

COMPARATIVE PROXIMATE COMPOSITION OF MALAYSIAN FERMENTED SHRIMP PRODUCTS

ILYANIE, H.Y.^{1,2}, HUDA-FAUJAN, N.^{1*} and IDA MURYANY, M.Y.²

¹Food Biotechnology Programme, Faculty of Science and Technology, Universiti Sains Islam Malaysia, 71800 Nilai, Negeri Sembilan, Malaysia

²School of Biology, Universiti Teknologi MARA, Negeri Sembilan Branch, Kuala Pilah Campus, 70450 Kuala Pilah, Negeri Sembilan, Malaysia

*E-mail: nurhuda@usim.edu.my

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ABSTRACT

Two different types of fermented shrimps locally known as *belacan* and *cincaluk* are amongst the most common fermented products consumed in Malaysia. Proximate composition of these products were analysed which include moisture, ash, protein, and fat. Total carbohydrate was calculated using difference of the value of each nutrient. Water activity, salt concentration, pH, and colour of each product were also measured for both fermented shrimp product. Results revealed that *cincaluk* has higher moisture, protein, ash, carbohydrate content, and water activity but lower content of sodium and pH value in comparison to *belacan*. The results for both products are also comparable with the other types of fermented shrimp products from different country, respectively.

Key words: *cincaluk*; *belacan*; fermented shrimps compositions; fermented shrimps properties

INTRODUCTION

Varieties of fermented foods and beverages are consumed tremendously across the globe and have become very common, where almost all ethnic groups have their own recipes passed from generations to generations (Hui *et al.*, 2004). Fermentation process changes the basic characteristic of a food or raw materials into palatable and acceptable products. It has its own prestige and values as the process could increase the product shelf life, as well as their qualities for instance feel, smell, taste, and colour (Marco *et al.*, 2017). Furthermore, fermentation process may also enhance nutritional value of the food, retain the viable microorganisms and their metabolites, which may give health impact to human host (Hui *et al.*, 2004; Motarjemi, 2002). Besides, fermentation process could contribute to food safety if other facilities related to food preservation are unavailable (Motarjemi, 2002). In fact, numerous studies have been done on myriad benefits of fermented foods (Alu'datt *et al.*, 2018; Kaprasob *et al.*, 2018; Rezac *et al.*, 2018; Haitham *et al.*, 2017; Joshi *et al.*, 2008).

Fermentation can occur naturally or could be initiated by addition of starter culture to the raw materials (Pongsetkul *et al.*, 2014). Fermented foods are produced from various sources such as cereal grain, vegetables and bamboo shoots, legumes, roots and tubers, dairy products, meats and marine animals (Tamang *et al.*, 2016). Fermented marine products are widely accessible and consumed around the globe as flavor enhancers or condiments. The raw materials used are commonly fishes, shrimps, or oyster. Examples of common fermented shrimp products of the world are *ronto* and *terasi* of Indonesia (Khairina *et al.*, 2016; Huda, 2012), *saewoojeot* of Korea (Kim *et al.*, 2014), *ka-pi* and *Koong-Som* of Thailand (Faithong *et al.*, 2010), as well as, *cincaluk* and *belacan* of Malaysia.

Belacan and *cincaluk* (also known as *cencalok* or *chinchalok*) are commonly consumed in Malaysia, besides other fermented seafood products such as *budu* and *pekasam*. *Belacan* is produced in all Malaysian state whilst *cincaluk* production is concerted in Melaka, Malaysia. The making of *cincaluk* and *belacan* used small shrimp such as *Acetes* spp. or *Mysid*. In *belacan* production, the shrimps will be washed and mix with salt in certain ratio before it is sun-dried and pounded. The paste

* To whom correspondence should be addressed.

will be stored into container to start up the fermentation. The process would occur repeatedly until the desired texture is achieved. However, different materials (types of shrimp, percentage of salt) and methods (dry or wet) are involved in the making of *cincaluk*. The shrimp will be washed before it is combined with salt and cooked rice. The mixture will be inserted into suitable container for a fermentation process (Huda, 2012).

Even though the raw materials are the same, differences in other ingredients used in each product and the fermentation steps could lead to dissimilar nutrient composition of the final products (Pongsetkul *et al.*, 2014). Available reports on proximate composition of *belacan* showed that the protein contents did not comply with the protein requirement stated in the Malaysian Food Act 1983 (Act 1981) and Regulations (1985) meanwhile no recent reports are available on the proximate composition of *cincaluk* other than study done by Tee *et al.* (1997). Thus, this study was conducted to determine the proximate composition and pH value of *belacan* and *cincaluk*, as well as to compare the values with other fermented shrimps from different country.

MATERIALS AND METHODS

Sample collection

Belacan and *cincaluk* were purchased from a market in Negeri Sembilan. Samples were transported to Food Microbiology Laboratory, Universiti Sains Islam Malaysia, Nilai, Negeri Sembilan, Malaysia. Samples were then stored in air-tight sample containers and kept in the refrigerator (4°C) until analysis. All the chemicals involved in the study are analytical grades which includes petroleum ether, sulphuric acid, and copper Kjeltabs.

Proximate composition determination

Proximate analysis of samples was carried out using standard method of the Association of Official Analytical Chemists (AOAC, 2005).

Moisture analysis

Moisture content of samples was determined by drying samples in an oven at 105°C until constant weights of crucible with samples are obtained. The percentage of moisture content was measured by calculating difference of wet weight and dry weight of the sample.

Ash analysis

Determination of total ash content of samples was carried out according to AOAC (2005) method 920.153 using conventional dry-ashing. Initially,

dried of 3.0 g samples were burnt and ashed in a muffle furnace at 525°C for 24 hr until a grey mass (ash) formed, and were then cooled in desiccator. The percentage of total crude ash was calculated using following equation.

$$\text{Crude ash (\% dry basis)} = [W_1 / W_2] \times 100$$

Where W_1 = weight of samples after ashing; W_2 = weight of samples before ashing.

Protein analysis

Protein content of samples was measured using nitrogen assay based on Kjeldahl method (AOAC, 2005) method 928.08 which include digestion and distillation process. The percentage of crude protein was expressed as total of nitrogen percentage and multiplied by a factor of 6.25 (nitrogen-protein conversion factor for fish and seafood product) as following equation.

$$\text{Crude protein (\%)} = \text{Nitrogen (\% in samples)} \times 6.25$$

Fat analysis

Fat was estimated using Soxhlet extraction with petroleum ether as the solvent. The fat content of each sample was determined after oven-drying the extracted fats overnight (Soxtherm[®] extractor, C. Gerhardt). The fat content of samples was calculated as following equation.

$$\text{Fat (\%)} = [(W_1 - W_2) / W_0] \times 100$$

Where W_0 = weight of sample after treatment; W_1 = total weight of extraction beaker with boiling stones and extracted fats; and W_2 = total weight of extraction beaker and boiling stones.

Carbohydrate analysis

Total carbohydrate was calculated using difference of the value of each nutrient using following equation.

$$\text{Carbohydrates (\%)} = 100 - [\text{Moisture (\%)} + \text{Ash (\%)} + \text{Protein (\%)} + \text{Fat (\%)}]$$

Water activity measurement

Water activity (A_w) of each sample was determined using Aqua Lab Dew Point Water Activity Meter 4TE (Decagon, Pullman, WA, USA) at about 25°C. The samples were placed into the cup before it is being distributed according to manufacturer's instruction.

Sodium content measurement

The sodium content of samples was determined using ICP-OES and ICP-MS method according to manufacturer's instruction.

pH analysis

The measurement of pH of samples was done using Mettler Toledo pH meter. Prior to analysis, 10 g of *belacan* sample were mixed with 2 mL distilled water to create a paste-like structure (Vijayakumar & Adediji, 2017), whilst pH of *cincaluk* was measured directly to the sample in a small beaker.

Colour measurement of samples

Determination of colour of samples was done using colorimeter (LabScan® XE Spectrophotometer Model, HunterLab) based on $L^*a^*b^*$ colour scale system. L^* value represents lightness/darkness, a^* value represent redness/greenness, and b^* value represents yellowness/ blueness and was measured according to the manufacturer's instruction.

Statistical analysis

Statistical analysis of the data was carried out using SPSS (Statistical Package for the Social Sciences) version 24.0. Independent T-test was used to measure significant differences in between values of both samples. A significant difference was considered at the level $p < 0.05$.

RESULTS AND DISCUSSION

Proximate composition of samples

The proximate compositions of *belacan* and *cincaluk* which include moisture, fat, protein and ash are shown in Table 1. Proximate composition of *belacan* and *cincaluk* were found significantly differed ($p < 0.05$) excluding the fat content. Even though the moisture content of *cincaluk* obtained in this study (67.44%) was slightly lower than the study done by Tee *et al.* (1997), the value was significantly higher ($p < 0.05$) compared to *belacan* (32.16%). The moisture value of *belacan* was almost in the same range as *ka-pi* (Faithong *et al.*, 2010) and *saewoojeot* (Kim *et al.*, 2014), and it complies with the water content stated in the Malaysian Food Act 1983 (Act 1981) and Regulations (1985)

(<40%). The high moisture content of *cincaluk* might be contributed by addition of cooked rice and tomato sauce in the ingredient (Huda, 2012). It might also be attributed by washing procedure and water retention that happens during fermentation process (Rapsang & Joshi, 2013), as well as other manufacturing steps (Kim *et al.*, 2014). However, the highest moisture content in fermented shrimp products have been reported by *Koong-Som* which ranged between 73.35 and 80.71% (Faithong *et al.*, 2010). Palm-sap-sugar concentrate that is mixed with shrimps to produce *Koong-Som* may cause the highest range of moisture content of the products, compared to the other type of samples.

The ash content signifies the presence of mineral in the food that are not destroyed by high temperature (Siti Mahirah *et al.*, 2018). Fresh shrimps itself is abundant in mineral contents, which are significant in maintaining various functions of living organisms (Ajifolokun *et al.*, 2018). According to Malaysian Food Act 1983 (Act 1981) and Regulations (1985), ash content in *belacan* shall be less than 30% whilst *cincaluk* shall contain not more than 15% of ash. Based on this study, it was found that ash was a major component in *belacan* and *cincaluk* (dry weight basis). Extrapolation of data to wet weight basis showed that ash content in *belacan* and *cincaluk* are approximately 38.09% and 14.32%, respectively, with the former did not comply to the regulations. Since high salt content is used in the fermentation process (Pongsetkul *et al.*, 2014), it contributed to high ash content of both *belacan* and *cincaluk*. As *Koong-Som* contained the highest moisture content, it reflects the least ash content compared to the other fermented shrimp products.

Protein content in fermented foods possibly will show slight decrease compared to fresh material as microorganisms involved in fermenting the food may produced proteolytic enzymes (Rapsang & Joshi, 2013). Besides, extended fermentation period may also cause rigorous degradation of proteins (Faithong *et al.*, 2010). Results obtained in this study found that protein content in *belacan* was

Table 1. Proximate composition of *belacan* and *cincaluk*

Proximate composition (%)	Samples	
	<i>Belacan</i>	<i>Cincaluk</i>
Moisture	32.16 ± 2.00*	67.44 ± 0.52
Ash	56.15 ± 0.56 (d.w.)*	43.97 ± 1.39 (d.w.)
Protein	31.83 ± 0.66 (d.w.)*	34.22 ± 0.47 (d.w.)
Fat	1.01 ± 0.23 (d.w.)	2.38 ± 0.95 (d.w.)

a) Value for *belacan* and *cincaluk* represents the mean of triplicates ± SD experiment.

b) * = indicate means are significantly different between *belacan* and *cincaluk* at $p < 0.05$.

c) d.w. = dry weight basis.

31.83% whilst *cincaluk* contained 34.22% protein ($p < 0.05$). In fact, Malaysian Food Act 1983 (Act 1981) and Regulations (1985) stated that *belacan* and *cincaluk* shall contain not less than 30% and 10% protein, respectively. The protein content in *belacan* when extrapolated to wet weight showed value that did not comply to the regulation (21.59%), which in agreement with the previous report done by Sharif *et al.* (2008). However, the extrapolated protein content value for *cincaluk* (11.14%) are slightly higher than the stated values.

Even though the moisture content was significantly ($p < 0.05$) dissimilar, fat content in *cincaluk* (2.38%) is nearly comparable ($p > 0.05$) to *belacan* (1.01%). Contrary to the outcome of the present study, Ajifolokun *et al.* (2018) suggested that fat content is negatively correlated with water content. Nevertheless, the values obtained in this study are in agreement with other fermented shrimps reported by Faithong *et al.* (2010), Kim *et al.* (2014) and Khairina *et al.* (2016), excluding *saewoojeot* with slightly higher in fat content. The fat content of fermented shrimp products might be contributed by polyunsaturated fatty acid content in the shrimp oil (Pongsetkul *et al.*, 2014).

Carbohydrate content will be reduced in fermented foods in comparison to fresh materials as the biomolecules are used by microorganisms in the fermentation process (Rapsang & Joshi, 2013). In a recent study, Ajifolokun *et al.* (2019) reported the carbohydrate content in sun-dried and oven-dried shrimps was approximately between 18.40 and 25.17%. In general, *belacan* is produced without addition of any carbon source, differ from *cincaluk* which has cooked rice as one of its contents. Thus, the ingredients correlate to the significant different ($p < 0.05$) in carbohydrate contents of both products. *Belacan* contained 11.01% carbohydrate content; rather lower than *cincaluk* (19.43%). This might also be due to various carbon sources that are added as exact ingredients or deliberately added to increase the yield and reduce the cost (Faithong *et al.*, 2010).

Chemical properties of samples

Table 2 shows the chemical properties of *belacan* and *cincaluk* include water activity, sodium content, and pH value of *belacan* and *cincaluk*.

The water activity of *belacan* was 0.723 which was slightly lower than that of *cincaluk* (0.823). The results for *belacan* are almost comparable to Bruneian fermented paste (0.728) and Korean dried shrimp paste (0.771) (Kim *et al.*, 2014). Meanwhile, *Ka-pi* from various sources showed water activity values between 0.64 and 0.72 (Daroonpant *et al.*, 2016). In food preservation method, active water is more important in the stability of food compared to the total amount of water present. Water activity can be reduced or regulated by various approaches such as addition of solutes or removal of water. Pathogens may not grow in food with water activity below 0.85 to 0.86 (Shafiur Rahman & Labuza, 2007).

In the assessment of sodium content, it was found that *belacan* contained a high salt content (10104.13 mg/100 g) which doubled the value of *cincaluk* (5246.34 mg/100 g). This was probably due to the process in *belacan* making which adds a massive amount of salt contrasted to the making of *cincaluk*. The salt content was in line with extrapolated ash content to wet weight basis. Findings from Faithong *et al.* (2010) also suggested that *Ka-pi*, which have the comparable feature as *belacan* contains higher percentage of salt compared to *Koong-Som*. Salting helps to reduce active water and causes the cells to shrink, thus converts fresh ingredients into products that are more shelf-stable (Shafiur Rahman & Labuza, 2007).

Belacan recorded the basic pH (7.31) which are slightly similar to *Ka-pi* (Faithong *et al.*, 2010), Bruneian shrimp paste, and *Saewoojeot* (Kim *et al.*, 2014). This may be due to the used of raw materials and processes that are slightly comparable. All four fermented shrimp product used only shrimps and salts as its ingredients. The slightly basic pH may be due to the formation of ammonia during fermentation process (Faithong *et al.*, 2010). Nonetheless, *cincaluk* presented acidic pH (4.96) ($p < 0.05$) from *belacan*. Other types of fermented shrimps which contains other raw materials as their ingredients also showed acidic pH, eg. *Koong-Som* (Faithong *et al.*, 2010) and *Ronto* (Khairina *et al.*, 2016), with the latter using rice as carbohydrate sources. Thus, with the addition of more carbon sources, it could stimulate more growth of micro-

Table 2. Water activity, sodium content, and pH values of *belacan* and *cincaluk*

Chemical properties	Samples	
	<i>Belacan</i>	<i>Cincaluk</i>
Water activity	0.723	0.823
Sodium content (mg/100 g)	10104.13	5246.34
pH	7.31	4.96

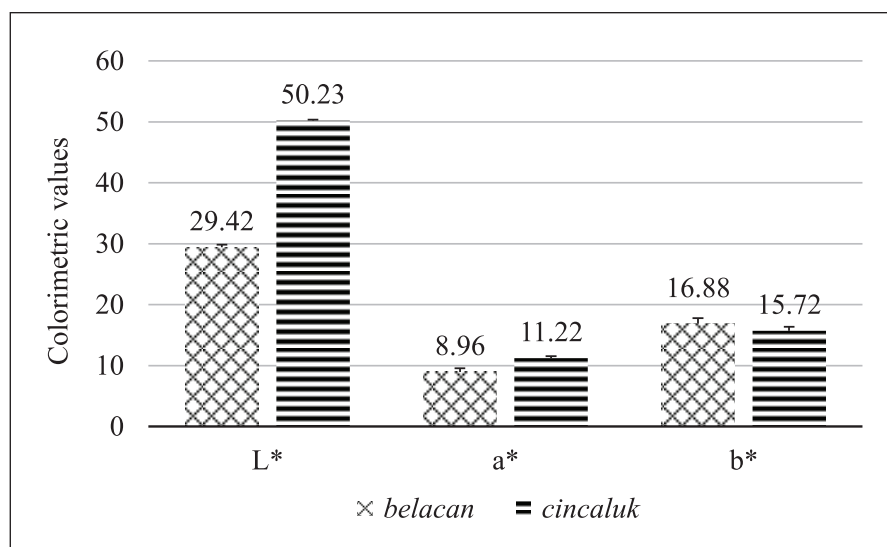


Fig. 1. Hunter L , a , b colorimetric values of *belacan* and *cinaluk*.

organisms (Khairina *et al.*, 2016). Theoretically, pH in fermented foods will be slightly lower as fermentation progression might produce various organic acids, for example lactic acid, acetic acid, and propionic acid (Erkmen & Bozoglu, 2016). Common microorganisms that can be isolated from fermented foods are yeast and lactic acid bacteria. Low pH environment is also beneficial in terms of suppression of pathogens growth (Chiang *et al.*, 2006). However, pH changes may occur depending on the methods used during the manufacturing (Kim *et al.*, 2014).

Colour of samples

Figure 1 shows the Hunter L , a , b colorimetric values of *belacan* and *cinaluk*. It was found that *belacan* provided darker colour (29.42) ($p < 0.05$) than *cinaluk* (50.23). However, the a^* (redness/greenness) and b^* (yellowness/blueness) values are almost parallel to each other. Even though both products make use of shrimps as their main ingredients, types of shrimps used, the process and other ingredients added could affect the colours of the end products. Besides, the chemical reactions involved for example oxidation, hydrolysis, and Maillard reaction could contribute to the product's colour development (Daroopunt *et al.*, 2016).

CONCLUSION

The proximate composition values of different type of fermented shrimps are diverse depending on the ingredients and fermentation procedures involved in the making of each products. *Belacan* and *cinaluk* may become a good source of nutrient as it contains high protein contents and low in fat contents.

However, as ash content is slightly high, a review on the manufacturing procedures are needed to ensure that each values is in accordance with range suggested by Malaysian Food Act 1983 (Act 1981) and Regulations (1985).

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