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Enhancing Nutritional And Functional Properties Of Pasta Using Roasted Little Millet And Soaked Soybean Flours

Aishwarya E. Mujmule[1], Dr. Surendra K. Sadawarte[2], Dr. Girish M. Machewad[3], Shital P. Chavanke[4]

[1*] M. Tech Research Scholar, Department of Food Process Technology,
College of Food Technology
Vasantrao Naik Marathwada Krishi Vidyapeeth
Parbhani (431402), Maharashtra, India.

[2] Associate Professor, Department of Food Process Technology
College of Food Technology,
Vasantrao Naik Marathwada Krishi Vidyapeeth
Parbhani (431402), Maharashtra, India.

[3] Associate Professor, Department of Food Microbiology and Safety
College of Food Technology,
Vasantrao Naik Marathwada Krishi Vidyapeeth
Parbhani (431402), Maharashtra, India.

[4] M. Tech Research Scholar, Department of Food Process Technology,
College of Food Technology
Vasantrao Naik Marathwada Krishi Vidyapeeth
Parbhani (431402), Maharashtra, India.

Abstract

This study investigates the functional properties, nutritional composition, and antinutritional factors of pasta formulated with whole wheat flour, roasted little millet flour, and soaked soybean flour. The functional properties, including water and oil absorption capacities and solubility index, were analyzed for wheat, little millet, and soybean flours. The processing treatments, such as roasting for little millet and soaking for soybean, improved nutrient bioavailability by reducing antinutritional factors like tannins and phytic acid. Nutritional analysis revealed that roasting little millet enhanced its carbohydrate and fat content while soaking soybean increased protein digestibility. The pasta formulations were prepared in varying proportions using an extruder, and the results demonstrate that these treatments enhance the nutritional and functional qualities of the final product, making it a potential option for nutritionally enriched and functional food applications.

Keywords: Whole wheat flour, Little Millet, Soybean, Pasta, Functional food.

1. Introduction

Millets are economically significant cereals, alongside wheat, rice, maize, and oats. They are particularly valuable in semi-arid and tropical regions of Asia and Africa due to their resilience against pests and diseases, short growth cycles, and ability to thrive in less fertile soils under conditions of heat and drought. These crops are seen as essential for food security because of their sustainability in harsh agro-climatic conditions. Recently, attention has increased towards their nutraceutical benefits, as they are rich in dietary fiber, and phytochemicals, and have a low glycemic index (Mannuramath and Yenagi, 2015).

Soybean is often incorporated to enhance the nutritional value of foods, as it is a functional food high in protein (38%–40%), fat (18%–20%), and lysine (5%–6%), making it ideal for addressing protein-calorie malnutrition (Dhingra & Jood, 2001). Additionally, it is a good source of complex carbohydrates, soluble fiber, micronutrients, minerals (Zhao et al., 2022), and phytoestrogens like isoflavones, which are bioactive compounds thought to help protect against cardiovascular disease (Hariri et al., 2021; Kim et al., 2022).

Recently, unripe plantain flour has been used as an alternative to blend with other common flours (such as wheat, maize, and rice) or protein-rich ingredients for making bread (Juarez-Garcia et al., 2006), pasta (Patiño-Rodríguez et al., 2019), and snacks (Flores-Silva et al., 2017). According to (Patiño-Rodríguez et al. 2019), unripe plantain flour minimally affects the sensory qualities of flour blends, leading to good consumer acceptance of such products.

Flour serves as a fundamental ingredient, and its quality should be suitable for the intended product. Incorporating significant amounts of sorghum or millet flour in wheat-based or wheat-free doughs has been successful in producing cereal products that don't require strict gluten standards, such as biscuits, cookies, pasta, and cakes. However, the absence of gluten proteins, which contribute to dough's viscoelasticity and fermentation, has limited the complete replacement of wheat flour with millet flours in fermented bread. Nonetheless, millet's positive nutritional and health benefits remain substantial. The cooking and eating qualities of food products are influenced by the flour's gelatinization, rheological, functional, and color properties (Shreeja K. 2021).

Various pretreatments like dehulling, dry heating, soaking, germination, fermentation, hydrothermal processes, irradiation, and extrusion can be applied before milling. Each of these treatments affects the grain and flour quality differently. Understanding these effects allows the food industry to select the best flour for specific applications. Several studies have investigated the impact of these treatments on flour properties. For example, when pearl millet grains underwent dry heating, they significantly reduced fat acidity, acid value, and free fatty acid content during storage, resulting in improved flour quality without negatively affecting acceptability (Kadlag et al., 1995).

2. Materials and method:

This research was conducted in the Department of Food Process Technology in collaboration with the Departments of Food Chemistry and Nutrition, Food Microbiology and Safety, and Food Engineering at the College of Food Technology, VNMKV, Parbhani, during the 2022-2023 academic years.

2.1 Materials:

The raw materials, including whole wheat flour, little millet flour, soybean flour, guar gum, and psyllium husk, were sourced from the local market in Parbhani.

2.2 Formulation preparation:

The pasta was produced in the laboratory using whole wheat flour, roasted little millet flour, and soaked soybean flour in various proportions. The ratios used were (100:0:0:0) for T0, (50:10:40) for T1, (50:20:30) for T2, (50:30:20) for T3, and (50:40:10) for T4. For each 100g sample, 2g of salt, 0.5% psyllium husk, 0.2% guar gum, and 38 ml of water were added. The different formulations were processed into pasta using an extruder (Model 16009, Kent Noodle and Pasta Maker). After extrusion, the pasta was dried in a cabinet tray dryer at 60°C for 2-3 hours.

2.3 Methodology for preparation of pasta

Combination of Flour

(whole wheat flour, little millet flour, soybean flour, guar gum and psyllium husk)

↓

Mixing of ingredients in extruder with water

↓

Kneading

↓

Extrusion (Automatic single screw)

↓

Drying (at 50° C for 2 hr.)

↓

Dried pasta

↓

Packaging in HDPE

Fig 1: Flow Chart for Preparation of Pasta

Ingredients	Quantity (g)				
	T_0	T_1	T_2	T_3	T_4
Whole wheat flour	100	50	50	**50**	50
Little millet flour	0	10	20	**30**	40
Soybean flour	0	40	30	**20**	10
Guar gum	0.2	0.2	0.2	**0.2**	0.2
Psyllium husk	0.5	0.5	0.5	**0.5**	0.5
Salt	2	2	2	**2**	2
Water	38ml	38ml	38ml	**38ml**	38ml

Table 1: Formulation of pasta incorporated with different flour

Control = 100 g wheat flour and 2 g salt

T1 = 50 g whole wheat flour, 10g Little millet flour, 40g Soybean flour

T2 = 50 g whole wheat flour, 20g Little millet flour, 30g Soybean flour

T3 = 50 g whole wheat flour, 30g Little millet flour, 20g Soybean flour

T4 = 50 g whole wheat flour, 40g Little millet flour, 10g Soybean flour

2.4 Functional Properties of wheat millet and legume flour

The water absorption capacity (WAC) of the pasta was measured using the A.A.C.C. method (1990). The oil absorption capacity (OAC) of pasta with added millet flour was assessed following the method described by Kinsella and Melachouris (1976). The solubility index (SI) was determined using a modified version of the method by Iwuoha (2004).

2.5 Effect of processing treatment on nutritional composition of little millet and soybean flour

The impact of processing treatments on the nutritional composition of little millet flour (raw and roasted) and soybean flour (raw and soaked) was evaluated. Little millet was roasted at 110°C for 10 minutes, while soybeans were soaked for 12 hours.

2.6 Effect on antinutritional factors of little millet flour (raw and roasted) and soybean flour (raw and soaked)

The tannin content in each sample was estimated by the method given by Makkar et al. (1993). The phytic acid content of the sample was estimated by the method given by Wheeler and Ferrel (1971).

3. Result and Discussion

3.1 Functional properties of flour

The functional properties of wheat, little millet, and soybean flours are presented in Table 1. In terms of water absorption capacity, wheat, little millet, and soybean flours demonstrated values of approximately 8.90 g, 8.70 g, and 6.30 g, respectively. Wheat flour showed the highest water absorption, closely followed by little millet flour, while soybean flour exhibited the lowest. Oil absorption capacities for wheat, little millet, and soybean flours were recorded at 85.20 g, 82.36 g, and 81.30 g, respectively. Soybean flour had the highest solubility index (6.80 g), followed by little millet flour (5.70 g) and wheat flour (3.25 g). These functional characteristics are consistent with the results reported by Thilagavathi et al. (2015).

Table 2: Functional properties of flour

Parameters	Wheat flour	Little millet flour	Soybean flour
Water absorption capacity (%)	8.90	8.70	6.30
Oil absorption capacity (%)	85.20	82.36	81.30
Solubility Index (g)	3.25	5.70	6.80

3.2 Effect of processing treatment on nutritional composition of little millet and soybean flour

The table presents the composition of roasted little millet flour and soaked soybean flour, both key ingredients for creating nutritionally enriched products. Roasted little millet flour consists of 7.20% moisture, 11.10% protein, 74.83% carbohydrates, 0.63% crude fiber, 4.90% fat, and 1.36% ash. These values indicate that roasting increases carbohydrate and fat content while lowering moisture, resulting in a more stable and energy-rich product.

In contrast, soaked soybean flour contains 8.8% moisture, 42.10% protein, 23.20% carbohydrates, 5.05% crude fiber, 16.05% fat, and 5.0% ash. Soaking improves its digestibility and enhances nutrient bioavailability. With its high protein content and balanced fat profile, soaked soybean flour complements roasted little millet in formulations, making their combination ideal for developing healthier food products. These treatments contribute to producing functional and sensory-appealing items like pasta.

Table 3: Effect of processing treatment on nutritional composition of little millet and soybean flour

Parameters (%)	Little millet flour		Soybean flour	
	Raw	**Roasted**	**Raw**	**Soaked**
Moisture	8.71	7.20	7.20	8.8
Protein	12.30	11.10	43.10	42.10
Carbohydrate	72.6	74.83	20.80	23.20
Crude fiber	0.61	0.63	5.9	5.05
Fat	4.6	4.90	17.8	16.05
Ash	1.20	1.36	5.2	5.0

3.3 Effect on antinutritional factors of little millet flour (raw and roasted) and soybean flour (raw and soaked)

The table effect of processing on the antinutritional factors in little millet and soybean flours. Roasting little millet flour lowers tannin content from 0.44 mg/100g (raw) to 0.32 mg/100g, and phytic acid from 22.1 mg/100g to 19.5 mg/100g. These reductions are beneficial because tannins and phytic acid can interfere with the absorption of nutrients, especially minerals like iron and zinc. By enhancing digestibility and nutrient bioavailability, roasting improves little millet's suitability for human consumption.

For soybean flour, soaking reduces tannin content from 480 mg/100g (raw) to 365 mg/100g, and phytic acid from 13.85 mg/100g to 11.49 mg/100g. This process effectively lowers these anti-nutritional compounds, enhancing the bioavailability of proteins and essential minerals in soybeans. Both treatments roasting for little millet and soaking for soybean are beneficial for producing more nutritionally robust and functional food products.

Table 4: Effect on antinutritional factors of little millet flour (raw and roasted) and soybean flour (raw and soaked

Parameters (mg/100g)	**Little Millet flour**		**Soybean flour**	
	Raw	**Roasted**	**Raw**	**Soaked**
Tannin	0.44	0.32	480	365
Phytic acid	22.1	19.5	13.85	11.49

4. Conclusion :

This research highlights the advantages of incorporating roasted little millet flour and soaked soybean flour into pasta formulations to improve nutritional value. Roasting reduced tannin and phytic acid content in little millet, while increasing carbohydrate and fat levels, making it a more energy-dense and stable ingredient. Soaking soybean flour significantly lowered antinutritional factors, enhancing protein bioavailability and digestibility. These treatments improve the functional properties of both flours, evidenced by favorable water and oil absorption capacities and solubility indices, which are essential for food product quality. Pasta formulations prepared using a combination of whole wheat, little millet, and soybean flours, exhibited enhanced nutritional profiles and are suitable for producing health-focused, functional food products. The study confirms the effectiveness of specific pretreatments in improving the sensory and nutritional characteristics of flour-based products, providing a foundation for future food innovations targeting health-conscious consumers.

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6.Competing interests

The authors declare that there is no competing of interest regarding the publication of this research paper.

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