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Property quality of Lombok dried squid treated with different water types and soaking time

[1,*]Handayani, B.R., [1]Werdiningsih, W., [1]Rahayu, T.I. and [2]Yuliarti, O.

[1]*Department of Food Science and Technology, Faculty of Food Technology and Agroindustry, University of Mataram, Jl. Majapahit No.62 Mataram, West Nusa Tenggara, Indonesia 83125*
[2]*School of Chemical and Life Sciences, Singapore Polytechnic, 500 Dover Road, Singapore*

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Abstract

To date, fishermen from the southern coast of Lombok have been drying fresh squid in direct sunlight for insufficient time, resulting in low quality. It is known that seawater contains salt that have function as an antimicrobial. Therefore, this study sought to examine the effect of immersion in seawater on the quality (physiochemical and sensory) of dried squid. Different types of water (seawater and freshwater) and soaking time (30, 60, and 90 mins) were carried out. Seawater was chosen as a brine solution to follow a common practice conducted in the area of study. The yield, moisture, and ash content as well as the surface dried meat squid colour were determined. The research was statistically analysed in a Completely Randomized Design with three replications. In general, the results showed that soaking the squid using seawater resulted in a higher yield than that when freshwater was used. No significant difference ($P<0.05$) was obtained for moisture and ash content as well as dried squid colour (^{o}Hue). The results also indicated that fresh squid soaked using seawater for 90 mins was the best treatment with the yield, moisture content, ash content, and colour value of 15.63%, 23.99%, 9.44%, and ^{o}Hue 53.09 respectively. Dried squid sensory characteristics showed that the texture of the meat squid was relatively soft and has a unique aroma and taste.

1. Introduction

Squid (*Loligo* sp.) is one of the economically important fishery commodities after fish and shrimp in Indonesia (Trilaksani *et al*., 2010) and West Nusa Tenggara (NTB) province of Indonesia is identified its potential as a squid producer. Based on data obtained from the Department of Fisheries and Maritime Affairs, NTB (2015), the production of squid in NTB in 2014 was 3.280 tons and 24% of this production was produced by the East Lombok region (southern coast). To date, very limited research has been attempted to support the processing of squid in Lombok. Drying is the most common and traditional method of fish and fishery preservation technology in Indonesia besides other processing methods such as cooking and iced storage. In a drying method, before the drying process, a salting treatment by soaking the fresh squid in a concentrated brine solution is often carried out. The combination of salting with other preservation methods such as drying (Bellagha *et al*., 2007) was able to extend the shelf life of fishery products (Jeevanandam *et al*., 2001).

Salting is not only considered a preservation method (Bellagha *et al*., 2007), but this process is also regarded as an osmotic treatment which aims necessarily to give specific organoleptic and sensory characteristics to the product (Boudhrioua *et al*., 2009). Hence, controlling the salting process in fishery production is crucial. It has been reported (Bellagha *et al*., 2007) that in the wet salting method, the length of the salting period, the salt concentration, drying time, and temperature contribute significantly to the final product properties. Furthermore, these authors also mentioned that the salting technique, brine solution concentration, and salting period have a significant effect on the drying kinetics and characteristics of the final product properties such as water content, salt content, and textural properties. A study on mildly (21% of brine solution) salted sardine (Bellagha *et al*, 2002) has indicated that the formation of salt during the drying period on the surface of the sardine affected the drying rate and chemical properties of the final products. In addition, salting techniques have been reported to affect the sensorial characteristics of other fishery products such as steamed tuna (Handayani *et al*., 2017), salted hilsa (Mukit *et al*., 2016) and salted

*Corresponding author.
Email: *baiqrienhs@unram.ac.id*

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fermented "peda" mackerel (Astria *et al*., 2020).

In the coastal areas of Lombok, the availability of freshwater is very limited, hence seawater is mostly used in fish processing which includes washing, steaming, and boiling. Steaming using seawater was found to be beneficial to enhance the shelf life and sensory attributes of the tuna as compared to when brine solution was used (Handayani *et al*., 2017). A similar study has also been reported on the use of seawater as a method of fish processing (Nakasone and Akeda, 1999). To date, no study has been conducted on the use of seawater as a salting method of wet salting to preserve the squid and the study of the salting period is very limited. Therefore, this study aimed to investigate the influence of different types of water and soaking time on the yield and sensory characteristics of the dried squid. The results of this study could bring potential applications of squid preservation and the approach would support the economic growth of coastal communities in West Nusa Tenggara, Indonesia.

2. Materials and methods

2.1 Materials

The freshly harvested squid (*Loligo* sp) with uniform size(length 20.7 +/- 0.3 cm; and weight 26+/-1 g) was obtained from Selat Alas Lombok -NTB, Indonesia. The squid was cleaned from the coloured inks and quill. The head and tentacles remained intact with the squid as this is the common method used in the coastal community. The seawater (containing 3.4% NaCl) and freshwater used in this study were obtained from Tanjung Luar Beach, East Lombok. The freshwater in this study was referred to as groundwater.

2.2 Squid processing

A total of 750 g of squid for the experimental unit were soaked using two different types of water *i.e*. seawater and freshwater with different soaking times (30, 60, and 90 mins). The squids that have been soaked were then placed on a *kampu* (bamboo sticks) and then dried under the sun for approximately 13±0.5 hrs with an approximate temperature of 35±2°C. The dried squid was then calculated for the yield using the below equation.

$$\text{Yield} = \text{dried squid (g)}/\text{ fresh squid (g)} \times 100$$

2.3 Colour, moisture and ash content

Colour testing to evaluate colour development of dried squid was carried out using a MiniScan EZ chromameter using a method described in a study (Hunt *et al*., 1991) using ^{o}Hue which derived from $^{o}\text{Hue} = \tan^{-1}$ (b/a) in the Hunter in L, a, and b colour space. The average value of the surface colour of the samples was obtained by taking a triplicate of measurements. The moisture and ash content of the dried squid was determined gravimetrically according to the method of AOAC method (AOAC, 1990). Triplicate measurements were taken for these analyses.

2.4 Sensory assessment

The sensorial attributes of dried squid were evaluated by a panel of twenty untrained panellists. The sample of 100 g of dried squid was deep-fried using vegetable oil individually and immediately presented to the panellists (each panellist evaluated approximately 20 g of squid sample). Panellists were tasked to score for colour, aroma, taste, and texture of fried squid using a scale of 1–5 descriptive hedonic, where one represented the lowest intensity of liking and five the highest intensity of liking. Sensory evaluation on the colour, aroma, texture, and taste was also conducted and evaluated by the twenty untrained panellists to relate to the preference test. The score of the criteria is shown in Table 1.

2.5 Statistical analysis

This study was arranged factorial in a Completely Randomized Design (CRD) with three replications of two factors *i.e.* the types of water (seawater and freshwater) and soaking time (30, 60, and 90 mins). The observation data of physical and chemical parameters were subjected to analysis of variance (ANOVA) ($P<0.05$) and if significantly different were further tested using Tukey with SPSS 20 software. Sensory parameters were analyzed by Friedman Test ($P<0.05$) and real differences were further tested with Wilcoxon Match Pairs Test using SPSS 20 software (Sugiyono, 2015).

3. Results and discussion

3.1 Yield

The dried squid was analyzed for the yield as the yield is an important factor to consider in squid drying

Table 1. Sensory score of dried squid.

Score	1	2	3	4	5
Colour	Ivory white	Pink	Pale Red	Reddish	Reddish brown
Aroma	Very strong	Strong	Moderately	Slightly	No aroma
Texture	Very hard	Hard	Moderately hard	Slightly soft	Soft
Taste	Very salty	Salty	Moderately salty	Slightly salty	Not salty at all

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and salting technology. The yield is the percentage obtained from the ratio of the initial weight and the final weight of a product (Ariyarathna and Þórarinsdóttir, 2011). The types of water for soaking the squid contributed significantly ($p<0.05$) to the dried squid yield (Table 2). The squid soaked using freshwater have a higher yield (~21%) than squid that were soaked using seawater (~16%). The longer the soaking time using freshwater, the higher the yield of dried squid increased significantly ($p<0.05$) from ~16% (30 min) to ~21% (90 min).

On the contrary, the squid soaked in seawater showed a slight reduction in the yield *i.e.* from ~17% (30 min) to ~16% (90 mins). This could be contributed to the osmosis process which occurred during the soaking process. Important to note that seawater contains a NaCl concentration of ~3.4%. The salt penetrated the squid meat, which caused a discharge from the body of the squid and led to a decrease in yield. A reduction in yield could also be attributed to the shrinkage of the meat due to the denaturation and coagulation of proteins (Rahmani and Martati, 2007). A similar finding was also observed in dried sardine (*Sardinella aurita*) (Bellagha *et al.*, 2007).

Table 2. Effect of combination of water type and soaking time on the yield of dried squid.

Combination of Water Type and Soaking Time (min)	The yield of dried squid (%)		
	30	60	90
Freshwater	16.01^{Aa}	20.17^{Aa}	20.70^{Ba}
Seawater	16.45^{Ab}	15.74^{Ab}	15.63^{Bb}

Values with different lowercase superscripts within the same column (comparing water types) and values with different uppercase superscripts within the same row (comparing soaking times) are statistically significantly different at 5% significant level.

3.2 Moisture and ash content

Table 3 shows the moisture content of the dried squid treated with different types of water and soaking time and 13 hrs drying time. In general, depending on the treatment, the moisture content of dried squid ranged from ~13% to ~23% and this value is following the Indonesian National Standard *i.e.,* SNI 09-7388: 2009 maximum moisture content of dried squid, which is 20% (Badan Standarisasi Nasional, 2009). The moisture content of dried squid soaked in freshwater was markedly lower (~13 – 17%) than the dried squid soaked in seawater (~20 – 24%). Salting of the squid seemed to lead to conformation changes in the collagen molecule or other structural components, which in turn influences the water retention of the muscle (Thorarinsdottir *et al.*, 2011). In addition, the incorporation of salt in fishery products has been reported to have good water-binding properties (Neklyudov *et al.*, 2003). Therefore, it is possible to deduce that dried squid pre-treated with brine solution could have a higher moisture content as compared with no added salt.

There was no significant difference in the ash content of dried squid soaked with different types of water and soaking time (Table 3). However, the ash concentration of dried squid has met the Indonesian National Standard 09-7388-2009, with a maximum value of 14%. This could be attributed to the low amount of NaCl (3.4%) content in the seawater. An increasing amount of salt in the solution and a longer period of soaking could lead to a significant difference in ash content. According to Nielsen (2010), the ash content of the material shows the total minerals contained in the material. According to Konani (1991), the increase in ash content of materials occurs due to the precipitation of mineral elements during the immersion process *i.e.* the higher the ash content of the product, the higher the minerals contained in the material. According to Rahmani *et al.* (2007), the longer soaking time of a product in saline solution could enhance the osmosis process, which results in more minerals, especially the diffusion of sodium in the product tissue.

3.3 Colour

The °Hue is a colour gradation of the spectrum of light that is caught in the eyes and it represents the dominant colour wave of an image, or the centre of the colour tendency that arises from a combination of various colour waves (Nielsen, 2010). The colour changes in squid meat according to some studies (Fu *et al.*, 2007; Vega-Gálvez *et al.*, 2011) are related to the degree of protein structural changes, which cause a difference in the light-scattering properties and browning reactions. In seafood muscle, myoglobin is responsible

Table 3. Effect of combination of water type and soaking time on the moisture and ash content of dried squid.

Combination of Water Type and Soaking Time (min)	Moisture content (%)			Ash content (%)		
	30	60	90	30	60	90
Freshwater	13.37^{Aa}	16.13^{Aa}	17.27^{Aa}	7.88^{Aa}	13.12^{Aa}	11.80^{Aa}
Seawater	22.37^{Ba}	19.61^{Ba}	23.99^{Ba}	6.94^{Ba}	9.25^{Ba}	9.44^{Ba}

Values with different lowercase superscripts within the same column (comparing water types) and values with different uppercase superscripts within the same row (comparing soaking times) are statistically significantly different at 5% significant level.

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for a major contributor (Guizani *et al*., 2008).

The treatment of the types of water and soaking time had no significant effect on the dried squid °Hue value. As shown in Table 4 the Hue value of all treatments fell in the range of ~33 – ~53 indicating the red colour value of °Hue 18 – 54 (Red) (Hutchings, 2011). Sensory evaluation of the colour has also been conducted to find the differences in the treatment towards the preference of dried squid colour among panellists. The types of water and soaking time did not affect the preference for squid colour. This result was in agreement with the colour determination by Hue value as previously described. Panellists' assessment of colour preference is on a scale of 2.80 – 3.20, which was rather preferred. The highest level of colour preference was obtained from immersion treatment using seawater for 60 mins, while the lowest average was obtained from soaking treatment using freshwater for 30 mins (Figure 1a).

Table 4. Effect of combination of water type and soaking time on ohue values of dried squid.

Combination of Water Type and Soaking Time (min)	Colour value (°Hue)		
	30	60	90
Freshwater	44.58^{Aa}	35.53^{Aa}	32.90^{Aa}
Seawater	40.77^{Ba}	44.06^{Ba}	53.09^{Ba}

Values with different lowercase superscripts within the same column (comparing water types) and values with different uppercase superscripts within the same row (comparing soaking times) are statistically significantly different at 5% significant level.

As indicated, the colour of the dried squid was slightly red towards reddish (Figure 1b) with the panellist's preference level of moderately like. This shifting of squid colour score could be due to the drying process, drying under the sun in particular. This finding is in agreement with a study (Vega-Gálvez *et al*., 2011) which found that drying can cause discolouration of fresh squid. Deng *et al*. (2014) stated that squid contains high protein components and free amino acids that allow a browning reaction. High drying temperature and long drying time may cause denaturation of myoglobin and pigment oxidation

3.4 Aroma

The treatment given did not affect the preference for the aroma of dried squid ($p>0.05$). The criteria for the preference for aroma given by the panellists varied from 3.25 to 3.60, which is moderately towards like. As shown in Figure 2a, the highest preference value of aroma was obtained by soaking treatment of seawater for 90 mins, with the preference score of 3.60. On the other hand, the lowest aroma preference value was achieved by seawater treatment of 30 mins. Based on aroma scoring values in Figure 2b, the panellists had detected that dried squid soaked in freshwater had a distinct squid aroma, while dried squid soaked in seawater had a rather unique aroma of squid and was preferred. The use of seawater appeared to reduce the distinct aroma of dried squid produced. Perhaps, the increase of salt content in the squid had contributed to the overall dried squid aroma.

According to Deng *et al*. (2015) drying process affects the overall squid aroma. The typical aroma of dried squid comprises a mixture of several amino acids such as lysine, taurine, aspartic acid, glutamic acid, histidine, threonine, dioxyphenylalanine, and threonine. The salt could diffuse into the squid meat tissue during the soaking of seawater, causing lysis that allows several water-soluble amino acid components to come out. Probably, these are the amino acids that are responsible for a pungent aroma.

3.5 Texture

The texture is one of the most important sensory characteristics that affect the overall quality of fishery products and is highly affected by the drying process (Vega-Gálvez *et al*., 2011). The results of this study showed that the water types and soaking time did not affect the preference for the texture of dried squid significantly. The range of texture preference values given by the panellist was 2.95 to 3.55 with the criteria of moderately like to like. The highest value of the

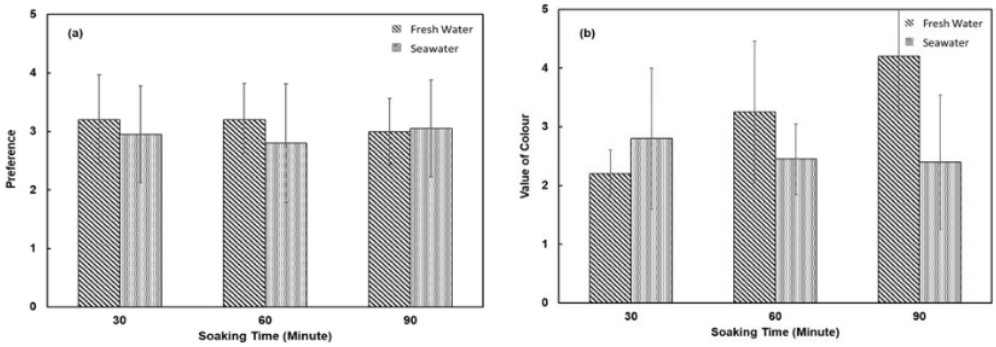

Figure 1. Influence of water types and soaking time on preference (a) and scoring (b) of the dried squid colour.

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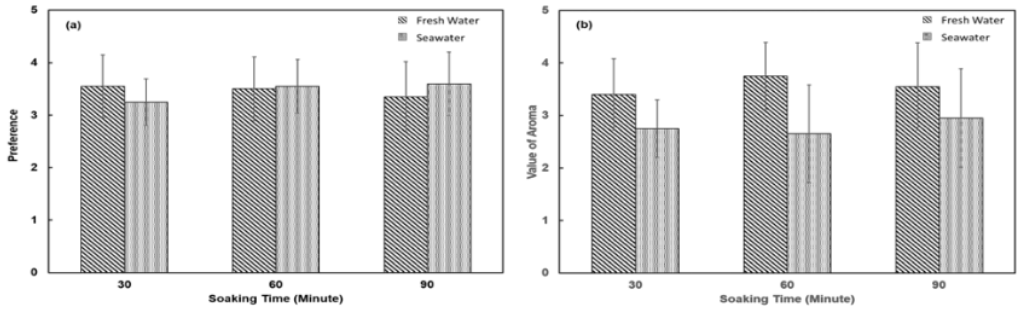

Figure 2. Influence of water types and soaking time on preference (a) and scoring (b) of the dried squid aroma.

texture of the squid was obtained from the soaking treatment using seawater for 90 min, which was 3.55 (like), while the value of the lowest squid texture was obtained from soaking using seawater for 60 mins (2.95).

Similarly, the treatment of water types and soaking time did not affect the dried squid texture significantly (Figure 3). The texture score of dried squid ranges from ~3 to ~4, which is moderately hard towards slightly soft. One of the factors that could influence the texture of dried fish and squid is drying (Mujumdar, 2015). Hulalata *et al.* (2013) have reported that drying time could affect the level of preference for dried squid because the amount of water content in the product decreases. Nuruzzakiah *et al*. (2016) found out that in the process of salting, the ability of NaCl to bind water has a greater affinity than protein thus the distance between protein molecules is getting closer, which causes the interaction between protein molecules to be stronger. This strong bond causes the protein to denature which causes the squid texture to become harder.

3.6 Taste

Figure 4a-b indicates the overall liking of the dried squid taste and the score of dried squid saltiness. The duration of immersion treatment had a significant contribution ($p<0.05$) on the overall taste of dried squid. The preferred score of dried squid taste varied from ~3 (like moderately) to ~4 (like). The highest preference for the taste of dried squid was obtained from the immersion treatment using seawater for 90 mins (score of ~4) indicating the likeliness of the taste, while the lowest squid flavour was obtained from soaking using freshwater for 90 mins with a score value of ~3 (like moderately).

The panellist had indicated their preference for dried squid that were treated with immersion using seawater. This is probably due to the distinctive flavour of dried squid with the presence of salt. According to Sugiyama *et al.* (1989), the standard of dried squid taste for quality 1 and 2 should have a unique taste/flavour with a score of 3 (like moderately) where the squid has slightly flavorful criteria. The major volatile compounds found are trimethylamine and toluene along with the 15 important compounds that exhibited dried squid flavour. The difference in treatment and drying method will affect the flavour-forming components of dried squid (Sukhwon *et al*., 2018). Types of water and soaking time have a significant effect on the saltiness level of dried squid water. The range of saltiness taste given by panellists in all treatments was between ~2 to ~4, indicating salty taste towards a slightly salty taste (Figure 5).

The saltiness sensation in dried squid, which was soaked in freshwater, had become weaker as soaking time was prolonged. Oppositely, the saltiness perception of dried squid that was soaked in seawater was stronger as soaking time was extended. This finding was in good agreement with a study by 24. Dimakopoulou-Papazoglou and Katsanidis (2020) where the longer the material is immersed in a saturated salt solution, the

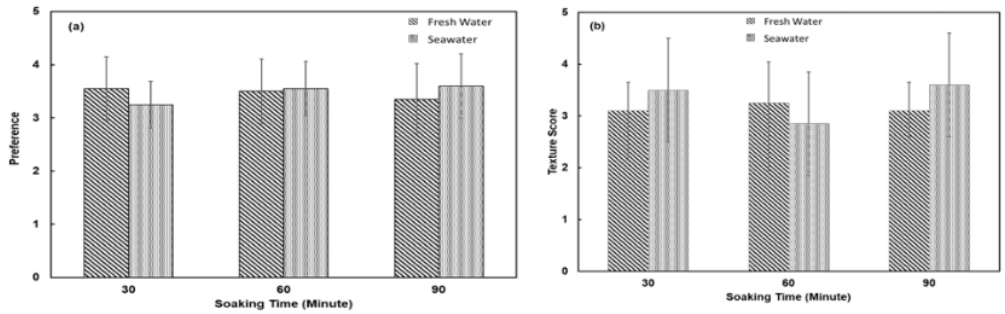

Figure 3. Influence of water types and soaking time on preferences (a) and scoring (b) of the dried squid texture.

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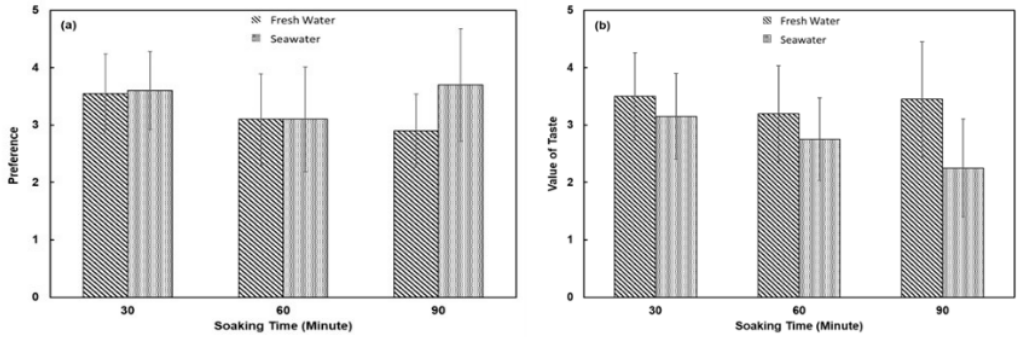

Figure 4. Influence of water types and soaking time on preference (a) and scoring (b) of the dried squid taste.

osmosis process would occur gradually through selectively permeable membranes hence the salt content of the product increased to a certain level. According to Nuruzzakiah *et al.* (2016), NaCl can cause the bonds between molecules to become stronger, causing the protein to denature and resulting in a salty effect.

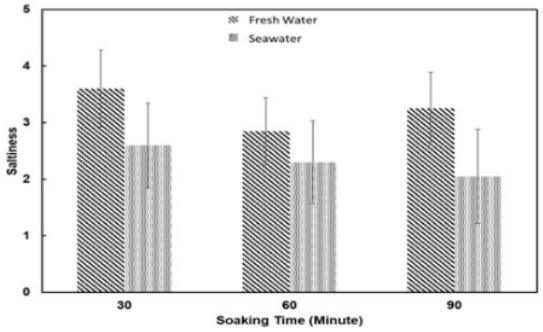

Figure 5. Influence of water types and soaking time on the saltiness of dried squid.

4. Conclusion

In conclusion, this study has shown that different types of water to soak and soak periods of squid had a significant effect on the yield and sensory properties of the dried squid. Furthermore, the results indicated that soaking squid using seawater for 90 mins was the optimum treatment with 15.63% of yield, 23.99% of water content, 9.44% of ash content, and red colour with ^{o}Hue of 53.09. In regards to the dried squid sensory properties, the dried squid treated with seawater for 90 mins was preferred due to it has characteristics of being reddish, moderately hard in texture, moderately-slightly aroma of squid, and moderately salty which is favoured by panellists.

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