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Comparison of Proximate Composition of Raw and Cooked Intramuscle Tissue of *Thunnus tonggol* from Terengganu, Malaysia

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ABSTRACT

A study was carried out to determine the effects of the steaming process on the proximate composition of the dark and white muscle tissue of *Thunnus tonggol* sampled from Terengganu waters. The mean percentage of moisture, ash, lipid, and protein of the raw dark muscle was 59.1%, 3.8%, 12.1% and 33.9%, while in the raw white muscle were 66.7%, 2.9%, 2.7% and 33.9%, respectively. Both types of muscle showed a significantly different value in the lipid content. There was significant increase recorded in the protein content in both types of muscle after the steaming process (79.1% and 93.0% in dark and white muscles, respectively). Likewise, the percentage of ash showed some increment with 4.8% in the dark muscle and 7.9% in the white muscle. However, the cooking process decreased the percentage of moisture and lipid in both dark and white muscles. The percentage of moisture in dark muscle was reduced to

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7.7%, and 9.7% in white muscle. On the other hand, percentage of lipid content in both types of muscles after the steaming process was 0.43% in dark muscle and 0.03% in white muscle. This study reveals that the cooking process had considerable effects on the proximate composition of both dark and white muscles.

Keywords: Dark and white muscles, longtail tuna, proximate composition, raw and cooked, *Thunnus tonggol*

INTRODUCTION

Fish is known as the major source of food and essential nutrients to fulfil the nutritional requirements in most human populations of the world. Fish have been obtained a wide attraction as an excellent source of digestible protein, vitamins, and other minerals (Elmadfa & Meyer, 2017; Abraha et al., 2018; Mohanty et al., 2019). It has been reported that the population in eastern Asia consumed fish with rice daily or as part of a rice dish or as a side dish (Burger et al., 2003; Tang et al., 2015; Ahmad et al., 2016). The annual per capita fish consumption of Malaysian was the second highest after Japan when comparing among Asian nations or ranked number fifth throughout the world (York & Grossard, 2004). In particular, the consumption of fish among Malaysian has been recorded at least once a day in the amount of one and one–half medium size fish per day (Norimah et al., 2008; Ahmad et al., 2015).

Terengganu state situated at the east Peninsular of Malaysia has the longest coastline in Peninsular Malaysia around 244 km facing South China Sea waters. This region experienced monsoon seasons every year from November to March with a high density of rainfall, strong winds, and waves (Mohamed & Amil, 2005; Antonina et al., 2013; Daud et al., 2016). Terengganu is known as one of the centers of fisheries landing areas in Malaysia (Terengganu Tourism, 2018). In Terengganu, the most popular commercial fish species landed and consumed is Longtail tuna, *Thunnus tonggol* (Figure 1), or known as "*Ikan Tongkol*" (Basir et al., 2016; Azmi et al., 2019) by local communities. Terengganu people were estimated to consume this species 239.7 g per person and 1.83 times per week which is about 437.4g/person/week (Norhazirah et al., 2020). This species is among the smaller members of the Tuna family (Griffiths et al., 2010; Al-Mamari et al., 2014). In Terengganu, *Thunnus tongkol* is often served with a special local delicacy called *Nasi Dagang* cooked with curry gravy and served with glutinous rice. Another Terengganu's popular *Thunnus tonggol* dish is *Singgang*, a healthy yet delicious fish soup prepared with turmeric, chili, garlic, and onion serve for lunch.

Despite its nutritional value and consumer preference, the effect of cooking on this species has been scarcely inscribed. Generally, the nutritional value in fishes can be altered by processing and heat applied through cooking methods (Alia et al. 2020). Therefore, it is appropriate to undertake a thorough analysis of the proximate composition of this species' intramuscle, hence this research was accomplished.

Figure 1. The Longtail tuna (*Thunnus tonggol*) which is among the smaller members of the Tuna family and is in high abundance in Terengganu waters.

METHODOLOGY

Sample Preparation and Cooking

The fresh *Thunnus tonggol* fish samples with mean and length recorded were 1567±107.3 g and 48.4±1.3 cm respectively (n = 25) was obtained from the local fishermen from fish landing port at Pulau Kambing, Kuala Terengganu. Then the samples were transferred to the laboratory for further analysis. During transportation, the samples were kept in the icebox at low temperature, ±4^{o}C. On arrival at the laboratory, the fish samples were washed with distilled water three to four times to discard foreign substances and fish blood before the samples were eviscerated. The bone and skin were removed using a ceramic knife. Steaming of the samples were performed in a domestic steamer Pensonic PRC-25 G (Malaysia) at approximately 100^{o}C for 20 minutes (Adepoju et al., 2017). The dark and white muscle were steamed separately. The raw and steamed samples were dried in the oven at 60°C for 12 hours as to express in dry basis. For steamed samples, the Longtail tuna muscles were steamed before undergoing the drying process. Then the dried samples were homogenized using a kitchen blender (Lombardo-Agüí et al., 2015; Gan et al., 2016) and analyzed to determine the proximate composition.

Proximate Composition

For futher analysis, the moisture content of raw and steamed muscle samples was determined by oven-drying method at 95 – 105°C for 24 hours. Crude protein content was calculated by converting the nitrogen content as determined by Kjeldahl's method (Gerhardt KBL40S and Foss Kjeltec 2100) using the conversion factor of 6.25 (Sullivan & Carpenter 1993). The lipid content was determined by the method described by AOAC (2006) using the Soxhlet system (Foss ST310). The Ash content in the muscles were gravimetrically determined by dry–ashing in a muffle furnace at 600°C for 6 hours.

Statistical Analysis

The normality test was run by using SPSS software where the p-value < 0.05, not normally distributed. A non-parametric Chi-square test was run to prove that the data was statistically significant where the p-value < 0.05.

RESULTS

The average percentage of proximate composition in raw and cooked *Thunnus tonggol* muscles were presented in Table 1. All the data were expressed in percentage dry basis. Generally, in raw muscles, the highest proximate composition was moisture with 59.1%, ranged from 58.5% to 59.5%, and 64.9%, ranged from 64.5% to 69.7% in dark and white muscle, respectively. The average ash content was slightly higher in the dark muscle which is 3.8% compared to 2.9% in white muscle. On the other hand, there was a significant distinction in the value of lipid content in both types of muscle, which the average value recorded was 12.1% and 2.7%. However, there were no significant differences in the average percentage of protein in both dark and white muscle.

Table 1

The mean and range percentage of lipid, moisture, ash and protein in raw muscle samples and cooked samples of Longtail tuna. All the values were expressed in percentage dry basis.

Proximate composition (% dry basis)		Moisture (%)	Ash (%)	Lipid (%)	Protein (%)
Raw sample	Dark muscle	[a] 58.5 – 59.5* [b] 59.1	3.6 – 4.2* 3.8	10.1 – 14.4 12.1	32.2 – 35.5 33.9
	White muscle	64.9 – 69.7* 66.7	2.9 – 3.1* 2.9	– 4.2 2.7	33.0- 35.6 33.9
Cooked sample	Dark muscle	6.1 – 7.2* 7.7	4.3 – 5.3* 4.8	0.38 – 0.47 0.43	78.5–79.6* 79.1
	White muscle	8.6 – 10.1* 9.7	7.5 – 8.6* 7.9	0.02 – 0.04 0.03	91.5- 94.4* 93

[a] The ranges percentage of proximate composition in intramuscle of raw and cooked samples.
[b] The averages percentages of proximate composition in intramuscle of raw and cooked samples
*Significantly different compared to the raw and cooked samples

Nevertheless, the cooking process reduced lipid content by 96.4% in dark muscle while 98.9% in white muscle. Apart from that, the moisture content also dropped after the cooking process in both types of muscle. However, the content of ash and protein showed an increment in dark and white muscle after being treated with the steamed process. The ash content raised by 63.3% in white muscle, while only 20.8% in dark muscle. Meanwhile, the protein values were increased tremendously after cooking treatment. The protein content in dark muscle increased by 133.3% while 174.3% in white muscle after the cooking process.

DISCUSSION

The nutritive values of the fish muscles may be altered by processing or cooking methods (García–Arias et al., 2003; Rahman et al., 2012; Moussa et al., 2014). The heat applied to the muscle may alter the content of moisture, ash, lipid, and protein (Feng et al., 2017; Abraha et al., 2018). Other than that, the structure of dark and white muscle may contribute to the changes of proximate composition in both raw and cooked samples.

In this study, both dark and white muscles of *Thunnus tonggol* were declining in the percentage of moisture by 87.0% and 85.5% in dark and white muscle, respectively, after been treated with the steaming process for 20 minutes. Water loss in both types of muscle was anticipated after the steaming phase as the heat was applied to them. This finding also agreed by other researchers (Ersoy & Ozeren 2009; Hosseini et al., 2014; Ersoy et al., 2016; Weber et al., 2018) in their studies where there was significant moisture loss in fish muscle after culinary treatment. The decrease in the percentage of moisture in both types of muscle through evaporation of dripping under heat condition may alter other components content such as protein and ash.

On the other hand, the protein content increased up to 93 % in both types of muscle. Protein increased in samples after cooking methods was derived from the loss of moisture (Eduardo et al., 2016; Ersoy & Ozeren, 2009). The declining of water content has been defined as the most factor that caused the protein and ash contents to increase significantly in the steamed fish (Arias et al., 2003; Weber et al., 2008). This is in accordance with the findings of Puwastien et al. (1999), Nalan et al. (2004), Weber et al. (2008), and Goswami and Manna (2020) where the cooked fish (steaming, boiling, and grilling) contained higher protein levels. Other than that, Ng and Rosman (2019) suggested that the increment of protein content possibly an effect of enzymatic hydrolysis, which might cause the free amino acids to discharge. On the other hand, the increased of protein content in cooked muscle sample might be due to the solubilization of some nitrogenous compounds (Mustafa et al., 2012).

The ash content in muscle samples indicated the information on the distribution of bony parts to the flesh (Sofoulaki et al., 2018). The increase of ash percentage indicated the larger skeletal mass of the fish (Rasmussen & Ostenfeld, 2000; Daramola et al., 2007). Respecting the ash percentage, it consists mainly of minerals (Murray & Burt, 2001). In this study, the increase of ash content by 63.3% in white muscle and 20.8% in dark muscle after the steaming process might be provoked by the remarkably dropping of moisture content.

On the other hand, the comparison data on the proximate compositon analysis of few different fish species that treated with various cooking methods were demonstrated in Table 2. Rainbow trout (*Oncorhynchus mykiss*) treated with boiling, frying and grilling methods were analysed and the findings showed that there were changes occurred in proximate composition when compared to the raw sample. The moisture was decreased with all cooking treatments while ash, protein and lipid were increased in contents. Frying methods showed the great increment in lipid content from 3.44 ± 0.013 to 12.7 ± 0.08 % probably due to the usage of oil in the process. The frying methods that applied to the fish in few studies demonstrated the increment in lipid percentage due to the fat absorption by the fish (Nalan et al., 2004; Turkkan et al., 2008; Lira et al., 2017).

Morever, study by Turkkan et al. (2008) presented the same pattern of proximated composition when cooking methods were applied to the seabass muscle samples. The increasing of lipid percentage in the samples after treated with frying method was 65.3 % while baked and miscrowaved methods were 40.7 and 23.2 %, respectively. Nonetheless, the research by Lira et al. (2017) determined the contradicting findings with other studies where the percentage of ash, and protein decreased. However, the various pattern found in that study might be controlled by the cooking methods and additional ingredients applied to the fish samples.

Table 2

The comparison data on the proximate composition analysis in various species of fish in raw and cooking treatment samples. All the data were expressed in mean percentage ± sd.

Species	Cooking Treatment	Moisture (%)	Ash (%)
Rainbow trout (*Oncorhynchus mykiss)*	Raw	73.4 ± 0.015	1.35 ± 0.012
	Fried	62.7 ± 0.024	1.66 ± 0.006
	Boiled	69.2 ± 0.035	1.61 ± 0.02
	Grilled	65.8 ± 0.05	1.54 ± 0.025
Seabass (*Dicentrarchus labrax,* Linnaeus, 1758)	Raw	71.62 ± 0.23	0.92 ± 0.4
	Fried	62.9 ± 4.47	2.41 ± 0.49
	Baked	66.5 ± 3.08	2.18 ± 0.25
	Microwave-cooked	69.3 ± 0.38	2.90 ± 0.53
King mackerel (*Scomberomorus cavalla,* Cuvier, 1829)	Raw	-	5.15 ± 0.88
	Fried in coconut oil	-	5.03 ± 0.70
	Cooked in coconut milk	-	3.69 ± 0.26

Table 2 *(Continued)*

Species	Cooking Treatment	Protein (%)	Lipid (%)	References
Rainbow trout (*Oncorhynchus mykiss)*	Raw	19.8 ± 0.035	3.44 ± 0.013	Nalan et al. (2004)
	Fried	26.3 ± 0.23	12.7 ± 0.08	
	Boiled	20.7 ± 0.67	4.32 ± 0.75	
	Grilled	25 ± 0.41	5.95 ± 1.49	
Seabass (*Dicentrarchus labrax,* Linnaeus, 1758)	Raw	18.5 ± 0.43	4.18 ± 0.26	Turkkan et al. (2008)
	Fried	24.3 ± 0.67	6.91 ± 0.16	
	Baked	21.1 ± 0.65	5.88 ± 0.05	
	Microwave-cooked	26.5 ± 0.71	5.15 ± 0.22	
King mackerel (*Scomberomorus cavalla,* Cuvier, 1829)	Raw	92.4 ± 4.97	4.18 ± 1.63	Lira et al. (2017)
	Fried in coconut oil	82.4 ± 4.56	12.5 ± 3.75	
	Cooked in coconut milk	81.6 ± 5.74	14.8 ± 2.03	

CONCLUSION

The composition of fish is basically composed of water, lipid, and protein, which create the nutritional value, functional aspects, and sensory characteristics of the flesh. The cooking method that applied the increasing heat will definitely contribute to the changes of proximate composition of the fish due to the oxidation and evaporation process. Data resulting from this study can contribute to the nutrient information in the raw and cooked muscle of *Thunnus tonggol* from Terengganu, Malaysia. These data suggested that there was a significant alteration in the proximate composition of this species muscle after been treated with one type of culinary method, namely the steaming process. These data also accommodate the loss of water content might alter other proximate composition such as protein, lipid, and ash.

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