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Research paper

Evolution of Fiber-Rich Papad from Psyllium Husk: A Comparative Study

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KEYWORDS

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Papad
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Deep frying
Expansion
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Bajra flour

ABSTRACT

Papad is a familiarly known food adjunctly consumed as snack food extensively in India and in many other parts of Southern Asia, which is traditionally prepared using rice flour, contains a high amount of carbohydrates and lack of fiber, which can be a major root cause for several health diseases such as diabetes, cardiovascular diseases, obesity and gastrointestinal disorders. Therefore, the present study was undertaken to increase the fiber content with the incorporation of psyllium husk into the bajra flour at different concentrations (5g, 10g, 15g, 20g), further processed by using various methods such as soaking, grinding, drying and frying, which helps in reducing the anti-nutritional properties also help in preventing the microbial load through improving the organoleptic properties by assessing its sensory attributes. The results of sensory evaluation concluded that among all the variations PHP2 was most acceptable which was prepared by using 70g of bajra flour and 10g of Psyllium husk, further nutritional analysis revealed the moisture content (9.15g), protein content (9.95g), fat content (2.42g), fiber content (5.50g), total ash content (4.92g), carbohydrates (73.96g) and energy (356 kcal). Through the physical examination millet papad has less expansion ratio when compared to rice flour papad due to the gelatinization property which is comparatively high in cereals compared to millets. Therefore, papad supplemented with psyllium husk powder is nutrient-dense and cost-effective, the best alternative as a crispy snack on air frying, which helps to reduce CVD, diabetes, obesity and GI Issues.

1. Introduction

Food is the basic requirement of mankind. Humans have been inventing and reinventing naturally available

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edible products, to suit their desires and needs. India has been known for its rich cuisine from time immemorial, in India where cereals, pulses, millets and spices are richly used (Nixon, 2018).

Millets are plants, which can grow in short duration and require low amount of water for growth, even can tolerate heat and drought. They also easily adapt to degraded saline, acidic and aluminum-toxic soils (Anil, et al., 2021). Millet grains are a good source of macronutrients such as energy, protein and micronutrients such as vitamins and minerals including other trace elements. The edible component of millet kernel is a rich source of phytochemicals such as phytochemicals and polyphenols (Dayakar et al., 2017). Pearl millet (*Pennisetum typhoidenum* / Bajra) is largely grown in Rajasthan and contributes to over 80% of total bajra production in India. Its protein quality is comparable to wheat protein. Pearl millet is high in prolamine content followed by globulin and albumin. Essential amino acid composition showed that bajra contains a higher amount of tryptophan but a lower amount of lysine. Bajra contains iron (6.42mg/100g) and B complex vitamins such as thiamine (0.25mg/100g), riboflavin (0.20mg/100g), niacin (0.86mg/100g) and total fiber content is (11.49g/100g). Nutritional value can be improved by fermentation (Vineeta, 2023) it is classified into two categories based on their solubility dietary fiber is defined as the edible parts of the plant or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine, with complete or partial fermentation in the large intestine water insoluble such as cellulose, hemicellulose, lignin, and water soluble such as pectin, gums, and mucilage. Dietary fiber is present in vegetables, bran of cereals and pulses, fruits, legumes, and vegetables. It promotes beneficial physiological effects including laxation, lower cholesterol, blood sugar levels and prevents gastrointestinal disorders (Jonathan, et al., 2003). Psyllium husk is from Plantago ovata and belongs to the *Plantaginaceae* family, commonly known as psyllium in English and Isabgol in Hindi. It has been used in Asia and Europe since the 16th century as an herbal medicine for chronic constipation (Julia, et al., 2009).

A snack is a small portion of food generally consumed between meals. The term ‘snack foods' tends to indicate energy-dense, nutrient-poor foods usually containing sugar and saturated fats for example cakes, cookies, chips and other salty snacks and sugar-sweetened beverages. However, not all the foods consumed as snacks are nutrient-poor (Tas, et al., 2020). A food environment, dietary choices and eating behavior impact the food preference of the individual. Papad is a familiarly known food adjunctly consumed as snack food extensively in India and many other parts of Southern Asia (Parab, *et al*., 2012).

It is made from the finest quality cereals, legumes flour, mostly sun dried the papad can be roasted or fried according to individual preference. The study aimed to increase the fiber content with the incorporation of whole psyllium husk powder for the development of a novel snack product.

2. Materials

Raw materials used for the preparation of fiber-rich papad such as bajra, psyllium whole husk, black gram, rice, salt, cumin seeds and red chilli were procured from local suppliers in Bangalore. Bajra was used as the main ingredient, whereas black gram and psyllium husk exhibited binding properties, rice adds to the crispiness and cumin seeds and red chillies increase the flavour of the papad.

3. Method

Steps1: Soaking
Firstly, wash bajra and rice separately in water and soak bajra for 12 hours and the rice for 8 hours.

Step 2: Drying
After soaking drain the water completely and transfer them separately in dry cloth and sundry.

Step 3: Grinding
Grind bajra and rice separately in a mixer grinder to make a fine powder and store.

Step 4: Soaking
Soak black gram dal for 5-6 hours and make a paste out of it.

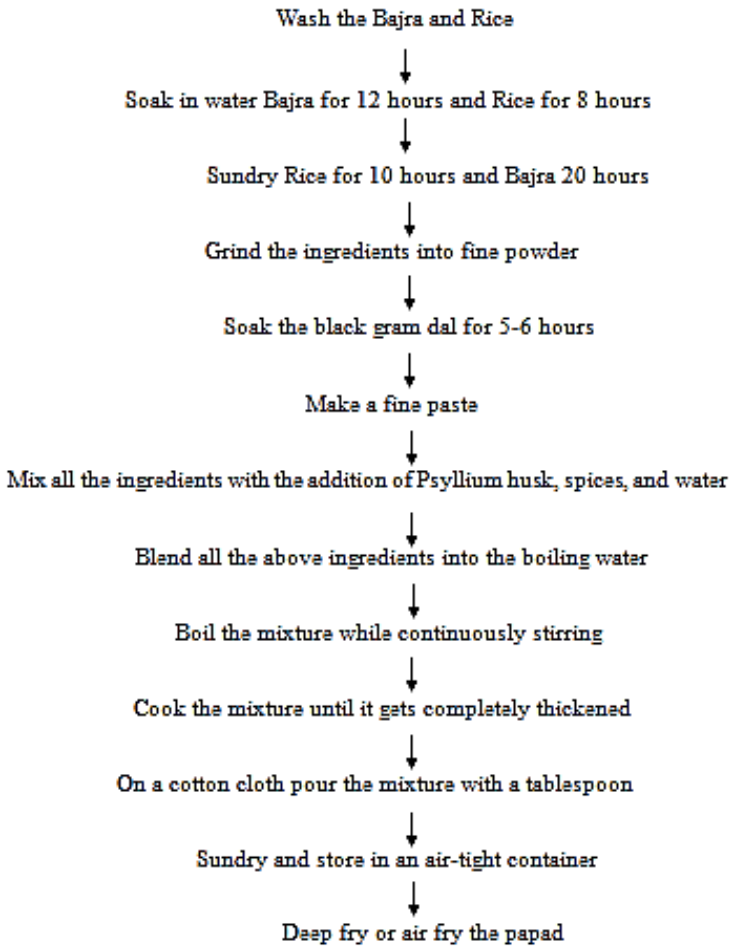
Step 5: Boiling
Add all the prepared ingredients along with psyllium husk, and spices as shown in table 1 and with the addition of water stir well to avoid the formation of lumps cook the mixture at a low flame until the raw taste is off, with thick consistency achieved.

Step 5: Drying
Once the mixture is cooked, pour the mixture in small quantities on dry, cotton cloth and sundry for 7 hours until the papad gets dried completely and stored in an air-tight container.

Table 1 Formulation of papads with the incorporation of psyllium husk

Ingredients	Control	PHP1*	PHP2*	PHP3*	PHP4*
Bajra Flour (g)	-	80	70	60	50
Rice flour (g)	100	5	5	5	5
Psyllium husk (g)	-	5	10	15	20
Black gram (g)	-	10	15	20	25
Red chillies flakes (g)	5	5	5	5	5
Cumin seeds (g)	1	1	1	1	1
Salt (g)	4	4	4	4	4
Water(ml)	As required	As required	As required	As required	As required

*PHP – Psyllium husk papad varying in Psyllium husk (5,10,15,20g)



Flow Chart 1 Standardization of papad with psyllium husk incorporation
[Kalange et al., (2020) *International Journal of Food Science and Nutrition*]

3.1 Sensory Evaluation

Sensory evaluation was done to find the acceptability of fiber-rich papad by using a nine-point hedonic scale and was evaluated by 30 semi-trained panelists at Padmashree Institute of Management and Sciences, various characteristics like appearance, colour, texture, taste, flavour, odour, and overall acceptability (Wichchukit et al., 2014).

3.2 Nutritional analysis

Nutritional composition of a developed product was analyzed such as moisture content (Indian Standards: 16072, 2012), protein content (Indian Standards: 7219, 1974), fat content (Indian Standards: 7874, 1976), crude fiber content (India Standards: 10226, 1982), total ash content (Indian Standards: 14433, 2008), carbohydrates (Indian Standards: 1656, 2009) and total energy.

3.3 Physical Analysis

Physical characteristics of papad were analyzed such as diameter (cm) and expansion percentage (Nitin, et al., 2014).

4. Results and Discussion

4.1 Standardization of Papad

An attempt was made to develop a nutrient-rich papad with bajra flour as an alternative to rice flour, to increase the fiber content with the incorporation of psyllium husk at different proportions such as 5g, 10g, 15g, and 20g. The lump formation and water consumption gradually increase during the preparation of the papad with an increase in the ratio of the psyllium husk, which in turn increases cooking time to get rid of the raw taste of the mixture. Even the study conducted by (Khaliq, et al., 2015) incorporated psyllium husk has various roles such as thickening and binding properties in the food industry.

4.2 Soaking

Soaking the millet reduces anti-nutrients such as phytic acid. Phytic acid can bind to minerals, making them less available for absorption, hence the soaking process can improve the bioavailability of essential minerals and also helps in breaking down their complex structure, making them easier to digest and improving nutrient availability (Neha, et al., 2015) conducted a similar study related to effects of different soaking conditions on inhibitory factors and bioaccessibility of minerals.

Soaking dal decreases the tannin content which inhibits the absorption of minerals and also reduces the number of oligosaccharides that cause gas formation (Shah et al., 2011) studied the effects of soaking and cooking on black gram.

4.3 Drying

The drying process helps in increasing the shelf life of products by decreasing moisture content (Mahesh, et al., 2013) conducted a similar study related to the effects of greenhouse drying on papad.

4.4 Grinding

Grinding is a method of food processing the big larger food particles are broken down into smaller particles through mechanical action which in turn improves protein and starch digestibility (Tongshuai, et al., 2022) conducted a similar study related to the effect of processing methods.

4.5 Cooking

Cooking is the process that makes food soft and tender with increases the food's palatability of the food (Dr. Luxita et al., 2020) reported that papads developed with semolina and chia seeds during various cooking processes would improve the texture and make it more palatable.

Fig. 1 Various frying methods of deep-fried and air-fried papads

4.6 Sensory Evaluation

The sensory evaluation of different proportions of papad is shown in Table 2. Among the four variations, the PHP2 sample was overall acceptable on deep frying (8.2) and air frying (8.1). The texture of the deep-fried papad (8.11) was comparatively better than air frying (8.15). The taste and appearance of deep-fried papad were better when compared to that of air-fried papad because cooking the food in oil increases palatability, but air-fried papad makes it more nutritious.

Table 2 Interpretation of sensory evaluation scores

Sensory Attributes	Control		PHP1*		PHP2*		PHP3*		PHP4*	
Method of frying	**A.F**	**D.F**	**A.F**	**D.F**	**A.F**	**D.F**	**A.F**	**D.F**	**A.F**	**D.F**
Appearance	8.2	8.6	7.95	8.06	8	8.1	8.13	8.16	8.11	8.08
Colour	8.05	8.68	7.9	8.13	7.93	8.2	8.01	8.13	8	8.28
Odour	7.8	8.55	7.2	7.53	7.46	7.6	7.75	7.76	7.6	7.8
Taste	8.26	8.65	7.11	7.61	7.78	8.05	7.95	8.3	8	7.95
Texture	8.06	8.71	7.91	8.03	8.15	8.11	8.05	8.28	7.9	8.03
Overall Acceptability	8.25	8.71	7.51	7.91	8.1	8.2	8.08	8.2	7.8	8.11

*** PHP-**Psyllium husk papad, **A.F-** Air frying **D.F-** Deep frying

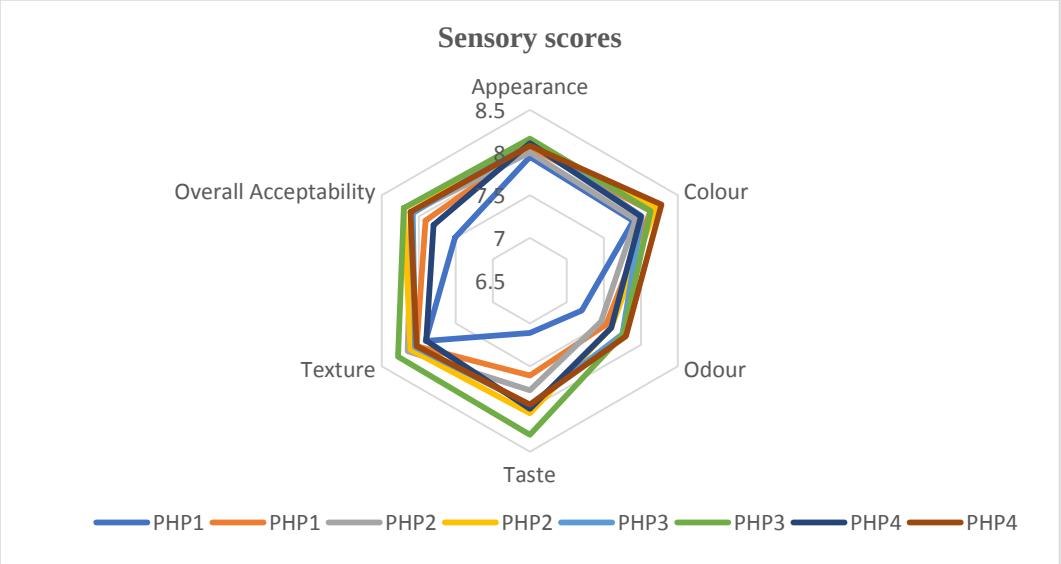


Fig. 2 Sensory evaluation of different papads developed from psyllium husk

4.7 Physio-chemical Properties

4.7.1 Weight

The weight of the papad comparatively increased after deep frying (15g) whereas, before frying the weight of the sample was (11g) this can be due to the absorption of the oil. There was no significant change in weight on air frying the papad.

Table 3 Weight of papads

Samples	Before		After	
Method of frying	**Air fried (g)**	**Deep fried (g)**	**Air fried (g)**	**Deep fried (g)**
Control	8±0.25	10±0	9.5±0.15	11.5±0.47
PHP2	14±0.69	11±0.3	13±0.48	15±0.52

***PHP-**Psyllium husk papad, **A.F-** Air frying **D.F-** Deep frying

4.7.2 Diameter

The diameter with the length and width of each papad was measured. A sample was taken and measured as shown in table 4, the diameter of deep-fried papad is high compared to air-fried papads. The percentage of expansion ratio is calculated by using the formula given by (Nitin et al., 2014). The expansion ratio of PHP2 was high in deep-fried papad (35.24) compared to air-fried papad (7.20) because the gelatinization process is high

in cereals compared to millets which can be due to the expansion of the starch granules having low amylose content (AC) (Ting, et al., 2012) and as per (Akshatha, et al., 2019) millet papad had diameter (9.5) after deep frying.

Table 4 Physical parameters of papad

Samples	Diameter in cm		Diameter in cm		Expansion ratio %	
Method of frying	Before AF	After AF	Before DF	After DF	Air fried	Deep fried
Control (g)	11.23	13.77	10.20	14.57	22.61	42.84
PHP2 (g)	25.12	26.93	20.71	28.01	7.20	35.24

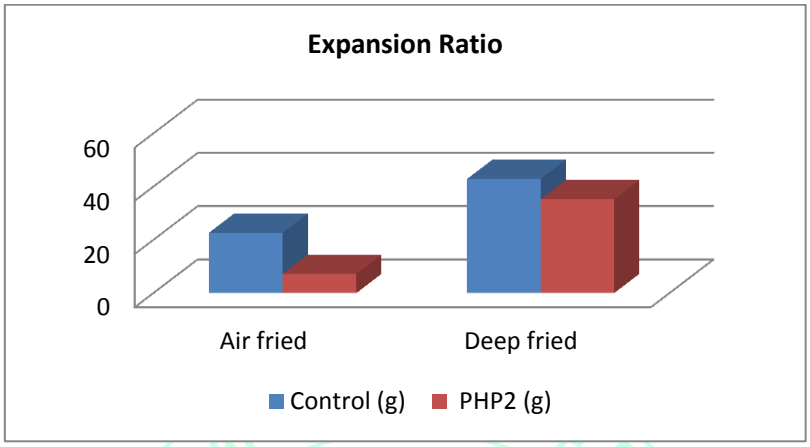


Fig. 3 Variation in expansion ratio of fried papads

4.8 Nutritional Composition

The nutritional composition of developed papad with psyllium husk (10g) enhanced the nutritive quality of the product wherein protein (9.95g), fiber (5.50g), fat (2.42g), carbohydrates (73.96g) and total ash content (4.92g) which was comparatively better than the control papad, as depicted in Table no 5. The reduction in energy value might be due to the increase in fiber content, indirectly reducing the total digestible carbohydrate content. It has been reported that protein contents were increased in papad due to the replacement of rice flour with Bajra flour and supplemented with Psyllium husk (Michaella et al., 2024) conducted a similar study with the incorporation of psyllium husk to enhance the nutritional value of the processed food product.

Table 5 Proximate composition of Papads

Nutrient	Control *	PHP 2
Moisture (g)	12.08	9.15
Protein (g)	6.24	9.95
Fat (g)	1.29	2.42
Crude Fiber (g)	2.25	5.50
Total ash (g)	0.39	4.92
Carbohydrates (g)	79.25	73.96
Energy (kcal)	366	356.00

*Srikari et al., (2023) *IP Journal of Nutrition Metabolism and Health Science*

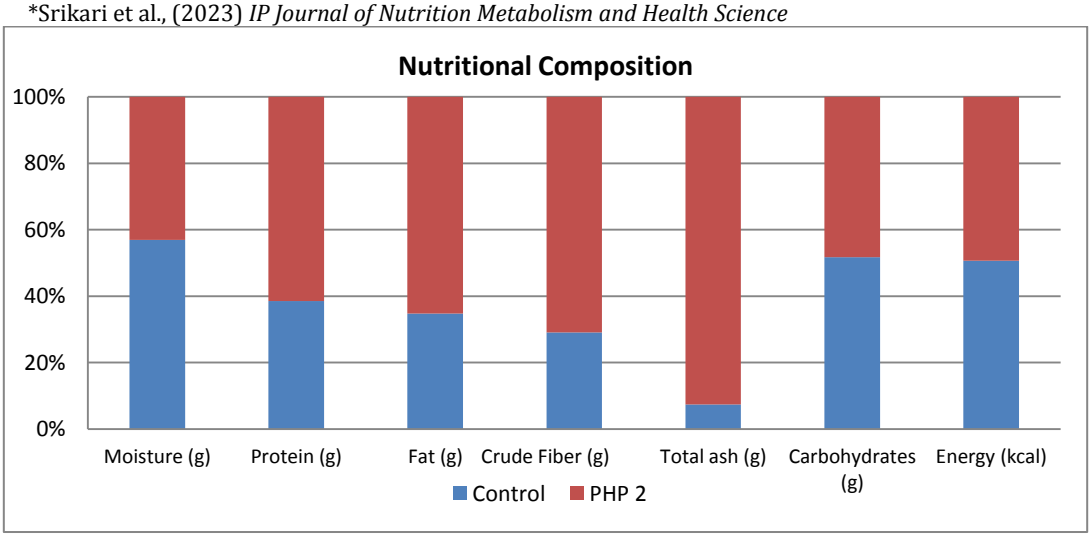


Fig. 4 Nutrient composition of papads

5. Conclusion

Papad is a traditional snack, it is liked by everyone irrespective of their age as it is crunchy and spicy. Generally, it is prepared with rice or urad dal. Since rice is a simple sugar, high glycaemic food and low in other micronutrients it can elevate the blood sugar levels and cholesterol level on deep frying. Hence an attempt was made to develop papad using bajra and psyllium husk through an air fryer. Bajra is gluten-free and rich in antioxidants, fiber and minerals whereas psyllium husk is rich in fiber, so it can be the best alternative for rice or urad dal. In our study partial replacement of rice flour with 70g of Bajra and 10g of Psyllium husk was most acceptable with having the nutritional composition of fiber (5.50g), protein (9.95g), fat (2.42g) and total ash (4.92g).

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Declaration of Conflict

We here by declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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