



The effect of food additive on physicochemical characteristics of seaweed stick snack and consumer acceptance

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Abstract

Seaweed is considered high class marine and fisheries sector in international demand for its derivative products. One of traditional use of seaweed as food is stick snack which is widely consumed due to its crunchiness and deliciousness. The objective of this study was to characterize the proximate analysis, hardness, and sensory perception of stick snack derived from seaweed. Seaweed stick were prepared with varying food additives such as sodium acid phosporphate (SAPP), stearyl lactylate (SSL), sodium bicarbonate (NaHCO₃), and control (without addition of food additives). The results confirmed that the use of food additives induce change in proximate, hardness, and sensory perception. Seaweed stick with addition NaHCO₃ has the highest fat content while seaweed stick with addition of SAPP has the highest crispness. In addition, sensory test showed that seaweed stick with addition with NaHCO₃ provide the highest acceptance in texture and flavour.

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Keyword

Stick, Seaweed, Food Additive, SAPP, NaHCO₃, SSL

1. Introduction

Seaweed is one of the largest marine biological resources in Indonesia. China and Indonesia contributed over 23 million tonnes of wet seaweeds in 2014, followed by Phillipines and Korean Republic which contributed over 1 million tonnes (1). Seaweeds can be used in many different forms (e.g. fresh, dried, powder) and their use has grown significantly. Seaweed's extracts contain many bioactive compounds, such as terpenoids, phlor-otanins, fucoidans, sterols, and glycolipids (2). Seaweeds have potential novel applications in foods and beverages industries since they can function as food additives such as emulsifier, gelling agent, stabilizer, texturizer, and as source for dietary iodine and fibers (3). In addition, seaweed can be used as ingredient for cosmetics (4), nutraceuticals (5), pharmaceuticals (6–8), and bioenergy (9,10). The possibility to develop novel food products from seaweeds such as seaweed stick remain a challenge.

Stick snack is considered one of the most popular snacks which is composed from wheat flour, tapioca flour, sago flour, fat, eggs, and water. This food is generally produced through frying and it has savory taste and crunchy texture (11–13). However, stick snack can easily absorb moisture from the air and loses its texture and become rancid which in turn can significantly alter the taste and flavor.

There have been numerous studies addressing the influence food additives on food quality. Long, Gál, and Buňka (2011) investigated the use of Sodium Acid Phosporphate (SAPP) in food. The authors reported that SAPP can be used to adjust the pH, maintain color, improve water-holding capacity and reduce purge during retorting (14). In addition, Brodie and Godber (2001) reported the use of SAPP as leavening agent in baking powders

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(15). Panghal, Navnidhi, and Khatkar (2011) used sodium bicarbonate as food additive in bread making. The results reported by the authors indicated that sodium bicarbonate (NaHCO_3) is an alternative additive in bread making. This compound dissolves in water and produces CO_2 when it is used in bread making (16). In addition to SAPP and sodium bicarbonate, another food additive that is mostly used in food production is sodium stearyl lactylate (SSL). SSL has the ability to strengthen dough, to emulsify, and to replace fat and sugar in formulation (17). Meanwhile, if fat and protein content in the product is high, SSL will reduce water absorption. For these reasons, the addition of food additives such as SAPP, NaHCO_3 and SSL into stick formulation can affect its taste, texture and aroma, which in turn will likely alter consumer acceptance. Therefore, the aim of this study was to determine the physical, proximate content, and sensory perception of stick snack with the above additives.

2. Materials and Methods

2.1. Materials

The materials used in this study were dry seaweed, medium protein wheat flour (Bogasari), margarine (*Blue band*, Unilever), garlic, shallots, salt, *Sodium Stearyl Lactylate* (SSL) (Foodchem), Sodium Acid Pyrophosphate (SAPP) (Indo food Chem), and Sodium bicarbonate NaHCO_3 (Brataco).

2.2. Research Procedure

Processing steps for seaweed sticks consist of soaking, refining, milling, mixing all ingredients into dough, frying, and draining. The dried seaweed used was first soaked in clean water for about 30 minutes to allow the seaweed to swell and to facilitate the grinding process. The grinding was done using a household blender.

All ingredients, except SAPP, SSL, sodium bicarbonate, were mix and formed into dough which consists of 1 kg flour, 225 g of butter, 25 g of salt, 5 g of garlic and 5 g of onion. The dough was divided into four parts, one part was added with SAPP (0.5%), one part was added with SSL (0.5%), one part was added with sodium bicarbonate (0.5%), and the other as control.

2.3. Observation Parameters

2.3.1. Moisture Content Analysis

Seaweed sticks samples were weighed about 2 g in cups of known weight and dried in oven at a temperature of 105°C until constant weight. The moisture content as determined using the following equation (18):

$$\text{Moisture content (\%)} : \frac{B-C}{B-A} \times 100 \quad (1)$$

Note:

A = Weight of cup (g)

B = Weight of cup and sample before drying (g)

C = Weight of cup and sample after drying (g)

2.3.2. Protein Content Analysis

Protein content was determined using Kjeldahl method. About 1.5 g of seaweed stick samples was mixed with 2 g of selenium and 25 ml H₂SO₄ in Kjeldahl flask and heated in fume hood until clear solution was obtained. After cooling, 200 ml of distilled water and 1 g of Zn was added. The solution was neutralized with 45% of NaOH and then distilled into boric acid solution. The distillate was added with methyl red colour indicator and titrated with HCl 0.02 N. The protein content as determined using the following equation (19):

$$N (\%) = \frac{(\text{ml HCl} \times N \text{ HCl}) \times 14.008 \times 100 - \text{ml NaOH} \times N \text{ NaOH} \times 14.008}{\text{mg sampel}} \quad (2)$$

$$\% \text{ Protein} = \% N \times \text{conversion factor} \quad (3)$$

2.3.3. Fat Content Analysis

Fat content was determined using Soxhlet method using hexane. About 2 g of samples was wrapped with filter paper and dried at 80°C for 1 hour. After that, the sample was placed in the extraction column and extracted for 6 hours. The extract obtained was dried in oven at 105°C to evaporate all of the solvent. Fat content was determined with the following equation (20):

$$\% \text{ Fat} = \frac{W - W_1}{W_2} \times 100 \quad (4)$$

Note :

W = Weight of sample in (g)

B = Weight of fat before extraction

C = Weight of fat after extraction

2.3.4. Ash Content Analysis

Ash content was determined by igniting 2 g of sample in muffle furnace at 550°C. Ash content was determined with the following equation (21):

$$\text{Ash content (\%)} = \frac{\text{Weight after ignition}}{\text{Initial weight}} \times 100 \quad (5)$$

2.3.5. Carbohydrate Content Analysis

Carbohydrate content is calculated by "Carbohydrate by difference". Carbohydrate content was determine by difference with the following equation (22):

$$\text{Carbohydrate (\%)} = 100\% - \% (\text{water content} + \text{protein content} + \text{fat content} + \text{ash content}) \quad (6)$$

2.3.6. Crude fiber Content Analysis

Crude fiber content measurement performed using AOAC method (1990) (23). Two grams of defatted bread sample was transferred into a 750 ml Erlenmeyer flask, then 0.5 g asbestos was added to the flask and following with the addition of two hundred millilitres of boiling 1.25% H₂SO₄. The flask then was connected to cold finger condenser, and immediately placed on a hot plate for 30 minutes. The flask then was removed and the mixture was filtered through a linen cloth in a funnel and washed with boiling water to remove the acid content. The charge and asbestos was washed back into the flask with 200

ml of boiling 1.25% NaOH solution. The flask was again connected to a condenser and heated for 30 min. The mixture then filtered through linen cloth and thoroughly washed with boiling water. The residue was transferred into a gouch crucible, washed with 15ml of 95 % ethanol and dried at 100°C in the oven for 1 hr. The flask was cooled in a desiccator, weighed and ignited in a pre-heated muffle furnace (Gallenkamp muffle furnace, England) at 600°C for 30 minutes. The flask was again cooled and reweighed. The weight difference was recorded and percent crude fiber content was calculated (23).

2.3.7. Hardness Test Method

The hardness of seaweed stick was determined using penetrometer method. The hardness of samples was read directly from the instrument.

2.3.8. Hedonics Test Method

Level of acceptance was measured with 5 scale hedonic test. Twenty five panelists were asked to rate the color, texture, and flavor. The preference scale used in this study were 1 (very dislike), 2 (dislike), 3 (neutral), 4 (like) and 5 (like very much).

2.4. Research Method and Data Analysis

This study was conducted using completely randomized design (CRD) with three treatments. The data obtained were analyzed using ANOVA and the differences among the means were analyzed using Duncan Multiple Comparison Test. All statistical analysis were performed using SPSS Version 22 software.

3. Results and Discussions

3.1. Moisture Content

Moisture content in food materials affects the quality and storage capacity of these materials. In this study, the highest water content was found in control seaweed stick product while the lowest water content was found in the seaweed stick with the addition of NaHCO₃. The difference in water content can be attributed to the texture of the products. With the presence of pores in seaweed sticks with addition of texture enhancement agents, water molecules can easily escaped from the food matrix during frying.

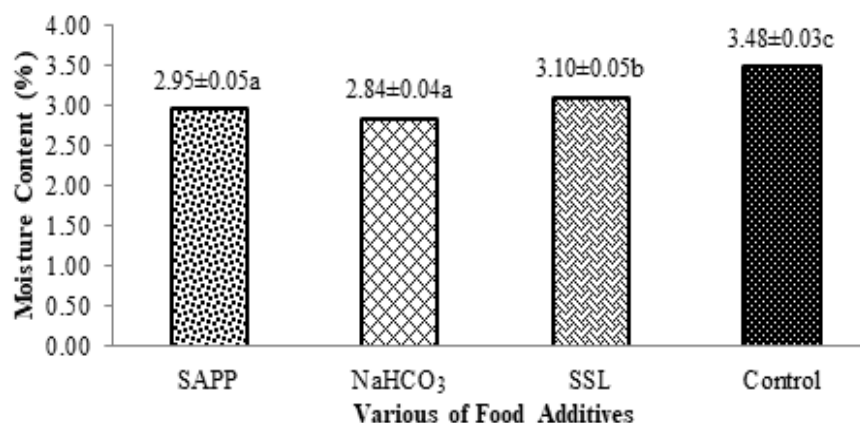


Figure 1. The moisture content diagram of seaweed stick with adding of various of food additive.

Note: The different superscript notations show significant differences at the test level $\alpha = 5\%$.

Based on figure 1, the moisture content of seaweed sticks with SSL was higher than those with SAPP and NaHCO_3 . This is because of the higher hygroscopicity of SSL and its polar group that can bind water molecules. In addition, NaHCO_3 is able to form pores so that it can provide path for water removal.

3.2. Protein Content

Protein is one of the substances found in food ingredients that are very important for humans because its functions as a builder and regulator in the body (24). The results presented in figure 2 showed that the highest protein content was found in control seaweed stick. Meanwhile, the lowest protein content was found in seaweed sticks with NaHCO_3 .

The protein in the control was higher. It is assumed that the protein content in the raw material for seaweed sticks decreased due to Maillard reaction which occurred during frying. The result of hedonic test indicated that seaweed stick samples with addition of texture enhancement agents had darker colour with resulted lower acceptance. This darker color is indication of more intense Maillard reaction which can bring about reduction in protein content.

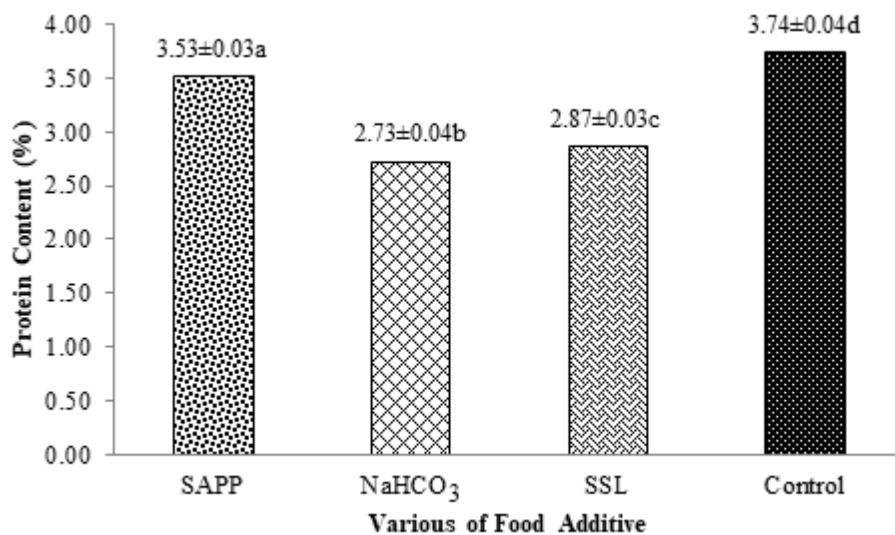


Figure 2. The protein content diagram of seaweed stick with adding of various of food additive.

Note: The different superscript notations show significant differences at the test level $\alpha = 5\%$.

3.3. Fat Content

The results of analysis on fat content indicated that treatment with the addition of texture enhancing agent significantly affected fat content. The overall results showed that the use of texture enhancing agent significantly increase fat content of products as presented in figure 3. This trend can be attributed to formation of pores. The highest fat content was found in seaweed stick products with the addition of NaHCO_3 while the lowest fat content was found in the control. The pores in food matrix can act as a sink for oil absorbed during frying. The more pores in the food matrix, the more oil that can be entrapped which causes the fat content to increase.

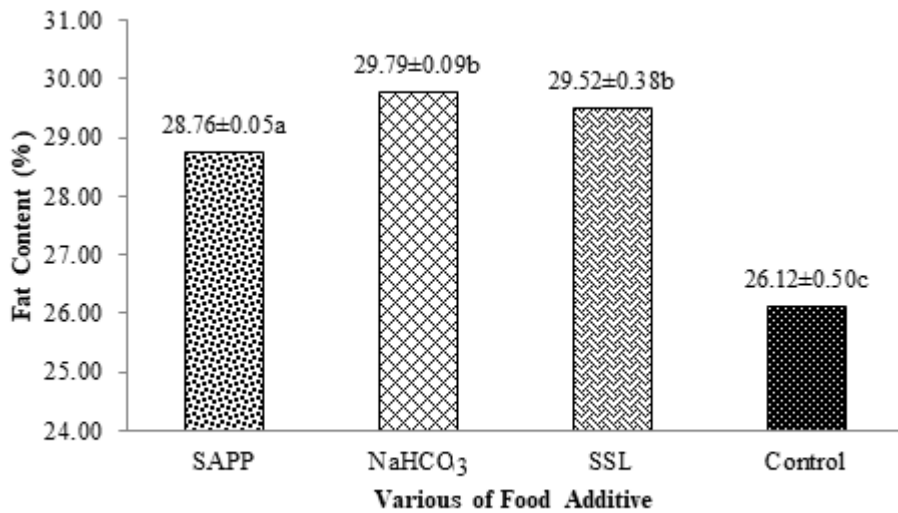


Figure 3. The fat content diagram of seaweed stick with adding of various of food additive.

Note: The different superscript notations show significant differences at the test level $\alpha = 5\%$.

3.4. Carbohydrate Content

The result of carbohydrate content calculation shows that carbohydrate contents in seaweed sticks samples with addition of NaHCO₃ and SSL were significantly higher than those of SSAP and control samples even though the differences were only about 1 % as shown in figure 4. Since carbohydrate contents were determined using difference method, the increase in carbohydrate content observed in this study might be more due to the reduction other components such as moisture and protein content.

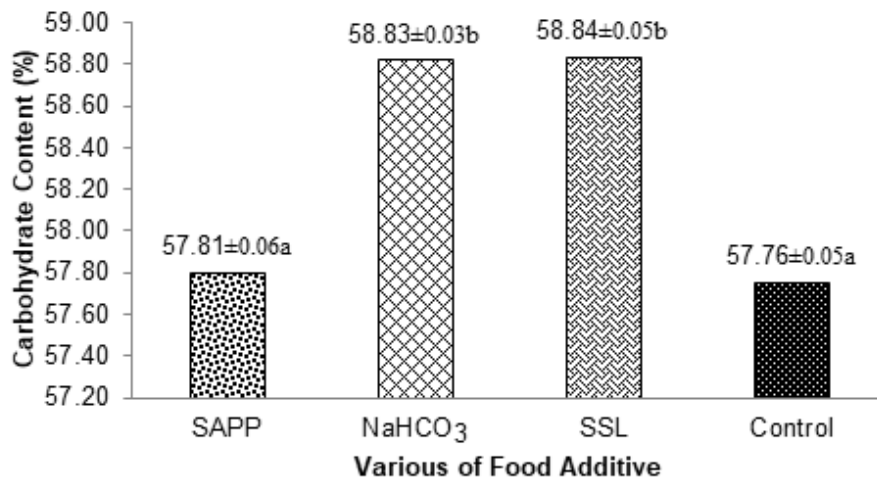


Figure 4. The fat content diagram of seaweed stick with adding of various of food additive.

Note: The different superscript notations show significant differences at the test level $\alpha = 5\%$.

3.5. Crude Fiber Content

Dietary crude fibre is a complex carbohydrate in food which cannot be hydrolysed by digestive enzymes. Total dietary fibre consists of soluble dietary fibre and insoluble dietary fiber (25,26). Seaweeds are natural material which has high fibre contents and many researchers indicated that substitution with seaweed can increase fibre content in the product.

The results show that the highest (11.82 ± 0.05) crude fibre was found in seaweed sticks with the addition of SAPP, followed by samples with NaHCO_3 , and the lowest was found in control samples as shown in figure 5. This shows that the addition of texture enhancing agents can result in higher crude fibre content in the seaweed stick product.

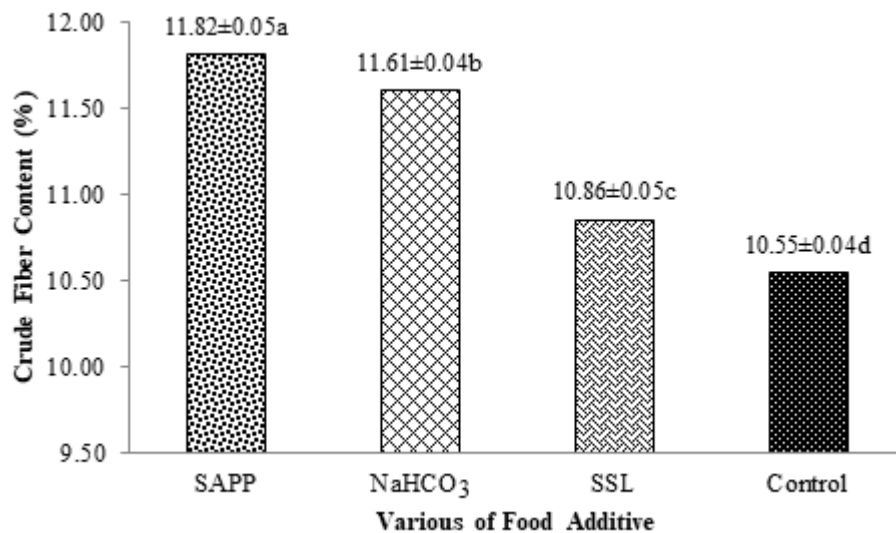


Figure 5. The fat content diagram of seaweed stick with adding of various of food additive.

Note: The different superscript notations show significant differences at the test level $\alpha = 5\%$.

3.6. Hardness

Hardness is one of the most important quality criteria for types of stick products (27,28). The hardness of seaweed sticks obtained from the experiment were presented in figure 6 which indicated that the addition of texture enhancement agents significantly affects hardness. The addition of SAPP and SSL tend to increase hardness, which is undesirable. On the other hand, the addition of NaHCO_3 significantly decrease hardness level which make the product crunchier. It is important to note that this result is relevant to the likeness level on texture, especially for seaweed sticks with the addition of NaHCO_3 .

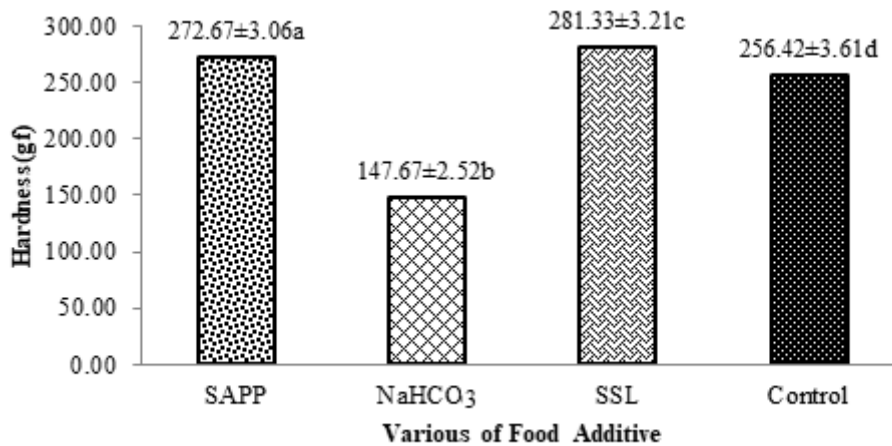


Figure 6. The hardness diagram of seaweed stick with adding of various of food additive.

Note: The different superscript notations show significant differences at the test level $\alpha = 5\%$.

3.7. Crispness

The test results showed that the highest crispness value was found in the seaweed stick with the addition of NaHCO₃. Meanwhile, the lowest crispness value was found in control seaweed stick as shown in figure 7.

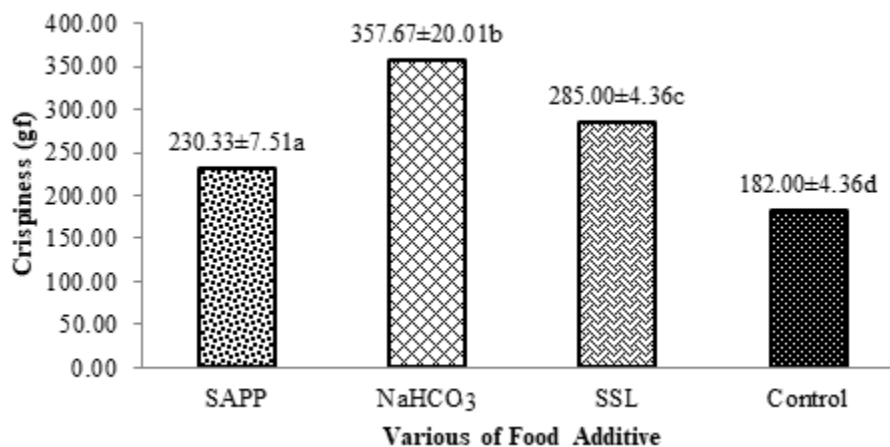


Figure 7. The crispness diagram of seaweed stick with adding of various of food additive.

Note: The different superscript notations show significant differences at the test level $\alpha = 5\%$.

The level of product crispness is inversely proportional to the hardness and moisture content, where the higher the level of crispness, the value of water content and hardness tends to be lower. In addition, crispness is also influenced by the addition of texture enhancement agents such as NaHCO₃ which promote the formation of pores inside the product. The pores in food ingredients have an important role in the crunchiness and texture of snacks. In extreme conditions, many crunchy foods become hard if they do not have pores (29).

3.8. Hedonic Test

Results of hedonic test on flavour, texture, and colour are shown in Figure 8. Overall results indicate that treatment with NaHCO_3 provide the highest overall hedonic score. It is interesting to note that the use of texture enhancement agents such as SAPP, NaHCO_3 , and SSL affected the colour as indicated by the hedonic score and appearance. This result might suggest an increase of Maillard or browning reaction during frying due to the addition of the texture enhancement agents. Beside its function as bread improver, baking powder can also changes the colour of the crumb which is often unwanted or even an indication of deterioration (30). In addition, the decrease in brightness level occurs because high protein levels can increase the risk of the Maillard reaction (31).

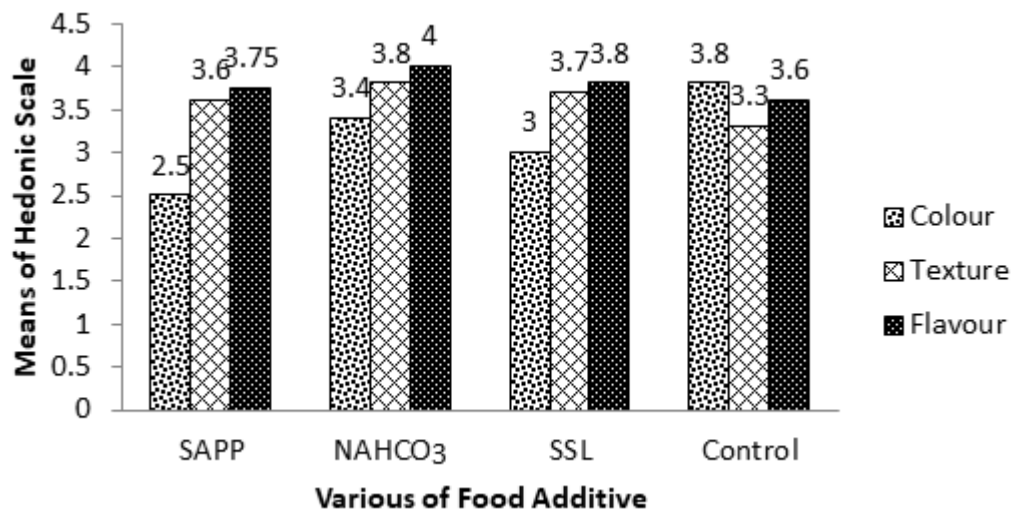


Figure 8. The hedonic scale of seaweed stick with various additive.

The texture of seaweed sticks that the panelists preferred was the texture of the samples with the addition of texture enhancement agents which give crunchier sticks compared to the control as shown in figure 9. Sticks without the addition of texture enhancement agents are tougher and harder to chew. Likewise, the panelists preferred the flavour and mouthfeel of seaweed stick with the addition of texture enhancement agents since they provide their intrinsic flavour such as alkaline taste from sodium bicarbonate.



Figure 9. The appearance of seaweed stick with various additive.

3.9. Ash Content

Ash content is a mixture of inorganic or mineral components contained in food and food products (32). The ash or mineral content is parts and minerals of the material on which it is based on dry weight (33). The ash content of seaweed sticks in this study were measured and presented in figure 10.

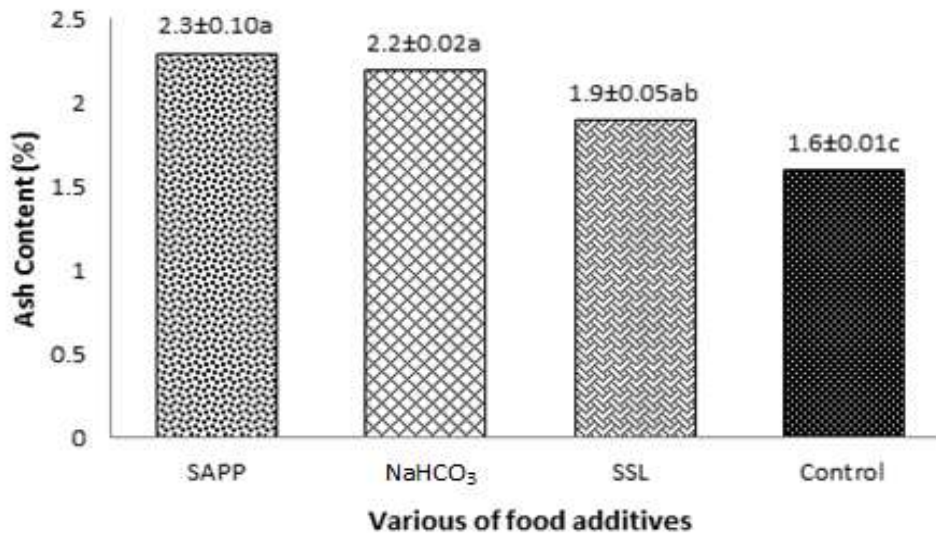


Figure 10 . The ash content diagram of seaweed stick with adding of various of food additive.

Based on figure 10, it can be seen that the ash content of seaweed sticks found in this study, in all different food additives used, were significantly different with control and show no significant difference between the treatments. It is suspected that all the food additives used contained a significant amount of inorganic content and contribute to the increasing of ash content of the resulted product.

4. Conclusions

The use of texture enhancing agents such as SAPP, NaHCO₃, and SSL can significantly affect physical and sensory properties of seaweed sticks. The overall results of organoleptic test suggested that treatment with NaHCO₃ provide the highest acceptance. In addition, the addition of NaHCO₃ can also make seaweed sticks more crunchier. Moreover, the use of texture enhancing agents particularly NaHCO₃ and SSL can increase carbohydrate content, crude fibre content and fat content while SAPP can increase protein content.

Author Contributions

Sumartini, Sellen Gurusmatika, and Wan Amira conceived and designed the experiments, performed the experiments, analyzed the data, contributed reagents/materials/analysis tools and wrote the paper.

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