

Study on Preparation and Quality Evaluation of Foxtail Millet Fortified Noodles

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Abstract- The current study aims to increase the utilization of composite flours made of wheat and foxtail millet. The base materials used in the current study, comprising wheat flour and foxtail millet flour, are taken into account as independent variables that are optimized. The projected responses for cooking loss, cooking time, water absorption index, moisture content, total ash content, total dietary fiber content, and sensory characteristics are as given. The experimental design generates 8 peculiar combinations, which are then examined to assess the impact of independent factors on results. It is possible to determine the values of raw materials that are processed like foxtail millet flour and wheat flour. This effort also uses millets because of their high nutritional value. Foxtail millets are rich in dietary fiber, phosphorus, manganese, chromium and other minerals. It has been reported that due to its low glycemic index, it is beneficial for diabetics. In general, rye, barley, and refined wheat flour include the protein known as gluten. People often consume gluten-rich foods including pasta, noodles, bread, and other items. Many people experience a negative reaction after consuming gluten, necessitating the maintenance of a gluten-free diet. Noodles are an example of an extruded product that is highly popular and consumed all over the world. With the availability of gluten-free noodles, health issues can be avoided. Hence the type 'noodles' is used to boost its nutritional content by using millets. This improves the nutritional properties of extruded foods and it could have a far-reaching impact on the market.

Index Terms- Foxtail millet flour, Wheat flour, Composite flour, Gluten-free, Noodles.

I. INTRODUCTION

Extrusion technology is a widely used food industry processing technique for the development of various food products. Extrusion technology has been used for the production of snacks, pasta, bread, pet food, and many other food products. The basic principle of extrusion technology involves the use of an extruder, which is a machine that forces a mix of ingredients through a die under controlled conditions of temperature, pressure, and shear. The mix of ingredients typically includes a starchy or proteinaceous base, water, and other additives such as flavors, colors, and nutrients [1]. The extruder uses a combination of heat, pressure, and mechanical shear to transform the mix of ingredients into a final product with the desired properties. Extrusion technology benefits the food business by facilitating the production of a wide variety of food products with consistent quality, high production efficiency, and the ability to incorporate a variety of ingredients and nutrients into the final product. Additionally, extrusion technology is a continuous process that can be easily scaled up or down depending on the demand [2].

Millets are becoming increasingly popular as an ingredient for making extruded products, such as breakfast cereals, snacks, and ready-to-eat meals. Millets can be combined with other ingredients, such as wheat, corn, or rice, to create extruded products that are nutritious, tasty, and convenient. Foxtail millet noodles have gained popularity in recent years due to their various health benefits and unique flavor profile. Kangni, Kang, and Kakum are the native names for foxtail millets. They have a sweet and nutty flavor and are eaten as ready-to-eat foods, quick foods, etc. It is a crop that benefits farmers in addition to serving as a healthy food source, making it "good for you" (due to its nutritional worth) and "good for the world" (as it requires a lesser quantity of water along with other resources to cultivate). Foxtail millets are rich in nutrients like phosphorus, calcium, magnesium, salt, and other minerals as well as proteins, carbs, vitamins like Vitamin A and E, and other vitamins and minerals [3].

The following characteristics of foxtail millets have been verified by scientific research:

- It can possess antioxidant capabilities.
- It may exhibit attributes that reduce blood sugar.
- It might possess gastro-protective qualities.
- It might possess anti-carcinogenic qualities.
- It might be able to treat fungal infections.

Here are some reasons why foxtail millet noodles have a future scope globally:

1. **Rich in Nutrients:** Foxtail millet is a nutrient-dense grain that is rich in dietary fiber, protein, minerals, and vitamins. Millet noodles made from foxtail millet can provide these nutrients in a tasty and convenient way.
2. **Low Glycemic Index:** The low glycemic index of foxtail millet noodles indicates that they release sugar into the bloodstream gradually. The risk of developing diabetes can be decreased and the levels of sugar in the blood can be regulated.

3. **Sustainable and Environmental Friendly:** Foxtail millet is a crop that requires less water and inputs compared to other grains like rice or wheat. Growing foxtail millet can contribute to sustainable agriculture and consuming foxtail millet noodles can reduce the environmental impact of food production.

4. **Delicious Taste and Texture:** Foxtail millet noodles have a unique nutty flavor and a pleasant chewy texture that makes them a great alternative to traditional wheat noodles. They can be used in a variety of dishes and cuisines, and are a delicious and healthy option for anyone looking to add more variety to their diet.

Incorporating foxtail millet noodles into diet can contribute to a well-rounded and nutritious eating plan. However, as with any dietary change, it's essential to ensure variety and balance to meet all nutritional needs. Enjoying foxtail millet noodles as part of a diverse and balanced diet is an excellent way to experience their many benefits. Overall, foxtail millet noodles offer a great alternative to traditional wheat noodles and can provide various health benefits. They are a sustainable and delicious food option that can contribute to a healthy and balanced diet [4,5].

In this project our objectives were:

1. To prepare an innovative specialty food product from foxtail millet
2. To study the processing technique and effect on foxtail millets.
3. To understand the importance of foxtail millets in our daily diet.
4. To analyze and evaluate the quality of the foxtail millet noodles for its characteristics.

II. MATERIALS AND METHODS

A. Materials Required

Following mentioned tools were used for this experiment.

- **Hot Air Oven:** A hot air oven is an essential piece of equipment for various cooking and baking tasks. In the context of making noodles, it was used for specific steps such as drying the noodles.
- **Weighing Balance:** A weighing balance is used to accurately measure and portion the ingredients required for making the noodles. Precise measurements are crucial for consistent and high-quality results.
- **Pasta and Noodle Maker:** This is the primary equipment for making pasta or noodles. It typically consists of a machine with different attachments or rollers for rolling and cutting the pasta or noodle dough into various shapes and sizes. It simplifies the noodle-making process and allows for customization.

B. Ingredients Required

Table 1 Ingredients

Ingredients	Quantity
Foxtail Millet Flour	50 g
Wheat Flour	40 g
Salt	1 g
Oil	2 ml

These ingredients mentioned in table 1, will likely be used to prepare the FTM50 (as 50gm foxtail millet is used) noodle dough. It is done by mixing the foxtail millet flour and wheat flour, adding a small amount of salt for flavor, and using a bit of oil to help with the texture of the dough.

C. Noodles preparation

Noodle preparation process is done in following steps:

1. **Weighing Ingredients:** We accurately weighed the foxtail millet flour, wheat flour, salt, and oil according to the provided formulation.
2. **Mixing Flour:** Foxtail millet flour and wheat flour were combined in a plate.
3. **Salt Solution:** Salt was dissolved in water to create a salt solution, which was then mixed with the flour mixture to form the dough.
4. **Resting the Dough:** The dough was allowed to rest at room temperature for 10 minutes. Resting dough allows it to relax and becomes easier to work with.



Fig. 1 Dough formation



Fig. 2 Extruded noodles

5. **Kneading:** After resting, the dough was manually kneaded for 1 minute to develop its elasticity and structure.
6. **Sheeting:** The kneaded dough was sheeted using a pasta machine. This step involves rolling out the dough into thin sheets.
7. **Cutting Noodles:** The thin sheets of dough were passed through a manually operated pasta machine to create 3 mm noodle threads.
8. **Steaming:** The noodles were placed in a cooker and steam-cooked for 3 minutes at a temperature of 100°C. This cooking process helps to partially cook the noodles.
9. **Drying:** After steaming, the foxtail millet noodles were allowed to air dry for 1 to 2 hours in a cabinet dryer set to 50°C. This step helps to remove excess moisture and preserve the noodles.
10. **Packaging:** The dried noodles were then packed using polyethylene packaging. This packaging helps protect the noodles and keep them fresh. The packaged foxtail millet noodles were stored at 22–25°C for further analysis.



Fig. 3 Steamed noodles



Fig. 4 Air dried noodles

This process seems well-documented and suitable for making foxtail millet noodles. The final noodles can be stored and used for various culinary purposes.

D. Proximate Analysis

Proximate analysis is a series of tests and procedures used in food chemistry and nutrition to determine the approximate or proximate composition of a food product. It provides essential information about the major components present in a food item. Proximate analysis is done with the help of following parameters:

- **Cooking Time:** Cooking time refers to the amount of time required to cook the noodles until they are ready for consumption. It can be an important parameter as it affects the convenience of preparing the noodles.
 - **Cooking Loss:** Cooking loss measures the weight of the noodles before and after cooking. It provides insights into how much moisture the noodles absorb during cooking. This can impact the texture and quality of the noodles.
 - **Water Absorption Index:** Water absorption index measures the ability of the noodles to absorb water during cooking. It reflects how well the noodles can retain moisture, which is an important quality factor.
 - **Moisture Content:** Moisture content measures the amount of water present in the noodles. It's a critical parameter as it affects the shelf life and texture of the noodles.
 - **Ash Content:** Ash content quantifies the mineral content of the noodles. It includes minerals like calcium, magnesium, and potassium. Ash content can be an indicator of the nutritional value and purity of the noodles.
 - **Total Dietary Fiber:** Total dietary fiber measures the amount of fiber present in the noodles. Fiber is an essential component of a healthy diet and can have various health benefits, including promoting digestive health.
- These analyses provide valuable information for both quality control and nutrition labeling of food products. It helps ensure that the noodles meet quality standards and provides consumers with accurate information about the product's nutritional content.

E. Cooking time and cooking loss analysis:

A 25g portion of noodles is taken and dispersed into 250ml of boiling water. This ratio of 1:10 (noodles to water) is a standard method for testing. The noodles are cooked in the boiling water, and at regular intervals (in this case, every 30 seconds), a single strand of noodle is taken out. To determine if the noodles are cooked to the desired level, the removed strand is pressed between two glass slides. This step is done to check the texture and tenderness of the noodles. The cooking time is recorded as the time it took for the noodle strand to reach the desired texture. This can be useful for providing cooking instructions to consumers or for quality control during production.

The cooking loss is calculated using the formula:

$$\text{Cooking Loss(\%)} = \frac{\text{Weight of dry residue (W}_1\text{)}}{\text{Weight of sample before cooking}} \times 100$$

Weight of dry residue (W₁): This is the weight of the noodles after cooking and after removing excess water.

Weight of sample before cooking (W_2): This is the initial weight of the dry noodles before they were cooked.

The cooking loss percentage provides information about how much of the noodle's weight was lost during cooking. This can be an indicator of how well the noodles retain their structure and texture during the cooking process. Lower cooking loss percentages are generally desirable as they indicate less structural breakdown during cooking. These analyses are essential for quality control and for providing consumers with instructions on how to achieve the desired texture when preparing the noodles.

F. Water Absorption Index analysis

The Water Absorption Index is a measure of how much water the noodles absorbed relative to their original dry weight. It provides information about the noodle's ability to absorb water during cooking. A higher WAI indicates that the noodles absorbed more water, potentially resulting in a softer texture or greater moisture content in the cooked noodles.

A 40g portion of dry noodle sample is taken. This dry noodle sample is dispersed in 30ml of distilled water. The mixture is then cooked for the optimum cooking time, ensuring that the noodles absorb water during the cooking process. After cooking, the sample is strained to separate the cooked noodles from the cooking liquid. The weight of the cooked noodles (W_2) is recorded. The Water Absorption Index (WAI) is calculated using the formula:

$$\text{Water Absorption Index} = \frac{W_2}{W_1}$$

Where,

W_1 = weight of raw noodles and W_2 = weight of cooked noodles

This analysis is valuable for understanding the cooking characteristics of the noodles and can be used to fine-tune the cooking instructions provided to consumers or for quality control during production.

G. Moisture content analysis

The Moisture Content Analysis described is a common method used to determine the amount of moisture present in a food sample. In this process, a 5g sample of powdered noodles is taken for analysis. The sample is placed in a petri plate and then put in a hot oven set at 105°C. It is left in the oven for 4 hours. This extended exposure to heat causes the moisture within the sample to evaporate. After the 4-hour drying period, the petri plate containing the sample is removed from the oven and allowed to cool in a desiccator. The desiccator is a sealed container that prevents moisture from re-entering the sample. Once the sample and petri plate have been cooled to room temperature, the petri plate is weighed again. The moisture content is calculated using the formula:

$$\text{Moisture Content (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

Where,

W_1 = weight of sample before drying and W_2 = weight of sample after drying

H. Total ash content analysis:

This method is used to determine the percentage of inorganic or mineral matter (ash) present in a food sample. Initially 5g sample was burned in crucible till appearance of fumes. It was then held in a muffle furnace for two hours at 660°C and later kept in desiccator to be cooled down and weighed for further calculations as per below mentioned formula:

$$\text{Percent ash count (\%)} = \frac{(\text{Weight of sample} - \text{Material burnt})}{\text{Weight of dried empty silica crucible}} \times 100$$

The Total Ash Content Analysis provides valuable information about the mineral content of the food product. It is important for nutritional labeling, as well as for assessing the purity and quality of the food, especially in cases where excessive ash content might indicate contamination or improper processing.

I. Total dietary fiber analysis:

The analysis of total dietary fiber (TDF) in food products is a crucial nutritional assessment to determine the amount of fiber present. These methods are established by organizations like AOAC International (Association of Official Analytical Chemists) and are designed to provide accurate and consistent results for assessing the dietary fiber content of food products. The calculated TDF value is typically reported in grams per 100 grams of the food product.

J. Organoleptic Evaluation

Organoleptic evaluation, also known as sensory evaluation, is a critical aspect of food product development and quality control. It involves assessing food products based on sensory attributes such as appearance, color, texture, flavor, and taste. In this case, the evaluation was conducted on the foxtail millet noodles [6].

The cooked noodles were examined from an organoleptic approach. The nutritional properties were assessed using a 9-point hedonic scale by 10 trained taste panel examiners from the MIT School of Food Technology, MIT ADT University, Loni Kalbhor, Pune, India. The produced noodles' appearance, color, texture, flavor, taste, and overall acceptance were evaluated. The scale of 9-points scored as "like extremely", "like very much", "like moderately", "like slightly", "neither like or dislike", "dislike slightly", "dislike moderately", "dislike very much" and "dislike extremely".

III. RESULTS AND DISCUSSION

Comparing the results of various tests and analyses with the standards set by the Food Safety and Standards Authority of India (FSSAI) is a critical step in assessing the quality and safety of a food product. Table 2 depicts the results of tests of analysis compared with FSSAI standards

Table 2 Results of tests of analysis

Analysis	FSSAI standard	Result
Cooking time	N/A	4 min 46 sec
Cooking loss	Not more than 8%	6%
Water absorption index	N/A	3 units
Ash content	Not more than 2%	2%
Total dietary fiber	Between 8-14%	12.2%

The various tests results and its comparison with FSSAI standards show that foxtail millet enriched noodles are safe to consume. The lesser moisture content conforms to the government regulations. Hence, it can be successfully said that chances of spoilage are negligible. Total ash content which is exactly 2%, conforms to government standards and this states that there are no toxic minerals present. The sensory evaluation states that the foxtail millet enriched noodles have an average 7.5 overall acceptability, including its various sensory aspects. This leads to the conclusion that the product has great benefit and acceptance of the market.

Because of its high vitamin B12 content, foxtail millet is beneficial for skin and hair growth, maintaining a healthy heart and ensuring proper functioning of the nervous system. Dietary changes may help people with Type-2 diabetes manage their blood sugar levels and reduce their insulin, cholesterol, and fasting glucose levels. Natural iron found in abundance in foxtail millet aids in reducing muscle spasms and calming restless syndrome.

Millets are becoming increasingly popular as an ingredient for making extruded products, such as breakfast cereals, snacks and ready-to-eat meals. Millets can be combined with other ingredients, such as wheat, corn or rice, to create extruded products that are nutritious, tasty and convenient. Foxtail millet noodles are gaining popularity in recent years due to their various health benefits and unique flavor profile.

Foxtail millet noodles offer a great alternative to traditional wheat noodles and can provide various health benefits. They are a sustainable and delicious food option that can contribute to a healthy and balanced diet.

When compared to commercial noodles, the FTM50 noodles had a higher nutritional quality, according to the investigation. The FTM50 noodles are able to be used as a substitute form of protein to help with energy and protein deficiencies.

IV. CONCLUSION

Traditional store-bought noodles often lack in nutritional value. This sets the stage for introducing your nutrient-rich instant noodles as a healthier alternative. The use of a 50:40 flour combination of foxtail millets (FTM) and wheat is highlighted as a promising source of protein, fiber, and minerals. This balanced combination is likely to appeal to health-conscious consumers looking for more balanced dietary options. The study's findings reveal that FTM50 noodles have a higher nutritional quality compared to commercial noodles. This comparison is a powerful way to communicate the nutritional benefits of your product to potential consumers. The low moisture content of FTM50 noodles is stressed, indicating their longer shelf life and reduced susceptibility to spoilage. This can assure consumers of product safety and quality. FTM50 noodles can be a valuable substitute source of protein for individuals dealing with energy and protein deficiencies. This positions your product as a health-conscious choice. The mention of FTM's versatility in home cooking, including making noodles, bread, pasta, and biscuits, is a practical selling point. Additionally, highlighting the convenience for working mothers, who need quick meal options for tiffin (lunchbox) or office meetings, adds a relatable aspect to your product.

Thus, the FTM50 noodles can therefore be utilized as a substitute source of protein to treat energy and protein deficiency. Additionally, FTM may be used to make foods at home (such as noodles, bread, pasta and biscuits) and will be preferred by working mothers who need to make meals quickly for tiffin or office meetings.

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