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Adding Value Channa Striata Flour Waste Using an Autoclave and Drying Machine to Turn Functional Flour

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A B S T R A C T
This study aims to process snakehead fish processing waste (head, skin, bones) into functional flour with added value as a contribution to the utilization of agro-industrial waste. The variables tested include sensory characteristics (odor, taste, color, texture) and nutritional content (protein, fat, phosphorus, calcium, water content, ash). The research method refers to the process of making snakehead fish flour, followed by hedonic organoleptic tests and chemical analysis, with samples from waste snakehead fish flour products resulting from student practicums. Observations were made throughout the production process until laboratory testing. The results show that functional flour from snakehead fish processing waste (head, skin, bones) has high nutritional value with 7.42% phosphorus, 2.43% calcium, and 6.77% fat, and is sensorially accepted, so it has the potential as a functional food ingredient

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INTRODUCTION

One of the students' practical activities in the agro-processing technology laboratory involves processing snakehead fish into fish meal. The fish processing technology strives to produce the highest quality flour. The criteria for the best flour include a smooth, perfectly dry texture and a glossy white color. To achieve these criteria, only white fish meat is used in the processing. Other parts of the snakehead fish, such as the head, skin, and bones, are discarded as waste (Hall, 2011).

This waste has increased, resulting in negative impacts, both in quantity and the foul odor it produces. The PLP (Laboratory Assistant) in charge of the laboratory recognized the waste from this lab as a valuable resource with the potential to be developed into something beneficial for humans, as it contains various substances essential for the human body, including calcium and albumin (Ghaly, Ramakrishnan, Brooks MS, Budge SM, 2013).

The utilization of processed snakehead fish waste varies widely (Yuniar, Sofiah, Martha Aznury, n.d.). stated that the public can develop knowledge about how to process snakehead fish heads into kemplang snacks (Rofiatu Sholihah, Agus Heri Santoso, 2017). also reported the results of their research on making instant cereal.

This waste can be utilized by processing it into functional flour. Therefore, the PLP is focusing on waste from student lab activities, which can be further processed through this research. Considering that the albumin and calcium content of snakehead fish is not limited to the fish meat, this waste will be processed into functional flour in this study (Elfariyanti, 2021).

The problem formulation in this research is: The head, skin and bones of snakehead fish are waste from the snakehead fish itself, because the snakehead fish is only taken for its meat as a raw material for making snakehead fish meal. In practical activities in the Agro Process Technology Lab, snakehead fish are cleaned to get the meat while the waste in the form of heads, skin and middle bones of snakehead fish is simply thrown away (waste). Waste from student practical activities that are simply thrown away causes environmental problems, this is what the researcher is concerned about to find a solution (SK Menteri, 2020).

The aim of this research is to add value to the waste from processing snakehead fish meal, so that it is more useful.

The results of this study are expected to be a source of information, literature and be useful for further research in efforts to utilize and produce functional flour from waste from processing snakehead fish flour, so that it can be useful for the community in general in Indonesia, and especially in Makassar City.

LITERATURE REVIEW

Snakehead Fish (*Channa Striata)*

According to (Rofiatu Sholihah, Agus Heri Santoso, 2017), There is a source of animal protein, one of the food ingredients is a type of freshwater fish commonly consumed in Indonesia, namely snakehead fish (channa striata) where this fish is rich in albumin and protein content. The potential nutrients of snakehead fish are quite high, including protein content of 70%, albumin content of 21%, complete amino acid content, zinc micronutrient content, selenium content and iron content. Protein in fresh snakehead fish is 25.5%, while 6.224% of the protein is in the form of albumin content. This snakehead fish can be used as an alternative to substitute protein sources such as in flour as a substitute for basic ingredients in making processed foods. The protein content of snakehead fish (channa striata) is higher than egg protein, chicken protein and beef protein; the protein content of the three is 12.8%, 18.2% and 18.8% respectively (Mehdi Nikoo , Joe Regenstein, 2023).

Snakehead fish (Channa striata), which has a higher concentration of nutrients and other albumin than other fish species, is one of the promising fish in Indonesia. Albumin is abundant in snakehead fish, an important type of protein. When viewed from the level of utilization, especially for non-economic fish, namely snakehead fish, which is limited to traditional processing and fresh consumption (Muliani, Asriany, 2021).

Research Procedures Process of Making Snakehead Fish Meal and its Waste

The standard operating procedure for the production process of snakehead fish meal involves following the sequence of production activities according to the stages of each selected processing method. For non-steamed snakehead fish meal, the following steps are sorting, filleting, washing, soaking, filtering, drying, grinding, and packing. For steamed snakehead fish meal, the following steps are sorting, cutting, steaming, sorting the fish meat, drying, grinding, and packing (Fatmawati, 2014).

The washed fish waste is then dried using a dryer at 650°C for 14 hours for method 1. Method 2 is dried at 400°C for 24 hours. The purpose of drying is to reduce the water content in the snakehead fish meat. Once dry, it is ground using a blender, sieved, and packed (Delti, 2023).

The drying process aims to remove water content by heating the material until it reaches a certain moisture content. If the moisture content is limited, enzymes will be inactive and microorganisms will not be able to grow (Hartati, 2016).

Hedonic Organoleptic Testing (SNI 01-2346-2006)

Hedonic testing is necessary to determine consumer preference for a product by assessing various product characteristics, such as appearance, color, taste, aroma, and texture. This test, also known as a preference test, is a type of product acceptance testing. Hedonic product testing involves at least 25 semi-trained respondents.

The hedonic organoleptic quality test is a more specific hedonic test for a specific quality type. The difference is that the hedonic test aims to determine panelists' responses to general product quality characteristics, such as color, aroma, texture, and taste. Hedonic quality testing refers to SNI 01-2354-2006, which measures water, protein, fat, carbohydrate, and albumin content in products (Badan Standardisasi Nasional, 2006).

Albumin Testing

In the litmus paper test, what is observed is there a color change? Albumin is basic, so the albumin test on litmus paper shows a color change on red litmus paper to blue and on blue litmus paper there is no color change. Protein is an amphoteric compound, which means it can be basic or acidic. Protein is amphoteric, meaning it can react to acidic or basic solutions. The solubility of proteins is not the same in water, acidic or basic. Some are easily soluble and some are difficult to dissolve and all proteins are insoluble in fat solvents such as chloroform and ether. However, in this study, litmus paper will be replaced with a PP indicator to determine the pH value obtained. If the litmus paper displays a color change, it indicates the presence of an acidic or basic element. Protein is a basic or acidic compound, therefore a color change occurs on the litmus paper. This proves that one of the elements in proteins is acid (H+) and base (OH-), H and O (Pandiangan et al., 2024).

Research Quality Testing

Table 1. Fishmeal quality requirements according to SNI 01-2715-1996 include:

No	Parameter	Grade 1	Grade 2	Grade 3
1	Moisture content (Max)	10%	12%	12%
2	Ash (Max)	20%	25%	30%
3	Calcium/Ca	2.5-5.0%	2.5-6.0%	2.5-7.0%
4	Phosphorus/P	1.6-3.2%	1.6-4.0%	1.6-4.7%
5	Sodium Chloride/NaCl (Max)	2%	3%	4%
6	Organoleptic (minimum)	7%	6%	6%
7	Salmonella microbiology (Fatiqin et al., 2019)	negative		
8	Protein	albumin present		

The results of (Mahardika, 2017) research show that the chemical composition of snakehead fish meal is 5.68% water content (bb), 6.29% ash content (bk), 86.13% protein content (bk) and 2.31% fat content (bk) and 5.27% carbohydrate (bk). Therefore, it is necessary to test these components on the test samples of this research.

METHODOLOGY

This study used an experimental approach to process snakehead fish waste (head, skin, and bones) into functional flour and analyze its sensory characteristics and nutritional content. The research procedure refers to the stages of making modified fish meal, including raw material preparation, washing, boiling, drying, milling, and sieving to obtain a homogeneous flour.

The population in this study was all waste from the snakehead fish processing practicum in the agro-processing technology laboratory, while the samples used were waste from the head, skin, and bones of snakehead fish which were processed into functional flour.

Data analysis was conducted descriptively. Hedonic organoleptic testing was used to assess panelists' preference for odor, taste, color, and texture. Chemical analysis was performed to determine protein, fat, moisture, ash, and mineral content such as phosphorus and calcium using standard laboratory methods. The test results were then interpreted to evaluate the quality and potential use of functional flour as a food ingredient (emawati, yani, 2017).

The working method for making functional flour begins with raw material preparation, the functional flour manufacturing process, and the resulting product. The stages in the working method for making functional flour can be seen in the flowchart in Figure 1 below (Tangke et al., 2020).

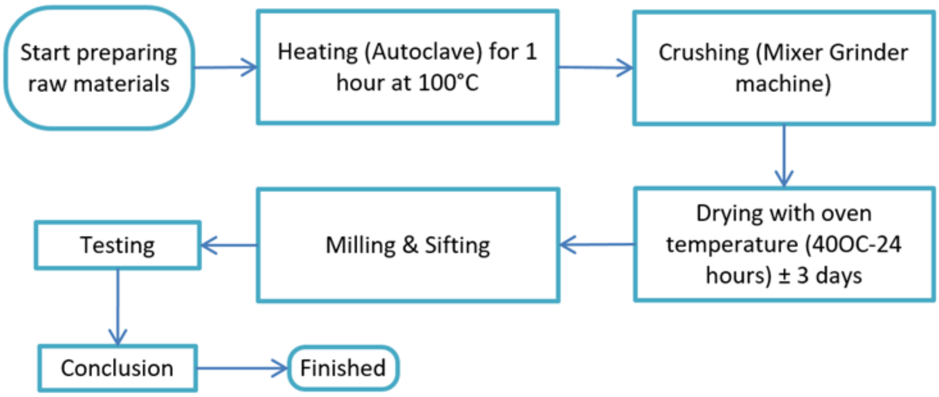

Figure 1. Flow diagram of the functional flour manufacturing process

RESEARCH RESULT

Research activities in the Agro Processing Technology Lab are processing waste from the production of snakehead fish meal into functional flour. This research aims to add value to the waste from snakehead fish meal processing, making it more useful for other processed food products (Venugopal, 2006).

The initial step in processing this waste was to follow the POB for making snakehead fish meal. This aimed to establish the flow of the production system. The production procedure for this study began with waste sorting (fish bones, skin, and heads), heating in an autoclave, grinding, drying, milling, and packaging. Excessive heating during the drying process can cause nutritional damage to food ingredients. This damage can include chemical, physiological, and physical changes. Some proteins are damaged by heat (Fatmawati, 2014).

Sorting and Washing

This stage of the process involves sorting the raw materials used in the production of snakehead fish meal, including fish bones, heads, and skin. The next step is to clean the waste from any remaining dirt and blood, and then cut the bones to size in an autoclave. The waste (fish bones, heads, and skin) weighs 2 kg and will be processed into functional flour.

Figure 2. Sorting materials

This heating process uses an autoclave for approximately 1 hour. This heating treatment aims to soften the fish bones and sterilize the material so that it is easy to grind. At this stage it is heated at a temperature of ±100ºC. The weight of the material after the heating process is 1.6 kg (Helmi Harris, 2018).

Figure 3. Heating process

Grinding Process

The grinding process reduces the particle size of processed materials from large/coarse particles to smaller ones. At this stage, the research material is made into a soft dough, facilitating the grinding process using a meat grinder. The weight after grinding is 1.3 kg (Tangke et al., 2020).

Figure 4. Grinding Process

Drying

The drying process essentially aims to remove water content by heating until it reaches a certain moisture content. With limited water, enzymes are inactive and microorganisms cannot grow. The research material was dried using a drying machine at 400°C for 24 hours for 3 days. The weight after the process was approximately 1 kg (Hartati, 2016).

Figure 5. Drying

Milling and packing

The dried ingredients are then ground using a grinding machine. To obtain a fine functional flour, the resulting flour is then sieved using a 100-mesh sieve to obtain a particle size of 149 μm. The resulting functional flour is packaged in vacuum-sealed food-grade plastic bags.

Figure 6. Milling and packing

Product Test Results

The analysis of the results was carried out using several test methods for this functional flour product. The test methods used were SNI 01-2715-1996 (Fish Meal as Feed Raw Material), SNI 01-2346-2006 (organoleptic and sensory testing instructions), and laboratory tests at the Center for Plantation Products Industry (BBIHP), as follows (Badan Standardisasi Nasional, 1996) : (National Standards Agency. 2005 & 2009)

Table 2. Product Test Results

No	Parameter	Unit	Results	SNI Quality Requirements	Test Method
1	Smell	-	Normal, Typical	Normal, Typical	Organoleptic
2	Flavor	-	Typical	Typical	Organoleptic
3	Color	-	Light and Light Brown	Light and Light Brown	Observation
4	Texture	-	Non-clumping, Dry & Smooth	Non-clumping, Dry & Smooth	Organoleptic
5	Water content	%	2,6	10–12%	SNI**01-2715-1996**
6	Ash Content	%	56,8	20–30%	SNI **01-2715-1996**
7	Protein	-	There is	AlbuminThere is	SNI**01-2715-1996**
8	Carbohydrate	-	There isn't any	There isn't any	Iodine test reaction
9	Phosphorus	%	7,42	1.6-3.2 % (Quality 1); 1.6-4.0 % (quality 2); 1.6-4.7 % (quality 3)	IK-MT-29.10 (Spectrophotometry)
10	Calcium (Ca)	%	2,43	2.5-5.0 % (Quality 1); 2.5-6.0 % (quality 2); 2.5-7.0 % (quality 3)	IK-MT-29.11 (AAS)
11	Fat Content	%	6,77	8 % (Quality 1); 10 % (quality 2); 12 % (quality 3)	SNI 01-2891-1992

The table above shows that the functional flour produced has high nutritional value based on sensory characteristics such as odor, taste, color, texture, protein, moisture content, and ash content. The phosphorus, calcium (Ca), and fat content values will serve as a reference that this research has added value to the waste from processing snakehead fish flour into functional flour that is more useful for use in processed food products (Mahardika, 2017).

DISCUSSION

The research results show that snakehead fish processing waste, including heads, skin, and bones, has significant potential to be processed into functional flour with added value. This finding reinforces the concept of utilizing agro-industrial waste into high-value products, in line with the principles of zero waste and a circular economy. The consistently high nutritional content indicates that important nutrient components such as protein, minerals, and fat are not only concentrated in the fish flesh but also distributed in other, previously underutilized, parts.

Sensory assessments by panelists indicated that the resulting functional flour had acceptable characteristics, including odor, taste, color, and texture. This demonstrates that the processing method minimized the fishy odor characteristic of fish waste and produced a product with organoleptic qualities suitable for food applications. Process factors such as heating, drying, and refining are thought to play a significant role in shaping these characteristics.

In terms of nutritional content, the relatively high presence of minerals such as phosphorus and calcium indicates that this flour has the potential to be a source of minerals to support bone health. Furthermore, its high protein content suggests potential use as a fortification ingredient in food products. This aligns with previous research indicating that fish waste, particularly bones and skin, is rich in minerals and collagen, which are beneficial for health (Lizárraga-velázquez et al., 2025).

The implications of this research extend beyond increasing the economic value of waste and also open up opportunities for developing functional food products based on local resources. With proper processing, previously underutilized waste can be transformed into high-value alternative raw materials. However, further research is needed on product stability, food safety, and application in various product formulations to ensure its widespread sustainability.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

This study demonstrates that snakehead fish processing waste, consisting of heads, skin, and bones, can be processed into functional flour with good nutritional value and sensory qualities. The applied processing process produces a product that is not only organoleptically acceptable but also has the potential to be a source of protein and minerals. Thus, the utilization of this waste has been proven to increase added value and support the principles of sustainable waste management (Rustad et al., 2014).

Recommendations

Further research on storage stability, food safety, and testing of functional flour applications in various processed products is recommended. Furthermore, optimization of the production process is necessary for industrial-scale application. Implementation of this research finding can also be encouraged through collaboration between laboratories, the food industry, and the community to increase the widespread and economically valuable utilization of fish waste.

ADVANCED RESEARCH

This study has several limitations, including its laboratory scale and the lack of stability testing during long-term storage. Furthermore, sensory testing was conducted on a limited scale, thus not fully representing consumer preferences at large. In-depth food safety aspects, such as the potential for microbiological contamination and heavy metals, have also not been comprehensively analyzed. Furthermore, variations in the formulation and application of functional flours in food products have not been further explored.

Therefore, further research is recommended to assess product stability during storage, expand sensory testing with a more diverse panel of panelists, and conduct a more comprehensive food safety analysis. Furthermore, formulation development and application testing on various processed products are needed to determine acceptance and potential for broader commercialization.

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