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CHEMICAL CHARACTERISTICS OF A NATURAL FLAVORING AGENT MADE FROM SQUID HEAD FLOUR (*Loligo* sp.) USING A FOOD DEHYDRATOR

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ABSTRACT

Squid heads are typically discarded and treated as waste. They contain protein and glutamic acid, which have potential as natural flavor enhancers. Utilizing squid head waste as a flavor enhancer is a solution for managing fish waste and hence can be used as an alternative to replace synthetic flavor enhancers. The objective of this study is to observe the chemical composition of a natural flavor enhancer made from squid head waste flour with addition of maltodextrin as filler, and then dried using a food dehydrator. The research method used in this study is a laboratory experiment employing a Completely Randomized Design (CRD) with 4 treatments and 3 replicate, varying the addition of squid head flour and maltodextrin. The amount of squid head flour for each treatment is P1 (15 g), P2 (30 g), P3 (45 g), and P4 (60 g). Maltodextrin was added at 2.5% of the total ingredient weight for each treatment: P1 (1 g), P2 (1.375 g), P3 (1.75 g), and P4 (2.125 g). The food dehydrator was set to 60°C for 40 hours. The chemical analysis included protein, glutamic acid, and moisture content. The results showed that the highest protein content was found in P3 (39.60%) and the lowest in P1 (23.58%). The lowest moisture content was found in P4 at 5.16%. The moisture content results did not meet the requirements of SNI 01-4273-1996 (beef flavor enhancer), which specifies a maximum value of 4%. Meanwhile, the highest glutamic acid content was found in P3 (3.52%) and the lowest in P1 (1.93%).

Keywords: Glutamic Acid; Maltodextrin; Flavor Enhancer; Squid Head

INTRODUCTION

Flavor enhancers are food additives used to impart savory, delicious, and appealing flavors (Rahmah *et al*., 2023). There are two types of flavor enhancers: natural and synthetic. The use of synthetic flavor enhancers has a drawback: long-term consumption can lead to health problems. The use of synthetic flavor enhancers remains a subject of debate in society, with debate over their pros and cons and the potential side effects that may arise from excessive consumption. Additionally, the use of synthetic flavor enhancers continues to rise year after year. A report from the Indonesian Association of Monosodium Glutamate and Glutamic Acid Manufacturers (P2MI) states that MSG consumption in Indonesia has increased from 100,568 tons to 122,966 tons, estimated at 1.53 g per capita per day (Arapa et al., 2023). This has driven the development of natural flavor enhancers in Indonesia, which have the potential to replace the steadily rising consumption of synthetic flavor enhancers.

Natural flavor enhancers can be obtained from fishery food resources. Previous studies have reported that mackerel (Novianti, 2020), milkfish (Lichafuddin & Ainiyah, 2024), mud crab shells (Yonata *et al*., 2021), and mackerel hydrolysate and byproducts of fishery products (Djohar *et al*., 2018) can be used as flavor enhancers. This is because marine food ingredients contain free amino acids (FAAs), including glutamate (Glu), which produce the umami taste (Coleman *et al*., 2024).

Squid is a fishery commodity with significant potential. According to catch data reports from the Cilacap Oceanic Fishing Port (PPSC), squid catches have increased by 2,050.5 tons since 2017. Squid processing still leaves behind unused waste, namely the heads. Squid heads account for 20–30% of the total body weight of squid (Simanjuntak *et al*., 2019). Processing squid heads into useful products is necessary to achieve zero waste.

According to a study by Kristiningsih *et al*. (2024), the composition of squid head flour consists of water (4.08%), ash (5.78%), fat (4.91%), protein (63.98%), and fiber (1.97%). The primary component of squid head flour is protein, which is composed of amino acids as its building blocks. The most abundant amino acid is glutamic acid, which stimulates taste receptors on the human tongue and is widely used in the flavor enhancer industry (Coleman *et al*., 2024). Given this potential, squid head waste flour can be utilized as a natural flavor enhancer.

One factor influencing the quality of flavor enhancers is the manufacturing method, specifically the drying method used (Prasetyaningsih *et al*., 2018). The drying method considered to have low production costs and be the easiest to implement involves adding maltodextrin (Amini & Susanto, 2023). The addition of maltodextrin aims to prevent heat-induced damage to ingredients, accelerate drying, and protect flavor components (Assalam *et al*., 2022; Novitasari *et al*., 2021). Drying with the addition of maltodextrin can produce products with preserved nutritional quality and a long shelf life (Khatri *et al*., 2024).

Based on the above discussion, data on flavor enhancers derived from squid head waste flour are not yet available. Therefore, this study aims to evaluate a flavor enhancer product made from squid head waste flour, produced by drying with a food dehydrator and adding maltodextrin. The quality of the flavor enhancer was analyzed based on its chemical composition, specifically protein, glutamic acid, and moisture content.

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RESEARCH METHOD

Time and Location of the Study

The production of squid head flavor enhancer was carried out at the Agoindustry Product Development Analysis Laboratory, Cilacap State Polytechnic. Analyses of glutamic acid content, protein content, and moisture content were conducted at the Chem Mix Pratama Laboratory in Yogyakarta.

Research Design

The research method used was a laboratory experiment employing a completely randomized design (CRD) with 4 treatments and 3 replicates, varying the concentration of squid head flour and maltodextrin added (Novitasari *et al*., 2021). The amount of maltodextrin added to each treatment was 2.5% of the total ingredients used (excluding distilled water), as reported by by Meiyani *et al*. (2014).

Preparation of Raw Material Flours

The process of making squid head seasoning begins with preparing squid head flour, shallot flour, and garlic flour. The flour preparation method is based on that of Rahmah *et al*. (2023), with modifications. Fresh squid is weighed, and the heads are separated. The squid heads are washed thoroughly and then weighed. Red onions and garlic are washed thoroughly, then weighed and sliced thinly. The squid heads, red onions, and garlic are then dried using a food dehydrator at 70°C for 19 hours. After drying, the squid heads, red onions, and garlic are ground into a fine powder, then sifted using a 70-mesh sieve and weighed. The yield of the resulting flour was then calculated using the formula: (weight of the final product (g) divided by the initial weight of the ingredients (g)) multiplied by 100% (Novitasari *et al*., 2021). The three flours were then mixed with other ingredients, namely maltodextrin, salt, pepper, and distilled water.

Product Formulation and Manufacturing Procedures

The formulation of the flavor enhancer made from squid waste flour is based on modified versions of the studies by Ilma *et al*. (2024) and Meiyani *et al*. (2014). The formulation of the flavor enhancer used in this study is presented in Table 1.

Table 1. Flavor Enhancer Formulation from Squid Head Waste Flour

	P1	P2	P3	P4
Squid Head Flour (g)	15	30	45	60
Maltodextrin (g)	1	1.375	1.75	2.125
Red Onion Flour (g)	15	15	15	15
Garlic Powder (g)	5	5	5	5
Salt (g)	3	3	3	3
Pepper (g)	2	2	2	2

Each ingredient was weighed for each treatment, and 60 mL of distilled water was added to each. Maltodextrin was added at a concentration of 2.5% of the total ingredients used in each treatment. The solution was then stirred for approximately 15 minutes and dried in a food dehydrator at 60°C for 40 hours (Rahmah *et al*., 2023). The resulting squid head flavoring powder was then analyzed for glutamic acid, protein, and moisture content.

Chemical Character Analysis

Protein content was analyzed using the micro-Kjeldahl method (Amini & Susanto, 2023), which consists of three steps: digestion, distillation, and titration. The titration step used 0.02 N HCl. The titration ended when the color changed from blue to pink. The titrant volume was then calculated using Equation 1.

$$\frac{Titration\ Volume\ x\ N\ HCL\ (0.02\ N)\ x\ (14.008)}{Sample\ Weight\ (mg)} x\ 100\% \quad (1)$$

The protein content is calculated using the formula: protein content (%) = nitrogen content × 6.25.

The glutamic acid concentration was determined by ninhydrin spectrophotometry. The first step was to prepare a filtrate by dissolving 1 g of the sample in 100 mL of distilled water. The filtrate was then filtered, and 2 mL of ninhydrin reagent was added. The sample was then heated at 50°C for 30 minutes, cooled, and 96% ethanol was added until the volume reached 10 mL. The next step is to identify the sample's hydrolysis products using a spectrophotometer at 520 nm. The results from the spectrophotometer are then substituted into Equation 2 (Amini & Susanto, 2023).

$$\%\ Glutamic\ Acids = \frac{X\ x\ Dilution\ Factors}{Sample\ Weight\ (mg)} x\ 100\% \quad (2)$$

The moisture content was determined according to AOAC, 2005 (Novitasari *et al*., 2021). An empty dish was heated in an oven for 15 minutes, then cooled in a desiccator for 30 minutes, and finally weighed. A 2-g sample in a dish was heated in an oven for 4 hours at 105–110°C. After that, the dish was cooled in a desiccator and weighed again. The percentage moisture content was calculated using the following equation: initial sample weight (g) minus final sample weight (g) divided by initial sample weight (g) multiplied by one hundred percent.

The data from the glutamic acid, moisture content, and protein content tests were then processed and statistically analyzed using an ANOVA test in SPSS. If significant differences were found, the analysis was followed by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Flour Yield from Raw Materials

The yield of garlic flour is higher than that of shallot flour because garlic has a lower moisture content than shallots. Garlic yields 60.9–67.8% (Husna *et al*., 2017), while shallots yield 80–85% (Mutia *et al*., 2014). The yield values of the materials used in the production of the squid head flavor enhancer are presented in Table 2. Descriptively, the resulting squid head flavor enhancer has a light brown color, a smooth texture, and a characteristic squid aroma. The appearance of the squid head flavor enhancer is shown in Figure 1. The results of the chemical composition analysis of the squid head flavor enhancer are shown in Table 3.

Table 2. Yield Value of Ingredients in Squid Head Seasoning

Material	Initial Weight (g)	Final Weight (g)	Yield (%)
Squid heads	1924	183.04	9.51
Red onion	1000	86.05	8.60
Garlic	1000	156.09	15.60

Figure 1. Flavor Enhancer Made from Squid Heads

Table 3. Chemical Analysis Results of Squid Heads as a Flavoring Agent

Treatment	Protein Content (%)	Moisture Content (%)	Glutamic Acid Content (%)
P1	23.58±0.04a	6.84±0.05a	1.93±0.003a
P2	30.79±0.08b	6.08±0.02b	3.36±0.003b
P3	39.6±0.15c	5.69±0.04c	3.52±0.005c
P4	38.38±0.03d	5.16±0.03d	3.06±0.003d

Protein Content

Protein content is one of the determining factors in food product quality. Test results for protein content in flavor enhancers derived from squid heads showed an increase from P1 to P3, but a decrease from P3 to P4. The decrease in protein content from P3 to P4 is suspected to be due to dilution by non-protein components. Additionally, prolonged heating may cause structural damage to proteins in denser samples. The decrease in protein content may be influenced by the addition of maltodextrin in certain amounts. Maltodextrin is a product of hydrolysis, either chemical or enzymatic, derived from starch (Siska Tresna & Susanto, 2015). The acidic nature of maltodextrin promotes protein hydrolysis, leading to protein denaturation (Novitasari *et al*., 2021).

According to a study by Kristiningsih *et al*. (2024), the composition of squid head flour consists of water (4.08%), ash (5.78%), fat (4.91%), protein (63.98%), and fiber (1.97%). The primary component in squid head flour is protein, which consists of amino acids (Wulandari D.A., 2018). The protein content in the squid head flavor enhancer meets the protein standards for flavor enhancers. For comparison, SNI 01-4273-1996 (beef flavor enhancer) requires a minimum protein content of 7%, whereas the lowest protein content in the squid head flavor enhancer was found in P1 at 23.58%. The protein content of the squid head flavor enhancer is lower than that of squid head flour. This may be due to the two drying processes: during flour production and during flavor enhancer drying. Another factor is the relatively long drying time. Drying at excessively high temperatures can cause protein denaturation, thereby reducing protein content (Fauzy *et al*., 2016).

Moisture Content

The results of moisture content tests on the flavor enhancer made from squid heads show that as the amount of squid head flour and maltodextrin added increases, the moisture content decreases. The lowest moisture content was 5.16% in P4, and the highest was 6.84% in P1. These moisture content results do not meet the requirements of SNI 01-4273-1996, which stipulates a maximum moisture content of 4%. The reason the moisture content remains relatively high is the hygroscopic nature of maltodextrin, which can absorb water (Erfianti *et al*., 2022). Additionally, the high protein and carbohydrate content in P4 causes water to become trapped and difficult to evaporate at 60°C within the dehydrator system (Trisnawati *et al*., 2015).

For comparison, according to Tamaya *et al*. (2020), powdered food products with a moisture content below 10% are considered to be of good quality. Moisture content is a critical parameter in food products. It determines both the quality and shelf life of food items. The activity of spoilage microorganisms in food is directly influenced by its moisture content. Higher moisture levels in food facilitate microbial growth (Fauzy *et al*., 2016). This, in turn, shortens the product's shelf life. Moisture content also affects product quality, such as texture and consumer acceptance (Yuwana *et al*., 2022). Research findings indicate that the addition of maltodextrin affects the moisture content of squid head flavor enhancers. The more maltodextrin added, the lower the moisture content becomes. Maltodextrin can accelerate the evaporation process. The moisture content of food ingredients can decrease during the drying process. Higher drying temperatures result in flavor enhancer powder with lower moisture content and greater hygroscopicity (Almira *et al*., 2024).

Glutamic Acid Content

The glutamic acid content of food ingredients produces the savory, or umami, flavor. Glutamic acid is an amino acid that occurs naturally in food ingredients (Pramudya *et al*., 2022). The glutamic acid content of the squid heads used as a flavor enhancer ranged from 1.93% to 3.52%, with the lowest value in P1 (1.93%) and the highest in P3 (3.52%). Glutamic acid levels increased from P1 to P3 and decreased in P4. This may be due to high temperatures, which can trigger the Maillard reaction. The Maillard reaction is a reaction between amino acids and reducing sugars such as glucose and fructose that occurs at high temperatures (Rina *et al*., 2021). This reaction can lead to the loss of some essential amino acids and to a reduction in nutritional value.

The glutamic acid content is directly proportional to the flavor-enhancing protein content (Diode *et al*., 2021). The addition of maltodextrin can increase carbohydrate and mineral content, thereby increasing glutamic acid levels (Meiyani *et al*., 2014). The glutamic acid content in treatment P4 may be attributed to the drying temperature and duration. A study by Amini & Susanto (2023) reported that drying at 50°C resulted in higher glutamic acid levels than at 60°C or 70°C. The drying temperature and duration used will result in structural changes caused by broken bonds (Amini & Susanto, 2023). Compared to the results of a study by Ilma *et al*. (2024) on flavor enhancers from a combination of shrimp waste and oyster mushrooms, the glutamic acid content of the flavor enhancer derived from squid heads is still relatively low.

CONCLUSION

The amounts of squid head flour and maltodextrin added affect the resulting protein, moisture, and glutamic acid contents. Treatment P3 yielded the highest protein and glutamic acid contents, at 39.6% and 3.52%, respectively, while the lowest moisture content was observed in P4, at 5.16%.

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