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Effect of addition of locust bean gum on the characteristics of alginate grains

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ABSTRACT

This research aims to determine the amount of addition of locust bean gum to produce the best characteristics of alginate grains. The research was conducted in January - February 2018 at the Fisheries Product Processing Laboratory of the Faculty of Fisheries and Marine Sciences, Padjadjaran University. The method that was used in this research is the experimental method with Completely Randomized Design with four treatments and three repetitions. The parameters observed in this research include viscosity, gel strength, syneresis, stability, pH, water content, and ash content. The results of the research showed that the addition of locust bean gum in the alginate gel increases viscosity, gel strength, and decreases syneresis. The addition of 30% locust bean gum produced alginate grains with the best characteristics which had a viscosity of 337 cP, gel strength (), syneresis 3.10%, pH 3.10, moisture content 93.70%, and ash content 0.4%.

Keywords: Alginate, Alginate grains, Locust bean gum, Eucheuma, Gracillaria, Gelidium, Hypnea, Sargassum, Indo-Pacific region

1. INTRODUCTION

One of the aquaculture commodities that is the focus of the Ministry of Maritime Affairs and Fisheries (KKP) to continue to develop is seaweed. The national seaweed production volume is growing at an average of 11.8% per year, whereas the temporary figure for 2017 national seaweed production is 10.8 million tons. The export value of seaweed also grew by 3.09% per year. Indonesia's seaweed trade balance was positive with the Product Specialization

Index (ISP) higher than other exporting countries. This condition indicates that seaweed products have high competitiveness.

Several types of seaweed in Indonesia that have economic value and have been widely traded, namely *Eucheuma* sp., *Gracillaria* sp., *Gelidium* sp., and *Hypnea* sp. from the class of *Rhodophyceae*, and *Sargassum* sp. from the *Phaeophyceae* class. *Eucheuma* sp. seaweed and *Hypnea* sp. produce primary metabolites in the form of carrageenan hydrocolloids so that the type of seaweed is classified as caragenophytes. *Gracillaria* sp. seaweed and *Gelidium* sp. produce primary metabolites in the form of agar hydrocolloid, while seaweed *Sargassum* sp. produces primary metabolites in the form of hydrocolloid alginate so that this type of seaweed is called alginophyte.

Alginate can be extracted from brown seaweed like *Sargassum* sp. and *Turbinaria* sp. Not many people know that one of the results of the extraction of brown seaweed, namely alginate, has a wide range of benefits, both in the food and non-food industries. Several studies on how to extract alginate from local seaweed have been carried out. However, in general alginate products produced from this local seaweed have low viscosity. Low viscosity causes the use of alginates to be less developed. Alginate can form a gel that can be used to produce grains like oranges (analog grains) which are found in many drinks on the market. Orange grains are widely available on the market and are liked by consumers, but it seems that the number of grains of oranges that are still intact in these drinks is less than those that have been broken. Grains of oranges can be made with other ingredients such as using alginate plus orange juice to produce analog orange grains. The formation of analog orange grains can be done using alginate which is interacted with calcium ions and orange juice solution to form an orange gel. The interaction between alginate and calcium ions will form alginate grains. When alginate gel is formed in orange juice solution, the orange juice solution will be trapped in the gel to produce grains that resemble orange grains.

Locust bean gum, or what is known as the carob bean gum, is a galaktomannan extracted from carob tree seeds. Locust bean gum is a hydrocolloid with unique functional properties that can be used as thickener and stabilizer and can affect viscosity when added to food products which can ultimately improve texture and other functional properties through water phase management. Hoefler (2004) reports that alginate interacts synergistically with locust bean gum, guar gum, rich gum, and tragacanth to produce increased viscosity. Therefore, it is necessary to do research on the effect of the addition of locust bean gum on the characteristics of alginate grains using calcium CaCl_2 ions which are expected to be a source of information to increase the utilization of alginates from local seaweed.

2. MATERIALS AND METHODS

The materials used in this research are flour alginate (Na-alginate), granulated sugar, orange paste, food coloring, citric acid, orange juice, CaCl_2 , boiled water, locust bean gum. The tools used in this research are hand mixer, basin, spoon, filter, 500 ml spray bottle, measuring cup, funnel, plate, digital balance, 500 ml glass beaker, 100 ml schott bottle, and pH meter. The research was conducted from January to February 2019 which took place at the Fisheries Product Processing Laboratory of the Faculty of Fisheries and Marine Sciences, Padjadjaran University. Analysis of viscosity test, moisture content test, and ash content test were carried out at the Food Technology Laboratory of the Faculty of Engineering, University of Pasundan.

Gel strength test analysis was carried out at the Food Engineering Laboratory of the Faculty of Food Industry Technology, Padjadjaran University. This research uses an experimental method using a completely randomized design with 4 treatments and 3 replications.

2. 1. Manufacture of Analog Orange Grains

Preparations for making orange grains are alginate (0.8%), granulated sugar (10%), food coloring (0.1%), orange flavor (0.9%), citric acid (0.2%), water (87.8%), CaCl₂ (0.5%) for the formation of alginate grains. Formation of alginate gel was done using a 500 ml spray bottle.

2. 2. Observation Parameter

The resulting alginate gel was tested for viscosity, gel strength, syneresis, stability, pH, water content and ash content. Observation of the stability of the alginate gel was carried out on the weight with the consideration that the gel was stored in the solution with the possibility of a heavy increase due to water entering the gel. To study the stability of the gel weight, the alginate gel was immersed in an orange solution with a storage period of 4 weeks. Weight and color tanning have been carried out every week.

3. RESULT AND DISCUSSION

3. 1. Viscosity

Viscosity is a physical property of fluids showing resistance to flow. The higher the viscosity indicates the greater the resistance of the liquid being tested. The viscosity of alginate grains gel is in a range of 149.60 - 377 cP. The alginate gel with 30% addition of locust bean gum was seen to increase the viscosity 2.5 times from the initial viscosity of 149.60 cP to 377 cP (Figure 1). The results of analysis of variance at the 5% test level showed that the addition of locust bean gum gave a significantly different effect on the viscosity of the alginate grains gel which meant the addition of locust bean gum affected the viscosity of the alginate grains gel. The highest viscosity value at the addition of 30% locust bean gum is 377 cP and the lowest viscosity value at the addition of 0% locust bean gum or control treatment is equal to 149.60 cP. The results of the further Duncan test showed the addition of 0-20% and 40% locust bean gum, were not significantly different, but they were significantly different from the addition of 30% locust bean gum.

According to Subryono and Apriani (2010) gel viscosity is divided into three levels, namely low viscosity (<60 cP), moderate viscosity (60-110 cP), and high viscosity (110-800 cP). Based on the division, the treatment of addition of locust bean gum from 0 to 40% was included in the high viscosity, where the highest value was obtained at the addition of 30% locust bean gum at 377 cP.

The addition of 40% locust bean gum tends to reduce the viscosity of the alginate grains gel which is equal to 162.2 cP. This is presumably because there are too many locust bean gum so that it can reduce the interaction between Ca²⁺ ions and polyguluronate in alginate. This is consistent with the statement that the interaction between locust bean gum and Ca²⁺ ions does not produce gel formation, so that in the gel formation system more is determined by the interaction between Ca²⁺ and polyguluronic ions. It is possible that at certain comparisons locust

bean gum is able to compete with alginate in binding to Ca^{2+} ions, so it tends to reduce the viscosity of the gel if there is too high locust bean gum concentration.

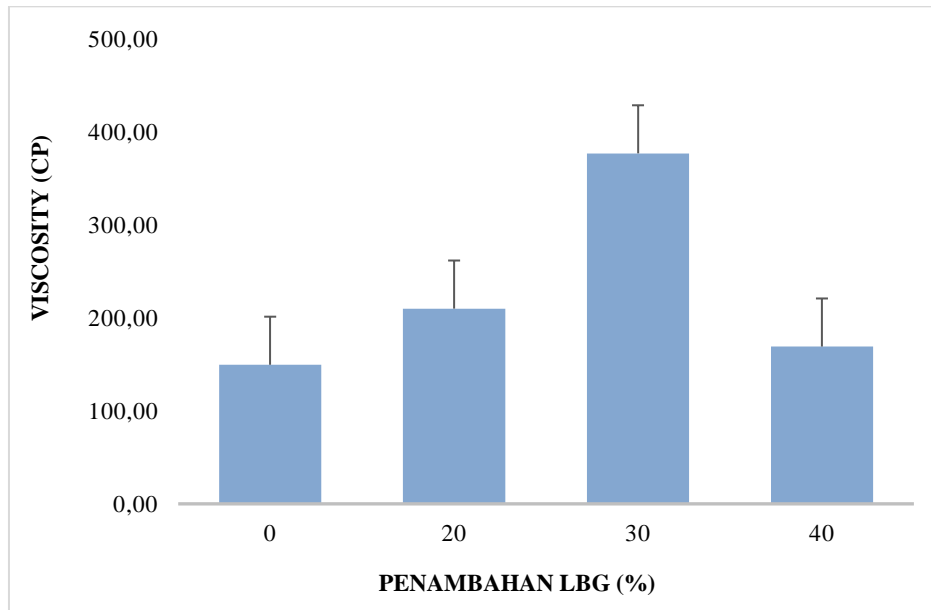


Figure 1. Graph of the Effect of Adding Several Locust Bean Gum Concentrations to the Viscosity of Alginate Grains Gel

3. 2. Gel Strenght

Gel strength is an essential physical property, because it indicates the ability of alginate in gel formation. Alginate gel strength has a range of 129.64 - 300.91 g/cm^2 . Grain alginate gel with 30% addition of locust bean gum was seen to increase gel strength from 129.64 g/cm^2 to 300.91 g/cm^2 (Figure 2). The results of analysis of variance at the 5% test level showed that the addition of locust bean gum gave a significantly different effect on the strength of the alginate grains gel which meant the addition of locust bean gum affected the strength of the alginate grains gel. The highest gel strength value at the addition of 30% locust bean gum is 300.91 g/cm^2 and the lowest one – at the addition of 0% locust bean gum or control treatment is 129.64 g/cm^2 . The results of the further Duncan test showed the addition of locust bean gum 0-40% was significantly different between treatments.

The strength of the gel is divided into three levels of quality, namely quality 1 (300-350 g/cm^2) including the strength of high gel, quality 2 (200-250 g/cm^2) including the strength of medium gel, and quality 3 (100-200 g/cm^2) that is placed in the low gel strength. Based on this division, the treatment of adding 0% locust bean gum to 129.64 g/cm^2 was included in the low gel strength, the treatment was 20% and 40% included in the medium gel strength, while the treatment of 30% of 300.91 g/cm^2 is included in the high gel strength. The strength of the gel of the alginate grains increases along with the increasing addition of locust bean gum. This is because the locust bean gum highly affects the gel strength.

The gel strength of gelatin formula with arabic gum at all ratios and gelatin formula with guar gum was lower than the gelatin gel strength value. This shows that adding arabic gum and

guar gum decreases the strength of gelatin gel. As for the gelatin formula with the locust bean gum and for the same with conjacates at all higher ratios it is compared to the gelatin gel strength value. This proves that the locust bean gum and konjac are able to increase the strength of gelatin gel.

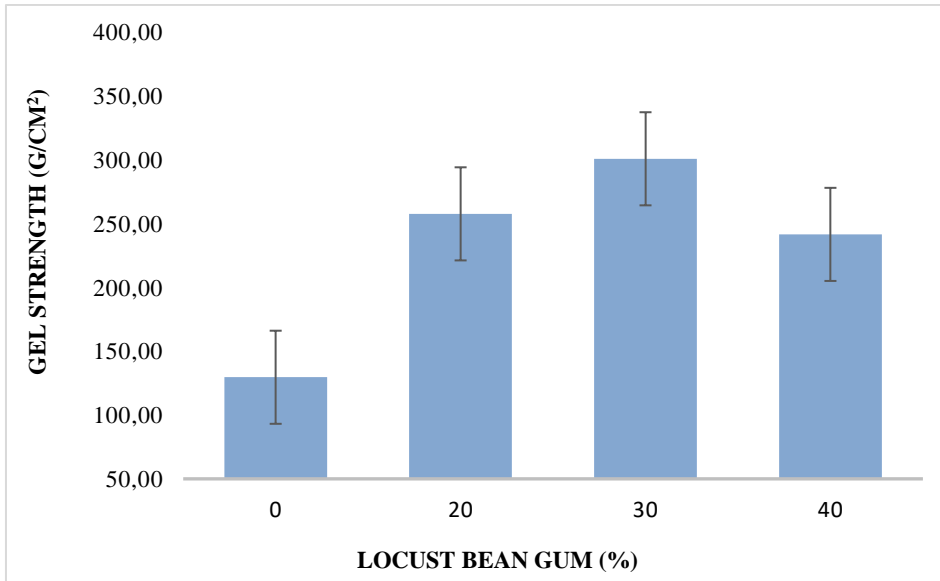


Figure 2. Graph of the Effect of Adding Several Locust Bean Gum Concentrations on the Strength of the Alginate Grains Gel

3. 3. Syneresis

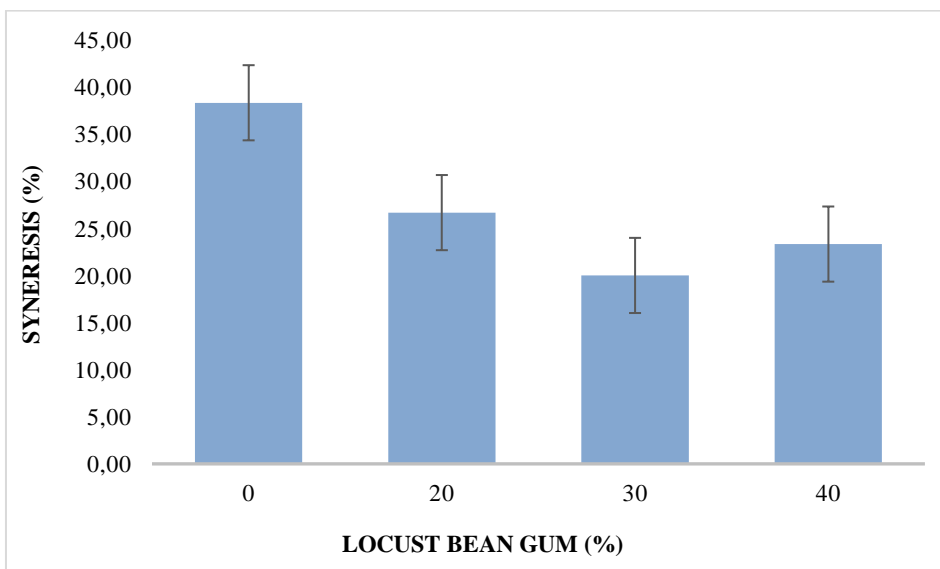


Figure 3. Graph of the Effect of Adding Several Locust Bean Gum Concentrations to Syneresis of Alginate Grains Gel

Syneresis is a characteristic that can be seen, namely gel shrinkage which is slow, is influenced by the time of release of liquid from the gel. The value of syneresis of alginate grains gel is in the range of 20.00 - 38.33%. Grain alginate gel with 30% addition of locust bean gum was found to reduce the value of syneresis (Figure 3). The results of analysis of variance at the 5% test level showed that the addition of locust bean gum did not have an effect on the syneresis of the alginate grains gel. The highest syneresis value at the addition of 0% locust bean gum, or control treatment, was 38.33% and the lowest syneresis value at the addition of 30% locust bean gum was 20%.

The synthesis of alginate grains gel decreased with the addition of 20-30% locust bean gum compared to alginate grains without the addition of locust bean gum. This is because the locust bean gum can improve water holding capacity so that the release of water from the gel can be inhibited. The biggest decrease occurred at the addition of 30% locust bean gum which equalled to 20%. Low synergy shows that a ficocolloid or combination has a strong water binding capacity, so that water will be trapped in the agate and it results in maintaining the product weight.

3. 4. Stability

Observation of gel stability of alginate in orange solution was carried out on weight and color considering that the gel from the alginate was stored in a solution, allowing for a heavy increase due to water entering the gel system. On the 7th day of storage the average weight of alginate grains was 11.42 g, on the 14th day of storage the average weight of the alginate grains increased by 12.85 g, and on the 21st day of storage the weight was flat – the average of alginate grains increased by 13.33 g. The alginate gel that was applied to the orange solution increased in weight, with an average of the overall sample of 11.90 g. This is probably caused by water entering the alginate gel matrix, so that the weight increases.

Table 1. The weight of alginate during storage for 4 weeks

Weight of Alginate Grains Gel				
Treatment	0%	20%	30%	40%
Day-1	10	10	10	10
Day-7	10.04	11.1	12.1	12.5
Day-14	11.7	13.8	12.2	13.7
Day-21	13.5	12.8	13.6	13.4

It was reported in war research on the effect of increasing the concentration of CaCl₂ and alginate on the characteristics of alginate grains produced on the 7th day storage of analog orange grains which was 15.09 g and decreased on day 14th to an average of 14.96 g.

The difference is suspected because the locust bean gum can improve the water holding ability so that the release of water from the gel is inhibited. The alginate gel will decrease the strength of the gel which is marked by the entry of water into the gel system so that the weight becomes increased and the gel color of the alginate grains turns brighter (the orange color is almost gone).

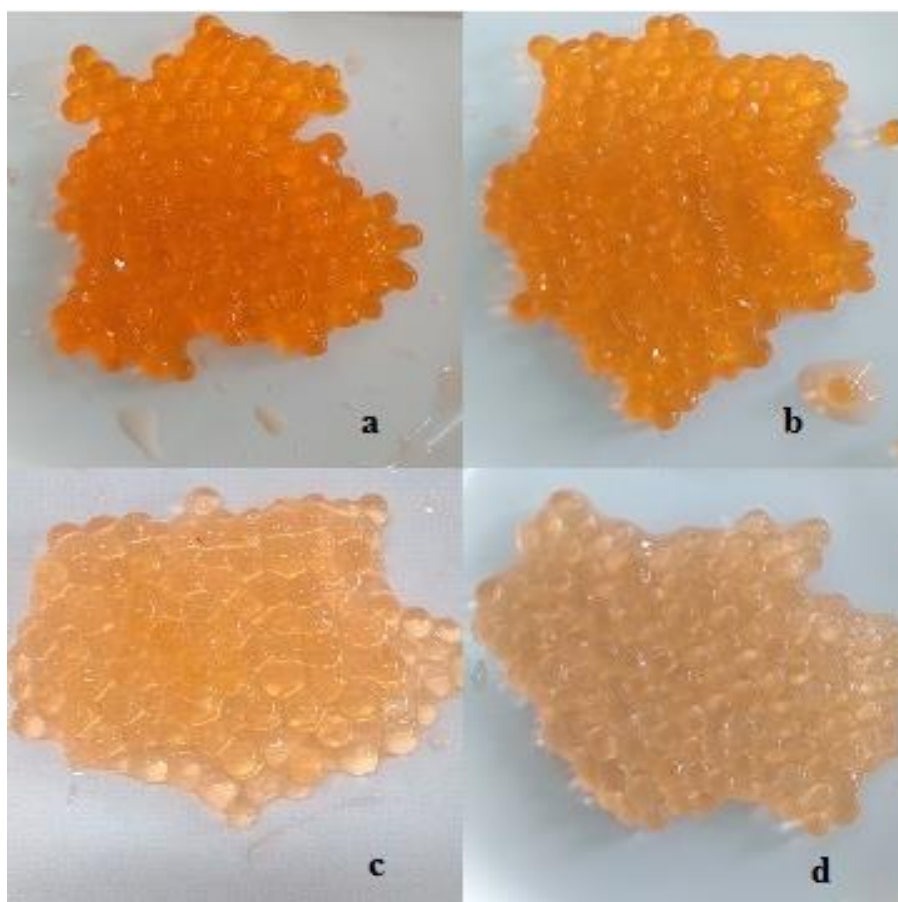


Figure 4. Effect of Addition of Locust Bean Gum on Discoloration of Alginate Grains Gel in 4 Weeks time (a) Week-1 (b) Week-2 (c) Week-3 (d) Week-4

In addition to the increase in weight in the alginate gel, color changes also occur from concentrated orange to bright orange which indicates the color of the alginate gel is degraded by an orange solution. The color intensity of the alginate gel gradually changes to brighter (the orange color is increasingly lost) at the storage for 4 weeks (Figure 4). This occurs because the ingredients of the alginate gel to formulation are hydrophilic materials such as orange paste.

3. 5. pH

Alginate grains in all treatments had a fairly low pH value, namely 3. A low pH value indicates that the product has a high acidity. High acidity levels are due to the addition of citric acid which apart from adding flavor will also reduce pH. A low pH will increase the electrostatic

H⁺ atom so that it will attract a negatively charged oxygen atom to its bond with calcium ions. The alginate gel will decrease the strength of the gel which is marked by the entry of water into the gel system so that the weight becomes higher and the gel color of the alginate grains turns brighter (the orange color is almost gone). Gel formation is influenced by the pH of the solution. Gelatin gel formation is optimum at pH 3-7. Gel formation is faster when the pH is high, whereas if the pH is too low a slow gel is formed.

3. 6. Water Content

The moisture content of alginate grains gel is in the range of 91.6 - 93.7%. The results of analysis of variance at the 5% test level showed that the addition of locust bean gum did not give a significantly different effect on the moisture content of the alginate gel (Figure 5). The highest water content value at the addition of 40% locust bean gum is equal to 94.27% and the lowest water content of gel alginate gel is at the addition of 0% locust bean gum which is 93.23%.

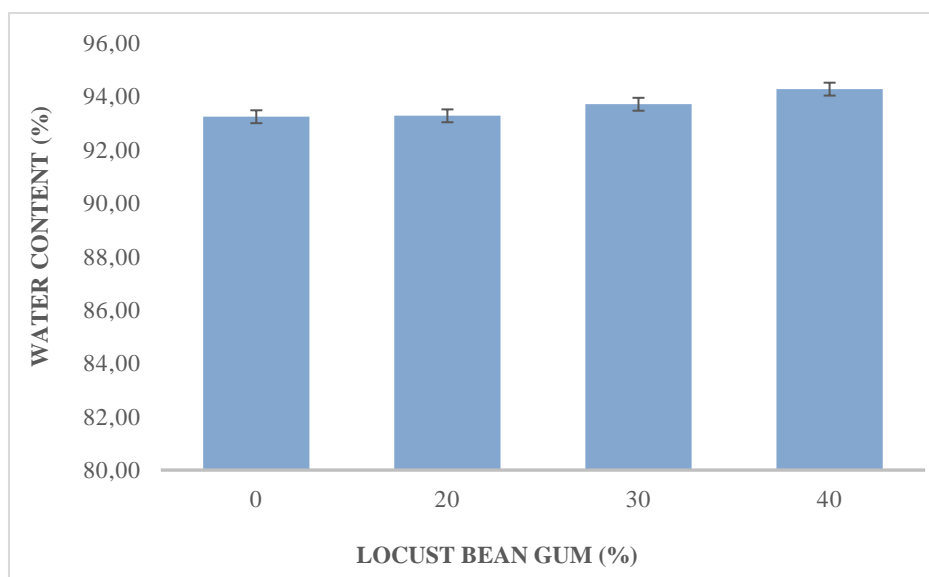


Figure 5. Effect of Adding Several Locust Bean Gum Concentrations to Water Content

The average yield of the water content of this study was lower than that of the value of water content of orange grains analogues which is ranging from 93-94%. The high water content can be caused by complex bonds of hydrocolloid material. In addition, alginate is a polymer with the ability to hold water very well so that the higher the purity of the alginate, the better the ability to hold water. The high water content also showed that the alginate gel in the previous study had more juicy properties when eaten than in this study.

3. 7. Ash Content

Ash content is a mixture of inorganic components or minerals contained in a food ingredient. Food consists of 96% inorganic materials and water, while the rest are mineral elements. The ash content can show the total minerals in a food ingredient.

The alginate gel ash content ranged from 0.33 to 0.6%. The results of analysis of variance at the 5% test level indicated that locust bean gum filling had no significant effect on the alginate gel ash content (Figure 6). The highest value of the ash alginate gel content at the addition of 40% locust bean gum is 0.6% and the lowest ash content is at the addition of 0% locust bean gum or control treatment that is equal to 0.27%.

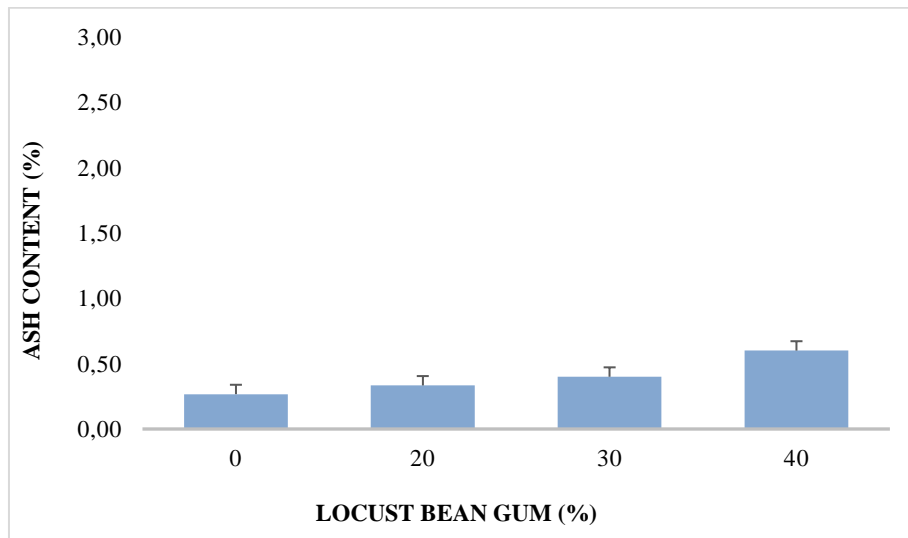


Figure 6. Effect of Adding Several Locust Bean Gum Concentrations to Ash Content

The more mineral content, the higher the ash content is. The results of the ash content analysis indicate that the higher the concentration of locust bean gum is used, the higher the value of the ash content. In addition, the content of CaCl_2 also plays a role in increasing the ash content.

4. CONCLUSIONS

Based on the results of the research performed, it can be concluded that the addition of 30% locust bean gum results in the best characteristics of the alginate gel with a viscosity value of 377 cP, and gel strength of 300.91 g/cm^2 .

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