

Gel Preparation from Modified Cassava And Sago Starch

Farah Salina Hussin¹, Abdul Manan Dos Mohamed,² Masniza Mohamed³, Rinani Shima Abdul Rashid⁴ and Nor Azam Abdul Rahman⁵

Food Technology Section, Universiti Kuala Lumpur, Malaysian Institute of Chemical and Bioengineering Technology, Vendor City, Taboh Naning, 78000 Alor Gajah, Melaka, Malaysia.

Abstract

The effect of time, temperature and NaOH concentration during cassava and sago starch modification was studied. Starch were treated at 40°C and 50°C respectively for 10, 20 and 30 minutes, with NaOH concentration of 0.1%, 0.5% and 1%, to differentiate and identify which treatment is effective for gel preparation. The purpose of these studies is to examine the properties of gel prepared from the modified starch, where it shows better results in swelling power, granule size and gel formation.

Keywords: starch modification, swelling power, gel formation.

1. Introduction

Starch, an α -D-glucan polymer, is produced in granules by higher plants. As the storage energy source of many seeds, roots and tubers, it is cheap and ubiquitous. Starch, as polymer of α -D-glucose, is readily digested and forms the major energy source in most diets. Starch also provides soluble macromolecules exhibiting properties typical of such materials, i.e. high viscosity, adhesion and surface coating. These properties are highly desirable in industry, thus making starch a versatile ingredient.

Sago and cassava starch are known to have high leaching and swelling abilities when cooked. This ability allows the application of both starches in expanded snack product made of starch-protein mixture. On the contrary, such leaching and swelling ability is rather restricted in a wheat starch system where the protein and lipid contents are higher. The mechanisms involved in maintaining the starch, that is amylose and amylopectin, within the deformed heated granules could be affected by the amount of proteins present in the granules and the viscoelastic properties of the granule envelope that helps retain the starch within the starch granules (Mohd Adzahan *et al.*, 2009).

2. Materials and methods

2.1 Starch modification

Native cassava starch and native sago starch were modified, by using alkaline treatment which involved sodium hydroxide (NaOH) solution as the modifying agent. In every 20% slurry of starch solution, 5 mL of NaOH from selected concentration was added.

During modification, the starch treated was placed inside a water bath at 40°C and 50°C, for 10, 20 and 30 minutes respectively. After that, observation on 2 layers of solution inside each beaker were done, where there were a layer of sediment starch and also supernatant. This sediment was washed, where distilled water was filled into the beaker, stirred until the solution was homogenous, and left for 30 minutes, in order to allow sediment formation. This washing process were repeated for multiple times. Once pH 7 was reached, the sediment starch was dried using a drying oven at 50°C for 24 hours. The dried sediment was ground using a marble mortar, until it turn to powder form.

The three samples selected for an upscale volume of modification were i) sago starch treated under 40°C and 0.1% NaOH concentration for 10 minutes, ii) sago starch treated under 40°C and 1% NaOH concentration for 10 minutes and iii) cassava starch treated under 40°C and 1% NaOH concentration for 30 minutes.

2.2 Gel preparation

An amount of 6 gram of modified starch was weighed, and mixed with 100 ml distilled water in a 250 mL beaker. The solution was cooked while continuously stirred, until a shiny and clear gelatinized form of starch was formed. Then it was left to 30°C for 24 hours, before used in further analysis.

2.3 Microscopic of Starch's Granule Size

An amount of 6 gram of starch (modified and native respectively) was dissolve in 100 ml beaker of distilled water, which made up into a 6% starch solution. The solution was gently stirred until homogenous. Then, by using a dropper, three drops from the 6% starch solution was dispersed on the microscopic glass slide, and it was left in room temperature for a few minutes. The granule size was evaluated using Light Microscope (Olympus BX 41) with 3 types of magnification power which is 5x, 10x and 40x.

2.4 Determination of Swelling Power.

Swelling power of the selected starch samples were determined in accordance to the method described by Leach et al. (1959) with modification for small volume of samples. An amount of 0.5 gram of selected starch was weighed and placed inside centrifuge tube, and the weight was recorded. After that, 20 ml of distilled water was filled inside the centrifuge tube and it was left at room temperature for 30 minutes.

After that, it was centrifuged at 3000 g for 15 minutes. Then, supernatant from the mixture was decanted carefully and the residue inside the centrifuge tube was weighed. The formula for swelling power calculation is :

$$\text{Swelling power} = \frac{W_2 - W_1}{\text{Weight of starch}} \quad (1)$$

2.5 Texture analysis

For textural profile analysis, starch gel were prepared from the selected starch samples. The 6% gel produced need to be cooled for 24 hours in room temperature, before being analyze. There are 6 parameters were evaluated by this textural profile analyzer (Stable Micro System Ltd.) which is gel hardness, gel cohesiveness, gel adhesiveness, gel gumminess, gel springiness and also gel resilience.

3. Results and discussion

3.1 Granule size

The granule size of native sago starch can be seen where the shape is round, with various size of area and length in parameters. The range of area is approximately from 5.4 sq μm for the smallest, and 50.3 sq μm as the largest. While the granule parameter varies from 8.2 μm as the shortest, to 25.1 μm as the longest.

For native cassava starch, its size is much more smaller, compared to native sago starch. Furthermore, the

distribution of its granule also were much closer to each other, compared to sago starch. The range of size for area of each granule varies from approximately 7.4 sq μm to 173.3 sq μm as the largest. While for the parameters, the range is from 9.7 μm as the shortest, to 55.5 μm as the longest.

While for modified cassava starch, the granule size seems to be much larger in term of its granule's size, and much longer in term of the granule's parameter. This is shown by increment in the range of its area, which is from 9 sq μm as the smallest, to 55.6 sq μm as the largest. Likewise, the range of parameter varies from 10.6 μm as the shortest, to 33.1 μm as the longest.

The same trend of data were found in modified sago starch (Figure 4.16), where the size of area is increase and the parameter of granules get longer. This were shown by the value of size, range from 29.8 sq μm as the smallest, to 149.2 sq μm as the largest. The parameter also shows increment in its range which is from 19.3 μm as the shortest, and 51.9 μm as the longest.

Through observation, granule size of 1% NaOH sago starch was way much larger than 0.1% NaOH sago starch. Therefore, it can be said that the concentration of NaOH used in modification played important role in granule swelling. This can be explained where NaOH as strong alkali breaks the intermolecular hydrogen bonds of starch granule, thereby enhanced its water solubility. As there is more water can be bound to the starch granule, the granules were swelled and increased in its size such as area and parameters (Yu and Rollings, 1987).

3.2 Swelling power

The trend of the chart in Figure 3.2 shows that as the concentration of NaOH in treated starch increased, the greater swelling power it has. This may be because when NaOH was added, some of the linkage between starch molecules break apart each other, therefore more space for free water to bound inside the starch molecule, potentially make it more expendable for swelling properties.

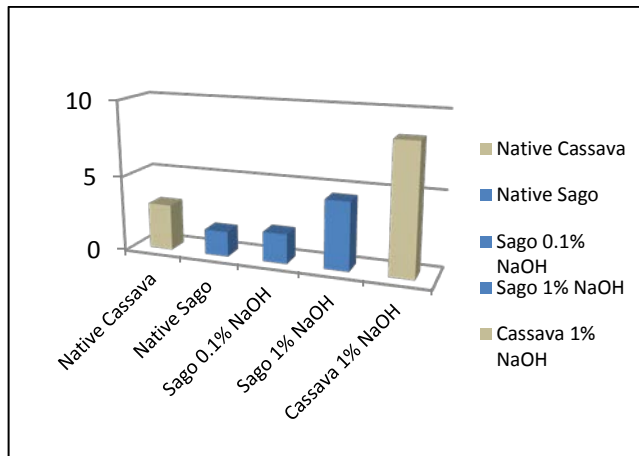


Figure 3.2 : Swelling power

3.3 Gel hardness

Based on Figure 3.3, modified sago starch gel treated with 1 % concentration of NaOH had a hardness of 4001 N, while the 0.1% NaOH modified sago starch gel had a hardness of 3268 N. This trend showed that the hardness was greater, when the NaOH concentration was higher. As for the native cassava starch gel, it has a hardness of 1409 N, while for its 1% NaOH modified starch gel, the hardness increased, with value of 3166 N.

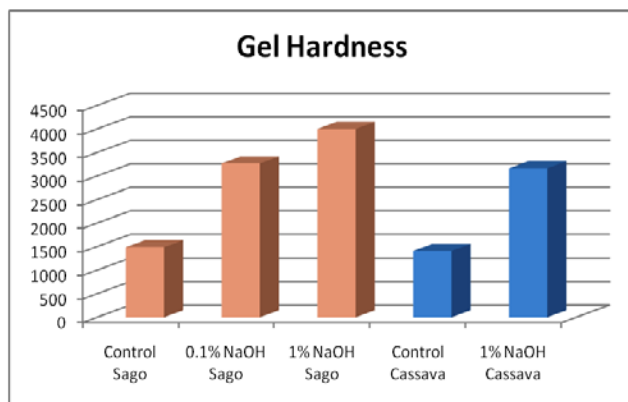


Figure 3.3: Gel hardness

3.4 Gel gumminess

Based on the results in Table 4.9, mathematically, the product of force (in Newton) x Cohesiveness (no units) should have a unit of force. However, according to the originators of the method, there are no units for this parameter. Native sago starch gel had a gumminess value of 742, while the gumminess value for 0.1% NaOH sago

starch gel was 1538 and 1% NaOH starch gel gumminess was 3130. For native cassava starch gel, the gumminess value was 933, while 1% NaOH cassava starch gel gumminess was 3620. The gumminess increased when the concentration of NaOH used during starch modification was greater (Figure 3.4).

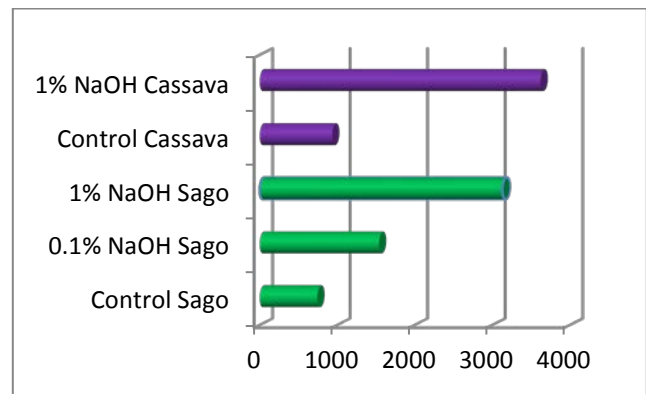


Figure 3.4 : Gel gumminess

4. Conclusions

The result of this study show that time and temperature during starch modification do effect starch physical attributes such as color and the duration it take for sediment to form during settling process. Moreover, the concentration of sodium hydroxide (NaOH) as the alkaline modifying agent influence the swelling abilities of the starch, which induce the granule size in its area and parameters. Besides, difference in concentration of NaOH used were also cause the gel prepared shows various result in the gel hardness and gel formation.

References

- [1] N. Mohd Adzahan, D. Mat Hashim, K. Muhammad, R. Abdul Rahman, Z. Ghazali, K. Hashim (2009). Pasting and leaching properties of irradiated starches from various botanical sources. *Int. Food Res. J.*, 16, pp. 415–429.
- [2] Leach, H.W., McCowen, L.D. & Schoch, T.J. (1959). *Cereal Chem.*, 36, pp.534.
- [3] Yu, L.-P., & Rollngs, J. E. (1987). Low angle laser light scattering aqueous size exclusion chromatography of polysaccharides: Molecular weight distribution and polymer branching determination. *Journal of Applied Polymer Science*, 33, pp.1909–1921.