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Research Article

Instant broth powder of mutiara catfish (*Clarias gariepinus*) using the spray drying method as a natural flavor enhancer

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Abstract

"Dumbo" catfish is a type of catfish that is widely consumed and cultivated. It includes the mutiara catfish (*Clarias gariepinus*) growing relatively fast and having a fairly high nutritional content. It can be used as a flavor enhancer in the form of instant broth powder. This research aims to determine the formulation and best quality of instant catfish broth powder products using the Spray Drying method as a natural flavor enhancer that the public likes and follows the Indonesian National Standard. This research was started by sampling the fish and separating the meat. Then, an analysis of fish meat, including a proximate test, was prepared and continued with making broth with different recipes based on the added weight of catfish meat (in percentage) with several spices used in several formulations: 75% (F1), 70% (F2), 65% (F3), 60% (F4) and 55% (F5) by boiling and mixing all the supporting ingredients according to the predetermined formulations. Next, the drying process was carried out using the Spray Drying method, followed by an organoleptic test to obtain a chosen formula and, finally, the quality of the instant Mutiara catfish broth powder product was tested. The instant powder (F4) was the selected product based on the organoleptic test, because this formula is the most preferred product by the panelists. The results of the analysis of physical, chemical, microbiological characteristics complied with SNI 01-4218-1996 concerning broth powder. In addition, the shelf life of this product with metallized plastic packaging was 1,028.24 days.

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Introduction

Catfish contains quite high protein, low fat as well as carotene, vitamin A, phosphorus, calcium, iron, vitamin B1, vitamin B6, vitamin B12 and many amino acids. The essential amino acids in catfish have many benefits for the growth and development of children, for example bone growth and the absorption of calcium. Besides, they are also needed to balance nitrogen in the body and maintain children's body mass so that they are not too fatty (Oonincx and Finke, 2021; Buwono et al. 2022; Iswanto et al. 2015). "Dumbo" catfish is a type of catfish that is quite commonly consumed and cultivated by fish farmers, it also includes mutiara catfish (*Clarias gariepinus*) with the advantages of fast growth, size uniformity, disease resistance, salinity and relatively high tolerance to the environment (Jovantheo et al. 2022).

Flavor enhancers have a quite important role in food now. Natural flavor enhancer ingredients found in food have fairly simple chemical structures with a relatively low level of toxicity (Schrankel, 2004). Meanwhile, the drying process is a way of removing some or all of the water in the material by evaporating it through heat energy. Drying has many advantages, among others, it can make a material become more durable and smaller in volume so as to simplify and save space for transportation and packaging. On the other hand, drying has some disadvantages, namely it can affect a material in shape, physical and chemical properties, as well as cause

quality degradation (Trimedona et al. 2022; Šturm et al. 2019). One of the drying methods, quite efficient and modern, is the spray drying method. This method is quite widely used in food, pharmaceutical, biochemical and other industries, resulting in the form of powder or granules (Rajasekar and Raja, 2022).

Flavoring comes from natural ingredients, one of which comes from fish and is still rarely used, even though it is known to be a reasonably high source of protein. So that this study aims to determine the best formulation and quality of instant powder broth products using catfish with the Spray Drying method as a natural flavor enhancer that is liked by the public and following SNI.

Method

Materials and Chemicals

The materials used in this study were catfish, shallots, garlic, pepper, salt, white sugar, distilled water, filter paper, ethanol, 30% NaOH, 0.01 N HCl, 37% HCl, 98% H_2SO_4, 2% H_3BO_3, $AgNO_3$ 0.1 N, K_2CrO_4 5%, HNO_3, selenium, MgO, Hexana, PP and BCG-MR indicators, $MgCl_2$, KI, $BaCl_2$, NaCl, KCl, Butterfield's phosphate buffered solution, peptone water, DG18 agar medium, anaerobic indicator, standard acid amino, Ortho Ptaldehyde, potassium borate buffer, Na-EDTA, Sodium acetate, THF.

Physical and Chemical Characteristics of Fresh Mutiara

Physical characteristics include the average weight and length of the fish, color, aroma, taste and texture, and then organoleptic tests are carried out and the panellist's preference level (rating) to obtain a formula that the panellists like. Chemical characteristics include a proximate test consisting of a moisture content test using the gravimetric method, ash content test using the gravimetric method, protein content test using the Kjeldahl method, fat content test using the Soxhlet test, sodium chloride content test, amino acid profile test, solubility test and contamination microbial test.

The making of Mutiara catfish

This research covers the manufacture and characteristics of the instant powdered broth of Mutiara catfish (*Clarias gariepinus*) using the Spray Drying method with several formulations. The spice formulation used in this study refers to research (Pratomo and Nugroho, 2020) and (Meiyani et al. 2014). First, clean the fish from the bones and heads of catfish and add supporting ingredients in the form of shallots, garlic, pepper, sugar, salt and Maltodextrin as a thickener as much as 4% of the volume of added water (Sobri and Lestari, 2017), It was then boiled with five formulations (F), as follows: 75% (F1), 70% (F2), 65% (F3), 60% (F4) and 55% (F5), with the addition of respective supporting ingredients: 100 g shallots, 100 g garlic, 100 g salt, 20 g pepper, 2 g water and 80 g maltodextrin. The boiling was done for 30 minutes at a temperature of 100oC. Stirring was continuously done during the boiling process. The broth from the boiling was filtered. Next, the drying process was carried out using a Spray Dryer, producing broth in the form of powder.

Physical Characteristics of Pearl Catfish Powder Instant Broth

The hedonic method organoleptic test was carried out to obtain the panellist's most preferred formula from the five formulations tested. The organoleptic test in this study is the rating test, with the scoring method giving an assessment score and a ranking test which shows the panellist's most preferred product. The organoleptic test was carried out with 20 untrained panellists. The organoleptic test is carried out by sorting the samples from left to right with a specific code, and then the panellist writes the assessment on the questionnaire sheet.

Shelf-Life Product by Labuza

Determination of the shelf life of snacks was carried out using the critical moisture content model. This model estimates the shelf life of food products that are relatively easily damaged due to moisture absorption from the environment. Snacks are products that can be damaged due to the influence of moisture so that the water content increases. Product damage is caused by the absorption of moisture by the product by penetrating the packaging so that the product's water content increases and changes its texture. The moment when the product is no longer sensory acceptable indicates its expiration date. Through the equation derived by Labuza et al. (1985) regarding shelf life, several factors determine the shelf life with the critical moisture content approach. These factors are initial product moisture content (Mi), critical moisture content (Mc), equilibrium moisture content (Me), constant water vapor permeability of the packaging (k/x), and the ratio of packaging area to product dry weight (A/Ws), saturated water vapor pressure at storage conditions (Po) and slope of the isothermic sorption curve (b).

Results and Discussion

Broth is a product obtained from meat or poultry by cooking protein-rich ingredients or filtering it with or without adding seasonings or flavouring agents (SNI No. 01-4218-1996).

Physical and Chemical Characteristics of Fresh Mutiara Catfish

The physical characteristics of Fresh Pearl Catfish (*Clarias gariepinus*) include an average weight of between 750 and 900 g/head and an average length of around 60 cm/head. The fish meat which has been separated from the spines and heads has an average weight of 300-650 grams, as shown in Table 1.

Proximate testing was carried out on Mutiara catfish meat, including test parameters for water content analysis, ash content analysis, fat content analysis, protein content analysis, and carbohydrate and dietary fibre analysis. The water content of the Pearl Catfish meat is 79.35%. The high-water content in the Pearl Catfish meat indicates that the fish meat is still fresh because the water content in the ingredients determines the freshness of an ingredient (Winarno, 2004). The ash content contained in the Pearl Catfish meat is 1.07%. The fat contained in Pearl Catfish meat is 3.8%. The protein content in the Pearl Catfish is quite large, namely 19.4%. This high fat and protein content can improve taste. The carbohydrate content in the Pearl Catfish is 0.4%, and the dietary fibre content in the Pearl Catfish is 1%.

Table 1. Physical and Chemical Characteristics of Fresh Mutiara Catfish

Parameter	Characteristics of Fresh Mutiara Catfish
Average length	60 cm
Weight	750-900 g
Water	79.35%
Ash	1.07%
Protein	19.4%
Fat	3.8%
Carbohydrate	0.4%
Dietary fiber	0.99%
Amino acids	164.512 mg/kg

Table 2. Preference Level Test

Formulation	Average	Ranking
F1 : 75% pearl catfish	4.3	5
F2 : 70% pearl catfish	3.6	4
F3 : 65% pearl catfish	2.75	3
F4 : 60% pearl catfish	1.7	1
F5 : 55% pearl catfish	2.65	2

The amino acids contained in catfish meat are 164,512 mg/kg, in the form of essential amino acids and essential amino acids. The essential amino acids in pearl catfish meat are glycine, glutamic acid, alanine, proline, aspartic acid, serine and tyrosine. At the same time, the non-essential amino acids contained in pearl catfish meat are arginine, phenylalanine, leucine, lysine, threonine, valine, histidine and isoleucine. Based on the above data, it can be seen that the meat of this catfish contains rich amino acids. The relatively high content of amino acids in pearl catfish meat makes the catfish meat very tasty. It can be used as instant powdered broth as an alternative to natural flavouring.

High moisture content in Mutiara Catfish meat indicates that it is still fresh, as stated by Winarno (2004) that the moisture content in an ingredient determines the freshness of that ingredient. The protein content in Mutiara catfish is quite large, that is 19.4% and the high fat and protein contents can improve taste (Swastawati et al. 2021).

The making of Mutiara Catfish Broth

The broth was made with Five formulations and also the supporting ingredients, namely shallots, garlic, pepper and Maltodextrin. F1 was composed of 75% catfish and 25% spices; F2 was composed of 70% catfish and 30% spices, F3 was composed of 65% catfish and 35% spices, F4 was composed of 60% catfish and 40% spices, and F5 was composed of 55% catfish and 45% spices. The addition of Maltodextrin acts as a filler in the manufacture of instant broth powder and also protects against damage due to the heating during the processing and drying

(Selvira et al. 2022; Febrian, 2022; Litaay et al. 2022; Trimedona et al. 2022; Jalgaonkar et al. 2022; Kiranmai, 2022).

The boiling process with water for 30 minutes at 100^{0}C was done to produce broth. However, it could cause loss of nutrients in fish (Schrankel, 2004). It was followed by the filtering process and the filtrate obtained was dried using the Spray Drying method. Drying with the Spray Drying method is a fairly effective method for drying and preserving food. The % yield in instant Mutiara catfish broth powder, with various formulas (F1-F5). In formulas (F1-F5), the sequential yields are, as follows: 25.9, 29.7, 33.9, 31.8, and 31.3%.

Physical Characteristics of Pearl Catfish Powder Instant Broth

The organoleptic test is a test using human senses as the main tool for assessing product quality (Burt, 2004; Joesidawati et. al. 2022). The results of panelists' preference level test for instant Mutiara catfish broth powder is shown in Table 2. The higher the number, the higher the panelists' preference. The results of the ranking test showed that the composition of each formulation affected the average ranking, formulas 1 and 2 had a relatively high average value, followed by formulas 3 and 5. While formula 4 was the most preferred product by the panellists. Formula 4 was the most widely chosen formulation, and then chemical and microbiological characteristic tests were carried out with the results shown in Table 3. This table compares the test results for water, ash, protein, nitrogen, fat, carbohydrates, NaCl, solubility, amino acids, lead (Pb), Tin (Sn), Arsenic (As), Copper (Cu), ALT, and fungal yeast with SNI standard. The data shown in Table 3 shows that the formula four (F4) broth product complies with SNI standards.

Table 3. Comparison of Test Results for Chemical Characteristics of Pearl Catfish Instant Broth with SNI standards

Parameter	Unit	F4 Broth Powder	SNI 01-4218-1996 Standards
Water	%	4.6	-
Ash	%	1.42	-
Protein	%	14.8	-
Nitrogen	mg/L	23.8358	Min. 100
Fat	%	5.43	Min. 3
Carbohydrate	%	73.75	-
NaCl	%	7.32	Max. 12.5
Solubility	%	91.98	-
Amino Acids	mg/kg	82.867.98	Min. 210
Lead (Pb)	mg/kg	Not Detected - Detection Limit = 0.015	Max. 1,00
Tin (Sn)	mg/kg	Not Detected - Detection Limit = 0.03	Max. 150
Arsenic (As)	mg/kg	Not Detected - Detection Limit 0.01	Max. 1
Copper (Cu)	mg/kg	Not Detected - Detection Limit 0.027	Max. 20
ALT	CFU/g	$3x10^{-1}$	-
Yeast Mold	Negative	Negative	Negative

The determination of the water content in the instant Mutiara catfish broth powder sample was to find out the limit or maximum range of water content in the sample as the water content affects the purity or product resistance to contaminants (Joesidawati et al. 2022; Khalifah et al. 2022; Buwono et al. 2022). The water content in the sample was 4.6%. The ash content in the material is a mineral or inorganic substance contained in the food; and the ash content in instant catfish broth powder was 1.43%.

The determination of protein and total nitrogen contents aimed to determine the amount of protein content in this sample because during the processing and drying some protein could be lost. The protein content was 14.8% with a total nitrogen content of 23835.8 mg/L. The determination of fat content applied the Weibull method, a method of determining fat content through a hydrolysis process in an acidic environment. The high or low fat content in the sample could be caused by the supporting materials used. The fat content obtained in this research was 5.43%. Moreover, carbohydrate content can be done with the by difference method where calculations are carried out by adding up the macro compounds in food ingredients such as water, ash, protein and fat contents by subtracting 100%. The sample carbohydrate content obtained was 73.75% (Oonincx and Finke, 2021; Iswanto et al. 2015).

The analysis of sodium chloride content was made to find out its amount in the sample, which was 7.32%. While, the solubility of the powder mass in water is usually influenced by the water content of the material to be tested (Huang et al. 2022). The greater the solubility is, the faster a product dissolves in water. In the catfish sample, a solubility of 91.98% was obtained. There was no heavy metal contamination in the sample because the results of the analysis showed that the metal content was less than the detection limit for each metal.

Heavy metal contamination in food is generally caused by the processing, from the beginning to the end of it and the contamination from the tools or the raw materials used are contaminated with heavy metals. There was no metal contamination in the sample. In addition, a microbial analysis aims to determine the microbiological quality of a food ingredient. The Total Plate Count in the sample was 3x10-1 cfu/25 gram. The tests for mold and yeast on the instant Mutiara catfish broth powder were negative. The results can be seen in table 3 and they meet the requirements of SNI 01-4218-1996.

Table 4. Amino Acid Contents in Mutiara Catfish Instant Broth Powder

No	Amino Acids	Results (mg/kg)
Essential Amino Acids		
1	Glycine	7401.965
2	L- Glutamic Acid	8425.330
3	L- Alanine	4484.880
4	L-Proline	3329.225
5	L-Aspartic Acid	5075.735
6	L-Serine	2794.910
7	L-Tyrosine	872.970
Non-Essential Amino Acids		
8	L- Arginine	4948.275
9	L- Phenylalanine	1960.805
10	L- Leucine	2971.205
11	L- Lysine	4706.825
12	L- Threonine	3144.305
13	L- Valin	2101.365
14	L- Histidine	1090.725
15	L- Isoleucine	1559.455
	Total	54867.975

Table 5. Shelf life of Instant Mutiara Catfish Broth Powder

Factor in the critical water approach	θ (Shelf life)
Initial moisture content (g H_2O/ g solid)	0.0483
Critical moisture content (g H_2O/ g solid)	0.0931
Curve slope	0.2836
Packaging permeability (g/m2hr.mmHg)	0.0037
Product moisture content in RH storage (g H_2O/solid)	0.2283
Product dry weight (g)	9.973
Saturated water vapor pressure (mmHg)	28.349
Packaging area(m2)	0.0075
Days	1,028.24
Months	33.6
Years	2.8

An amino acid profile test was carried out on instant Mutiara catfish broth powder to find out how much amino acid content was present in it because amino acids are also flavor enhancing agents, one of which is glutamic acid. It also contained lysine, glycine and alanine which enhanced the broth's delicious taste. Other amino acids were found such as alanine, proline, and arginine which also play a role in the taste development of the instant Mutiara catfish broth powder. The results of the analysis of the amino acid profile are presented in Table 4. The determination of sample shelf life was carried out using the critical moisture content method. This method is suitable for food products that are easily damaged due to absorption of increased moisture content from the environment.

Initial Moisture Content (Mi) and Critical Moisture Content (Mc)

Initial moisture content is the water content possessed by a product immediately after it is produced and ready to be marketed. Meanwhile, the critical moisture content is the water content when the product does not meet the acceptance criteria. In table 4 below, it is shown that the initial moisture content (Mi) in instant Mutiara catfish broth powder is 0.0483% and the critical moisture content (Mc) 0.0931 %.

Equilibrium Moisture Content (Me)

Equilibrium moisture content is the water vapor content in equilibrium with its environment and when the product has experienced a constant weight, based on the moisture sorption isotherm for instant Mutiara catfish broth powder product, the water content can be obtained. Several RH conditions are needed to create an equilibrium curve (Me) at 70% RH storage.

Moisture Sorption Isotherm

Moisture Sorption Isotherm is a curve describing the relationship between water activity (AW) or the equilibrium relative humidity (ERH) in the storage room with the water content per gram of a food ingredient (Huang et al. 2022). This was done by conditioning the samples at various levels of water activity (AW) using saturated salts, namely NaOH, KI, $MgCl_2$, NaCl, KCl and $BaCl_2$ at 28^0C. The isothermal curve is obtained by plotting the resulting equilibrium moisture content with the water activity values presented in the Fig.-1; the sorption isotherm used various saturated salts with RH conditions from lowest to highest.

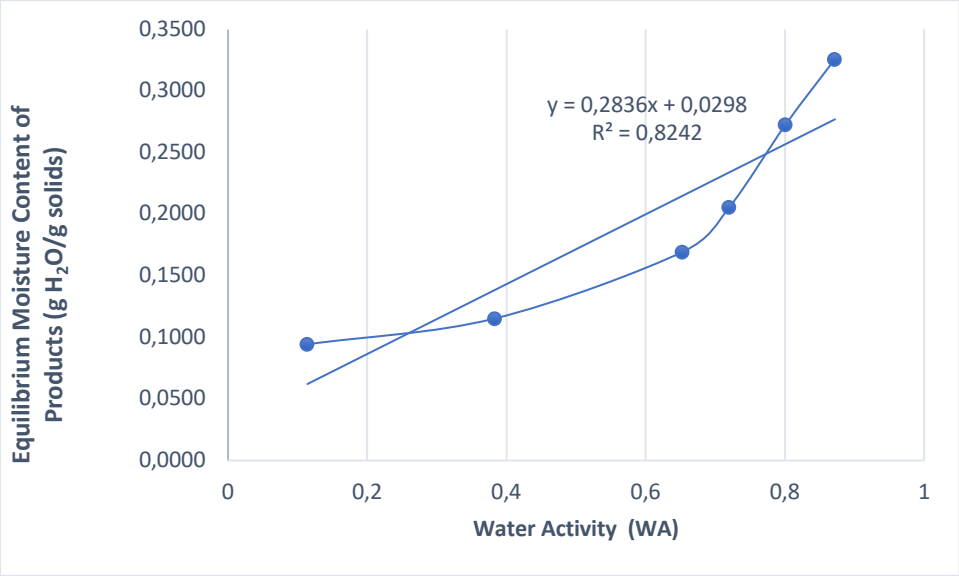

Fig.-1. Water Absorption Isothermic Curve

Packaging Moisture Permeability

Moisture permeability of packaging (k/x) is the transmission speed/rate of differences in water vapor pressure units between the surface of a product and its environment at a certain temperature and humidity (Montero-Prado and Morales, 2022; Fairey and Hiltz, 2019; Bauer et al. 2022; Ibrahim et al. 2022). The packaging used was metallized plastic. The surface area of the package was 0.0075 m2, with a ΔW/ΔΘ (g/m2.day) value of 0.0006, and a Po (mmHg) value of 21.403 so that a k/x value (g/m2.day.mmHg) was obtained, namely 0.0037.

Shelflife Estimation of Instant Mutiara Catfish Broth Powder

Based on the theory of Labuza (1985) the shelf life of a packaged product is predicted based on the theory of product diffusion or absorption. Shelf life can be determined based on several factors in the critical moisture approach. The factors of this approach are initial product moisture content (Mi), critical moisture content (Mc), equilibrium moisture content (Me), constant water vapor permeability of the package (k/x), ratio of packaging area to product dry weight (A/Ws), saturated water vapor pressure at storage conditions (Po) and the slope of the sorption isothermal curve (b). The theory is described in a mathematical equation as follows: $\theta = [ln\ (Me - Mi)\ /\ (Me - Mc)]\ /\ [\ k/x.(A/Ws).\ Po/b]$. Shelflife calculation data is presented in Table 5. The calculation results show that the shelf life of instant Mutiara catfish broth powder with metallized plastic packaging is 2.8 years (1.028 days).

Conclusion

Pearl catfish meat has a relatively high nutritional content, namely a protein content of 19.4%, fat content of 3.8%, the carbohydrate content of 0.4%, a dietary fibre content of 1%, a moisture content of 79.35%, ash content of 1.07% and a reasonably high amino acid, namely 164512 mg/kg, which causes a savory taste in the pearl catfish meat. The best formulation is instant catfish broth powder with a ratio of 60% catfish to 40% supporting

ingredients, namely Formula F4. The chemical characteristics of this catfish instant powder broth have a water content of 4.6%, ash content of 1.43%, fat content of 5.41%, the protein content of 14.80%, a sodium chloride content of 7.32%, total amino acids of 54867, 97 mg/kg, metal contamination of Pb, Sn, As and Cu were not detected, the total plate count was 3x10-1, and the solubility of powder broth was 91.98%. The characteristics of instant catfish broth powder formula F4 comply with SNI 01-4218-1996. The shelf life of F4 pearl catfish, instant powder broth, packaged in metallized plastic packaging, is 2.8 years (1028.24 days) at room temperature 25^{0}C.

Conflict of Interests

The author (s) declares that there is no conflict of interest in this research and manuscript.

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