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# Studies on the development of soya-based pasta by utilizing okara, a by-product from soymilk

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## Abstract

This research focused on the formulation and evaluation of functional pasta developed using soya flour and whole wheat flour. The primary aim was to enhance protein and dietary fiber content while maintaining acceptable sensory attributes. Three pasta samples (S1, S2, S3) were developed by progressively replacing whole wheat flour with soya okhara at 10%, 20%, and 30%. The samples were evaluated for proximate composition and sensory properties. Sensory evaluation revealed that Sample 2, formulated with 30% soya okara, was well accepted by the panel members, showing favorable scores for appearance (8.2), color (8.4), texture (8.1), and taste (8.3) and mouthfeel (8.4). The study demonstrates that incorporating soya okara in pasta significantly improves nutritional and functional properties while maintaining consumer appeal at moderate substitution levels.

**Keywords**: Functional pasta, Soya okara, Whole wheat flour, Sensory evaluation, Nutritional enrichment

## 1. Introduction

Pasta is one of the most common and popular staple foods thanks to its sensory and nutritional value, convenience, and versatility. It is reported that about 14.3 million tons of pasta are produced annually worldwide. The main producer is Italy, followed by the United States, Brazil, Turkey, and Russia. Italians are the main pasta consumers, with 23.1 kg per capita per year, followed by Tunisians (17 kg), Venezuelans (12 kg) and Greeks (11.4 kg). Pasta plays a key role in the Mediterranean Diet. WHO (the World Health Organization) and FAO (the Food and Agriculture Organization of the United Nations) described pasta as a healthy, sustainable, and quality food model. Moreover, in 2010, UNESCO (United Nations Educational, Scientific and Cultural Organization) declared pasta an intangible cultural heritage of humanity. **(Bresciani *et al*.,2022)**

One of the main reasons for the success of pasta is its nutritional profile. Indeed, pasta generally is very nutritious, due to its low amount of fats and readily digestible carbohydrates [8]. Moreover, pasta can supply healthy components, such as fibre or prebiotics [9,10]. The low cost and long shelf life of pasta make it popular with many diverse groups of consumers. **(Bresciani *et al*.,2022)**

 

There are over 600 pasta shapes, the most popular being spaghetti, elbow, macaroni, lasagne, and shells. Pasta can be sold fresh (as made in the home or restaurant) or refrigerated but most pasta is dried (with or without eggs), canned, or frozen. **(Sissons *et al.,* 2016)**

Pasta is durum wheat-based inexpensive food product, famous worldwide because of its low cost, versatility, convenience, and excellent shelf-life attributes **(Desai *et al*., 2019)**

Soybean seeds are considered a source of dietary fiber, represented by both swelling and water-insoluble fractions. Swelling fiber reduces cholesterol and glucose levels in the blood. Insoluble fiber enhances peristalsis and increases the speed of food movement through the gastrointestinal tract. Soy seeds do not contain lactose and cholesterol. Due to this, they can be used as raw materials for the production of products for specialized and dietary nutrition, especially for people suffering from diseases of the gastrointestinal tract, heart disease, diabetes, etc. **(Lukin *et al.,*2023)**

Dry okara contains about 50% fiber, 25% protein, and 10% lipid. Other soy components that are also likely present in okara include isoflavones (genistein and daidzein), lignans, phytosterols, coumestans, saponins, and phytates. These compounds have various physiological and therapeutic functions, including antioxidant activity, prevention of cardiovascular diseases, and effective chemo preventive agents for certain types of cancer. **(Li bi Quino *et al.,*2012)**

## 2. Material and Methods

Table 1. illustrates the formulation of pasta prepared by incorporating varying levels of soya okara as a partial replacement for whole wheat flour. The control sample was formulated using 100% whole wheat flour without the addition of soya okara. Experimental samples were designated as S1, S2, and S3, where 10%, 20%, and 30% of the whole wheat flour, respectively, was replaced by soya okara on a weight basis.

This substitution aimed to assess the impact of increasing levels of soya okara on the nutritional composition, sensory quality, and overall acceptability of pasta. The increase in soya okara content was intended to enhance the dietary fiber and protein content of the product while maintaining desirable textural and sensory attributes.

**Table 1. Formulation of soya okara enriched pasta**

| Sr. No. | Sample | Soya okara | Whole wheat flour |
|---|---|---|---|
| **1.** | Control | 0 | 100 |
| **2.** | S1 | 10 | 90 |
| **3.** | S2 | 20 | 80 |
| **4.** | S3 | 30 | 70 |

 

**Preparation of Soy okara enriched pasta:** The soya okara enriched pasta prepared by using process given by **Kamble *et al*., (2020).** The flowchart (Figure 1) illustrates the stepwise processing of soybean seeds to obtain dried soya okara, which was further used for pasta formulation. The process began with cleaning and washing of soybean seeds to remove dirt, debris, and other extraneous matter. The cleaned seeds were then hydrated at 25°C for 12 hours, allowing sufficient water absorption to soften the beans and facilitate easier grinding.

**Preparation of soya okara enriched pasta**

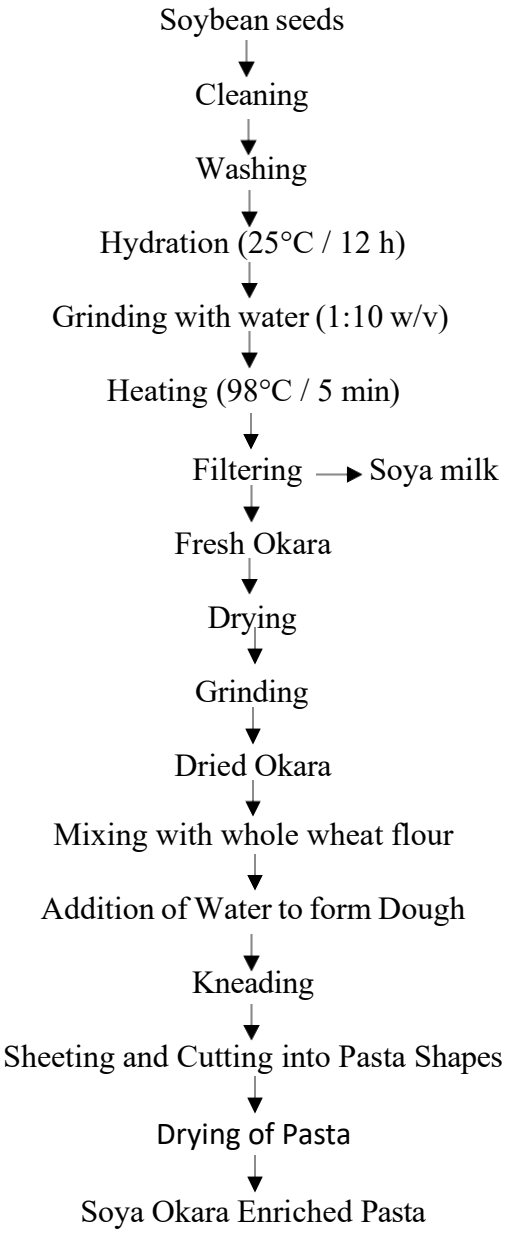


**Fig 1. Process flow chart for preparation of soya okara enriched pasta**

 

Following hydration, the soaked soybeans were ground with water in a 1:10 (w/v) ratio to form a slurry. This slurry was then heated to 98°C for 5 minutes to deactivate trypsin inhibitors and other antinutritional factors. The heated slurry was subjected to filtration, which separated the liquid (soymilk) from the solid residue (fresh okara).

The fresh okara, which is a by-product rich in dietary fiber and protein, was dried to reduce moisture content, followed by grinding to produce a fine powder. This resulting dried okara powder was then utilized as a functional ingredient in the preparation of pasta samples by partially replacing whole wheat flour. Whole wheat flour and dried okara powder were combined in predetermined amounts. To create a dough with the right consistency for making pasta, water was added little by little. To improve shelf life and reduce moisture, the dough was sheeted, cut into macaroni forms, and then dried under carefully monitored conditions.


**Observations and assessment**

In accordance with typical macaroni shapes, the macaroni pasta made with 20% soy okara (Sample S2) had an average length of roughly 3 cm and a diameter of 0.8 cm. Although the increasing fiber content caused little changes in texture and wall structure, the addition of okara did not drastically impact the pasta's size.

**Table 2. Nutritional assessment of soya okara enriched pasta**

| Parameter | Estimated Value (per 100 g) |
|---|---|
| Energy | 328 kcal |
| Moisture | 11.2% |
| Protein | 15.2% |
| Fat | 3.6% |
| Dietary Fibre | 17.6% |
| Ash | 2.34% |

 

**Sensory evaluation of Soya okara enriched Pasta**

The sensory quality of pasta samples enriched with varying levels of dried soya okara was evaluated using a 9-point hedonic scale, considering six parameters: appearance, color, texture, taste, mouthfeel, and overall acceptability. The results are summarized in Table 3. and depicted graphically in Figure 2.

Among the samples, Sample S2 (20% soya okara + 80% whole wheat flour) scored the highest across all attributes, with an overall acceptability of 8.3 ± 0.3, indicating a strong preference by the sensory panel. Notably, it received superior scores in appearance (8.2 ± 0.3), color (8.4 ± 0.4), and mouthfeel (8.4 ± 0.3), suggesting a positive impact of moderate okara inclusion on the visual and textural appeal of the pasta.

**Table 3. Sensory evaluation of Soya okara enriched pasta**

| Sample | Color | Appearance | Texture | Taste | Mouthfeel | Overall Acceptability |
|---|---|---|---|---|---|---|
| **Control** | 7.2 ± 0.6 | 7.0 ± 0.5 | 6.8 ± 0.7 | 6.9 ± 0.6 | 7.0 ± 0.5 | 7.0 ± 0.6 |
| **S1** | 7.5 ± 0.5 | 7.3 ± 0.4 | 7.1 ± 0.6 | 7.2 ± 0.5 | 7.3 ± 0.6 | 7.3 ± 0.5 |
| **S2** | 8.4 ± 0.4 | 8.2 ± 0.3 | 8.1 ± 0.3 | 8.3 ± 0.4 | 8.4 ± 0.3 | 8.3 ± 0.3 |
| **S3** | 7.0 ± 0.7 | 6.9 ± 0.6 | 6.7 ± 0.6 | 6.8 ± 0.5 | 6.9 ± 0.6 | 6.8 ± 0.5 |

Sample S2 (20% okara) showed better sensory qualities, especially in color and taste, with good overall acceptability, indicating its effectiveness in enhancing pasta's nutritional and sensory profile. In contrast, Sample S3 (30% okara) had lower scores, likely due to excess fiber affecting texture and mouthfeel. Thus, 20% okara addition is considered optimal. Similar effects of higher okara levels on sensory decline were reported by **Kamble *et al.* (2019).**

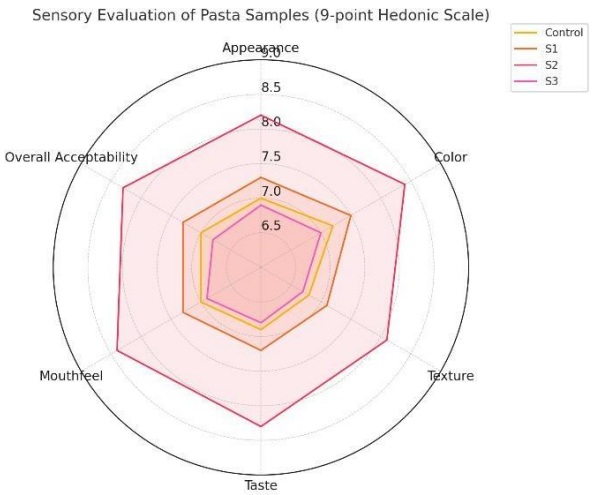


**Figure 2. Sensory evaluation chart**

 

## Conclusion

The potential benefits of adding dry soy okara, a by-product of the production of soymilk, to pasta formulation to enhance its nutritional and functional properties was well illustrated by the current study. With a much higher protein and dietary fiber content and better sensory acceptability than the control and other formulations, pasta enriched with 20% soy okara (Sample S2) demonstrated the best results among the evaluated samples. Up to a certain extent, the addition of okara improved the pasta's look, flavor, and mouthfeel; after that, the quality declined, most likely as a result of the texture being affected by the higher fiber content. Therefore, it was determined that a 20% substitution level was ideal for striking a balance between consumer acceptance and nutritional enrichment. By using okara in functional food development in a sustainable and valuable way, this method helps to reduce waste and promote dietary health.

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