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CHARACTERIZATION OF SEA GRAPES (*Caulerpa lentillifera*) FROM VIETNAMESE COMPANY'S PRODUCTS

Imran Lapong[*1], Nicholas Paul[2] and Akbar Reza[3]

[*1]Department of Aquaculture, STITEK Balik Diwa, Makassar, Indonesia
[2]University of the Sunshine Coast, Maroochydore, QLD Australia
[3]Departement of Fishery, University of Gajah Mada
**Corresponding author: lapong.mula@gmail.com*

ABSTRACT

Species of sea grapes (*Caulerpa* spp.) are consumed broadly in many regions such as in Southeast Asia and Pacific areas. However, it damages easily if packed incorrectly and may only last for couple of days. A company in Vietnam (Tritin Pty Ltd) has developed a preservation technique for sea grapes that enables export to many countries. The aim of this study is to characterization of the Vietnamese company's product of *Caulerpa*. The study found that the product based on a 10% brine concentration (114.33 g/L ±2.30 SD). The average weight of each sachet package is 22.47 g ±0.37 containing 65 fronds of *Caulerpa lentillifera*. The average weight and length of the fronds is 0.73 g ±2.30 SD and 7.27 cm ±1.59 SD. There was a significant relationship between the weight and the length of the fronds during the rehydration process in freshwater (R^2=0.35, p<0.01), with rehydration of weight and length complete after x seconds.

Keywords: Sea grapes, *Caulerpa lentillifera*, characterization, fronds, preservation, brine

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1. INTRODUCTION

There are several species or varieties of *Caulerpa* also known as sea grapes or green caviar are utilised for human consumption. In many countries particularly in Asian, seaweeds already consumed since 4th centuries. Furthermore, *Caulerpa* as edible seaweed is one of the valuable commodities in Pacific islands and Southeast Asia with long traditional history for collecting and consuming [1]. One of the most popular as edible seaweeds from this genus is *Caulerpa lentillifera* [2]. *Caulerpa* usually is eaten raw, in the form of fresh vegetables, as well as a salad [3, 4]. In addition, *Caulerpa*is not only used as food but also has the health benefits for human such as medicine, antioxidant, dietary fibres, minerals, and vitamins [5, 6, 7].

Sea grapes are found in tropical and temperate areas, mostly inhabiting muddy and sandy sea bottoms in shallow protected areas, and have diverse morphology and varieties [8,2]. In the Pacific countries such as Fiji, Samoa, and Tonga, most sea grapes were collecting and harvested from the wild surround the islands [1]. Following that, *Caulerpa* is also considered as food and collected from the islands or coastal areas in Southeast Asia countries such Indonesia, Malaysia and the Philippines [9].

The history of *Caulerpa* aquaculture production begins since 1952 when *C. lentillifera* was started to culture in the fish ponds by Philippine local farmers. It was recorded that 827 tonnes of *Caulerpa* were traded to Japan and Denmark in 1982 [4]. Local farmers in South Sulawesi, Indonesia are now also culturing sea grapes in their fishponds. These farmers are reporting high production, with less than 20 farmers producing almost 100 Kg/ha within a six-month period, which is then distributed fresh to the local market [10]. The aim of this study is to characterization the Vietnamese company's product of *Caulerpa*.

2. MATERIAL AND METHOD

Characteristics of brine solution

Brine solution was taken from three jars of 200 g package and stored in three 20 ml plastic tubes. Each of tubes with the brine solution was tested using an YSI probe (details of probe) to determine the brine concentration. For the package of 20 g sachet, six sachets were selected randomly and were divided to become three replicates. Two sachets combined as one replicate and their brine solution sampled then stored into 20 ml plastic tube. Each tube with brine solution also was tested using a probe. The data of the brine concentration from two different packages are tested using a t-test.

Weight of whole product

Three 20 g sachets were selected randomly to determine the biomass of preserved sea grapes before soaking and after soaking in freshwater. Preserved *Caulerpa* fronds from each sachet were taken out and stored in a weigh boat. Preserved fronds were weighed using a three decimal place scale before soaking. Following 3-minute soaking time, the fronds were weighed again to measure the total biomass.

Weight and length of individual fronds

Three Following the method above, the weight and lengths of each frond was measured after 3 minutes soaking time. The length of the fronds was measured using a digital calliper. Averages and standard of deviation of the weight and length for each of the 3 sachets were calculated (n = 65). Furthermore, the overall mean and standard deviation (SD) were calculated (n = 3).The frequency of different weights and lengthsacross the 3 sachets are presented in a histogram. In addition, a regression analysis between weight and length across all 3 sachetswasrun to understand the morphometric of the product.

3. RESULTS AND DISCUSSION

Characteristics of brine solution

There was no significant different in brine concentration between preserved sea grapes in the sachet (20 g) package and the plastic Jar (200 g) package, t-test (p=0.56). However, both types of the packages have above 10% of brine or over 100 g/L of dissolved salts inside the packages (Table 1). The average brine concentration from three samples from the sachets and three samples from the jars are 114.33 ±2. 30 g/L.

Table 1. Brine solution of the preserved sea grapes (g/L)

Brine solution			Summary Mean ± SD
Sample 1	Sample 2	Sample 3	Average of six
116.5	110.1	114.4	
Sample 4	Sample 5	Sample 6	114.33 ± 2.30
115.5	115.8	113.7	

Weight of the whole product

Three random samples of the 20 g sachet have similar weight (g) before three minutes soaking time in the tap water. The average initial weight was 22.47 g ±0.37 SD and after three minutes soaking time the average biomass weight doubled to 47.76 g ±1.42 SD. The average ratio between the weight of biomass before and after soaking time is 2.12 g ±0.03 SD. Moreover, each of the random samples had exactly the same number of fronds, a total of 65 (Table 2).

Table 2. Weight of the preserved sea grapes (g)

Measurements	Bag 1	Bag 2	Bag 3	Summary Mean ± SD
Biomass before 3 min soaked in tap water	22.23	22.27	22.90	22.47 ± 0.37
Tot. biomass after soaked in tap water	47.62	46.42	49.25	47.76 ± 1.42
Ratio	2.14	2.08	2.15	2.12 ± 0.03
Number of fronds	65	65	65	65 ±0

Weight and length of individual fronds

There was a significant relationship between the weight and the length of the fronds ($F_{1,\ 193}$ = 104.17, p< 0.01, R^2 = 0.35). However, based on the r-square calculation, only 35.05% of the variation in the weight can be explained by the variation of length i.e., length can be used to predict the weight of the fronds but there are other factors.

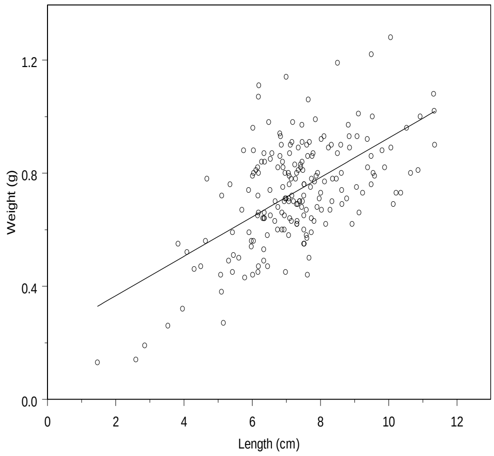

Figure 1. Regression analysis between length and the weight of the fronds. Significant shown (($F_{1,\ 193}$ = 104.17, p< 0.01).

From the total 195 fronds from three sachets, the average weight of the soaked product is 0.73 g ±0.18 SD while the average length is 7.27 cm ± 1.59 SD (Table 3). However, the measurements of the fronds from each sachet revealed that the weight and the length varied in scale. Data of the weight spread out from less than 0.4 gram to above 1 gram. The lightest is < 0.4 g (0.24 ±0.09 SD) while the heaviest is >1 g (1.12 ± 0.09 SD). (Table 4 & 5).

Table 3. Average weight and length of the fronds

Total number of fronds (195)	Weight (g)	Length (cm)
Mean	0.73	7.27
SD	0.18	1.59

Table 4. Summary of weight of the fronds

Weight	< 0.4	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	1.00	> 1
Mean	0.24	0.44	0.48	0.54	0.58	0.64	0.68	0.73	0.78	0.83	0.88	0.95	1.12
SD	0.09	0.01	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.03	0.09

Table 5. Summary of length of the fronds (cm)

Length	< 5	5	6	7	8	9	10	11
Mean	3.68	5.53	6.51	7.46	8.44	9.41	10.42	11.33
Mean	3.68	5.53	6.51	7.46	8.44	9.41	10.42	11.33

Overall there was greater and asymmetrical variation in the weight of fronds compared to the length of fronds. The most frequent weight was 0.8 gram (0.78 ±0.02 SD) with over 25 fronds, and the weight was skewed right to the heavier fronds (Figure 2a). The proportion of 0.8 gram among the group of weight is 13.33%, followed by 0.70 gram (0.68 ±0.02 SD) with 23 fronds (11.79%). Respectively, the proportion of weight below 10% are 0.75 g (0.73 ±0.01 SD) and 1.00 g (0.95 ±0.03 SD) with similar proportion (9.74%), 0.85 g (0.83 ±0.01 SD) with 8.71% followed by 0.65 g (0.64 ±0.01 SD) with 8.20% and 0.60 g (0.58 ±0.02 SD) with 7.17%. The frequency of heavy fronds over 1 g was only 5.12% and whereas the weight from < 0.4 g to 0.55 g all together is 14.8%.

In addition, there are more than 77% of the fronds of the weight from 0.70 gram to above 1 gram (152 fronds). On the contrary, only 43 fronds with 0.40 gram to 0.65 gram (22%).

The length of the fronds from total 195 fronds varied from less than 5 cm to 11 cm and appears like a classic bell curve However, the most frequent are 7 cm with 63 fronds (7.46 ±0.25 SD) followed by 6 cm (6.51 ±0.33 SD) with 54 fronds and 8 cm (8.44 ±0.29 SD) with 23 fronds (Figure 2b).

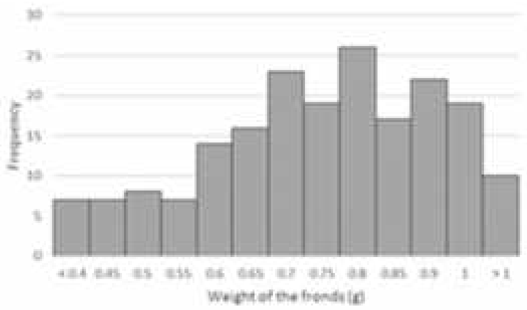

Figure 2a. The weight of the fronds with the frequency

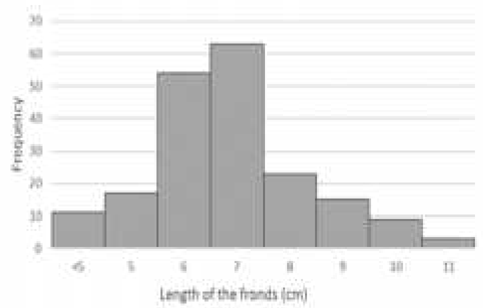

Figure 2b. The Length of the fronds with the frequency

The longest frond was 11 cm but with only three fronds (11.33 ±0.01 SD) followed by 10 cm (10.42 ±0.33 SD), 9 cm (9.41 ±0.25 SD), and 8 cm (8.44 ±0.29 SD) with each number of fronds are 9, 15, and 23. Furthermore, the proportion of the length between 8 cm to 11 cm is less than 30% (50 fronds), while over 70% of the length between <5 cm to 7 cm (145 fronds).

The study found that the preserved product packages of the sea grapes both had the same, high concentration of salt as the preservative material. This preserved product manufactured by TriTin company from Vietnam is using above 10% brine (100g/L) for preserving Caulerpa lentillifera. In the only previous study on the preservation of Caulerpa, a high concentration of brine (10-40%) was utilised for *Caulerpa racemosa* preservation [1]. According to [11], brine and salting method are commonly used for other foods such as meat, fish, dairy, and some plant products. [12] stated that high concentration of sodium chloride in seawater could be used to preserve algae. Furthermore, there is some evidence for using salts with 20-22% also used to stabilising alginate of brown alga [13].

The preserved product is very different to the rehydrated product.The product rapidly increases from an average weight of the whole sachet package of 22 g to 50 g, doubling in size. The findings indicate that actual weight of the product is slightly different compared to the package labelled, which was 20 g. The amount of the fronds inside the sachet bag samples are exactly same, 65 fronds, which indicates a high level of control of the processing technique. However, even though it is the same number of the fronds, each sample had a different weight, particularly after it soaked in the tap water. The different weight of the whole product may have influenced by the size of the individual fronds and their ability of absorption. According to [15], upright branches of *Caulerpa* varied in length (3 – 10 cm). Furthermore, naturally, seaweed may uptake nutrients in solution from all part of their body [8]. Therefore, the total weight of sachet package also might be different from each other.

In regards to the weight and the length of the individual fronds, 77% of the weight is between 0.7 g to above 1 g. Similar with that, the proportion of the fronds length from each package is over 70% for <5 to 7 cm long. Based on the regression analysis, the length and weight are related to that increased length gives more weight of the frond. However, there was also 65% of the variation in weight that was not explained by length. The different size of the grapes on each frond may be one of the factors why only 35% of weight variation can be explained by length variation. These findings highlight that particular size such as similar weight and length of the fronds or optimum size were intended to choose for the product. Moreover, picking the bigger size of the fronds may be a compulsory standard during the processing of this product, to ensure a consistent weight product. Since the raw material stocked from their sea grapes culture, the similar size of the fronds may the result of particular treatment of farming. The previous study demonstrated that length of the *C. lentillifera* and *C. racemosa* at the culture trays inside recirculated seawater system are approximately 3 – 6 cm long [14]. In the wild, the length of the fronds from *Caulerpa* genus may vary from 3 – 10 cm long [15]. However, in the culture system, shape and texture of the fronds affected by the high density of cultivation [16].

4. CONCLUSION

The preserved sea grapes product manufactured by Tri Tin Company is *Caulerpa lentillifera* with more than 10 %

of brine as a primer preservative material. The brine sea grapes packaged in 20 g plastic sachet has a consistent amount of the fronds inside the package. However, the weight labelled in the package is different compared to measurement results. The weight and length of the fronds have a positive relationship, and the optimum size of the fronds was chosen for the product as a standard of processing technique.

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