Development of Ready-to-Eat (RTE) Extruded Snack Products with Multigrain Flour and Potato Peel Powder

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Abstract:
The increasing awareness of sustainable practices and functional foods has prompted innovations in snack production. This study investigates the development of ready-to-eat extruded snacks using multigrain flours (refined wheat, sorghum, pearl millet) and potato peel powder (PPP), a nutrient-rich by-product. The integration of PPP into millet-based pasta enhances dietary fiber, protein, and antioxidant content while addressing food waste. Sensory and nutritional analyses demonstrate that the optimized formulation (Sample A) was most acceptable, offering both health benefits and commercial viability.
Keywords: Multigrain, potato peel powder, extrusion, RTE, Sensory evaluation

1.Introduction
Potato (Solanum tuberosum) has a global production of approximately 368 million tons per year generating a massive amount of processing wastes, equal to about 15–40% of the fresh potato and posing a potential environmental risk. Most potato processing wastes consist of peels, which contain significant amounts of antioxidants and dietary fibers. The addition of potato peel flour with a high level of dietary fibers and protein to pasta significantly increased dietary fibers content.

Pasta is typically made with an unleavened dough of wheat flour and water formed into sheets or other shapes and cooked by boiling or baking. Pasta is broadly classified into two types: dried and fresh. Most dried pasta is commercially produced through an extrusion process .Globally, the demand for pasta continues to grow due to its cost-effectiveness, ease of preparation, long shelf life, low glycemic index, low sodium and fat content, and high complex carbohydrates content .According to the International Pasta Organization (IPO), global pasta production was estimated to be 14.3 million tons in 2019. As a result, pasta can serve as a vehicle for bioactive ingredients such as dietary fibers, antioxidants, omega-3 fatty acids, and protein, contributing to human health maintenance The growing demand for functional and sustainable food products has led to the exploration of innovative ingredients in food formulations. One such innovation is the incorporation of potato peel powder (PPP)in millet-based pasta. Potato peel, often discarded as waste, is a rich source of dietary fiber, phenolic compounds, antioxidants, and essential minerals. By repurposing potato peels into powder, this byproduct becomes a valuable functional ingredient, contributing to both nutritional enhancement and waste reduction.

Millet, known for its high nutritional value and gluten-free nature, serves as an excellent base for developing healthy pasta alternatives. However, millet-based pasta often faces challenges such as poor texture, reduced elasticity, and limited functional properties compared to traditional wheat-based pasta. Incorporating PPP can address these issues by improving the pasta's structural integrity and boosting its health benefits.

This study explores the potential of potato peel powder in millet-based pasta to enhance its nutritional profile, functional properties, and environmental sustainability. The inclusion of PPP not only adds value to millet-based pasta but also aligns with global efforts to reduce food waste and promote circular economy practices in the food industry.

2.Material and Methods

2.1 Materials

The required raw materials like refined wheat flour,Pearl Millet flour, Sorghum Millet Flour And Potato peel Powder,Salt,Water were purchased from local market of loni Kalbhor, Pune.

2.2 Preparation of composite blend

The control product was prepared by using 100 percent of refined wheat flour. In order to formulate the recipe of composite flour for the preparation of extruded pasta with enhanced nutritional quality, a different preliminary trial was carried out followed by the sensorial evaluation of the product to optimize the concentration of multigrain flours.

Ingredients	Sample A	Sample B	Sample C
Refined wheat flour	150	140	130
sorghum	20	20	20
Pearl wheat	20	20	20
Potato peel powder	10	20	30

2.3 Method for preparation multigrain pasta

The production of multigrain extruded pasta was started by cleaning and drying using methods Like oven drying of potato peel then the grind the dried potato peel into fine powder to ensure even mixing. Dough formation combine millet flour and potato peel powder in the desire ratio. Add binding agent and water to form a cohesive dough. Than Extrude the dough into pasta shapes using a pasta extruder keep the pasta in hot air oven for drying In temp of 75° C for three hours until it turns dry.

2.4 Chemical analysis of multigrain pasta

The muitigrain pasta were analyzed for their nutritional parameters like moisture, fat ,protein ,ash, and carbohydrates by following the standard procedures mentioned in AOAC (2005).

2.5 Sensory evaluation of multigrain pasta

The sensory quality characteristics of the developed products such as colour, taste, texture, flavour, and overall acceptability were evaluated by a semi-trained panelitis using a 9-point hedonic scale (9-extreme like dislike). From the results of sensory evaluation, the product having maximum acceptability was selected with consumer preference.

3. Results and discussion

3. 1 Proximate analysis of selective raw materials

The proximate compositional parameters of raw materials have a significant role in deciding the nutritional quality of the finished product. The results obtained are tabulated in table 1.

Table 1: Proximate analysis of selective raw materials

Raw material	Proximate Composition (%)					
	Moisture	Fat	Protein	Ash	Crude fibre	Carbohydrate
Refined wheat flour	10-14%	0.5-1.5%	8-12%	0.3-0.5%	2-3%	72-75%
Sorghum flour	8-12%	2-4%	8-14%	1.0-1.5%	6-10%	70-75%
Pearl millet flour	8-12%	3-5%	11-15%	1.5-2.5%	8-12%	70-75%
Potato peel powder	7-10%	0.5-2%	6-8%	3-5%	20-30%	60-70%

In the above the fat and protein content of rice flour was found

In this study, refined wheat flour was used as a base along with sorghum and pearl millet flours to develop multigrain pasta fortified with potato peel powder (PPP). Sorghum flour contributes 2–4% fat, 8–14% protein, 6–10% crude fiber and 70–75% carbohydrates. Pearl millet flour provides 3–5% fat, 11–15% protein, 8–12% crude fiber, and 70–75% carbohydrates. These grains are naturally gluten-free, rich in dietary fibers, and enhance the nutritional profile of the final product. Potato peel powder, often discarded as waste, was repurposed as a functional ingredient due to its high fiber (20–30%), ash (3–5%), and antioxidant content. Its inclusion supports environmental sustainability while contributing nutritional enhancement.

3.2 Sensory Evaluation of Multigrain Pasta

Sensory evaluation is an essential criterion to determine the consumer acceptability of developed food products. The developed product was analyzed for consumer acceptability based on sensory parameters like colour, flavour, taste, texture, and overall acceptability using a 9-point hedonic scale. The scores reported by the panellists for sensory preferences of the product are presented in Table.2.

Table 2: Sensory analysis of multigrain Pasta

TREATMENTS	SENSORY PARAMETERS				
	COLOUR	FLAVOUR	TASTE	TEXTURE	OVERALL ACCEPTABILITY
CONTROL	8.0 ± 0.1	8.2 ± 0.1	8.4 ± 0.2	8.3 ± 0.1	8.5 ± 0.1
MS1	7.5 ± 0.2	7.8 ± 0.2	7.9 ± 0.1	8.5 ± 0.2	8.2 ± 0.2
MS2	7.2 ± 0.1	7.1 ± 0.1	7.3 ± 0.2	7.0 ± 0.1	7.1 ± 0.2

*Each value indicates an average of three determinations

The maximum score for colour was received by sample A (8.0) while the lowest score was obtained by sample B (7.5). The texture of the Sample B product was found to be excellent (8.5) whereas the lowest score for texture was recorded by the sample B as (7.0). The highest score for flavour was obtained for

sample A (8.2) whereas the lowest score was received by sample C (7.1). The highest score for taste was obtained for sample A (8.4) and the lowest for Sample l (7.3). The overall acceptability of product sample A was found to be the highest (8.5) among all other treatments indicating the formulation was liked very much by majority of panelists.

3.3 Proximate analysis of Multigrain Pasta

The proximate compositional parameters of raw materials have a significant role in deciding the nutritional quality of the finished product. The results obtained are tabulated in Table 1.

Table 3: Proximate analysis of multigrain sticks

Raw Materials	Proximate Composition (%)					
	Moisture	Fat	Protein	Ash	Crude fibre	Carbohydrate
Sample A	8.4 %	3.4%	20%	1.8%	6.5%	69.4%
Sample B	8.1%	3.4%	19.5%	2.1%	7.8%	68%
Sample C	7.8%	3.4%	19%	2.5%	9.1%	65.3%

*Each value indicates an average of three determinations

The moisture content had not shown much significant difference among all treatments. The moisture content in MS2 was found to be (8.1%) whereas control sample showed (8.4%) moisture content. The fat content of the control sample was (3.4%) and MS1, MS2 was found as (3.4%), and (3.4%) respectively. The protein content in control, MS1 and MS2 were in the range of (20%), (19.5%), and (19%) respectively. The maximum crude fibre content was found in MS2 as (9.1%) whereas minimum crude fibre content was found to be (6.5%). The ash concentration representing mineral content in the multigrain sticks ranged from (69.4%) in the control sample to (68%) and (65.3%) in MS1 and MS2 respectively.

4. Conclusion

Thus, in the light of the scientific data of the present investigation, it can be concluded that multigrain ppp pasta developed with 85% refined wheat flour, 20% sorghum flour ,20 % pearl millet flour and 10% potato peel powder was found to be more acceptable with respect to mentioned quality parameters. This addition of multigrain flours in the development of extruded products found to have better nutritional benefits as compared to the other snack products. The raw material required are also easily available, so this product can be manufactured commercially on a large scale.

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