Article

Glucomannan sponge: Effect of different amount of SLS and Sodium Hydroxide

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Abstract.
An attempt to increase the economic value of porang flour was made by utilizing it for making of sponge. The sponge was made by direct foaming of glucomannan solution with the addition of SLS and NaOH. Dried sponge were obtained through freezing-thawing process followed by drying. The aim of the work was to investigate the influence of the amount of SLS and NaOH on the cell size and swelling degree of the sponge. It was found that increasing amount of SLS and NaOH made the cell size of the sponge smaller. While there was no tendency for swelling degree according to the various amount of SLS, the increasing amount of NaOH caused in increasing the swelling degree.

Keywords: sponge, glucomannan, sodium laureth sulphate (SLS), sponge cell size, swelling degree.

EQUILIBRIUM Volume 3 No.1 July 2019
Online at http://equilibrium.ft.uns.ac.id

1. Introduction

Sponge or foam is a colloidal system in which air bubbles or gases are dispersed in solid or liquid substances. Flexible foam is widely used as household appliances such as dishwashers, makeup equipment, foam mattress fillers and many more. Foam or sponges are generally polyurethane, which is made from a mixture of polyols, toluene diisocyanate, $CaCO_3$, H_2O, melamine and coloring.

As a makeup equipment, sponges are used as blending tools to applicate moisturizer or foundation. In recent time a special kind of sponge was used to clean faces. This konjac sponge was named from the material for making it, konjac tuber. This tuber contains glucomannan, a polysaccharide composed of mannose and glucose [1].

The source of commercial glucomannan is konjac tuber (*Amorphallus konjac*) which grows in China and Japan. In Indonesia, porang tuber (*Amorphallus muelleri* Blume) was the source of glucomannan. One of the porang yellow tuber plantation is located in Madiun, East Java. Currently, porang tubers are exported to Japan and China in the form of chips. Increasing the economic value of porang can be done by using it as a basic ingredient in natural sponges.

Glucomannan is a polysaccharide consisting of 67% D-glucose and 33% D-mannose. According to Koswara [2], if the porang tuber slices observed under a microscope, it will be seen the glucomannan cells. Glucomannan cells are 0.5 - 2 mm larger 10-20 times than starch cells. According to Prasetya et al. [3], yellow porang flour contains 64.98% glucomannan; 6.8% water; 10.24% starch; and 17.33% is protein, fat fiber, ash and heavy metal (Cu). Yellow porang tuber is a potential source for making natural sponge for this high content of glucomannan.

Glucomannan sponges can be made by drying wet sponge of glucomannan gel. Gel of glucomannan was formed when glucomannan solution mixed with an alkaline solution accompanied by heating. The gel formed is an irreversible gel. Surfactant like *sodium laureth sulfate* (SLS) is needed in the process for making sponges to form cavities in glucomannan sponges [4]. Foam can be produced by stirring the material that causes the polysaccharide to become foam. Mechanical foam is produced by inserting gas into the solution. The mixing effect produces a very fine dispersion of gas bubbles in solution. In the early stages of mechanical foaming, when gas is trapped in a solution, gas bubbles may be round. If the volume of gas trapped in the solution increases, the gas bubbles can experience a transition from the spherical form to the polyhedral form. Foam pore size is usually in the range of 50–500μ [5] [6]. Because the potency of porang flour is quite large and the knowledge of processing porang flour in Indonesia is still low, so research on processing porang flour into a product innovation that has more value is needed. The influence of process conditions on the properties of sponges in the production of glucomannan sponges was less reported. The aim of the work was to investigate the influence of the amount of SLS and NaOH on the cell size and swelling degree of the sponge.

2. Materials and Methods

Materials.

Porang flour was bought from a reseller in Bekasi, West Java. Distilled water was obtained from Sub Laboratorium Kimia, Universitas Sebelas Maret. . Ethanol 96%, *Sodium Laureth Sulfate* (SLS) and *Sodium Hydroxide* (NaOH) were obtained from local market.

Preparation of sponges.

Two and a half grams of porang flour was dissolved in 100 mL of distilled water. After stirring for an hour, 0.25 g of SLS and 10 mL of 0.1 N NaOH solution were added with continuous stirring to form foam. The foam formed was left to stand for 12 hours before was soaked for 24 hours with 96% ethanol. A wet sponge was then obtained. The wet sponge is heated with an oven at a temperature of 100°C for 90 minutes and then was punched in the outer surface. Water separation was done by twice the refrigerator freezing process for 12 hours and thawing for 6 hours. Dry sponges are obtained after drying in the sun. Foams were made by preparing with different amount of SLS and volumes of NaOH solution.

Caracterization of sponges.

(i). Swelling ratio.

The welling ratio was performed by soaking the dry foam in a boiling water then then lifting it and leaving it until there is no more water dripping from the sponge. Wet sponges are weighed to determine the wet weight

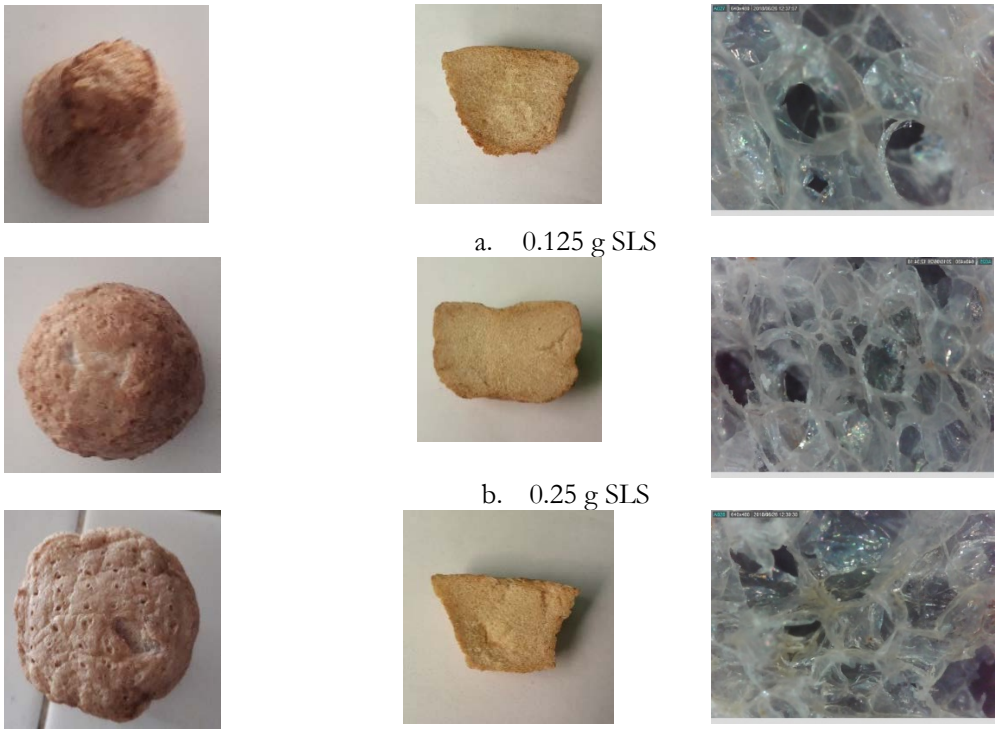
$$SR = \frac{weight\ of\ absorbed\ water}{weight\ of\ dry\ foam}\ x\ 100\ \%$$

(ii). The appearance of a sponge cavity.
The sponges were cut so it looks the cavities. Visual observations of sponge cell size were done by photographing using both digital photos and magnification using the Dinolite camera microscope.

3. Results and Discussion

3.1. Effect of the amount of SLS.

Dried glucomannan sponges have a hard texture. Observations are made on the appearance of sponges on the outside and inside. Observation of the outer part of the sponge includes color, while the observation on the inside is on the cavity. Observation of sponge cavities using digital photos and Dinolite camera microscopes with 230 magnifications. The results of observations on the sponge can be seen in Figure 1.



a. 0.125 g SLS

b. 0.25 g SLS

c. 0.372 g SLS

Figure 1. The appearance of the outer and inside part of glucomannan sponge for a different amount of SLS.

From Figure 1 it can be seen that all the sponge have light brown surface color. This color occurs due to the influence of the drying process in addition to the color of the porang flour itself. The cavities of the sponges differ as the different amount of SLS. An increase in the amount of SLS added to make the cavities of the sponge decrease. The cell size of the foam was estimated by 'Image J" software package. The mean diameter of the cavities for a different amount of SLS can be seen in Figure 3. The average diameter of the cavities was 0.1725, 0.1542 and 0.138 mm for the addition of SLS 0.125, 0.25 and 0.375 g, respectively.

a. 0.125 g b. 0.25 g c. 0.375 g

Figure 2. Pores of the sponges at different amount of SLS.

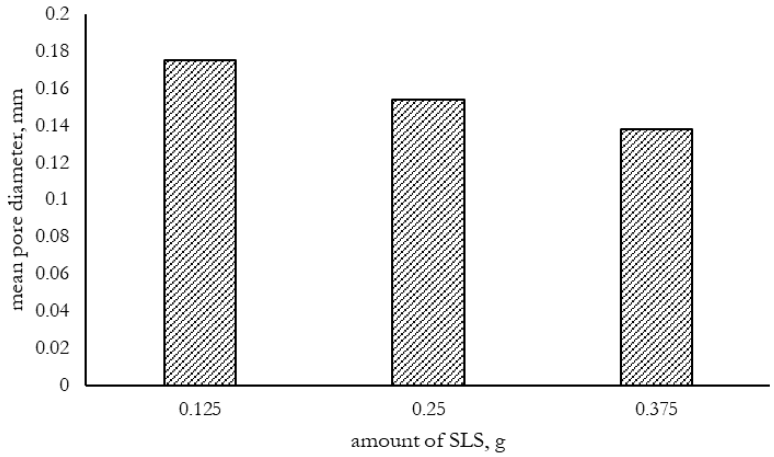


Figure 3. The average diameter of sponge cavities for various amount of SLS.

SLS is a surfactant and a foaming agent that facilitates the formation of foam. A surfactant, when present in small amounts, reduces the surface tension of a liquid (reduces the work needed to create the foam) or increases its colloidal stability by inhibiting coalescence of bubbles. Increasing in the amount of SLS would create more bubbles.

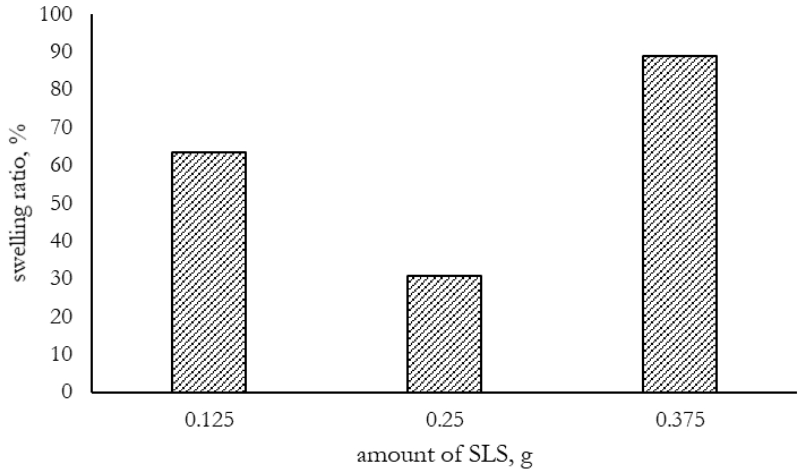
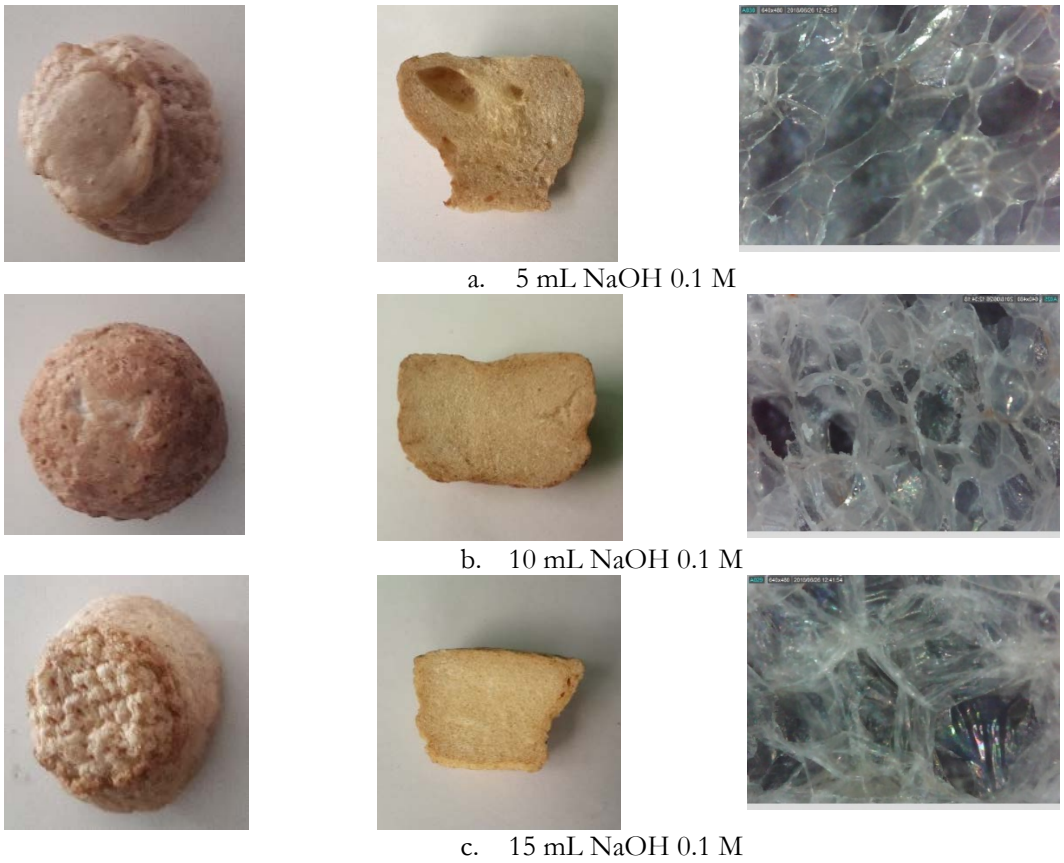


Figure 4. The swelling ratio for a different amount of SLS.

Dried glucomannan sponges would absorb water and expand when it is soaked in water. This swelling properties was influenced by the degree of crosslinking and the degree to which the polymer "likes" the solvent. The percentage of swelling degree for various amounts of SLS can be seen in Figure 4. The highest percentage of the swelling degree was 88.99% for the addition of 0.375 grams of sodium laureth sulfate. As SLS was not the factor that influence the degree of crosslinking, it may affect the degree to which the sponge likes water.

3.2. Effect of the amount of NaOH.

Figure 5. shows the effect of different amount of NaOH on the appearance of the sponge. Increasing quantity of NaOH made the cell sponge denser. NaOH promoted the deacetylation of glucomannan, resulting in the formation of the gel. Increasing NaOH favored interlinking of molecular chains by promoting the formation of a larger number of junction zones, thus producing tighter gel networks [7][8].



a. 5 mL NaOH 0.1 M

b. 10 mL NaOH 0.1 M

c. 15 mL NaOH 0.1 M

Figure 5. The appearance of the outer and inside part of glucomannan sponge for a different amount of NaOH.

The cell size of sponges differs when different amount of NaOH added as can be seen in Figure 6 and Figure 7. Sponge with higher addition of NaOH have a smaller cell size. The average diameter of the cavities was 0.1593, 0.1542, and 0.1428 mm for the addition NaOH 5, 10 and 15 mL, respectively.

a. 5 mL b. 10 mL c. 15 mL

Figure 6. Pores of the sponges at different amount of NaOH 0.1 M.

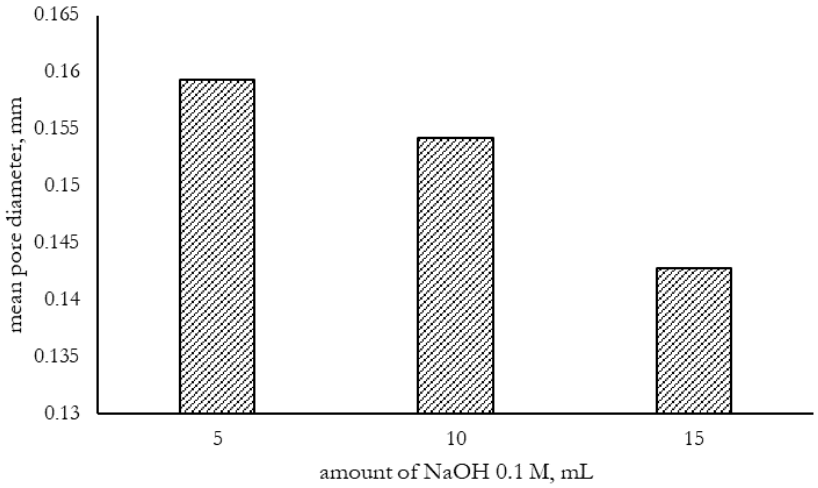


Figure 7. The average diameter of sponge cavities for various amounts of NaOH.

The expansion of sponges when it is soaked in water for a different amount of NaOH can be seen at Figure 8. The gel of glucomannan was formed by the deacetylation process in aid of alkalies. Increasing in the amount of NaOH made an increasing number of junction zones which means more interlinking the glucomannan chain.

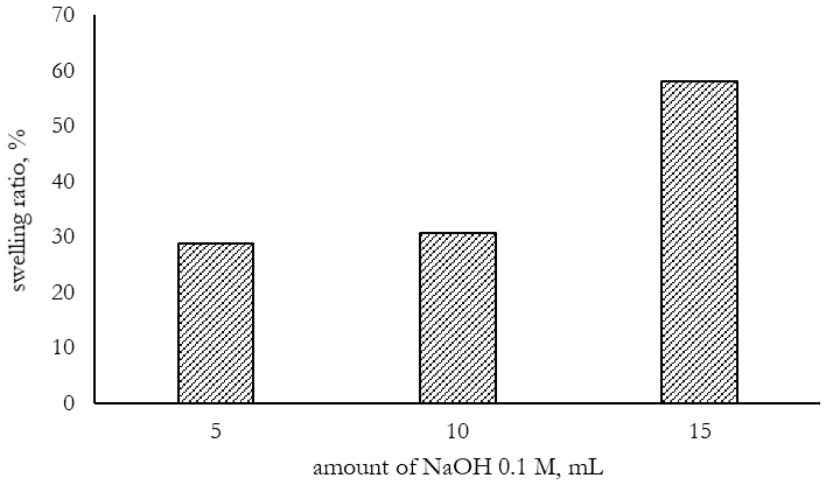


Figure 8. The swelling degree ratio for various amounts of NaOH.

Conclusions

Glucomannan sponges were successfully prepared by direct foaming of glucomannan solution with the addition of SLS and NaOH followed by freezing-thawing and drying. Increasing in the amount of SLS and NaOH makes the cell size of the sponge decrease. While the swelling degree didn't show any trend with the amount of SLS, an increase in NaOH made the swelling dgree increase.

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