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The Impact of Smoked Lizardfish on Chemical and Amino Acid Profile of Sprinkled Chili

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A B S T R A C T

Smoked lizardfish can be utilized as an alternative ingredient in smoked fish sprinkled chili to enhance its flavor and nutritional value. Smoked fish sprinkled chili is a new type of seasoning product derived from chili, characterized by a coarse powder texture. This study aims to examine the effects of varying concentrations of smoked lizardfish on the nutritional content and amino acid profile of smoked fish sprinkled chili. The preparation method for smoked fish sprinkled chili includes raw material preparation, smoking of lizardfish, and mixing chili with other spices through a roasting method. The roasting process is conducted in a pan at a temperature of 80°C for 5 minutes. The experimental design employed in this study is a Completely Randomized Design (CRD) with different formulations of smoked fish sprinkled chili (K(50g:0g), A(37,5g:12,5g), B(25g:25g), and C(12,5g:37,5g)) as treatments. Parametric data were analyzed using Analysis of Variance (ANOVA) and Honest Significant Difference (HSD) tests with SPSS 25 software.

Formula C (37,5g lizardfish:12,5g chili) yielded the best smoked fish sprinkled chili, showing a significant difference ($P<5\%$) with a confidence interval of $7.59 < \mu < 7.67$. Different concentrations of lizardfish significantly affected ($P<5\%$) the moisture content (3.39%±0.02), ash content (18.52%±0.23), fat content (4.18%±0.08), and protein content (34.96%±0.24). The amino acid profile analysis indicated an increase in total amino acids from 25.67 mg/g in fresh fish to 231.726 mg/g in smoked fish sprinkled chili. The appropriate fish-to-chili ratio produced smoked fish sprinkled chili with distinct smoked fish characteristics, which was chemically and sensorily acceptable

Keywords: Amino acids, Saurida tumbil, Sprinkled chili, Smoked fish

Introduction

Lizardfish (Saurida tumbil), is one of the demersal fish species typically inhabiting muddy, sandy, and rocky environments in shallow coastal waters, and is widely distributed in tropical and subtropical regions. Based on data from the (Ministry of Marine Affairs and Fisheries [KKP],2022), the catch of lizardfish reached 22,695 tons. Central Java recorded the highest catch, with 7,468 tons of fish. Therefore, the potential for processing lizardfish in Central Java should be maximized. Fresh lizardfish contains 80.42% moisture, 13.58% protein, 3.74% fat, and 0.66% ash (Kusmiati, 2018). Lizardfish are considered to have a low market value in Southeast Asia due to their appearance and susceptibility to spoilage. Improper handling of the fish post-capture accelerates its quality deterioration (Park and Morrissey, 2000). Lizardfish is not commonly consumed directly; communities prefer to process this fish into surimi or smoked fish.

Smoking is one of the primary methods for preserving fish. Food processing of fish products that leads to diversification processes will enhance the consumption of fish products by the community, including flavour enhancers. According to Ghassani & Rudiana (2022), flavour enhancers are food additives that function to intensify and enhance the taste of food. Flavour enhancers are additives that elicit umami taste, which includes tastes such as sour, sweet, bitter, and salty. Sprinkled chili is classified as a seasoning ingredient that is added to finished dishes.

There are already numerous commercial products of sprinkled chili marketed by various brands, such as BonCabe, PAMMA, D'Veggie, and Sasa. This indirectly indicates the high level of public interest in sprinkled chili products. Scientific research on this sprinkled chili preparation is considered highly important, given the need for scientific inquiry to determine the quality standards and nutritional value of sprinkled chili. The process of making sprinkled chili has recently gained attention from the public due to its relatively simple production process. Moreover, apart from adding economic value to chili, sprinkled chili is one of the chili processing methods used for preservation. This is because sprinkled chili is made through a drying process, which reduces the water content in chili and extends its shelf life. The addition of smoked fish as a flavor enhancer in ground chili can increase its market value.

The addition of lizardfish (Saurida tumbil) to sprinkled chili products can enhance their nutritional value, and its high protein content can avoid the use of flavour enhancers such as MSG, which can be harmful to the body when consumed excessively. Product innovation has the potential to increase the value of the product beyond its previous state, thus affecting the magnitude of value addition from chili processing to sprinkled chili. This innovation is one way to obtain added value by increasing farmers' income in Desa Bulo (Hartina et al., 2023). To enhance the flavour of the resulting sprinkled chili,

smoked dried lizardfish can be added. The use of liquid smoke on lizardfish can improve flavour characteristics and preserve amino acid content by inhibiting bacterial growth. According to Anggeline et al. (2019), the glutamate cluster will combine with other compounds that create the delicious taste. This is due to the content of smoke components present in smoked fish, such as phenols, acids, and carbonyls, which function to inhibit protein denaturation processes. However, further research is necessary to measure the impact of adding smoked lizardfish to sprinkled chili so that the resulting nutritional value and amino acid content can be scientifically quantified.

Material and methods Materials and tools

The materials to be used in this study are fresh lizardfish, 5% liquid smoke for smoking the fish, and chili flakes, shallots, garlic, sugar, and salt for making sprinkled chili. This research was conducted in January 2024 at the Laboratory of Fishery Product Processing Technology, Faculty of Fisheries and Marine Sciences, Diponegoro University, and the Laboratory of PT. Saraswanti Indo Genetech Banyumanik, Semarang.

Procedure

The preparation of the main seasoning recipe for sprinkled chili, based on modifications from Gobel (2012) with ingredients consisting: curly chili, garlic powder, shallot powder, salt, sugar, and smoked lizardfish.

Treatments regarding the ratio of chili to smoked lizardfish are as follows: K (50g:0g), A (37.5g:12.5g), B (25g:25g), and C (12.5g:37.5g). The process of smoking the fish begins with filleting fresh lizardfish, which is then soaked in a 5% salt solution for 1 hour. After draining, the fillets are soaked again for 12 hours. The soaked fish is then placed in an electric oven and heated at graduated temperatures for a total duration of 6 hours (80°C for 2 hours, 100°C for 2 hours, and 120°C for 2 hours). The preparation of sprinkled chili involves grinding the smoked lizardfish. The addition of 5g each of salt and sugar, and 20g each of shallots and garlic is done subsequently. This is followed by homogenization with a chopper according to the treatment formula, then roasted for 5 minutes at 80°C. After the samples were prepared, tests were conducted on several parameters, including hedonic test, moisture content, ash content, fat content, protein content, and amino acid profile.

Hedonic test

The end products were tested to measure the degree of consumer preference and acceptance of the product using a hedonic scale. According to SNI 2346:2011 (BSN,2011) The hedonic or preference testing involves filling out a hedonic test form. The form includes satisfaction indicators with the following categories: like extremely (9), like very much (8), like moderately (7), like slightly (6), neutral (5), dislike slightly (4), dislike moderately (3), dislike very much (2), dislike extremely (1). The data obtained from the assessment forms are tabulated, and the quality score is determined by calculating the mean score for each panelist at a 95% confidence level. The best treatment was chosen based on the highest score of total parameters tested

Chemical analysis

The moisture content was analysed by drying the sample in an oven at 105oC for 2 hours according to SNI 2354.2:2015 (BSN,2015). ash content was analysed by drying the sample at temperature of 100oC for 24 hours, then it was further heated in a furnace at 550oC until white ash is obtained based on (Tuapattinaya et al., 2021). The fat analysis performed by weighing a sample of 2 grams, then extracting it at 60°C for 8 hours and evaporating it to dryness. The sample is then oven-dried for 2 hours at 150°C and weighed based on SNI 2354-3:2017(BSN,2017). The protein content is carried out using the micro Kjeldahl method. destruction and distillation method based on SNI 01-2354.4-2006 (BSN, 2006)

Amino acid profile

The amino acid analysis can be conducted using the UPLC (Ultra Performance Liquid Chromatography) method based on (Waters, 2012).

Result and discussion Hedonic test

Based on the hedonic test results involving 30 consumer panelists (uneducated and untrained) from the Faculty of Fisheries and Marine Sciences, Diponegoro University, it can be concluded that treatments K and A are not suitable for consumption, with confidence interval values where K ranges from 5.80 to 5.86 and A ranges from 6.41 to 6.49. Values for K and A below the standard SNI 7690:2019 or less than 7 make Treatments K and A directly eliminable. Furthermore, in treatments B and C, the respective confidence intervals are 7.51 to 7.59 and 7.59 to 7.67, where C has a higher range than B, thus it can be concluded that C is the best treatment in terms of consumer preference. The initial factor that determines consumer preference is appearance, as the first aspect that can be evaluated in a product is its appearance, including colour, shape, and size.

Table 4.1. Hedonic Test of Smoked Lizardfish (*Saurida tumbil*) Sprinkled Chili.

Parameter	Treatment			
	K	**A**	**B**	**C**
Appearance	5,73±0.980a	6,47±0,900b	7,53±0,900c	8,00±1,017cd
Aroma	5,53±0,900a	6,27±0,980b	7,73±0,980c	8,00±1,017cd
Taste	4,53±0,968a	6,00±1,017b	7,60±0,932c	8,20±0,997d
Texture	7,47±0,860a	7,07±0,828b	7,33±0,758b	6,33±0,959c
Confidence interval	5,80 < μ < 5,86	6,41< μ < 6,49	7,51 < μ < 7,59	7,59 < μ < 7,67

Information:- Data are the average results of 30 panelists ± standard deviation.

The appearance in treatment K has an average value of 5.73 (neutral), but it is the lowest among the other treatments. The panelists disliked the appearance in treatment K because the colour appeared too dull. This is because in treatment K, there was no addition of lizardfish meat, so the appearance depended solely on the colour of the chili, which turned dark brown during the roasting process, resulting in a dull appearance.

Conversely, in treatment C, with an average value of 8 (very liked), with a ratio of 37.5g meat to 12.5g chili, the colour became brighter brown. This is due to the Maillard reaction on the heated protein, which gives the product a brown colour. According to Ridhani & Aini (2021), the Maillard reaction is a reaction that occurs between carbohydrates containing reducing sugars and primary amine groups, resulting in a brown colour or melanoidins. The Maillard reaction can also influence the aroma of a product.

The aroma in treatments K, with a value of 5.53 (neutral), and A, with a value of 6.27 (somewhat liked), was disliked by the panelists because the smell of the sprinkled chili was still too dominant compared to the fish meat, resulting in only the spicy aroma being noticeable. This finding is consistent with the research by Zulfahmi & Swastawati (2014), where the control group received a low score due to the absence of fish addition in the production of crackers, resulting in no fish aroma in the crackers. This result indicates that the addition of fish meat at different concentrations affects the smell or aroma. Treatments B and C were preferred by the panelists because of the more significant addition of meat (25g and 37.5g), resulting in a stronger fish aroma compared to the chili aroma. Huthaimah *et al.* (2017) reported that the type of fish significantly influences the aroma of the produced sprinkled chili. In addition to aroma, the type of fish can also affect the fishy taste. This is because different types of fish have varying protein contents.

The taste of sprinkled chili is influenced by the amount of added lizardfish meat. The high protein content of lizardfish can affect consumer acceptance in terms of taste parameters due to the savoury taste it produces. According to Winarno (1995), the savoury taste can be attributed to the presence of free amino acids that form flavour compounds such as glycine, alanine, lysine, and especially glutamic acid, which can result in a delicious taste. The average score for treatment K only reached 4.53 (somewhat disliked), while treatments B and C significantly increased to 7.93 (liked) and 8.00 (very liked), respectively. This indicates that the stronger the fish tastes, the more the panelists will like the sprinkled chili. Taste is one of the key factors in the acceptance of a product, so the addition of fish meat is an important factor in the acceptance of lizardfish sprinkled chili. Research by Yanuar et al. (2016) also mentions that fish sticks made from mackerel, grenadier, and lizardfish have high protein levels in the fish meat used as raw materials. This influences the taste of the fish sticks, giving them a strong fish flavour and a savoury taste. However, it is important to note that while fish meat can enhance the flavour of sprinkled chili, adding more lizardfish meat will make the texture of the sprinkled chili became denser.

The texture of treatment C sprinkled chili, with a score of 6.33 (neutral), is less preferred by the panelists compared to treatment K, which scored 7.47 (liked). This is because the more dominant fish meat makes the texture of the sprinkled chili too dense. Treatment B is preferred because of its balanced texture between the dense meat and crispy dried chili. This is consistent with the research by Mukminah (2019), where the higher the concentration of catfish meat, the higher the average texture score. The smoked lizardfish used has been dried, resulting in a harder and crispier texture, which ultimately affects the panellist's assessment. This is also in line with the research by Hasan et al. (2023), which found no significant effect on the texture of gammi fish sprinkled chili, presumably because gammi fish sprinkled chili products use the same type of fish and are dry products with low moisture content.

Chemical analysis

Table 4.2. Proximate Analysis of Smoked Lizardfish (*Saurida tumbil*) Sprinkled Chili Parameter Treatment

	K	**A**	**B**	**C**
Moisture (%) Ash (%)	5.08±0.02a	4.47±0.02a	3.96±0.25a	3.39±0.02a
Fat (%)	15.51±0.24a	17.22±0.19b	17.62±0.19b	18.52±0.23c
	5.51±0.10a	5.43±0.10b	5.2±0.10b	4.18±0.08b

The results of the moisture content test, ranging from 3.39% to 5.08%, indicate that the moisture content of the smoked lizardfish sprinkled chili product meets the standards set by SNI 7690:2019 for Fish Sprinkled Chili. The test results show that different concentrations of lizardfish meat do not have a

significant effect on the moisture content of smoked lizardfish sprinkled chili (P ≤ 5%). The moisture content in treatment K (5.08%) is higher than in treatment C (3.39%), which is because the added lizardfish meat has undergone a gradual drying

process for 6 hours, and after mixing with other ingredients, it was roasted, resulting in a very low moisture content. According to Harianti and Tanberika (2018), during the roasting process, the outermost layer of the material will wrinkle due to dehydration during drying, forming pores inside the food material due to the evaporation of water, thus accelerating the reduction of moisture content. The small moisture content of the product implies that the organic content is more concentrated, as evidenced by ash content testing.

The results of the ash content test show a range of 15.51% to 18.52%. The research results indicate that different concentrations of lizardfish meat have a significant effect on the ash content of smoked lizardfish sprinkled chili (P ≤ 5%). There is a proportional increase in ash content with the addition of more lizardfish meat. The ash content of a substance is influenced by the amount of minerals contained in the product. Ash is the organic residue from the combustion of organic materials. This ash usually consists of minerals such as

potassium, calcium, sodium, iron, and magnesium (Pomeranz, 1977). The ash content is the residue left when a food sample is completely burned in a muffle furnace. The determination of ash content is closely related to the mineral content present in a substance, as well as the purity and cleanliness of the material (Sudarmadji et al., 1997). The determination of ash content, closely linked to mineral composition and material purity, is relevant in understanding how different concentrations of lizardfish meat affect the fat content of smoked lizardfish with sprinkled chili.

The research results indicate that different concentrations of lizardfish meat have a significant effect on the fat content of smoked lizardfish sprinkled chili (P ≤ 5%). However, treatment A does not significantly differ from treatments B and C (P > 5%) in terms of fat content. The fat content in lizardfish meat is relatively small

compared to its protein content. According to Jaziri et al. (2021), lizardfish meat contains 1.34% fat. This results in the insignificant effect of adding lizardfish meat to the sprinkled chili. The low-fat content is also caused by the heating of the meat before mixing it into the sprinkled chili, resulting in the release of fat. This is consistent with the research by Suryani et al. (2016), where during fish meat processing, the decrease in fish protein content correlates with the decrease in fish fat content due to fat degradation and protein denaturation, resulting in a decrease in the functions of protein and fat. The fat content test results show a range from 4.18% to 5.51%. The addition of fish meat is inversely proportional to the increase in fat content.

The decrease in fat content is caused by the meat undergoing an oven-drying process for 6 hours at high temperatures, leading to fat degradation. This is in line with research by Hidayat et al. (2020), where the fat content of cooked tuna decreases with cooking time, and cooking at high temperatures will result to fat damage in food materials. In addition to fats, proteins can also be damaged by high-temperature cooking.

The protein test results show a considerable range from 11.26% to 34.96%. The research results indicate that different concentrations of lizardfish meat have a significant effect on the protein content of smoked lizardfish sprinkled chili (P ≤ 5%). There is an increase in protein content in each treatment. This is due to the high protein content of lizardfish, which is 20.82% (Jaziri et al., 2021), so the addition of concentration is directly proportional to the increase in protein content. Research by Muchtar et al. (2023) states that the increase in

protein content in fish stick crackers is due to the addition of fish meat. Fish is a protein source, so increasing the amount of lizardfish meat added will result in an increase in protein content. The addition of lizardfish meat is directly proportional to the protein content of smoked lizardfish sprinkled chili. This is because the protein content in lizardfish meat, according to Kusmiati (2018), is 13.58%, so adding lizardfish meat to the sprinkled chili mixture will increase its protein content. However, only treatment C meets the SNI 7690:2019 standard, where the minimum protein content is 30%, making treatment C the best treatment in terms of protein content. This also indicates a potential impact on high levels of amino acids.

Amino acid profile

Amino acids are the main components that make up proteins. Proteins are divided into two categories based on their synthesis ability within the body: essential amino acids and non-essential amino acids. Essential amino acids cannot be produced by the body and must be obtained through food, while non-essential amino acids can be synthesized within the body. The higher the concentration of essential amino acids in a food ingredient, the better the quality of protein in that food. The results of amino acid profile testing were then compared with the research of Annisah et al. (2019), which utilized fresh lizardfish meat. A significant increase was observed, with the total amino acid content of only 25.67 mg/g in fresh lizardfish compared to Treatment C being 231.726 mg/g with 43.6% consisting of essential amino acids.

Table 4.3. Amino acid profile testing results for Smoked Lizardfish Sprinkled Chili (Treatment C) with secondary data from Annisah et al. (2019).

Amino Acid Type	Treatment C (mg/g)	Annisah et al.(2019) (mg/g)
Leucine*	19.59	5.41
Lysine*	18.27	5.44
Phenylalanine*	17.29	ND (not detected)
Valine*	12.39	4.70

Isoleucine*	12.29	2.22
Threonine*	10.62	2.09
Histidine*	10.57	2.04
Glutamic Acid**	42.03	ND (not detected)
Aspartic Acid**	25.93	0.16
Arginine**	17.29	ND (not detected)
Alanine**	15.20	2.96
Glycine**	14.52	2.05
Proline**	10.10	2.01
Tyrosine**	9.85	ND (not detected)
Serine**	9.68	2.00
Total	231.726	25.67

Information: *essential amino acids **non-essential amino acids

The essential amino acid found in the highest amount in Treatment C is leucine, at 19.58 mg/g, whereas fresh lizardfish contains only 5.41 The essential amino acid found in the highest amount in Treatment C is leucine, at

19.58 mg/g, whereas fresh lizardfish contains only 5.41 mg/g of leucine. Leucine functions in muscle building and repair, regulates sugar and fat metabolism, enhances hormone production, and aids in bone healing. According to Szwiega et al. (2021), the estimated average requirement (EAR) and recommended dietary allowance (RDA) for leucine are currently set at 34 mg/kg/day and 42 mg/kg/day, respectively, for all adults aged >19 years, including older adults.

The second most abundant essential amino acid in Treatment C is lysine, at 18.27 mg/g, compared to only 5.44 mg/g in fresh lizardfish. Lysine is important for its role as a building block of blood antibodies, strengthening the circulatory system, maintaining the growth of normal cells, and collaborating with proline and vitamin C to form collagen and reduce excessive blood triglyceride levels. According to Swastawati & Wijayanti (2016), lysine is highly essential for the body as it cannot be produced internally in humans. Its functions include tissue growth and repair. The recommended daily intake of lysine averages between 1 to 1.5 grams per day, indicating that Smoked Lizardfish Sprinkled Chili under Treatment C can meet the body's lysine amino acid requirements. Another important amino acid for metabolism is phenylalanine.

Phenylalanine is an essential amino acid that plays a crucial role in body metabolism. Based on the test results, sample C contains 12.39 mg/g of phenylalanine, whereas fresh lizardfish contains 4.70 mg/g. Phenylalanine can function to reduce pain and alleviate depression. The body can utilize phenylalanine to produce the amino acid tyrosine. According to Kuvaini (2015), phenylalanine is required by the thyroid gland to produce thyroxine, which helps prevent goiter. Phenylalanine also aids in the production of brain epinephrine and norepinephrine, which assist in memory and learning processes. Another amino acid with similar functions to phenylalanine is tyrosine. The body's requirement for phenylalanine and tyrosine, according to FAO/WHO (1985), is 0.72% of total protein intake. In addition to containing essential amino acids, fish protein also includes non-essential amino acids such as glutamic acid, aspartic acid, and arginine.

The highest non-essential amino acid present is glutamic acid, with a content of 42.02 mg/g in Treatment C, whereas it was not detected in fresh lizardfish. Glutamic acid functions in aiding energy production, urea synthesis, glutathione synthesis, and acts as a neurotransmitter. Glutamic acid plays a crucial role in food processing as it enhances taste perception, contributing to deliciousness. According to Karim et al. (2014), glutamic acid is the most dominant source of umami (savoury) taste and significantly impacts the perfection or authenticity of that taste. Non-essential amino acids not only enhance flavour but also contribute to maintaining body health, such as aspartic acid.

The content of aspartic acid in sample C is 25.95 mg/g, whereas in fresh fish it is only 0.16 mg/g. Aspartic acid is a non-essential amino acid that functions to aid liver detoxification, enhance the immune system, inhibit tumour cell growth, promote hormone release, facilitate carbohydrate metabolism, and serve as a cellular energy source. According to Gianto et al. (2017), aspartic acid is involved in urea biosynthesis, gluconic precursors, and pyrimidine precursors. Additionally, aspartic acid is beneficial for managing chronic fatigue and increasing energy levels. Metabolism in the body is not only aided by aspartic acid; arginine also plays a role in metabolism, especially during growth stages.

The content of arginine in sample C is reported as 17,298.29 mg/kg. L-arginine plays a crucial role in body metabolism. In early life, arginine is an essential amino acid for optimal growth and development and therefore must be provided through food. For adults, arginine is a conditionally essential amino acid, particularly in conditions such as trauma, burns, small bowel resection, and kidney failure. Administration of L- arginine improves cardiovascular function, lung function, immune response, digestion, and protects against early stages of cancer development (cancerogenesis). According to Solichah (2022), arginine has an aliphatic amino acid structure type, and due to this structure, it serves as an intermediary metabolite in various metabolic pathways such as nitric oxide (vasodilation and molecular signalling), glutamine, proline (related to wound healing), polyamines (DNA

stabilization, gene regulation, immunity), and creatine (energy supply in muscles), also includes non-essential amino acids such as glutamic acid, aspartic acid, and arginine.

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Conclusions

Conclusion from the study on the chemical characteristics and amino acid profile of smoked lizardfish sprinkled chili with the addition of smoked lizardfish are, smoked lizardfish sprinkled chili was tested with different formulations combining chili and smoked lizardfish, and the best formula was determined through hedonic testing to be treatment C (37.5g smoked lizardfish: 12.5g chili). The addition of smoked lizardfish significantly affected the levels of fat, protein, and ash content, as observed through laboratory testing. The amino acid profile test showed that smoked lizardfish sprinkled chili contains higher levels of amino acids compared to when it was in fresh fish form. The highest essential amino acid found was leucine, and the highest non- essential amino acid was glutamic acid.

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