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PENGARUH KONSENTRASI KEMIRI (*Aleurites moluccanus*) TERHADAP KADAR AIR, KADAR ABU, WARNA DAN SIFAT SENSORI KALDU BUBUK TULANG DAN KEPALA IKAN KEMBUNG (*Rastrelliger* sp)

The Effect Of Candlenut (Aleurites moluccanus) Concentration On Moisture Content, Ash Content, Color, And Sensory Evaluation Of Powdered Broth From Bones And Heads Of Mackerel (Rastrelliger sp*)*

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ABSTRAK

Kaldu bubuk berbahan dasar ikan umumnya memiliki aroma amis yang disebabkan oleh tingginya kandungan senyawa trimetilamina (TMA) pada ikan. Untuk mengurangi aroma tidak sedap tersebut, ditambahkan kemiri yang akan berperan sebagai antioksidan. Penelitian ini bertujuan untuk mengetahui pengaruh konsentrasi kemiri terhadap kadar air, kadar abu, warna, dan sifat sensori kaldu bubuk berbahan dasar tulang dan kepala ikan kembung. Penelitian ini menggunakan Rancangan Acak Kelompok Lengkap dengan analisis lanjut menggunakan BNJ taraf 5%. Penelitian dilakukan dua tahap yaitu pembuatan produk dan analisis yang mencakup uji kimia (kadar air dan abu) uji fisik (warna) dan sifat sensori. Hasil penelitian menunjukan bahwa penambahan kemiri memberikan pengaruh yang signifikan terhadap seluruh parameter yang di uji. Formulasi K4 menunjukkan hasil terbaik, dengan kadar air 5,80%, kadar abu 3,42%, serta nilai warna L* 75,84, a* 2,48, dan b* 19,91. Skor uji sensori formulasi ini adalah 4,36 untuk rasa, 5,16 untuk aroma, 5,26 untuk warna, dan 4,54 untuk tekstur. Temuan ini menunjukkan bahwa penambahan kemiri dapat meningkatkan kualitas fisik dan sensori kaldu bubuk berbasis ikan, serta mengurangi aroma amis yang tidak diinginkan.

ABSTRAK

Fish-based powdered broth generally has a fishy odor caused by the high content of trimethylamine (TMA) compounds in fish. To reduce this unpleasant aroma, candlenut was added, which functions as an antioxidant. This study aims to determine the effect of candlenut concentration on moisture content, ash content, color, and sensory properties of powdered broth made from the bones and heads of mackerel fish. This study employed a Completely Randomized Block Design with further analysis using the Honestly Significant Difference (HSD) test at the 5% level. The research was conducted in two stages, namely product preparation and analysis, which included chemical tests

(moisture and ash content), physical tests (color), and sensory properties. The results showed that the addition of candlenut had a significant effect on all tested parameters. Formulation K4 showed the best results, with a moisture content of 5.80%, ash content of 3.42%, and color values of L* 75.84, a* 2.48, and b* 19.91. The sensory test scores for this formulation were 4.36 for taste, 5.16 for aroma, 5.26 for color, and 4.54 for texture. These findings indicate that the addition of candlenut can improve the physical and sensory quality of fish-based powdered broth and reduce undesirable fishy odors.

Kata Kunci	*Kemiri, Kaldu Bubuk, Ikan Kembung, Trimetilamina*
Keywords	*Candlenut, Powdered Broth, Mackerel Fish, Trimethylamine*
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INTRODUCTION

Powdered broth products circulating in the market generally contain synthetic monosodium glutamate (MSG), which may have negative effects on humans if used excessively and over long periods. The Federation of American Societies for Experimental Biology (FASEB) recommends that MSG consumption should not exceed 3 grams or 1/4 teaspoon per day (Muntaza & Adi, 2020). According to Djohar *et al*. (2018), fishery products have the potential to serve as natural flavor enhancer alternatives because they contain high levels of glutamic acid. Mackerel fish, also known as mackerel fish, is a species with high economic value, and its capture potential increases annually.

In the processing of fish-based food products, generally only the flesh is utilized, while the bones and heads are often discarded. Because fish bones and heads are hard, they are difficult for decomposers to break down and thus become waste. In fact, fish bones and heads contain substantial nutritional value, including fats, proteins, omega-3 fatty acids, glutamic amino acids, and minerals such as calcium, phosphorus, and carbonates (Siswanti *et al*., 2017). Therefore, innovation is needed to process mackerel fish heads and bones into powdered broth as an alternative substitute for MSG.

The selection of candlenut as an additional ingredient in the production of powdered broth from mackerel fish bones and heads, in addition to enhancing savory taste, is based on its essential oil content and distinctive aroma, which can neutralize fishy odors derived from organic compounds in fish, such as trimethylamine (TMA) (Safitri *et al*., 2019). According to Satriani *et al*. (2024), phytochemical screening results of candlenut seed extract are positive for phenolic compounds. These phenolic compounds can help reduce oxidation in fish bones and heads that leads to fishy odors. Candlenut is considered more effective in reducing fishy odors through an aroma-masking mechanism, as its phenolic compounds can inhibit bacterial growth and thereby suppress the formation of TMA compounds.

METHODS

This study was arranged using a Completely Randomized Design (CRD) with a single factor and four replications, resulting in a total of 24 experimental units. The single

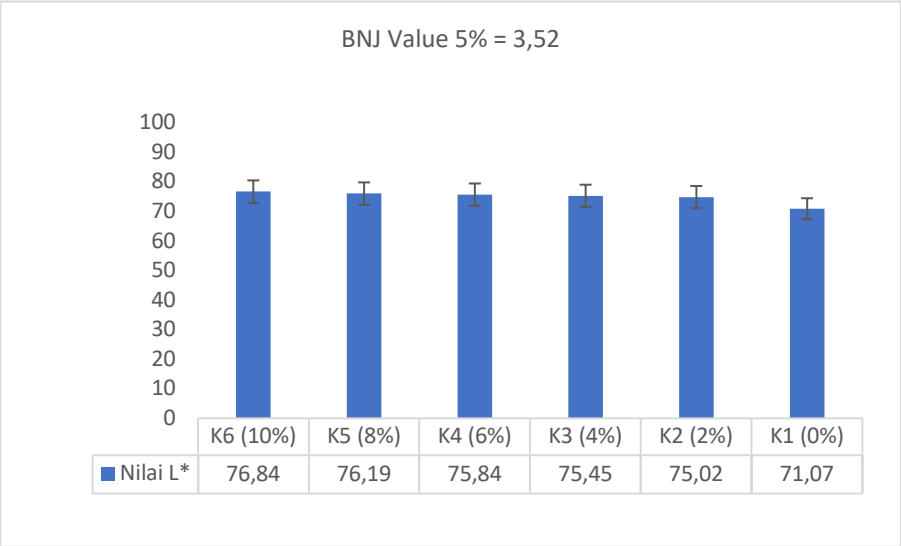
factor was candlenut concentration at six levels, namely 0% (K1), 2% (K2), 4% (K3), 6% (K4), 8% (K5), and 10% (K6). Data homogeneity was tested using Bartlett's test, and data additivity was tested using the HSD test. Data were analyzed using analysis of variance to determine the presence or absence of treatment effects and were further tested using the Honestly Significant Difference (HSD) test at the 5% level. The analyses conducted included moisture content, ash content, color testing (hedonic and colorimeter), sensory testing, and the best treatment was further analyzed for protein content and NaCl content.

RESULTS

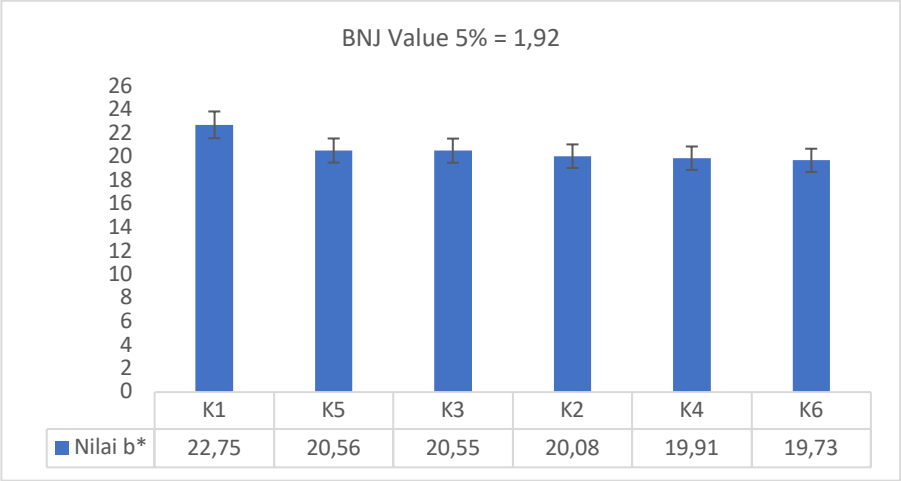
Table 1. Results of the study on powdered broth from mackerel fish bones and heads with the addition of candlenut at various concentrations

Parameter	Candlenut concentration treatment					
	K1 (0%)	K2 (2%)	K3 (4%)	K4 (6%)	K5 (8%)	K6(10%)
Water content (%)	9,03±0,60^{a}	7,83±0,56^{b}	6,65±0,35^{b}	5,80±0,34^{cb}	5,28±0,22^{cb}	4,40±0,22^{c}
Ash content (%)	2,60±0,41^{a}	3,45±0,24^{ab}	3,18±0,22^{ab}	3,42±0,31^{ab}	3,85±0,13^{a}	4,18±0,10^{b}
Flavor	3,34±1,18^{b}	3,96±0,99^{b}	5,48±1,21^{a}	4,36±1,09^{b}	5,04±1,23^{a}	4,30±1,16^{b}
Aroma	3,78±0,92^{b}	4,06±1,06^{b}	4,36±0,84^{b}	5,16±1,06^{a}	5,12±1,28^{a}	4,96±1,06^{ab}
Color	3,66±1,16^{c}	4,52±0,99^{ab}	4,48±1,25^{b}	5,26±1,10^{a}	4,60±0,91^{ab}	4,96±0,99^{ab}

Numbers in the same row followed by the same superscript letter are not significantly different at the 5% test level (Honestly Significant Difference test).



Description: L* = value indicating the level of brightness with values 0 (black) and 100 (white)



Description: b* = value indicating the level of yellowness with values - (blue) and + (yellow)

Figure 1. Comparison of powdered stock colors

DISCUSSION

Moisture Content

Moisture content is an important indicator in the evaluation of food quality. A low moisture content indicates that the product is more microbiologically stable and has a longer shelf life. The moisture content of the powdered broth in this study did not meet the Indonesian National Standard (SNI 01-4273-1996) for powdered broth, which specifies a maximum of 4%. Differences in moisture content were caused by the composition and physical properties of candlenut. Candlenut contains high levels of fat and protein, which affect the viscosity and moisture content of the resulting filtrate (Apriyanto, 2018). The greater the amount of candlenut added, the lower the moisture content of the powdered broth. The combination of protein and fat content in candlenut increases viscosity, as proteins form network structures that retain water, while fats improve texture and bind other components in the product, thereby slowing flow and increasing product viscosity (Pratiwi & Noer, 2014). Powdered products such as powdered broth are hygroscopic, meaning they readily absorb moisture from the surrounding environment. Vacuum packaging is an effective method to address this issue.

According to Pandit & Permatananda (2022), vacuum packaging is effective in reducing increases in moisture content during storage. Air inside the package is removed, creating a vacuum condition that inhibits water penetration into the product from the surrounding environment. According to Argo *et al.*, (2018), candlenut contains a moisture content of 1.70% after being dried for 18 hours using a drying machine. The moisture content of the six treatments with different concentrations of candlenut resulted in

moisture levels exceeding the SNI standard for powdered broth. Therefore, storage using vacuum methods prior to testing is necessary to protect the product from hygroscopicity, along with extending the drying time to adjust the moisture content of powdered broth made from bones and heads of Indian mackerel with candlenut so that it complies with SNI standards.

Ash Content

Ash content is an important parameter in assessing food quality because it indicates the total inorganic mineral content in the product after complete combustion. According to SNI 01-3709-1995, the maximum standard value for ash content in seasoning powder is 7% (w/w). This statement indicates that the ash content of the powdered broth produced in this study meets the SNI quality standard. The ash content of a product is determined by the type and amount of raw materials used. This study used candlenut (*Aleurites moluccanus*) as one of the ingredients, which contains minerals such as calcium and phosphorus (Lestari & Mustakim, 2024). According to Mudaim (2021), minerals such as calcium and phosphorus form stable crystalline compounds such as hydroxyapatite, calcium hydroxide, and fairchildite that are resistant to high temperatures and do not easily volatilize, thus remaining as ash after combustion.

Color

Color testing of the powdered broth was carried out using two methods, namely instrumental testing using a colorimeter and sensory color testing using a hedonic test. The higher the concentration of candlenut added, the brighter the color of the powdered broth produced. The color of the powdered broth can be seen in Figure 1. This occurs because candlenut contains a relatively high amount of oil, ranging from 35–65% of seed weight (Winona *et al*., 2024). Candlenut oil has a natural pale yellow color that can influence the color of the final product. In addition to oil, candlenut also contains bioactive compounds such as flavonoids and polyphenols. These compounds possess antioxidant properties and contribute to a brighter color in the product when it undergoes heating or drying processes (Astuti *et al*., 2023). Instrumental testing using a colorimeter also showed that increasing the amount of candlenut added resulted in higher L* values. The L* value in a colorimeter indicates the lightness level of a product. Meanwhile, the lower the amount of candlenut added, the higher the b* value obtained. The b* value indicates the yellowness of a product, where negative values indicate blue and positive values indicate yellow.

Taste

The average results based on the level of preference for taste showed that higher concentrations of candlenut resulted in a stronger savory taste and produced an aftertaste in the powdered broth, making it less preferred by panelists. Astuti *et al*., (2023) identified compounds that contribute to bitterness in candlenut seeds and their processed products through LC-MS (Liquid Chromatography–Mass Spectrometry) analysis. These compounds include isohumulone, colaflavone, quercetin, oleuropein, kaempferol, resveratrol dimer, luteolin, epicatechin, theobromine, caffeine, chlorogenic acid, linolenic acid, feruloyl caffeoylquinic acid, and coumarylquinic acid. These compounds, particularly flavonoids and tannins, are known to have strong bitter tastes. Therefore, in this study, the treatment preferred by panelists was sample K3, because the K3 treatment with the addition of 10 g of candlenut did not produce a bitter aftertaste in the product.

Aroma

The addition of candlenut in the production of powdered broth from bones and Indian mackerel can influence the aroma characteristics of the final product due to the

specific properties of candlenut. According to Pratiwi *et al*., (2019), unsaturated fatty acids found in seafood products are prone to oxidation during cooking processes, resulting in fishy odors in fish-based products. This fishy odor originates from trimethylamine (TMA) compounds present in fish. TMA is formed as a result of choline oxidation caused by bacteria that cleave the trimethylammonium group from choline and form trimethylamine oxide (TMAO). Subsequently, TMAO is enzymatically reduced to form TMA (Safitri *et al*., 2019).

Pratiwi *et al*., (2019) stated that choline oxidation can be prevented by the addition of antioxidants capable of inhibiting this reaction. Most natural antioxidants are phenolic compounds. According to Satriani *et al*., (2024), phytochemical screening of candlenut seed extract showed positive results for phenolic compounds. This demonstrates that the addition of candlenut at various concentrations is presumed to reduce fishy odors because candlenut contains phenolic compounds that function as antioxidants. Candlenut also contains volatile compounds that undergo thermal degradation during cooking, thereby enhancing the savory aroma of powdered broth made from bones and heads of Indian mackerel. One of the volatile compounds present in candlenut is volatile fatty acids. These compounds are produced through thermal degradation during heating and contribute to savory flavor and aroma; however, excessive amounts can cause rancid odors. In addition to volatile fatty acids, aldehydes formed from the degradation of unsaturated fatty acids during heating can also produce nutty and fresh leaf-like aromas (Winona *et al*., 2024).

Protein Content

The protein content of the powdered broth in this study was 54.07%. The powdered broth made from bones and heads of Indian mackerel met the SNI (01-4273-1996) requirement of a minimum of 7%. According to the Regulation of the Minister of Health of the Republic of Indonesia No. 28 of 2019 concerning Recommended Dietary Allowance (RDA) for children aged 1–12 years, the recommended protein intake is 20–50 g per day; therefore, powdered broth made from bones and heads of Indian mackerel is suitable to help meet protein requirements in children. The addition of candlenut in the production of powdered broth based on bones and heads of Indian mackerel can affect the protein content of the final product. Candlenut contains 19 g of protein per 100 g of candlenut (Miftahurahma *et al*., 2023). In addition to candlenut, the use of bones and heads of Indian mackerel as the main raw materials also influences the protein content of the powdered broth.

NaCl Content

The NaCl content of the candlenut-based powdered broth made from bones and heads of Indian mackerel was 25.74 mg or 0.51%. SNI (01-4273-1996) states that the maximum NaCl content in powdered broth is 65%, which means that the candlenut-based powdered broth from bones and heads of Indian mackerel meets the SNI standard. The World Health Organization (WHO) recommends a sodium intake of less than 2 g per day to reduce the risk of hypertension and cardiovascular disease (Fatimah *et al*., 2024). According to the Regulation of the Minister of Health No. 28 of 2019 concerning RDA for children aged 6–23 months, daily salt consumption should be below 1 g. This is because the kidneys of infants aged 6–23 months are not able to process large amounts of salt as adults do; therefore, excessive sodium intake can cause kidney damage in infants.

CONCLUSION

The concentration of candlenut significantly affected the quality of the powdered broth. The resulting moisture content ranged from 4.80% to 9.03%, ash content from

2.60% to 4.18%, color with L* values of 71.07–76.84 (bright) and b* values of 19.73–22.75 (pale yellow), protein content (best treatment), and sensory properties of the powdered broth made from bones and heads of Indian mackerel with taste scores of 5.48, aroma scores of 5.16, and color scores of 5.26. The best candlenut concentration determined using the DeGarmo method indicated that formulation K4 was the most preferred by panelists, with a candlenut addition of 15 g, resulting in a moisture content score of 5.40%, ash content of 3.42%, taste score of 4.36, aroma score of 5.16, color score of 5.26, protein content of 54.07%, and NaCl content of 0.51%.

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