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Aishwarya E Mujmule
M.Tech Research Scholar,
Department of Food Process
Technology, College of Food
Technology Vasantrao Naik
Marathwada Krishi
Vidyapeeth Parbhani,
Maharashtra, India

Dr. Surendra K Sadawarte
Associate Professor,
Department of Food Process
Technology, College of Food
Technology, Vasantrao Naik
Marathwada Krishi
Vidyapeeth, Parbhani,
Maharashtra, India

Dr. Anuprita A Joshi
Assistant Professor,
Department of Food Process
Technology, College of Food
Technology, Vasantrao Naik
Marathwada Krishi
Vidyapeeth, Parbhani,
Maharashtra, India

Shital P Chavanke
M.Tech Research Scholar,
Department of Food Process
Technology, College of Food
Technology, Vasantrao Naik
Marathwada Krishi
Vidyapeeth, Parbhani,
Maharashtra, India

Corresponding Author:
Aishwarya E Mujmule
M.Tech Research Scholar,
Department of Food Process
Technology, College of Food
Technology Vasantrao Naik
Marathwada Krishi
Vidyapeeth Parbhani,
Maharashtra, India

Development and nutritional properties of whole wheat, little millet and soybean based pasta

Aishwarya E Mujmule, Dr. Surendra K Sadawarte, Dr. Anuprita A Joshi and Shital P Chavanke

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Abstract

Extruded products are widely recognized as conventional foods globally, valued for their convenience, versatility, and ease of preparation. This research focused on developing an extruded product using the extrusion process with varying proportions of whole wheat flour, little millet flour, and soybean flour. The formulations used were 100:0:0 (T₀), 50:10:40 (T₁), 50:20:30 (T₂), 50:30:20 (T₃), and 50:40:10 (T₄). The resulting products were analyzed for their physicochemical properties, cooking quality, functional characteristics, and sensory acceptability. The proximate analysis highlighted the presence of proteins, minerals, dietary fiber, and a significant amount of fat, indicating superior nutritional content compared to standard pasta.

Keywords: Wheat, little millet, soybean, extrusion, extruded product, pasta

1. Introduction

People's dietary choices are changing along with their lives. Due to the hectic nature of modern life, people tend to search for quick and simple recipes. Extruded snacks, Pasta, spaghetti, noodles, baked goods, and ready-to-cook mixes are just a few of the many culinary products available on the market. made up of grains such as wheat, rice, etc. Teens and children love pasta, spaghetti, noodles, and vermicelli. When more people become aware of the health benefits of millet, there is an increasing demand for goods with additional value.

Wheat pasta is the most commonly available pasta all over the world. Wheat is the most commonly consumed grain in the world. Climate and soil are the two major factors that always tend to change the nutritional composition of wheat. Wheat contains about 12.1% water, 70.2% carbohydrate, 11.9% protein, 2% fat, 1.8% minerals and 2% crude fibers. Thiamine, niacin and riboflavin are the nutrients that are lost during the processing of wheat grains from germ and bran (Shewry *et al.*, 2009) ^[13].

Little Millet is a good source of protein (7.7 g/100 g), very rich in carbohydrates (67 g/ 100 g), fat (4.76 g/ 100 g), minerals, vitamins should be considered an essential food for nutritional security Nirmalakumari *et al.* (2010) ^[11]. Little millet has fat (4.7 g), crude fiber (7.7 g), iron (9.3 mg), and phosphorus (220 mg) per 100 g which is comparable to cereals and other millets (Gopalan *et al.*, 1989) ^[4] dietary fiber content of little millet is the contributing factor for its low glycemic index and a recent study conducted on little millet indicated that it exhibits hypoglycemic effect due to its higher proportion of dietary fiber (Itagi *et al.*, 2013) ^[7].

Numerous vitamins and minerals, including zinc, phosphorus, potassium, calcium, iron, vitamin B, and vitamins A, C, and E, are found in soybean grain. Although some studies have found that pasta with as little as 15% to 20% soybean flour tastes far worse than the control pasta, making pasta by combining soy flour with wheat flour is still advantageous for health reasons. It has been claimed that several soybean constituents, including genistein, isoflavones, sterols, saponins, and phytic acid, have anti-cancer activities against breast, colon, and prostate cancers (Raza, 2022) ^[12].

2. Materials and Methods

This study was conducted in the Department of Food Process Technology in collaboration with the Department of Food Chemistry and Nutrition, the Department of Food

Microbiology and Safety, and the Department of 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 prepared in the laboratory using whole wheat flour, roasted little millet flour 110 °C for 10 min, and soybean flour from soaked beans for 12 hr. in varying proportions: (100:0:0) for (T₀), (50:10:40) for (T₁), (50:20:30) for (T₂), (50:30:20) for (T₃), and (50:40:10) for (T₄). These formulations were made with the addition of 2 g of salt, 0.5% psyllium husk, 0.2% guar gum, and 38 ml of water per 100 g of the mixture. The pasta dough was processed using an extruder (Model no. 16009, Kent Noodle and Pasta Maker), producing pasta strands with a thickness of 2.0 mm. The pasta was then dried in a cabinet tray dryer at 60 °C for 2-3 hours.

2.3 Methodology for preparation of pasta

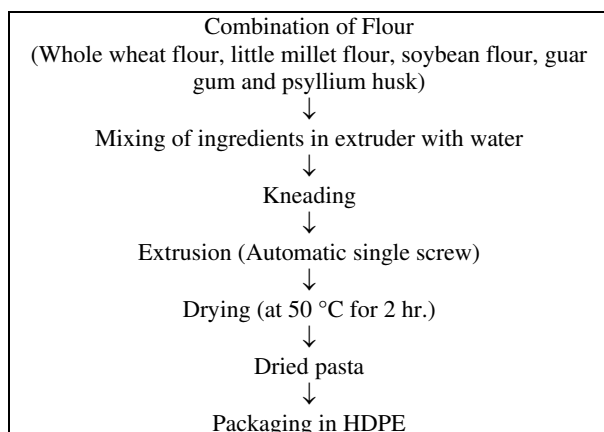


Fig 1: Flow Chart for Preparation of Pasta

Table 1: Formulation of pasta incorporated with different flour

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

Control = 100 g Whole wheat flour

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

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

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

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

2.4 Sensory evaluation of pasta

The sensory attributes of the millet and legume-based pasta, including color, appearance, taste, flavor, and overall acceptability, were compared to the control sample. This

evaluation was performed by a panel of 10 semi-trained members, all of whom were academic staff from the College of Food Technology, Parbhani. The assessment used a 9-point hedonic scale, where panelists rated the products based on their level of liking, ranging from 9 ("like extremely") to 1 ("dislike extremely") following the methodology described by (Weaver and Daniel 2003; Harish Nayaka *et al.*, 2015) [16, 5].

2.5 Proximate composition of pasta

The pasta made from millet and legumes was analyzed for its proximate composition using standard methods. Moisture content was measured by the hot air oven method (AOAC, 2000) [3], while protein content was determined using a Micro Kjeldahl apparatus. Crude fat was assessed through the Soxhlet method as per (AACC, 2000) [3], and crude fiber was also evaluated using the (AACC, 2000) [3] method. The ash content of the samples was estimated using the muffle furnace combustion method (AOAC, 2000) [3]. Minerals such as calcium, iron, zinc, and phosphorus were determined through titration and the spectrophotometric method (AOAC, 1990) [2].

2.6 Phytochemical analysis of pasta

The total phenolic content (TPC) was estimated using the Folin-Ciocalteu reagent, with absorbance measured at 750 nm in a spectrophotometer, following the method outlined by (Singleton *et al.*, 1999) [14]. The total flavonoid content (TFC) was determined using a colorimetric assay, with absorbance measured at 510 nm, as described by (Zhishen *et al.*, 1999) [17].

3. Result and Discussion

3.1 Sensory evaluation of pasta

Table 2: Sensory evaluations of pasta

Sample	Sensory				
	Color	Flavor	Taste	Texture	Overall acceptability
Control	8.1	8.2	8.2	8.2	8.1
T ₁	8.1	8.3	6.5	8.3	8.2
T ₂	7.6	7.3	7.2	7.4	7.6
T ₃	8.6	8.7	8.8	8.6	8.6
T ₄	7.5	7.7	7.8	7.7	7.7
SE	0.058	0.047	0.072	0.053	0.043
CD at 5%	0.175	0.142	0.217	0.159	0.132

Using a 9-point hedonic scale, panel members who were trained and semi-trained evaluated the prepared pasta sensory. The data presented in Table showed that the formulation of (T₃) got the highest score for taste (8.8), flavor (8.7), color (8.6), and texture (8.6). Sample (T₃) received the highest overall acceptability score of 8.6 while sample (T₄) had the lowest score of 7.7. it was selected for further studies.

3.2 Proximate composition of pasta

Table 3: Proximate compositions of pasta

Parameters (%)	Control (T ₀)	Selected Sample (T ₃)
Moisture	9.70±0.2	8.47±0.01
Protein	10.73±0.75	18.29±0.63
Fat	1.15±0.05	6.23±0.98
Ash	1.50±0.35	2.0±0.60
Carbohydrate	75.44±0.90	61.84±0.70
Crude fibre	1.48±0.02	3.33±0.10

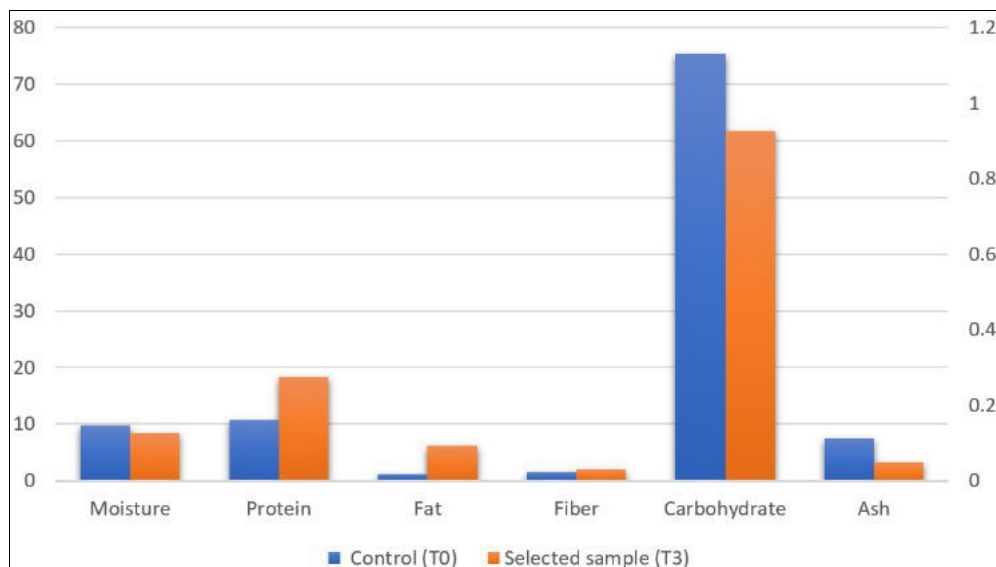


Fig 2: Chemical composition of prepared pasta

The table compares the proximate composition of the control sample (T₀) with the selected sample (T₃). Moisture content decreased from 9.70% in (T₀) to 8.20% in (T₃), indicating lower water content. Protein levels significantly increased from 10.73% in (T₀) to 15.35% in (T₃), enhancing the nutritional value of the selected sample. Fat content also rose notably, from 1.15% in the control (T₀) to 2.50% in (T₃). The ash content, which reflects mineral levels, increased from 1.50% in (T₀) to 2.7% in (T₃). In contrast, carbohydrate content decreased from 75.44% in (T₀) to 65.25% in (T₃). Additionally, crude fiber content improved from 1.48% in the control sample to 3.33% in the selected sample (T₃), indicating a boost in dietary fiber.

3.3 Phytochemical composition of pasta

Table 4: Phytochemical composition of pasta

Parameter	Control (T ₀)	Selected (T ₃)
TPC (GAE mg /100 g)	1.72±0.04	2.17±0.02
TFC (QE mg /100 g)	2.46±0.15	2.50±0.4

The table presents a comparison of the Total Phenolic Content (TPC) and Total Flavonoid Content (TFC) between the control sample and the selected sample (T₃). The TPC, expressed as gallic acid equivalents (GAE) per 100 g, showed an increase from 1.72 mg GAE/100 g in the control to 2.17 mg GAE/100 g in the selected sample, indicating a higher phenolic content in (T₃). The TFC, expressed as quercetin equivalents (QE) per 100 g, exhibited a slight increase from 2.46 mg QE/100 g in the control to 2.50 mg QE/100 g in the selected sample, suggesting a marginal enhancement in flavonoid content in (T₃). Flavonoids, which are powerful antioxidants with anti-mutagenic and anti-carcinogenic qualities, are among the polyphenolic substances found in plants, according to (Middleton and Kandaswami, 1994) [10].

4. Conclusion

This study demonstrated the successful development of pasta enriched with whole wheat, little millet, and soybean flour. The results revealed that the incorporation of little millet and soybean flour not only enhanced the nutritional and functional properties of the pasta but also improved its

sensory appeal. Among the formulations, (T₃) (50% wheat, 30% little millet, and 20% soybean flour) exhibited the best overall acceptability, with superior taste, flavor, and texture compared to the control and other formulations. Proximate analysis of (T₃) showed a significant increase in protein, fat, and fiber content while reducing carbohydrate levels, making it a healthier alternative to conventional wheat pasta.

Additionally, phytochemical analysis indicated an improvement in total phenolic and flavonoid content, which suggests enhanced antioxidant properties. The findings highlight the potential of using millet and legume flours to produce nutritionally enhanced pasta with desirable sensory qualities. This pasta formulation can serve as a healthier option, particularly for consumers seeking nutrient-dense, fiber-rich, and protein-fortified products. Further studies on large-scale production and consumer preferences can provide insights into its commercialization.

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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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