Nutrition content and amino acid profile of paper squid (*Loligo edulis*)

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Abstract. One of the ways to diversify squid products into ready to eat food that has the potential to be developed is paper squid. The main stages in paper squid processing are drying under the sun, pressing, and drying in oven. This research aims to determine the proximate and the amino acid profile contained in paper squid (*Loligo edulis*, Hoyle). The proximate analysis results showed that paper squid contains 8.25% of moisture content, 3.65% of ash content, 72.28% of protein content, and 11.96% of carbohydrates content. Amino acids detected in paper squid are 15 types of amino acids consisting of 9 essential amino acids and 6 non-essential amino acids. The highest essential amino acid in paper squid is arginine containing 6.24% and the lowest is histidine which is 1.43%. The highest non-essential amino acid in paper squid is glutamic acid which is 12.13% and the lowest is tyrosine which is 2.49%.

1. Introduction

Indonesian waters have high potential marine resources, and one of Indonesia's marine resources is squid. The potential locations of squid are in the Java Sea, Makassar Strait, Maluku Sea, Seram Sea, Flores Sea, Morowali Sea, Central Sulawesi, and the Arafura Sea [1]. *Loligo* is one of the squid genera that is often caught in Indonesian waters. Squid is a soft animal (Phylum Mollusca) that contains a high nutritional value such as essential amino acids, fatty acids, phosphorous, and calcium [2, 3, 4]. Almost all parts of its body are edible. The flesh of squid is clean, smooth, and has a unique odor. Squid is also considered as a commodity with important economic value.

The quality of squid is easy to decrease which means it is necessary to do processing to prevent taste decrease. One of the ways to diversify squid products into ready-to-eat food is through the processing of paper squid that has the potential for development and can increase the economy of the community is the paper squid. The paper squid is a durable dried product considered a snack that can be consumed by all age groups. The main stages in paper squid processing are drying under the sun, pressing, and drying in the oven [5, 6].

Processing techniques can change the nutritional components of food ingredients. Several studies have shown that the heating process of fishery products can affect water content, protein content, fat, and carbohydrate content in fish. The heat processing causes protein coagulation, which is the result of protein denaturation at high temperatures [7].

Protein is one of the nutrients needed by the human body. Protein is also a macromolecule consisting of a large number of amino acids. The amino acid is an organic component containing amino and carboxyl groups. The amino acid composition is unique for each type of protein [7]. The composition of the amino acid content can determine protein quality. Analysis of the amino acid profile can provide important information regarding the composition of essential and non-essential amino acids. Besides, the amino acid profile is useful for showing the overall amino acid composition that can affect the taste characteristics of the analyzed samples [8]. Amino acids and peptides play a direct role in the flavor of processed aquatic products [9].

Information regarding the nutritional composition of paper squid is still restricted. Therefore, this research needs to be done to determine the nutritional content of paper squid as well as its amino acid
profile. This research aims to determine the proximate and the amino acid profile contained in paper squid (*Loligo edulis*).

2. **Materials and methods**

2.1. **Materials**

The raw materials used were fresh squid (*L. edulis*) which was acquired from Nolloth, Central Maluku Regency, Maluku Province, Indonesia. The chemicals used in analysis such as distilled water, 40% NaOH, 0.1N HCl, 0.001N HCl, 10% HCl, H₃BO₃, H₂SO₄, 6N HCl, and Kjeldahl tablets. The equipment used includes knives, buckets, scales, styrofoam, molen device, oven, and a set of other laboratory glassware for analytical purposes such as porcelain plates, mortar, oven, desiccator, kjeltec tubes, Erlenmeyer, burette, socket, micropipette, and analytical scales.

2.2. **Sample processing**

The raw materials are weeded to remove guts, ink, and other impurities. Then, the fresh squid is washed under running water and dried for 8 hours under the sunlight. After drying, the squid is dried in the oven at 70°C for 15 minutes to flex the texture of the dried squid. The oven-dried squid is then pressed to produce thin dried squid. Then, the paper squid is cured by reheating it at 100°C for 45 minutes. Finally, the paper squid is packaged and then sent to be analyzed for its nutritional content through proximate testing and the amino acid profiles at the Integrated Chemical Laboratory of the IPB University. The results of this study were analyzed descriptively.

2.3. **Amino acid analysis**

The amino acid analysis begins with the hydrolysis of the squid sample by oven at 110°C for 24 hours. The results of the hydrolysis were added 5 ml of 0.01N HCl and then filtered with millipore paper. The 10 μl of the sample were derivatized with 25 μl of OPA reagent. The amino acid was analyzed using HPLC (ICL type with ODS column). Sample preparation was carried out by adding 1 ml of 6N HCl to the ampoule contained 3 mg of sample protein which has been freeze-drying. A mixture of 50 mg OPA in 4 ml ethanol and 0.025 ml mercaptoethanol, 0.05 ml brij 30%, 1 ml borate buffer 1mM (pH = 10.4) for 1 minute. 5 μl of the derivatized sample are then injected into the HPLC column until all the amino acids are separated. The time required for this process is approximately 25 minutes. HPLC operational conditions: Ultra tecsphere column; detector: fluorescence; column temperature: 28°C; and mobile phase flow rate: 1 ml / min. The mobile phase consists of Buffer A (0.025M Na-Acetate; Na-EDTA 0.05%; Methanol 9% and THF 1%) and Buffer B (Methanol 95%).

3. **Results and discussion**

3.1. **Nutrition content of paper squid**

Figure 1 showed that the moisture content of fresh squid experiences significant changes from 79.19% to 14.06% and decreases again to 8.25% in the paper squid. The decrease of moisture content in the paper squid was affected by drying and pressing methods. According to SNI 2326.1: 2010, quality requirements for moisture content in dried squid is 20% that means the squid products produced in this research have met the quality standards. The moisture content of salt-dried squid with several different treatments ranged from 19.33-40.46% [10]. The moisture content of the paper squid (*L. edulis*) produced in this study was higher than the paper squid from *Loligo* sp. which ranged from 3.19-5.72% [6]. 3 times of drying process which is 8 hours drying under the sun and 2 times drying in an oven at 70°C and 100°C resulted in the evaporation of water contained in the paper squid. The longer the drying time, the more water can evaporate from food materials [11, 12, 13, 14]. Besides, the pressing method which affects the thickness of the paper squid can also decrease the moisture content of the product.
The protein content of squid is experiencing an increase from 13.43% in the fresh squid to 52.10%, and when it becomes paper squid increased to 72.28%. A significant increase in protein levels is caused due to reduced moisture content during the processing, causing the squid protein to become more concentrated. A decrease in water content will result in an increase in the protein content in food [15]. The increase in protein content continues with the longer time used during the drying process [13].

The fat content of fresh squid containing 0.81% has increased to 3.27% in dried squid. The increase in fat content is caused by reducing moisture content due to the heating process during the paper squid processing. The reducing of moisture content will increase the concentration of other compounds in food such as proteins, fats, carbohydrates, and minerals [7]. While the decrease appears in fat content in paper squid to 3.01%, related to the drying and pressing process that causes some of the fat to melt out of the body of the squid.

According to the result, the ash content of the squid has increased from 0.89% in fresh squid to 3.65% in the paper squid. This increase is also caused by reduced moisture content due to heat treatment during the drying process. Besides, the ash content of food is also influenced by the raw material, the ashing method, and the time and temperature used during the drying process [16].

In Figure 1, The carbohydrate content of fresh, dried, and paper squid are 5.55%, 29.43%, and 11.96%, respectively. However, the result of total carbohydrate content using the by difference method includes the number of non-carbohydrate components due to there is no specific test on carbohydrates.

3.2. Amino acid profile of paper squid

Amino acid profile of fresh squid, dried squid, and paper squid contains 15 types of amino acids consisting of 9 types of essential amino acids, namely threonine, arginine, methionine, valine, phenylalanine, isoleucine, leucine, lysine, and histidine and also 6 types of non-essential amino acids, namely aspartic acid, glutamic acid, serine, glycine, alanine, and tyrosine. Total amino acids of squid relatively increased from 12.25% in fresh squid to 49.26% in dried squid and 67.39% in Paper squid. [18] states that food processing such as steaming, boiling, frying, and drying can affect the chemical composition of food ingredients such as amino acids and other nutrients.
3.2.1. **Essential amino acids.** The analysis showed that there were nine essential amino acids in squid consisting of threonine, arginine, methionine, valine, phenylalanine, leucine, isoleucine, lysine, and histidine. According to Figure 2, the highest essential amino acid is arginine, namely 6.24%, 4.23%, and 1.17% for paper, dried, and fresh squid, respectively. Arginine is frequently found in Mollusca muscles [18, 19].

![Figure 2. Profile of essential amino acids of fresh, dried, and paper squid (L. edulis)](image)

Arginine, lysine, and leucine are essential amino acids important from aquatic animals [20]. Therefore, fishery products are known as a high protein food. Leucine is an essential amino acid containing 1.05% in fresh squid, 4.36% in dried squid, and 6.13% in paper squid. The body’s need for leucine is 0.42% [21]. Lysine is the third amino acid which is high in squid for fresh, dried, and paper squid at 0.97%, 4.69%, and 5.21%, respectively. The body’s need for lysine is 0.66%. The isoleucine content of fresh squid is 0.65%, 2.78% for dried squid, 3.88% for paper squid. The body’s need for isoleucine is 0.46% [21]. The phenylalanine content in fresh squid is 0.57%; Dried squid, namely 2.31%, and paper squid, namely 3.18%. The body’s need for phenylalanine is 0.35% [21].

The threonine containing in fresh, dried, and paper squid was 0.51%, 2.06%, and 2.86%, respectively. The body requirement for threonine is 0.43% [21]. The methionine content of fresh squid is 0.51%, dried squid is 1.56%, and paper squid is 2.30%. The body’s need for methionine is 0.42% [21]. Histidine is the lowest amino acid that contained 0.26% in Fresh squid, 1.02% in dried squid, and 1.43% in paper squid. The histidine requirement for the human body is 0.26% [21]. From these results, it can be seen that paper squid can be a good source of animal protein because of the availability of essential amino acids.
3.2.2. **Non-essential amino acids.** Non-essential amino acids are amino acids that can be synthesized by the human body. The result shows that squids contain non-essential amino acids, namely aspartic acid, glutamic acid, serine, glycine, alanine, and tyrosine. According to figure 3, the highest non-essential amino acid in squid is glutamic acid containing 2.07% for fresh squid, 8.61% for dried squid, and 12.13% for paper squid. Glutamic acid is most decisive in flavor formation in fishery products. High glutamic acid in squid will give a distinctive aroma. Glutamate is a component of natural constituents of almost all food ingredients that contain high protein.

![Amino Acids Content (%)](image)

**Figure 3.** Profile of non-essential amino acids of fresh, dried, and paper squid (*L. edulis*)

The aspartic acid content in paper squid is 7.8%. The high content of amino acids glutamate and aspartate can occur due to the analytical process using the acid analysis method which has a higher degree of hydrolysis. Hence, aspartic acid and glutamate are produced by the acid hydrolysis of asparagine and glutamine [22]. The glycine content in fresh squid is 0.69%, dried squid is 2.36%, and paper squid is 2.91%. Glycine plays an important role in stimulating the release of growth hormone, helps wound healing, helps muscle development and growth, and can be used to reduce stomach acidity [23]. The alanine content in fresh squid, dried squid, and paper squid is 0.78%, 3.26%, 4.37%, respectively. Meanwhile, the serine content is 0.53%, 1.96%, and 2.84% in fresh, dried, and paper squid, respectively. Tyrosine content in fresh, dried, and paper squid each by 0.48%, 1.85%, and 2.49%.

**4. Conclusion**

The nutritional composition of paper squid (*L. edulis*) contains 8.25% of moisture content, 3.65% of ash content, 72.28% of protein content, and 11.96% of carbohydrate content, respectively. Amino acids detected in paper squid (*L. edulis*) are 15 types of amino acids consisting of 9 types of essential amino acids and 6 types of non-essential amino acids. The highest essential amino acid in paper squid is...
arginine containing 6.24%. While, the highest non-essential amino acid is glutamic acid containing 12.13% of paper squid.

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