Research Article

Sensory Evaluation of Smoked Sardine Coated WithLocal Spices

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ABSTRACT

Sardines refer to a group of fish from the Clupeidae family, including the genera Sardinella, Amblygaster, Decapterus, or Cetengraulis. The sensory evaluation of smoked sardines coated with local spices in this study involved the use of liquid smoke immersion. The study aimed to formulate the best-smoked fish coated with local spices, resulting in seven formulations: the control, F1, F2, F3, F4, F5, and F6. These formulations were immersed in liquid smoke and coated with varying percentages of three main spices: ginger, garlic, and dried chili. Based on sensory analysis with 50 panelists, it was concluded that F5, with 6% liquid smoke, emerged as the optimal formulation.

Keywords: formulation; sardine; sensory evaluation; spices; proximate analysis

1. Introduction

Sardine, a Clupeidae family fish (Sardinella, Amblygaster, Decapterus, Cetengraulis), is prevalent in tropical waters and ideal for various fish products due to its abundant pelagic presence and migratory behaviors (Khedkar et al., 2003). The fisheries sector, crucial for ensuring global food supply and nutrient intake, is driven by technological advancements, trade liberalisation, income growth, and increased consumer awareness (FAO & WHO, 2020).

The smoking process is an ancient preservation method that extends shelf life of food by reducing water activity and creating antimicrobial components (FAO, 2013). Applied to meat and seafood, smoking involves the production of smoke composed of liquid and solid particles, influencing organoleptic qualities. Indirect smoking, utilizing smoke condensate, is preferred for reduced Polycyclic Aromatic Hydrocarbon (PAH) production compared to direct smoking (FAO, 2009). Smoke condensate, a controlled thermal degradation product of wood, replaces traditional smoking methods. Its increasing use is driven by low cost, controlled production, product diversity, and reduced hazardous compound release. Smoke condensate which influencing product quality may contains water, acids, carbonyls, and phenols (Xin et al., 2021).

Spices like ginger, garlic, and dried chillies are rich in essential oils that contribute aroma and flavor. Ginger is known for its aromatic, hot, and pungent characteristic that arise from oleoresin essential oil; widely used in meat products (Chi & Wu, 2008). Garlic with its antimicrobial properties due to allicin, finds widespread use in cooking. Dried chillies, containing capsaicinoids, provide heat and spiciness. This study aimed to develop the best formulation of smoked fish coated with local spices.

2. Materials and Methods

Sardines were obtained from Kota Kinabalu Central Market, Sabah. Local spices used to create the coating for the sardines include ginger, garlic, dried chillies, onions, nutmeg, cloves, cinnamon, black pepper powder, sugar, and salt, purchased from the Bataras Supermarket in Kota Kinabalu, Sabah.

2.1 Salting and Immersion in Liquid Smoke

The fish, having been cut and cleaned, was then immersed in a 5% salt solution for 30 minutes. Then, the fish was removed and drained for 10 minutes to eliminate excess water. Subsequently, it was immersed in a 6% liquid smoke solution, which was made by dissolving liquid smoke in 1500 mL of water, for 20 minutes.

2.2 Local Spice Coating

Seasoning of fish with spices was performed after immersing the fish in liquid smoke. In this study, the formulation of the spice coating considers indigenous spices available in Malaysia, utilizing three key local spices: ginger, garlic, and dried chilli. These similar three spices were employed in previous smoked fish trials, as documented by Topuz (2016), specifically for the preservation of smoked fish. In the present investigation, the formulation of local spice blends involves varying percentages of ginger, garlic, and dried chilli, while maintaining consistent percentages for other ingredients. The control group comprises fish which was not immersed in liquid smoke but coated with the three main spices at identical percentages. Following spice coating based on the formulated recipes, the fish were left to stand for one hour at 4°C before undergoing a 4-hour heating process in a drying oven set at 80°C. Detailed formulations for all recipes are presented in Table 1.

Table 1 The formulation of spice coating for the purpose of seasoning smoked sardines.

	Formulation (%)						
Materials	**Control**	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**
Liquid smoke immersion	0	6	6	6	6	6	6
Ginger	12	6	18	12	12	12	12
Garlic	12	12	12	6	18	12	12
Chili powder	12	12	12	12	12	6	18
Onion	11	11	11	11	11	11	11
Nutmeg	10	10	10	10	10	10	10
Clove	8	8	8	8	8	8	8
Cinnamon	8	8	8	8	8	8	8
Black pepper powder	5	5	5	5	5	5	5
Sugar	4	4	4	4	4	4	4
Salt	3	3	3	3	3	3	3
Water	15	15	3	15	3	15	3
Total (%)	100						

2.3 Sensory Evaluation Test

The selection of the best formulation for smoked sardines with local spice coating was conducted through sensory evaluation tests. These tests aimed to identify the optimal formulation and public response to smoked sardines prepared with liquid smoke and coated with spice formulations containing varying percentages of ginger, garlic, and dried chili powder. The hedonic scale test was used to identify the best formulation among the seven provided formulations. A total of 50 randomly selected sensory panellists, consisting of students who were familiar with the 9-point hedonic scale, evaluated taste, colour, aftertaste, and overall acceptance. The obtained sensory evaluation data were analysed using the One-Way ANOVA (Analysis of Variance) and Tukey's Test (Lawless & Heymann, 2010).

3. Results and Discussion

3.1 Sensory Evaluation Analysis

In this study, a total of seven formulations were developed, namely the control formulation, F1, F2, F3, F4, F5, and F6. In the control formulation, smoked sardines coated with local spices were not immersed in liquid smoke, while all other formulations were immersed in liquid smoke at 6% concentrations. Additionally, the other formulations were distinguished by different percentages of ginger, garlic, and dried chilli content. Hedonic testing was employed in sensory analysis to identify the best formulation for smoked sardines with local spice coating. One-way ANOVA was used to analyse the data obtained for five key product attributes, including taste, aroma, colour, aftertaste, and overall acceptance in Table 2. The one-way ANOVA analysis revealed significant differences ($p<0.05$) among all formulations for each attribute, with formulation F5 having the highest mean score for taste, aroma, aftertaste, and overall acceptance.

Table 2 The minimum score values (n=50) from the sensory evaluation test for taste, aroma, colour, aftertaste, and overall acceptance attributes of smoked sardines with local spice coating.

Formulation	Attribute				
	Taste	**Fragrance**	**Colour**	**Aftertaste**	**Overall acceptance**
Control	4.22±1.57^{c}	4.14±1.13^{e}	7.80±1.14^{a}	6.88±0.66^{b}	5.84±0.91^{c}
F1	3.30±1.10^{d}	5.26±0.85^{cd}	7.14±0.64^{b}	5.44±0.64^{c}	3.70±0.86^{e}
F2	6.02±1.02^{b}	4.96±0.67^{d}	6.44±0.84^{c}	3.08±0.80^{e}	4.84±0.79^{d}
F3	6.18±1.66^{b}	6.74±0.85^{b}	5.08±0.67^{e}	7.20±0.61^{b}	6.42±0.91^{b}
F4	4.82±1.51^{c}	5.66±1.02^{c}	5.68±0.94^{d}	5.84±0.98^{c}	6.58±1.03 ^{b}
F5	7.42±1.07^{a}	7.86±0.86^{a}	4.70±0.61^{e}	8.18±0.56^{a}	7.96±0.86^{a}
F6	5.88±0.85^{b}	5.80±1.26^{c}	3.44±0.68^{f}	4.12±0.75^{d}	6.46±0.86^{b}

Different superscript letters within the same column indicate significant differences ($p<0.05$).

3.2 Taste

In the taste attribute, the minimum score values obtained indicated that formulation F5 had the highest minimum score for the taste attribute, specifically 7.42 ± 1.07, while formulation F1 had the lowest minimum score for the taste attribute among all formulations, amounting to 3.30 ± 1.09. One-way ANOVA analysis showed a significant difference ($p<0.05$) between F1 and other formulations. F5 also exhibited a

significant difference ($p<0.05$) compared to other formulations. This suggests that the taste attribute for formulation F5, which was immersed in 6% liquid smoke and coated with 6% concentrated dried chili powder, is the most preferred, while the taste attribute for formulation F1, coated with 6% concentrated ginger, is the least preferred. According to Ikasari et al. (2017), the smoked taste in fish is attributed to phenolic compounds produced by smoke. Additionally, a study conducted by Tegang et al. (2020) found that the characterization of volatile compounds in liquid smoke from various types of tropical wood contains specific phenolic and carbonyl compounds contributing to the smoked aroma and flavor. Martinez and Machado (2016) also reported that an increase in phenol content in smoked meat enhances the smoked flavor of the product.

These significant differences may indicate that the use of 6% liquid smoke with low percentages of dried chili powder on sardines is the most effective formulation. Furthermore, the technique of applying liquid smoke to sardines should be suitable for providing a significant smoked taste in the smoked sardine product with local spice coating. In a study by Berhimpon et al. (2018), liquid smoke treatments on fish, namely soaking fresh fish in liquid smoke, soaking pre-heated fish in liquid smoke, and steaming pre-heated fish in liquid smoke, affected the phenol content in all three fish. The study found that the phenol content in the first treatment, soaking fresh fish in liquid smoke, was the lowest. Additionally, ginger has characteristics of a biting taste due to the presence of oleoresin (Chi & Wu, 2008). Chilies, on the other hand, contribute to a spicy taste due to the presence of capsaicin compounds, with the spiciness level depending on the level of capsaicin content in the chilies (Srinivasan, 2016). This indicates that the panelists prefer formulations with less spicy taste.

3.3 Fragrance

The smoky aroma is a crucial attribute in the production of smoked food products, with characteristics that can be described using various terms depending on the concentration of phenolic compounds present in the smoking process, such as smoky, woody, ashy, and musty (Wang & Chambers, 2018). In the aroma attribute, one-way ANOVA analysis indicated a significant difference ($p<0.05$) between F1 and F5 compared to other formulations. The minimum score values obtained showed that formulation F5 had the highest minimum score for the aroma attribute, specifically 7.86 ± 0.86, while the control formulation had the lowest minimum score for the aroma attribute among all formulations, amounting to 4.14 ± 1.13. This could be due to the presence of 6% liquid smoke in formulation F5 and the absence of liquid smoke in the control formulation. Varlet et al. (2006) found that phenolic compounds like cresol or guaiacol provide a smoked aroma to salmon. Based on a study by Wang & Chambers (2018), when the concentration of phenolic compounds increases, the smoked aroma characteristics become more pronounced. Therefore, the concentration of liquid smoke used in F5 is sufficient to produce a more pronounced smoked aroma and taste on the fish. Additionally, aroma can also be generated by spices as some spices contain volatile compounds. Ginger has aromatic and hot characteristics, with the highest commercial use in meat products (Chi & Wu, 2008). The aromatic properties of ginger originate from the presence of essential oils that can be extracted through steam distillation (Wilson, 2016). Dried chili also contributes to a spicy aroma due to the presence of capsaicin volatile compounds (Srinivasan, 2016). In this study, the use of low-concentration dried chili powder was found to produce a more preferred aroma according to the panelists.

3.4 Colour

According to Angela et al. (2015), the ideal and attractive colour for smoked fish is golden yellow, and it is one aspect that can influence panelists' acceptance of smoked fish products. In this study, the use of liquid smoke on all formulations except the control was found to result in a slightly darker colour of the fish. One-way ANOVA analysis indicated a significant difference ($p<0.05$) among all formulations in terms of the colour attribute. The obtained minimum score values showed that the control formulation had the highest score for the colour attribute, at 7.80 ± 1.14, while formulation F6 had the lowest minimum score for the colour attribute among all formulations, at 3.44 ± 0.68. The highest minimum score for the colour attribute in the control formulation indicates that panelists are more inclined to choose smoked sardines with local spice coating that have a bright colour compared to those with a darker colour. Berhimpon et al. (2018) reported that the appearance of smoked fish is significantly influenced by liquid smoke. Formulation F6,

which had the lowest minimum score, contained 18% chili powder. The use of dried chili powder with a high percentage resulted in smoked sardines with a local spice coating, exhibiting a reddish colour. This is attributed to the presence of the carotenoid known as capsanthin in dried chili, contributing to the red colour (Tan et al., 2021).

3.5 Aftertaste

Aftertaste refers to the sensory effect in the mouth after consuming a product or food, and one of the key aspects of identifying aftertaste attributes is to determine the positive and negative characteristics of the product (Meilgaard et al., 2006). In the aftertaste attribute, one-way ANOVA analysis also showed significant differences ($p>0.05$) among all formulations, where the minimum score values indicated that formulation F5 had the highest minimum score for the aftertaste attribute, with a value of 8.18 ± 0.56, while formulation F2 had the lowest minimum score for the aftertaste attribute among all formulations, with a value of 3.08 ± 0.80. Aftertaste is also influenced by the flavour and aroma of the fish, as reported by Jamilah et al. (2001) in the detection of aroma and taste after swallowing for different Tilapia fish species. In this study, the aftertaste attribute indicated that formulation F5, immersed in 6% liquid smoke with the lowest percentage of dried chili powder coating, is the most preferred compared to formulation F2, immersed in 6% liquid smoke with the highest percentage of ginger coating. This suggests that the presence of liquid smoke contributes to a better evaluation of the aftertaste attribute due to the presence of specific phenolic compounds and carbonyls contributing to the aroma and flavor of the liquid smoke (Tegang et al., 2020). Additionally, formulation F5 also had the lowest percentage of dried chili powder, contributing to a less spicy aftertaste for the smoked fish. This is because dried chili powder has pungent characteristics that provide a sensation of heat and spiciness, originating from the presence of alkaloid compounds called capsaicinoids (Zhang et al., 2022).

3.6 Overall acceptance

Overall food acceptance is one of the crucial attributes in sensory analysis and is a factor influenced by the sensory quality of the product along with the consumer's habits towards the food (Mela, 2001). In the overall acceptance attribute, one-way ANOVA analysis indicated significant differences ($p<0.05$) between formulations F1 and F5, where the minimum score value for the overall acceptance attribute for F1 was the lowest at 3.70 ± 0.86, while the minimum score value for F5 was the highest at 7.96 ± 0.86. These findings align with a study conducted by Seo et al. (2020), where good acceptance of flavored meat positively correlated with taste and aroma attributes. Additionally, the overall acceptance attribute is also a factor that can indicate familiarity in the panelists' eating habits, influenced by past food intake that helps panelists avoid uncertainty in food selection (Methven et al., 2012). Furthermore, this study found that the use of dried chili powder in formulation F5 at a lower percentage compared to the other two spices is more preferred. This indicates that most panelists prefer smoked fish with less spiciness. In a study conducted by Cliff & Heymann (1992) on the descriptive analysis of the oral pungency of various spices, it was found that capsaicin compounds in dried chili powder provide a higher spiciness sensation compared to oleoresin compounds in ginger.

3.7 Selection of the Best Formulation

In terms of attribute assessment, one-way ANOVA analysis indicated that formulation F5 had the highest score values for taste, aroma, aftertaste, and overall acceptance attributes. Only the colour attribute showed F5's minimum score values as the second lowest after formulation F6. Additionally, there were significant differences ($p<0.05$) between formulation F5 and other formulations in each attribute. This indicated that formulation F5 is the best in terms of taste, aroma, aftertaste, and overall acceptance. In conclusion, formulation F5, immersed in 6% liquid smoke and containing 12% ginger, 12% garlic, and 6% dried chili, was selected as the best formulation based on one-way ANOVA analysis and the minimum score assessment of five different attributes.

4. Conclusion

Based on this study, it can be concluded that formulation F5, immersed in 6% liquid smoke with the main spice percentages of 12% ginger, 12% garlic, and 6% dried chili, had the highest minimum score values for each attribute except for the colour attribute, making F5 the best formulation among all other formulations. Additionally, the high minimum scores for all four attributes indicated significant differences ($p<0.05$) between formulation F5 and the other formulations.

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