PHYSIOCHEMICAL AND SENSORY ACCEPTANCE OF CATFISH-BASED KEROPOK LEKOR ADDED WITH OYSTER MUSHROOM

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Abstract

Keropok lekor is a popular Malaysian snack traditionally made using marine fish such as 'Selayang' (Decapterus punctatus) or 'Tamban' (Clupea fimbriata). Due to high demand and limited supply, the exploitation of African catfish (Clarias batrachus) has been explored. However, the mild flavour and earthy taste of catfish does not meet consumer preferences for keropok lekor. To improve product's acceptability, oyster mushroom (Pleurotus spp.) was incorporated into catfish-based keropok lekor formulations. This study investigated the effect of substituting different parts of oyster mushrooms on the physicochemical properties and sensory acceptance of the product. Three formulations of catfish-based keropok lekor were prepared: sample A (oyster mushroom stalk), sample B (oyster mushroom cap), and sample C (whole oyster mushroom). In terms of nutritional composition, sample B had the highest fat (0.68 %) and protein (7.22 %) contents, while sample A had the highest fiber (13.7 %) and carbohydrate (43.10 %) content. Texture profile analysis showed that sample A had the highest scores for hardness. On the other hand, sample C was found to have the highest value of springiness. The lightness (L) value decreased in sample C with the addition of whole oyster mushrooms. A 9-point hedonic scale test evaluating consumer preferences indicated that samples A and C were favoured in terms of appearance, taste, and overall acceptance.*

Keywords: *keropok lekor, catfish keropok lekor, oyster mushroom, texture profile analysis*

INTRODUCTION

Keropok lekor, a traditional fish-based product, is particularly popular on the East Coast of Peninsular Malaysia, especially in Terengganu and Kelantan. It is typically made by mixing marine fish meat, such as tamban and selayang, with sago flour and spices, and is usually fried and consumed with chili sauce. Due to the inconsistent supply of marine fish species, there has been a growing trend toward using freshwater fish, such as catfish, in the production of fish-based products.

Catfish, which has an appearance similar to an eel, often features a dark grey or black back and a white belly. Recent research has explored the use of catfish as a primary protein replacement for chicken or beef in various products, such as nuggets (Solichah et al., 2022), burgers (Abdel-Latif et al., 2021), and traditional Karak crackers (Yudhistira et al., 2019). However, in the context of keropok lekor production, the distinctive sweet fish flavor is crucial for consumer acceptability, and catfish flesh, which lacks this flavor and has a strong earthy smell, does not meet this requirement.

To address these issues, oyster mushrooms have been chosen as additional ingredient to the basic raw materials. Known for their umami flavor and fibrous meat-analogue structure, oyster mushrooms are compatible with meat-processed commodities (Kumar et al., 2017; He et al., 2020). The umami flavor of oyster mushrooms can enhance overall meal acceptability and make monosodium glutamate more palatable. Additionally, the incorporation of mushrooms has been successfully reported to increase the preference of selayang-based keropok lekor (Iqmal-Afifi et al., 2023).

This study investigates the addition of different parts of oyster mushrooms (stalk, cap, and whole mushroom) to catfish-based keropok lekor to improve the flavor of the product. The study examined the changes in the physicochemical properties and sensory preferences among the samples. The development of a healthier and more sustainable version of keropok lekor could have significant benefits for public health and the environment.

METHODOLOGY

Materials

A fresh African catfish (Claries Gariepinus) approximately 150-200 gram per head with 30-40 cm long, and oyster mushroom were bought from Giant Supermarket (Bandar Baru Nilai). For making dough, Sago flour Cap Bintang (Cap bintang, Pulau Pinang), Tapioca flour (ABC, Thailand), a salt (Sungai Petani, Malaysia), sugar (CSR, Malaysia) and monosodium glutamate (Ajinomoto, Malaysia) were purchased in local supermarket nearby Bandar Baru Nilai, Malaysia.

Catfish and Oyster Mushroom Preparation

Approximately, 1 kg of freshly catfish was cleaned by removing the internal organ. Unlike other fish, catfish doesn’t have scales, but its body is coated with slimy substance that requires washing with lime and vinegar, followed by flour rinsing to eliminate its earthy odour. The fish was then filleted by removing the inedible parts of the fish such as head, bone and only flesh was used in the production of keropok lekor. The fish fillet was minced in a food processor and the flesh is stored in -18°C prior use in keropok lekor formulation.

While for oyster mushroom, it was washed thoroughly using pipe water twice to remove mud, dirt, and foreign materials. Extra water was removed by squishing the mushroom using muslin cloth. The mushrooms was then blended according to their part, in food processor to get minced mushroom.

Keropok Lekor preparation

To make keropok lekor dough, minced catfish flesh, minced mushroom, sago flour, tapioca flour, monosodium glutamate, ice, salt and sugar (Table 1) was mixed and kneaded into a dough. The dough was divided into 200-gram balls, which was roll into cylinders of the same shape to ensure that each of the keropok lekor is uniformly compact and can cook evenly. Typically, keropok lekor cylinders are 3 to 5 cm in diameter and 10 cm long. The rolled dough was then boiled in a pot at 100˚C for approximately 10-15 minutes.

Table 1: Formulations for Catfish-Based Keropok Lekor

Ingredients	Formulation 1 (mushroom stalk)	Formulation 2 (mushroom cap)	Formulation 3 (whole mushroom)
Oyster mushroom (g)	25	25	25
Minced catfish flesh (g)	25	25	25
Tapioca flour (g)	17	17	17
Sago flour (g)	17	17	17
Ice (g)	7	7	7
MSG (g)	3	3	3
Salt (g)	3	3	3
Sugar (g)	3	3	3

Nutritional Composition

The determination of proximate composition of unfried catfish-based keropok lekor added with oyster mushroom were analysed using the Association of Official Analytical Chemists (AOAC) methods (AOAC, 2005). Moisture content was determined using a force draft oven (Binder, Germany). The weight loss during drying was taken as the weight of moisture content. For dry-ashing method to determine ash content, 1 gram of each sample was burns on an electric hot plate until it stops smoking. The crucibles containing the burnt samples was placed in a muffle furnace and heated for overnight at a temperature of 550 °C. The crucibles were allowed to cool before being weighed once again.

Crude protein of samples was determined using Kjeldahl apparatus. Sample with the weight of 1.0 g was put into digestion tube. After that, 1 tablet of Kjeldahl tab and 10 ml of sulfuric acid (H_2SO_4) were added into each digestion tube. The sample underwent digestion and distillation process. The percentage of crude protein indicates the total nitrogen percentage present in the sample was calculated by multiplying it with a conversion factor of 6.25. The fat content of samples were analyzed using Soxhterm method. The sample was weighed at 5 g into a pre-dried thimble and placed in a Soxhlet flask. Petroleum ether (90 ml) was added to the flask and heated for 2 hours. The flasks were then dried in an oven at 60 to 80°C to remove the solvent.

Carbohydrates was determined by substrating 100% with the total percentages of moisture, fats, protein, and ash. On the other hand, crude fibre of catfish-based keropok lekor was determined using Gerhadt method. The pre- dried fibre bag and crucibles were weighted. Appoximately 1 g of sample was put in fibre bag and soaked in petroleum ether and distilled water two times for each treatment. For instrument method, which was washing phase I, the sample was soaked in H_2SO_4, boiled gently for 30 mins, drained the acid, and rinsed with hot water. In washing phase II, for instrument method, the sample was soaked in potassium hydroxide (KOH) solution, boiled gently for 30 mins, drained the alkali, and rinsed with hot water. The sample was transferred to a crucible, weighed it, dried overnight at 105 °C, and reweighed. After that, the sample was incinerated at 600 °C for at least 4 hrs, then the crucible was weighed after cooling.

Texture Profile Analysis (TPA)

Texture Profile analysis (TPA) of keropok lekor was conducted using texture analyzer (TA-XT Plus Model, Stable Microsystems, Survey, UK) following the method by Hayes et al. (2005). The texture profile of freshly boiled keropok lekor were compared. Parameters were set at load cell: 25 kg, compression platen: P.75, constant rate: 1 mm/s, trigger force: 10 g (2s), pre-test and post-test speed: 3 mm/s and return distance: 35 mm. The sliced of keropok lekor (2.5 cm thickness) was placed horizontally on the platform and compressed. Samples are subjected to hardness and springiness. Triplicates of keropok lekor samples were performed to determine the properties.

Colour Analysis

A calorimeter (Minolta spectrophotometer CM 3500d, Japan) is used to measure the colour of the freshly boiled keropok lekor and was indicated by lightness level (L*). The samples were prepared by mincing the keropok lekor into small particles and placing them in petri dishes.

Sensory Evaluation

The 9 point-hedonic scale was used to evaluate the sensory attributes (appearance, texture, taste and overall accpetability) of fried keropok lekor. Each sample was cut into 2.0 cm in size and placed in a transparent container which was labelled with 3-digit random code. Every panel was evaluated the samples in an individual booth in fully air conditioner room to avoid bias between panel. Panellists were also supplied with water for mouth rinsing between samples.

Statistical Analysis

All experiments data was presented in Microsoft Excel 2019 data processing software and performed by one-way analysis of variance (ANOVA) to compare the data at the significant difference, α=5%. The data also was examined in Minitab Software (Minitab 19). Tukey's test was used to performed at confidence of 95% ($P<0.05$).

RESULTS AND DISCUSSION

Nutritional Composition

Nutritional composition of boiled catfish-based keropok lekor samples added with different part of oyster mushroom is shown in Table 2. Sample A (oyster mushroom stalk) showed the lowest value of moisture content (49.89%) followed by sample B (oyster mushroom cap) and C (whole oyster mushroom), with a value of 50.69% and 50.81% respectively. Keropok lekor with whole oyster mushroom (sample C) was found to have the highest ash content among all the samples while sample B (oyster mushroom cap) showed the lowest value. These data indicating that the addition of different parts of mushroom in the keropok lekor did not influenced the moisture and ash contents significantly.

In term of crude fat content, sample B obtained the highest value, while keropok lekor added with stalk oyster mushroom (Sample A) showed the lowest value. Oluwafemi et al. (2016) stated that oyster mushroom stalk had the lowest fat content (1.48%) followed by oyster mushroom cap (1.55%) and whole oyster mushroom (1.50%). Stalk's primary roles are to support the cap and aid in the movement of nutrients. It has a lower fat content because chitin and fibrous materials rather than lipids, which store energy for dominate its structural structure.

The crude protein content of catfish-based keropok lekor added with cap (Sample B), stalk (Sample A) and whole oyster mushroom (Sample C) were 7.22%, 4.25% and 5.46% respectively. Protein content in cap mushroom showed as the highest (34.19%) compared to stalk (20.96%) and whole mushroom (30.48%). In the other hand, mushrooms are often referred to as valuable protein sources (Adebayo et al., 2017). As for fibre content, sample A got the highest value (13.7%) follow by sample C (7.11%) and sample B (4.41%). Oyster mushroom stalk contains higher fibre than the other parts of mushroom due to its composition of cellulose stem. The cellulose forms the bulk of its structure, aiding in rigidity and stability. This result was correlated with previous study from Oluwafemi et al. (2016) reported that crude fibre for the stalk mushroom is the highest (7.5%).

Sample C (whole mushroom) obtained the highest value for carbohydrate percentage (40.69%) in comparison to sample A (mushroom stalk) and sample B (mushroom cap) with a value 43.10% and 39.39% respectively. This result was inagreement with Oluwafemi and his co-reseahers (2016) findings where carbohydrate constituent in edible oyster mushroom cap with 52.9%, stalk with 61.8% and the whole oyster mushroom with 51.9%. The incorporation of flours (sago and tapioca) in the preparation of keropok lekor dough in this experiemnt might affect the carbohydrate content of the final products.

Table 2: Proximate Analysis of Catfish-based Keropok Lekor

Percentage (%)	Formulation of Keropok Lekor		
	Sample A (mushroom stalk)	Sample B (mushroom cap)	Sample C (whole mushroom)
Moisture	49.89±1.70^{a}	50.69±1.99^{a}	50.81±0.22^{a}
Ash	2.29±0.42^{a}	2.20±0.17^{a}	2.58±0.08^{a}
Crude Protein	4.25±0.22^{b}	7.22±0.37^{a}	5.46±0.15^{c}
Crude Fat	0.38±0.03^{b}	0.68±0.18^{a}	0.46±0.05^{b}
Carbohydrate	43.10±1.82^{a}	39.29±2.30^{a}	40.69±0.09^{a}
Crude Fiber	13.7±4.98^{a}	4.41±0.99^{b}	7.11±1.79^{ab}

Mean ± standard deviation values with different superscript letters in the same row are significantly different at $P<0.05$.

Texture Profile Analysis (TPA) of Catfish-based Keropok Lekor

Out of all the quality and flavour, texture is the most significant property that affect the consumer acceptance to any food product available. A substance's texture is a property that comes from a mixture of its physical characteristics and is sensed by the senses of touch, sight, and hearing. Figure 1 provides the texture profile of catfish-based keropok lekor with substitution of different part of oyster mushroom including hardness and springiness properties. Hardness is an important factor that can be defined as force necessary to cause a material to undergo a specific deformation; the material's toughness, firmness, or resistance to deformation are usually used to quantify this force. Numerous processing variables, including the kind and quantity of materials, additives, heat treatment, and equipment employed, have an impact on texture profiles.

Based on Figure 1, sample A (oyster mushroom stalk) was found to be the highest in mean value of hardness (201.5 N), indicating the sample is the hardest among all the keropok lekor. The highest value might due to high fibre content in mushroom stalk as this mushroom part is composed with high fibre cellulose. This presumption is highly correlated (R^2= 0.940) with the fiber content obtained in this study as sample A had the highest fiber content among all the samples.

Springiness quantifies the keropok lekor's ability to recover, indicating its internal structure and quality when forces were hire to it. In terms of springiness, from the result shown in Figure 1, catfish-based keropok lekor with whole oyster mushroom (sample C, 1.818) was not statistically the highest (p>0.05) from sample B (oyster mushroom cap, 1.0243) and sample A (oyster mushroom stalk, 1.0457). The springiness data suggest that the addition of whole mushrooms to the keropok lekor formulation results in a product with a good elastic structure.

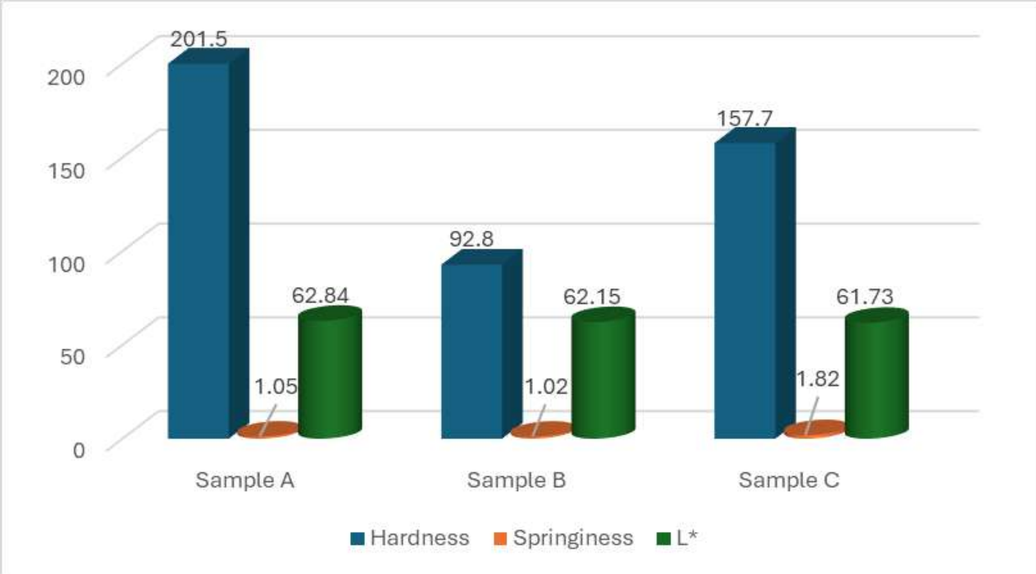

Figure 1: Textural Properties and "L" Values of Catfish-Keropok Lekor

Colour Analysis of Catfish-based Keropok Lekor

When it comes to judging the acceptability of people and quality of keropok lekor, colour also plays an important role for their first impression towards the keropok lekor. The brightness is represented by the degree of colour parameter L*, where a value of 0 denotes black and a value of 100 denotes white. For L*, the indicator colour for whiteness of the sample, the value in sample A (62.84) was significantly higher ($P<0.05$) than in sample B (62.15) and the sample C (61.73) (Figure 1). Catfish flesh is primary white in colour as this fish is high in lipids and water-soluble proteins like myoglobin and haemoglobin (Yahya et al., 2020). Khatijah-Najihah et al. (2023) was reported that keropok lekor prepared using catfish flesh showed higher L* values as compared to selayang keropok lekor indicating the former keropok lekor is ligher in colour as compared to the latter one. Furthermore, different part of oyster mushroom did not play a significant role in colour difference for catfish-keropok lekor due to insignificant 'L' values obtained.

Sensory Evaluation

Sensory evaluation provides useful information about consumer preferences, which aids in product creation and quality control. Generally, no significant difference was found between the keropok lekor added with different part of oyster mushroom (stalk, cap and whole mushroom) indicating the variable did not influence the sensory attributes evalauted. In terms of appearance attribute, sample C (whole mushroom, 7.250) scored as the highest in values than sample A (mushroom stalk, 6.750) and sample B (mushroom cap, 7.067) as shown in Figure 2. This is probably due to the dark colour of sample C as compared to the other samples which similar to commercial one. Furthermore, Shewfelt and Brückner (2000) assert that a product's colour and appearance can catch the eye of the customer and encourage impulsive purchases. Consumers utilise visual elements to determine freshness and taste quality at the moment of purchase.

For texture attribute, sample A obtained the highest mean value (7.00) followed by sample C and sample B with mean value 6.93 and 6.55, respectively. Next attribute evaluated was a taste. Taste is the most crucial part for every kind of food. Both sample B and sample C were found to obtain the value of 7.100, while sample A showed to score with 6.633 value. This result gives a hint that oyster mushroom cap or the whole oyster mushroom using in keropok lekor making give the same taste to the consumer preferences. The umami taste of oyster mushrooms would contribute to the palatability of mono-sodium glutamate and the improvement of overall food acceptance (Jeng-Leun, 2005). The presence of free amino acids like glutamic, aspartic acid, 5′-ribonucleotides and some peptides related to umami taste that build up on the tongue (Sun et al., 2020).

Lastly, the overall acceptance of the catfish-based keropok lekor with substitution of different part of oyster mushroom showed that the sample C had the highest mean score of 7.283. As a whole, the sensory preference shows that panelists preferred catfish-based keropok lekor added with whole mushroom as indicated by the highest score obtained for sample C for appearance, taste and overall accpetability.

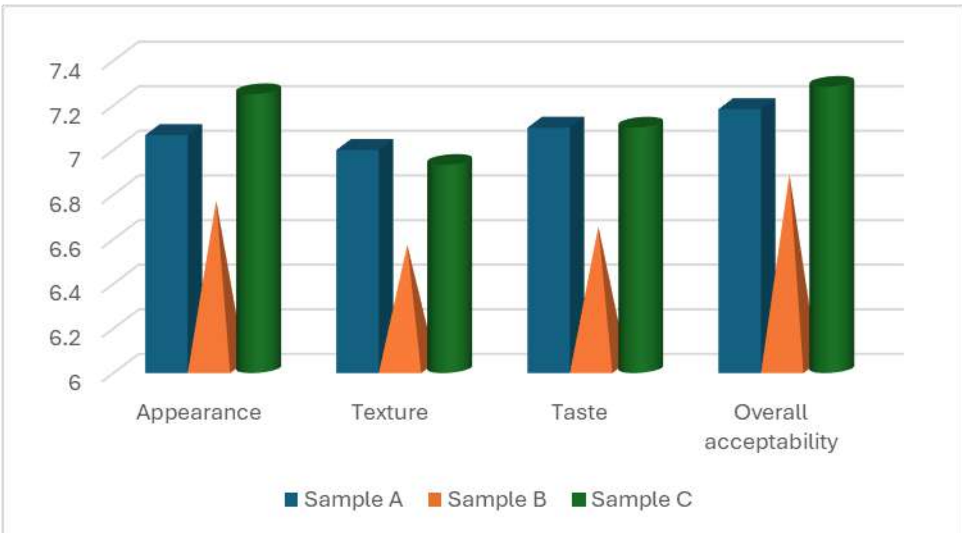

Figure 2: A 9-Point Hedonic Scale of Catfish-Based Keropok Lekor

CONCLUSION

Three formulations of catfish-based keropok lekor with different parts of oyster mushroom were prepared as follows: sample A (oyster mushroom stalk), sample B (oyster mushroom cap) and sample C (whole oyster mushroom). From the proximate, the addition of different part of oyster mushroom in keropok lekor formulations resulting in the significant changes for fat, protein and fiber contents.

While, moisture, ash and carbohydrates contents were not influenced by the mushroom part significantly. In texture profile analysis (TPA), the highest value of hardness was achieved by sample A (oyster mushroom stalk) probably due to high fiber content in this formulation. However, sample C (whole mushroom) showed good elasticity property indicating by the highest value in springiness. The addition of different parts of mushroom in keropok lekor was found to significantly affect lightness value. The 9-point hedonic scale scores indicated that consumers preferred sample C (whole oyster mushroom) as this sample obtained the highest score for appearance, aroma, taste and overall acceptability. All the samples also obtained scores higher than 6 (like very much). The findings suggested that addition oyster mushrooms in catfish-based keropok lekor has a great potential to be commercialized in the market and expand the market for this end product.

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