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Abstract. *Etak salai* is a popular traditional snack consumed by the people of Kelantan. Raw e*tak* or scientifically known as *Corbicula fluminea,* a bivalve which is marinated using special ingredients and undergoes a smoking process before being sold as a local snack. However, some people are sceptical when it comes to the hygiene aspect in the preparation of *etak salai*. Previous studies have also proven the nutritional values of the smoked *etak* may be reduced during the smoking method process because carried out openly thus becoming suscepticle to microbial contaminations. Therefore, this study aims to determine the effect of temperature on moisture, ash and crude fat content of *C. fluminea* by using a modified oven. The present study focused on the moisture, ash and crude fat content in *C. fluminea* soft tissue that has undergone the smoking process using a modified oven method, with optimum temperature, air flow and time. Samples were collected from Pasir Mas and Tumpat, Kelantan, Malaysia. Then, the *C. fluminea* were subjected to proximate composition analysis according to the Association of Official Analytical Chemists standard method (AOAC 2000). The results of smoked *C. fluminea* in Pasir Mas station shown the moisture (79.71%) and ash (3.70%) were significantly higher ($p<0.05$) at 75 °C and 100 °C, respectively. On the other hand, crude fat content (9.85%) was significantly higher ($p<0.05$) at 95 °C in Tumpat station. In conclusion, the smoking method should be improved to ensure the quality and safety of smoked *C. fluminea*.

1. Introduction

Corbicula fluminea is a bivalve that can be found in the sandy bottom of major freshwater rivers in Malaysia. Its filter-feeding nature allows it to filter the particles suspended in water. In the sediment, *Corbicula fluminea* also used their pedal foot to feed on organic materials and small organisms [1]. The life-span of freshwater mussels like *C. fluminea* ranged between 1 and 5 years in a variety of ecosystems [2, 3]. This species plays an important role as environmental bioindicator. Since it is tolerant towards contaminants, consumers become vulnerable to foodborne disease upon consumption of the contaminated bivalve [4,5] reported that the problem of bacterial contamination in *C. fluminea* should be properly addressed to reduce the risk of getting diseases among consumers. In certain states in Malaysia like Kelantan, Terengganu, Perak and Pahang, etak has a high demand thus being harvested the most in these locations [6]. As of late, the population and habitat of the *C. fluminea* have

been compromised due to anthropogenic activities such as clam harvesting as well as habitat modification and destruction [7].

In Kelantan, *C. fluminea* has been regularly consumed as a snack by the locals for a long time [8]. Raw *C. fluminea* is soaked in clean water for depuration where dirt attached to its shell are removed during this process. Then, the depurated *C. fluminea* is marinated with special ingredients such as garlic, shallots, lemongrass, ginger, monosodium glutamate (MSG), sugar and salt for 3-5 hours to get a good taste. The marinated *C. fluminea* was smoked using firewood at 55 C for 45 minutes. The smoked *C. fluminea* will then be called "Etak salai". Nowadays, *etak salai* is commonly sold along main roads around Kelantan in districts like Kota Bharu, Pasir Mas and Tumpat.

The smoking method is a common process that causes changes against the colour and taste of food. There are two types of smoking method that are often used in food preparation which is cold smoking and hot smoking [9,10] stated that cold smoking is carried out at a temperature not exceeding 30 ˚C or via a traditional kiln where the wood burning temperature usually exceeds the oven temperature of 80 °C. Apart from that, [11] reported that the smoking method does not require any advanced equipment or skilled workers. The increment or reduction in the food's nutritional values depends on the preparation method due to the presence of anti-nutrient substances [12]. In addition, the duration of the smoking process also plays an important role because of its effects on nutrient content [13].

Hygiene is a major concern when it comes to the preparation of *etak salai* especially among the younger generation. Besides, the nutritional value of the smoked etak may also be reduced during the smoking process because it is carried out in open air and exposed to microbial contaminations. At present, there is a lack of research on the nutritional value of *C. fluminea* using a modified oven as an alternative smoking method. Therefore, this research aims to determine the effect of temperature on moisture, ash and crude fat content in *C. fluminea* prepared by using a modified oven.

2. Materials and Methods

The sampling of marinated *C. fluminea* was carried out at each popular stall in Pasir Mas and Tumpat, Kelantan. The marinated *C. fluminea* were purchased monthly from local stalls that sold fresh *C. fluminea*. All the samples were sealed by using a sterilized zipper bag and upon collection and preserved at a temperature of approximately 4°C in the icebox while being transported to the laboratory in UMK.

2.1 Modified oven smoking process

The modified oven exterior surface consisted of stainless steel, painted sides with a smoking door which is made of durable glass. The dimensions of the modified oven are 83.5 cm x 79 cm x 46 cm as shown in Figure 1. For the smoking process, it has a single section tray to place the *C. fluminea*. In the control panel area, it was fixed with the main gas power on/off, surface-fire temperature adjusts function and assisted ignition. The air-blower was used to correspond to the natural airflow in the modified smoking method. The aeration system in the oven will be more even when using the air-blower. Therefore, time and temperature can be controlled throughout the smoking process.

2.2 Smoking process of Corbicula fluminea

The marinated *C. fluminea* were smoked by using a modified oven method under the optimum condition at different temperatures with constant time and airflow. The power-on of the modified oven was turned to light the gas. The temperatures used for the smoking stage include 75 ˚ C, 85 ˚ C, 95 ˚ C, 100 ˚ C and 105 ˚ C. During the smoking process, the temperatures were monitored using surface-fire temperature adjust function. The air – blower tool was turned on. The airflow was set at 1.0 m^3/min and the smoking time was 30 minutes which remained constant throughout the smoking process. When the oven was hot enough, it was indicated by a 'beep' sound. The marinated *C. fluminea* was placed and smoked in the modified oven.

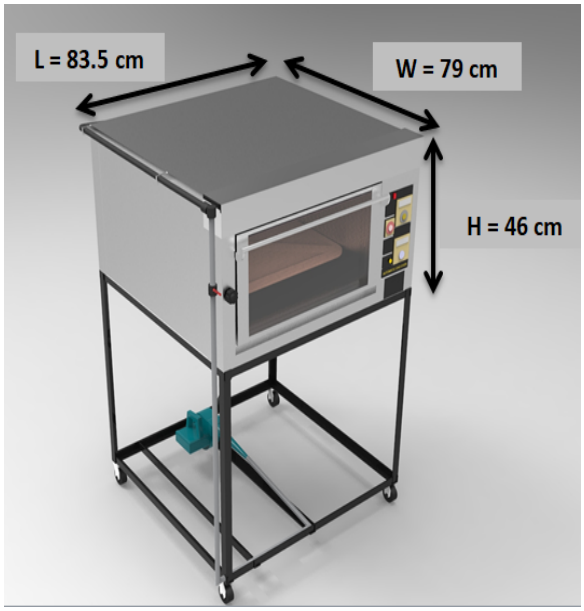

Figure 1 Modified oven smoking process

2.3 Proximate composition analysis

The determination of moisture, ash and crude fat (CF) content was done according to the guideline by the Association of Official Analytical Chemists standard method. The moisture content was determined by weighing 5.0 g of sample and oven-dried at 105 ˚ C until a constant weight was obtained. The ash content was determined by heating the sample at 600 ˚ C after 7 hours of combustion. The crude fat was determined through the Soxhlet Extraction method by using petroleum ether.

2.4 Statistical analysis

All data were measured in triplicates. There were expressed as mean ± standard deviation (SD). All the data collected were analysed using two-way ANOVA. If there were significant differences ($p<0.05$) between the different temperatures, further analysis was carried out using Minitab17 software.

3. Results and Discussion

3.1 Moisture content

The moisture content in smoked *C. fluminea* for five smoking temperatures at Pasir Mas and Tumpat were shown in Table 1. The moisture content of smoked *C. fluminea* at 75 ˚ C was found to be the highest (79.71%) result in Pasir Mas station. Besides that, the lowest (73.60%) result was obtained at temperature of 105 ˚ C in Tumpat. In Pasir Mas station, the moisture content showed no significant differences ($p>0.05$) at temperature of 75 ˚ C, 85 ˚ C and 95 ˚ C, but there was significant differences ($p<0.05$) at temperature of 100 ˚ C and 105 ˚ C. In Tumpat station, there were no significant differences ($p>0.05$) at temperature of 75 ˚ C and 85 ˚ C, but at 105 ˚ C showed a significant differences ($p<0.05$). However, temperature of 95 ˚ C and 100 ˚ C also showed no significant differences ($p>0.05$) between the temperature of 75 ˚ C, 85 ˚ C and 105 ˚ C.

Based on the results obtained, the lowest in the moisture content of *C. fluminea* occurred because of the temperature used during the smoking process was higher than the boiling point of water. Apart from that, the reduction can also be due to the desirable non-enzymatic browning reactions caused by the smoking process [14-16]. [17] stated that evaporation of water molecules and the reduction of the

moisture content in the fillet were due to the heat energy produced by the drying process. Furthermore, the smoking process has also been proven to be responsible for the loss of moisture content in food [18, 19]. Besides that, [20] explained that during smoking and other cooking process, the reaction of water or oil at high temperatures were believed to have caused the nutrients in foods and changes in the structure of oil.

Table 1 Proximate composition of smoked *C. fluminea* in Pasir Mas and Tumpat

Stations	Temperature (°C)	Moisture	Ash	Fat
Pasir Mas	75	79.71±1.44^{a}	3.15±0.93^{a}	8.36±1.20^{ab}
	85	79.66±1.59^{a}	3.12±0.96^{a}	8.84±1.37^{ab}
	95	79.47±1.82^{a}	3.35±0.88^{a}	7.92±1.25^{b}
	100	75.35±2.76^{b}	3.70±0.95^{a}	8.49±1.87^{ab}
	105	74.91±3.48^{b}	3.12±1.21^{a}	9.59±1.31^{a}
Tumpat	75	78.60±2.49^{a}	3.37±0.73^{a}	8.85±1.43^{ab}
	85	78.53±3.05^{a}	3.37±0.94^{a}	8.37±1.51^{b}
	95	78.15±3.14^{ab}	3.69±0.84^{a}	9.85±0.92^{a}
	100	75.79±3.22^{bc}	2.96±0.73^{a}	9.46±1.31^{ab}
	105	73.60±1.92^{c}	3.40±0.93^{a}	8.59±1.67^{ab}

^{abc} means in the same row with different superscript are significantly different ($p<0.05$)

3.2 Ash content

From the table 1, the ash content value of smoked *C. fluminea* was higher in Pasir Mas than Tumpat station. The ash content (Table 1) demonstrated the highest results in Pasir Mas station with temperature of 100 °C (3.70%). However, the ash content demonstrated the lowest results in Tumpat station at 100 °C (2.96%). In other work, ash content in Table 1 indicates that there were no significant difference ($p>0.05$) between Pasir Mas and Tumpat station at all smoking temperatures.

Many researchers studied that during smoking process, it was claimed that the ash content highest because of the dust and loss of humidity in *C. fluminea* [18, 19, 21]. However, this also might be due to the amount consumption of garlic and sugar during the process of marinating. According to [22], the increment of ash content in smoked *C. fluminea* could be related to the smoking process which is similar to the loss in moisture content. Moreover, [23] reported that this might be due to the presence of salt in the sample during the marinating process. [24] reported that after smoking process, the ash content of oyster increased from 2.08 to 8.35%. In fact, the instability of the mineral elements during smoking and the high temperature sales were due to the increased ash content in C. fluminea smoke.

3.3 Crude fat content

Table 1 presents the result of crude fat for five smoking temperatures at two different districts such as Pasir Mas and Tumpat. Based on the table, at 95 °C were produces the highest value (9.85%) in Tumpat station and lowest value (7.92%) in Pasir Mas station. In Pasir Mas station, the result of crude fat content showed no significant differences ($p>0.05$) at 105 °C but there was a significant differences ($p<0.05$) at 95 °C. Therefore, there were no significant differences ($p>0.05$) at temperature of 75 °C, 85 °C and 100 °C. By an observation in Tumpat station, crude fat content at 95 °C shows no significant differences ($p>0.05$), but there was a significant differences ($p<0.05$) at 85 °C. Crude fat content showed there was no significant differences ($p>0.05$) at 75 °C, 100 °C and 105 °C.

The result obtained agreed with the study done by [25] who reported that the higher results of crude fat content is due to the concentration of the nutrients. Meanwhile, [22] claimed that the crude fat content increased due to the heat processing method. The findings of this study showed that the low crude fat content in *C.fluminea* might be due to the increase in dry matter throughout the frying process and fat absorption [26, 27].

4. Conclusion

Based on the findings of the present study, it can be concluded that the extreme temperature of the modified oven had affected the moisture, ash and crude fat content of smoked *C.fluminea*. Further work is essential to study the sensory characteristics of *etak salai* where the smoking method is carried out using a modified oven to ensure the quality of smoked *C. fluminea* in terms of their cleanliness and safety for consumers.

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