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Chemical Characterization of Powdered Broth from the Use of Catfish Head Extract and Mulberry Fruit

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A B S T R A C T

One dried product that can enhance flavor in various food products is powdered broth. Glutamic acid is the main compound responsible for the umami taste in powdered broth products. This compound is naturally present in raw materials such as patin fish heads and mulberry fruit, which were used as the main components in this study. This research aimed to examine how different amounts of patin fish head extract and mulberry fruit liquid, along with varying levels of maltodextrin, affect the qualities of the powdered broth produced. The study employed a completely randomized design (CRD) with a two-factor factorial pattern. The first factor was the ratio of patin fish head extract to mulberry filtrate (1:2, 1:1, and 2:1), and the second factor was maltodextrin concentration (10%, 15%, and 20%). We analyzed the data using 5% ANOVA, and if we found significant differences, we proceeded with DMRT tests. The results indicated that the optimal treatment was the extract ratio of patin fishhead to mulberry (2:1) with a 10% maltodextrin addition. The resulting powdered broth had a moisture content of 14.80%, ash content of 1.88%, fat content of 6.08%, protein content of 12.06%, carbohydrate content of 66.41%, and yield of 12.56%.

Contribution to Sustainable Development Goals (SDGs):
SDG 2: Zero Hunger
SDG 3: Good Health and Well-Being
SDG 9: Industry, Innovation, and Infrastructure
SDG 12: Responsible Consumption and Production

1. INTRODUCTION

1.1. Research Background

Flavor enhancers are Food Additives (BTP) that function to enhance food taste, such as umami, sweet, sour, or salty [1]. They are divided into two categories: natural and synthetic. Natural flavor enhancers are derived from animals or plants through physical, enzymatic, or microbiological processes, whereas synthetic enhancers are produced through chemical reactions from natural or mineral sources [2].

One of the most commonly used flavor enhancers is monosodium glutamate (MSG), a sodium salt of glutamic acid, which contains around 78.2% glutamate that imparts a savory flavor [3]. However, excessive use of MSG has been linked to various health risks such as nerve cell damage, obesity, and organ function disorders. Therefore, it is necessary to develop safer and more natural alternatives [4] [5].

Patin fish head and mulberry fruit are promising candidates for natural flavor enhancers. Patin fish head, considered fish

waste, is still rich in nutrients, particularly protein (84.85%) and glutamic acid [6]. Mulberry fruit *(Morus spp.)* contains bioactive compounds like anthocyanins, phenols, vitamins, and amino acids, which can provide both sensory and functional benefits [7] [8]. The combination of patin fish head and mulberry may yield a natural flavor enhancer that enhances taste and aroma, improves nutritional value, and supports waste utilization and sustainability in the food industry.

Based on this background, this study aimed to produce powdered broth using patin fish head extract and mulberry filtrate with added maltodextrin. The resulting product was analyzed for moisture, protein, ash, carbohydrate content, and yield.

1.2. Literature Review

According to Permenkes No. 33 of 2012, flavor enhancers are defined as food additives that enhance the existing taste and aroma of food without introducing new ones [1]. Excessive MSG use is associated with health problems like hypertension, cognitive impairment, nerve damage, obesity, and even organ disorders [4] [5]. As a result, consumers tend to favor natural flavor enhancers that are healthier and contain additional nutrients from spices and herbs [9] [10].

Patin fish *(Pangasius hypophthalmus)* is a natural source of glutamic acid, containing up to 20.4%, higher than milkfish, which has only 7.38% [11] [12]. The high content of essential and non-essential amino acids like lysine, arginine, and glutamate contributes to its umami flavor [13]. Additionally, it offers health benefits such as preventing stunting and improving immunity [14].

Mulberry fruit contains about 20% glutamic acid, much more than tomatoes (0.313%), along with up to 21.39% protein, anthocyanins, flavonoids, vitamin C, and phenolic acids, which provide antioxidant and anti-inflammatory properties [7] [15] [16] [17] [18].

The foam mat drying method was chosen due to its efficiency in preserving sensory and nutritional qualities. Drying was conducted at 60°C for 4 hours to maintain phenolic compounds and minimize degradation [19]. Maltodextrin plays a role in protecting bioactive compounds and forming powder texture by binding water and stabilizing flavor [20]. Given its high glutamate, protein, and bioactive compound content, along with the proper drying and filler methods, this product shows potential as an innovative food industry flavoring that supports both health and the environment.

1.3. Research Objective

To determine the effect of the ratio between patin fish head extract and mulberry fruit filtrate with added maltodextrin on the characteristics of the resulting broth powder.

2. MATERIALS AND METHODS

2.1 Materials

Patin fish heads were obtained from Asemrowo District, and mulberry fruits from local farmers in Malang Regency. Additional materials used included food-grade maltodextrin and egg whites. Other reagents used were aquadest, Na_2CO_3, H_2SO_4, Kjeldahl catalyst tablets, NaOH, and HCl.

2.2 Methods

The study used a Completely Randomized Design (CRD) with two factors and two replications. Factor I: Ratio of patin fish head extract to mulberry filtrate 1:2 (A1), 1:1 (A2), and 2:1 (A3). Factor II: Maltodextrin concentration — 10% (B1), 15% (B2), and 20% (B3). Data were analyzed using ANOVA to determine significant differences. If significant, Duncan's Multiple Range Test (DMRT) was used at the 5% significance level.

2.3 Production of Powdered Broth from Patin Fish Head Extract and Mulberry Fruit Filtrate

Mulberry concentrate was prepared by washing, blanching at 80°C for 20 minutes, blending, and filtering the fruit. Patin fish heads were washed, chopped, and blanched at 80°C for 60 minutes, then filtered to obtain the extract. Both extracts were mixed with 30 mL egg white and maltodextrin (as per treatment), stirred for 20 minutes to form foam, poured into 30×30 cm trays (1–5 mm thick), and dried at 60°C for 4 hours using a cabinet dryer. The dried foam was ground and sieved (60 mesh) into fine powder.

3. RESULT AND DISCUSSION

3.1. Chemical Characteristics of Powdered Broth

The chemical characteristics of the powdered broth made from patin fish head extract and mulberry filtrate were determined through proximate analysis, including moisture content, ash, protein, carbohydrates, and yield, as presented in Table 1.

3.1.1. Moisture Content

The average moisture content of the powdered broth made from patin fish head and mulberry fruit ranged from 8.27% to 16.70%. The treatment with a 1:2 ratio of patin fish head extract to mulberry filtrate and the addition of 10% maltodextrin resulted in the highest moisture content at 16.70%, while the treatment with a 2:1 ratio and the addition of 20% maltodextrin produced the lowest moisture content at 8.27%.

The addition of mulberry filtrate tended to increase the moisture content, whereas patin fish head extract and maltodextrin decreased it. The rise in moisture content was due to the mulberry fruit's higher water content (90.32%) compared to the patin fish head (74.71%). In contrast, the decrease in moisture was associated with the increased proportion of patin extract, which is rich in protein, fat, and gelatin components that can bind water and reduce the amount of free water in the product [21] [22]. Additionally, the incorporation of maltodextrin contributed to lower moisture content in the broth powder by increasing the total solids, thereby accelerating the evaporation process and producing a product with lower moisture content within the same drying duration [23] [24] [25].

3.1.2. Ash Content

The average ash content of the powdered broth made from patin fish head and mulberry fruit ranged from 1.06% to 1.53%. The treatment with a 2:1 ratio of patin fish head extract to mulberry filtrate resulted in the highest ash content at 1.53%, while the 1:2 ratio treatment yielded the lowest ash content at 1.06%.

Increasing the ratio of patin fish head and decreasing the proportion of mulberry fruit can raise the ash content of the broth powder, as patin fish head contains gelatin and high levels of

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inorganic minerals such as calcium, phosphorus, magnesium, and potassium [24]. Ash content is also influenced by the type of raw material, temperature, duration, and the ashing method used. A lower concentration of maltodextrin may increase ash content, as most minerals are derived from the raw materials, while maltodextrin contributes very little mineral content and increases the total dry solids, thereby reducing the relative mineral proportion. [20] [26].

Table1. Proximate Analysis Results and Yield of Powdered Broth

Procedure		Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Yield (%)
Patin Extract and Mulberry	Maltodextrin (%)						
1:2	10	16.70 ± 0.17^{f}	1.34 ± 0.35	2.35 ± 1.81	11.47 ± 0.26^{cd}	68.13 ± 1.72	$10.75 \pm 0,29$
	15	14.33 ± 0.12^{d}	1.14 ± 0.22	1.03 ± 1.33	9.47 ± 0.53^{b}	74.01 ± 1.51	$15.13 \pm 0,32$
	20	10.62 ± 0.06^{b}	0.70 ± 0.34	0.70 ± 0.18	8.49 ± 0.11^{a}	79.47 ± 0.58	$17.72 \pm 0,96$
1:1	10	15.87 ± 0.12^{e}	1.44 ± 0.35	3.44 ± 0.02	11.77 ± 0.05^{de}	67.45 ± 0.39	$13.77 \pm 0,96$
	15	12.55 ± 0.40^{c}	1.44 ± 0.01	2.66 ± 0.64	11.23 ± 0.07^{c}	72.10 ± 1.10	$12.91 \pm 0,17$
	20	10.47 ± 0.09^{b}	1.06 ± 0.00	1.16 ± 0.39	8.62 ± 0.06^{a}	78.67 ± 0.55	$13.79 \pm 0,29$
2:1	10	14.59 ± 0.33^{d}	1.87 ± 0.02	5.06 ± 1.26	12.05 ± 0.04^{e}	66.41 ± 0.90	$12.56 \pm 0,10$
	15	10.71 ± 0.33^{b}	1.45 ± 0.00	2.97 ± 0.18	11.38 ± 0.03^{cd}	73.46 ± 0.19	$11.54 \pm 0,40$
	20	8.27 ± 0.19^{a}	1.28 ± 0.0	5.47 ± 1.02	9.89 ± 0.09^{b}	75.08 ± 0.92	$15.78 \pm 0,29$

3.1.3. Fat Content

The average fat content of powdered broth from patin fish heads and mulberry fruit ranges from 1.36% to 4.50%. The treatment with an extract ratio of patin fish heads to mulberry fruit (2:1) resulted in the highest fat content of 4.50%, while the treatment with an extract ratio of patin fish heads to mulberry fruit (1:2) resulted in the lowest fat content of 1.06%. Increasing the amount of patin fish head extract and decreasing the mulberry fruit extract can increase the fat content of the powdered broth due to the high fat content of the patin fish, where the greater the proportion, the higher the fat content of the product [27]. The addition of maltodextrin does not have a significant effect on the fat content of the powdered broth because maltodextrin does not contain fat and does not directly contribute to the fat content of the product, which is more influenced by the main ingredients, such as patin fish heads [28].

3.1.4. Protein Content

The average protein content of powdered broth from patin fish heads and mulberry fruit ranges from 12.05% to 8.49%. The treatment with an extract ratio of patin fish heads to mulberry fruit filtrate (2:1) with the addition of 10% maltodextrin produced the highest protein content of 12.05%, while the treatment with an extract ratio of patin fish heads to mulberry fruit filtrate (1:2) with the addition of 20% maltodextrin produced the lowest protein content of 8.49%.

Increasing the amount of patin fish head extract tends to increase the protein content, whereas increasing the mulberry fruit filtrate and maltodextrin causes a decrease in protein content. The increase in protein content of the powdered broth is due to the addition of patin fish, which is rich in protein (15.43%) compared to mulberry (2.65%), and contains essential amino acids, fats, and minerals that significantly enrich the nutritional value of the product [24]. The addition of maltodextrin reduces the protein content of the powdered broth because processing at high temperatures causes protein denaturation [29]. The decrease in protein content is caused by side effects during processing, where proteins dissolve along with other components.

This also applies to the decrease in moisture content; the longer the drying time, the lower the moisture content [30]. The measured protein value can be influenced by the amount of water lost (dehydration) from the material [31].

3.1.5. Carbohydrate Content

The average carbohydrate content of powdered broth from patin fish heads and mulberry fruit ranges from 71.65% to 73.87%. The treatment with an extract ratio of patin fish heads to mulberry fruit (1:2) resulted in the highest carbohydrate content of 73.87%, while the treatment with an extract ratio of patin fish heads to mulberry fruit (2:1) resulted in the lowest carbohydrate content of 71.65%.

The carbohydrate content of the powdered broth is influenced by the calculation method, which is done by difference, thus depending on the composition of other nutrients. The higher the addition of maltodextrin, the higher the carbohydrate content in the product, since maltodextrin is a hydrolyzed starch composed of short-chain glucose molecules and classified as a carbohydrate, thereby directly contributing to the increase in total carbohydrates [32].

3.1.6. Yield

The average yield of powdered broth from patin fish heads and mulberry fruit ranges from 13.88% to 16.21%. The treatment with the addition of 20% maltodextrin resulted in the highest yield of 16.21%, while the treatment with the addition of 10% maltodextrin produced the lowest yield of 13.88%.

Increasing the extract of patin fish heads and decreasing the proportion of mulberry fruit can reduce the yield of the powdered broth because patin fish has high moisture and fat content, which causes mass loss during drying, whereas the drier mulberry fruit can help increase the yield. Conversely, the addition of maltodextrin increases the yield because it functions as a filler material that increases total solids and adds to the final product weight [33][34][36].

4. CONCLUSION

Powdered broth is a dried product that can be used as a flavor enhancer in various food products. The main compound contributing to the savory taste in powdered broth is glutamic acid, which is naturally abundant in patin fish and mulberry fruit

as the main ingredients. The research results show that the combination treatment with an extract ratio of patin fish heads to mulberry fruit filtrate (2:1) with the addition of 10% maltodextrin produces powdered broth with optimal treatment based on its chemical characteristics. Analysis results indicate that powdered broth from patin fish heads and mulberry fruit contains 14.80% moisture, 1.88% ash, 6.08% fat, 12.06% protein, 66.41% carbohydrate, and 12.56% yield.

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