA

Ingredients such as gram flour, Makhana flour, jaggery and ghee. Heat a pan and fry Makhana flour and gram flour till an aroma arise. Add Jaggery to it and mix well. Add ghee and knead well. Cool and again knead it. Finally, make apple apple-sized shape and serve.

2.5 Processing of Makhana Flour Malpua

Ingredients such as Makhana flour, rice flour, cardamom powder, salt and ghee. Take a bowl and add Makhana flour, rice flour, cardamom powder, salt and ghee. Then mixed it thoroughly with some hot water and boiled milk. The mixed dough was then made into a round flat shape. Jaggery was crushed and made into syrup, and then filtered. The clear jaggery syrup was heated till it attained the correct consistency. Heat the oil in a pan and fry the round, flat-shaped dough, then put it in the jaggery syrup and add some cardamom powder for the flavour. Cool and serve.

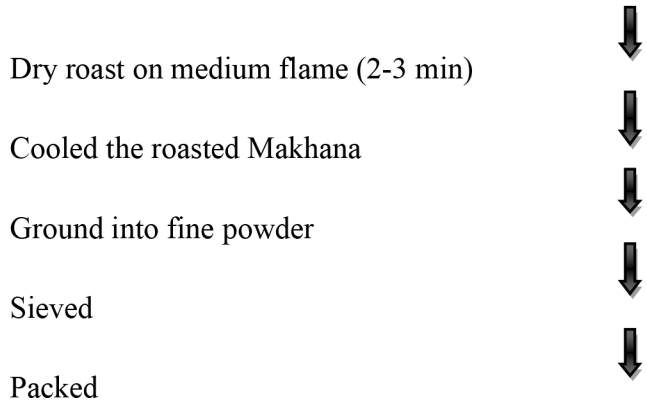


Figure 1. Preparation of Makhana flour.

2.6 Sensory Evaluation

The developed Makhana flour incorporated products were subjected to sensory evaluation using a nine-point Hedonic rating test. The evaluation was carried out with the help of 25 semi-trained.

The developed Makhana flour incorporated products were subjected to sensory evaluation using a nine-point Hedonic rating test. The evaluation was carried out with the help of 25 semi-trained people.

2.7 Physicochemical and Phytochemical Properties of Makhana Flour Incorporated Products

The physicochemical properties, bulk density, true density, and porosity of Makhana flour were analysed. The phytochemicals, such as carbohydrates, proteins, flavonoids, polyphenols and steroids, were qualitatively analysed in Makhana flour.

2.8 Nutrient Analysis

Nutritive value of Makhana flour incorporated recipes was analysed in terms of macronutrients and micronutrients

such as carbohydrate, energy, protein, fat, fibre, iron, potassium, calcium, and magnesium.

2.9 Shelf Life Analysis

The processed Makhana flour was stored in a glass container for 30 days. The microbial load was assessed on the 1st, 15th and 30th day of storage.

3. Results and Discussions

3.1 Yield of Makhana Flour

The yield of Makhana flour is obtained by calculating the percentage yield. The mass of Makhana was 100g, and the Mass of the Makhana flour was 78.2g. The percentage yield of Makhana flour was found to be 78.2%.

3.2 Nutrient Content of Makhana Flour Incorporated Recipes

The nutrient content of Makhana flour was analysed using a standard procedure, and the results are given in Table 1.

From Table 1, it is noted that 100g of Makhana flour contains 15.2 g of protein, 67.07 g, fat 0.37 g and energy, 332.41 Kcal, fibre 9.63 g, calcium 173 mg, iron content 18 mg and magnesium 213 mg. From Table 1, it is noted that the potassium content of Makhana flour was 1403 mg. The higher potassium content is due to the high amount of potassium present in Makhana flour. The content of protein and high potassium, magnesium and fibre content makes popped Makhana an extremely useful, ideal food for those suffering from heart diseases, high blood pressure, diabetes, kidney diseases and obesity.

Table 1. Nutrient content of Makhana flour

Nutrients	Result/100 g
Carbohydrate (g)	67.07 g
Energy (Kcal)	332.41 Kcal
Protein (g)	15.2 g
Fat (g)	0.37 g
Fibre (g)	9.63 g
Calcium (mg)	173.0 mg
Iron (mg)	18 mg
Magnesium (mg)	213.0 mg
Potassium (mg)	1403.0 mg

High magnesium content of Makhana keeps the arteries clean and regulates blood flow. Since Makhana is high in fibre, it also helps to avoid constipation. High content of calcium in Makhana is helpful in body pains and arthritis. An adult needs around 450 mg of magnesium, 1000 mg of calcium and 3000 mg of potassium intake a day[3].

3.2.1 Nutrient Value of Standard and Makhana Flour Incorporated Tacos

The nutrient content of standard and Makhana flour incorporated in tacos is given in Table 2.

From Table 2, it is noted that the protein content of standard tacos was found to be 18.6g. The protein content of Makhana flour incorporated into tacos was 26.2 g. The protein content of tacos increased due to the incorporation of Makhana flour, when compared to standard tacos. The calcium content of standard and Makhana flour incorporated tacos is 59.3 mg and 145.8 mg, respectively. Calcium content increased due to the incorporation of Makhana flour in tacos. The magnesium content of standard tacos was found to be 29.5 mg and due to the incorporation of Makhana flour in tacos. The magnesium content increased to 136mg. The potassium content of standard tacos was 134.8 mg, and the Makhana flour incorporated tacos were found to be 836.3 mg.

Due to the incorporation of Makhana flour in peda, carbohydrate (100.2 g), energy (589.9 Kcal), fibre (15.6 g), calcium (139.8 mg), and magnesium (272.5 mg) increased significantly. It showed a slight increase due to the addition of Makhana flour than the standard peda.

Due to the incorporation of Makhana flour in Malpua, carbohydrate (114.8 g), energy (577.5 Kcal), calcium (170.8 mg), and magnesium (111.8 mg) increased significantly. It showed a slight increase due to the addition of Makhana flour than the Standard Malpua.

The preliminary phytochemical screening was extended to identify the phytochemicals of Makhana flour by using aqueous extract. The results revealed that the phytochemical compounds, such as Carbohydrate, Protein and Flavonoids, were present phenols and steroids were absent in the aqueous extract of Makhana flour.

3.3 Physico-Chemical Parameters of Makhana Flour

The true density was 2.5±0, bulk density was 0.4±0, and porosity was 84±0 of Makhana flour.

Table 2. Nutritive value of standard and Makhana flour incorporated recipes

Nutrients	Standard tacos (145 g)	Makhana flour incorporated tacos (145 g)	Standard peda (110 g)	Makhana flour incorporated into peda (110 g)	Standard malpua (112 g)	Makhana flour incorporated malpua (112 g)
Carbohydrate (g)	78.4	111.7	66.6	100.2	81.2	114.8
Energy (Kcal)	432.2	598.4	423.7	589.9	411.3	577.5
Protein (g)	18.6	26.2	22.3	29.9	11.9	19.5
Fat (g)	7.2	7.4	6.6	6.8	2.7	2.9
Fibre (g)	3.35	8.16	10.8	15.6	13.7	18.5
Calcium (mg)	59.3	145.8	53.3	139.8	84.3	170.8
Iron (mg)	5.16	60.6	5.8	14.8	6.02	15.02
Magnesium (mg)	29.5	136.0	166	272.5	4.58	111.08
Potassium (mg)	134.8	836.3	967.3	1668.8	143.6	845.1

3.4 Mean Acceptability Scores for Organoleptic Parameters of Makhana Flour Incorporated Recipes

3.4.1 Mean Score for Organoleptic Parameters of Makhana Flour Incorporated Tacos

The mean scores for the acceptability of standard and Makhana flour incorporated tacos are given in Table 3.

From Table 3, it is noted that (A_1) Makhana flour incorporated Tacos received the highest scores for all the parameters, such as appearance, colour, flavour, taste, texture, and overall acceptability. Statistical analysis of the t value revealed that significant difference between standard and Makhana flour incorporated tacos.

3.4.2 Mean Score for Organoleptic Parameters of Makhana flour Incorporated Peda

The mean scores for the acceptability of standard and Makhana flour incorporated Peda are given in Table 4.

From Table 4, it is noted that (B_1) Makhana flour incorporated in peda has received the highest scores for all the parameters in terms of appearance, colour, flavour, texture and overall acceptability. Statistical analysis of the t value between Standard and Makhana flour incorporated peda showed a significant difference at the 5 per cent level.

3.4.3 Mean Score for Organoleptic Parameters of Makhana Flour Incorporated Malpua

The mean scores for the acceptability of standard and Makhana flour incorporated Malpua are given in Table 5.

From Table 5, it is noted that (C_1) Makhana flour incorporated Malpua received the highest scores for colour

Table 3. Mean acceptability score of Makhana flour tacos

Criteria	Mean±Standard deviation	
	Makhana flour incorporated into tacos	
	Standard	Tacos
Appearance	8.6 ± 0.56	8.72 ± 0.44
Colour	8.44 ± 0.57	8.56 ± 0.49
Flavour	8.4 ± 0.56	8.78 ± 0.44
Taste	8.6 ± 0.56	8.8 ± 0.4
Texture	8.28± 0.72	8.6 ± 0.48
Overall acceptability	8.44± 0.42	8.67 ± 0.29
Group compared		A_0 &A_1
't' value		*5.25

A_0 - Standard TacoS A_1 - Makhana flour TacoS * - Significant at 5% level

Table 4. Mean acceptability score of Makhana flour peda

Criteria	Mean±Standard deviation	
	Makhana flour incorporated Peda.	
	Standard	Peda
Appearance	8.48 ± 0.36	8.52 ± 0.33
Colour	8.28 ± 0.29	8.32 ± 0.30
Flavour	8.36 ± 0.30	8.32 ± 0.73
Taste	8.28 ± 0.15	8.28 ± 0.29
Texture	8.24 ± 0.29	8.32 ± 0.67
Overall acceptability	8.34 ± 0.40	8.36 ± 0.49
Group compared		$B_{0\,\&}B_1$
't' value		*2.44

B_0 - Standard Peda B_1 - Makhana flour Peda * - Significant at 5% level

and taste. Statistical analysis of t value for Standard and Makhana flour incorporated Malpua did not significant difference at the 5 per cent level.

3.4.4 Comparison of Mean Over all acceptability Scores of Standard and Makhana flour Incorporated Recipes

The comparison of mean overall acceptability scores of Standard and Makhana flour incorporated recipes is given in Table 6 and Figure 2.

Table 5. Mean acceptability score of Makhana flour malpua

Criteria	Mean±Standard deviation	
	Makhana seed flour is incorporated into Malpua.	
	Standard	Malpua
Appearance	8.16 ± 0.61	8.08 ± 0.79
Colour	7.92 ± 0.64	7.76 ± 0.64
Flavour	7.76 ± 0.76	7.25 ± 0.87
Taste	7.8 ± 0.69	7.96 ± 0.98
Texture	7.24 ± 0.99	7.2 ±0.89
Overall acceptability	7.77 ± 0.51	7.99 ± 0.64
Group compared		$C_{0\,\&}C_1$
't' value		1.204^{NS}

C_0 - Standard Malpua C_1 - Makhana flour Malpua NS - Not Significant at 5% level

From Table 6, it was observed that the Standard tacos received the highest mean overall acceptability score compared to peda and malpua. Among Makhana flour incorporated recipes, also tacos received the highest mean overall acceptability score, followed by peda (8.36 ± 0.49) and malpua (7.99 ± 0.64).

3.5 Shelf Life Analysis of Makhana Flour

The microbial count of Makhana flour was analysed on the 1st day, 15th day and 30th day and is presented in Table 7.

Table 6. Comparison of the mean over all acceptability scores of standard and Makhana flour incorporated recipes

Recipes	Standard	Makhana flour incorporated recipes
Tacos	8.44 ± 0.42	8.67 ± 0.29
Peda	8.34 ± 0.40	8.36 ± 0.49
Malpua	7.77 ± 0.51	7.99 ± 0.64

Table 7. Total microbial count of Makhana flour

Sample Name	Total Microbial Count		
	1st Day	15th Day	30th Day
Makhana flour	0 CFU/g	$3x10^3$ CFU/g	$6x10^5$ CFU/g

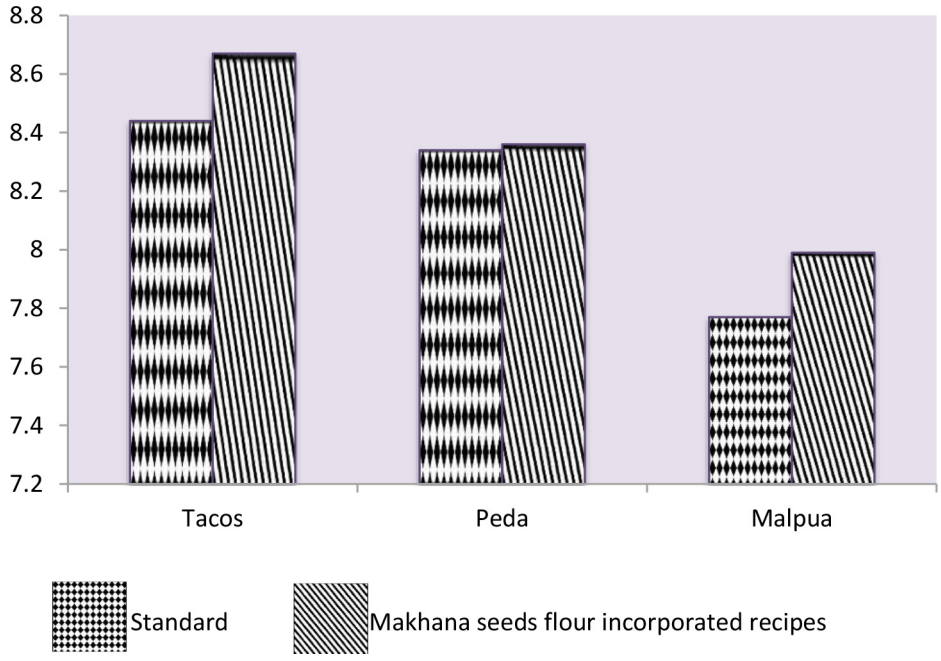


Figure 2. Comparison of the mean over all acceptability scores of standard and Makhana flour incorporated recipes.

From Table 7, it is noted that the Makhana flour stored in a glass container recorded a bacterial count of 0 CFU/g on the 1st day, $3x10^3$on the CFU/g 15th day and $6x10^5$ CFU/g on the 30th day of analysis, respectively.

4. Conclusion

Makhana flour contains a bioactive compound that has a lot of health benefits. However usage of Makhana is limited. Makhana can be processed into useful flour, and it can be incorporated into various useful recipes. Makhana flour was found to be rich in potassium, calcium and magnesium. The mean overall acceptability of standard and Makhana flour was highly acceptable when compared to peda and malpua. Therefore, Makhana flour incorporated tacos can be considered a healthier and tastier alternative to the standard tacos. The presence of phytochemicals in Makhana flour has wide therapeutic potential in human volunteers.

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