The effect of edible coating application based on cassava starch and calcium chloride concentration on the quality of orange sweet potatoes french fries

R Isnaini¹, M Nurminah¹,²* and Z Lubis¹

¹Department of Food Science and Technology, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.
²Centre for Tubers and Roots Crop Study, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.

E-mail: *miminurminah@usu.ac.id or mimisinaga@yahoo.co.id

Abstract. French fries is snack which usually made from potatoes with the first frying treatmen and then frozen. Orange sweet potatoes can also proceed to become French fries as diversifying food form. This study used two factors, the concentration of cassava starch (CCS): (0.5%, 1.0%, 1.5%) and the concentration of calcium chloride (CCl₂): (0.5%, 1.0%, 1.5%, 2.0%). The best edible coating was from cassava starch concentration of 0.5% and calcium chloride concentration of 2.0% of French fries.

1. Introduction
Sweet potato is one of the main carbohydrates sources in Indonesia besides rice, corn and cassava. Sweet potato has high productivity. Based on several studies, sweet potato has health benefits like controlling the increase in blood sugar levels in diabetics, and can maintain memory (anti-senile). Sweet potato is also rich in fibre, complex carbohydrates, and low calories. Sweet potato has other advantages, such as containing of vitamin B6 and folic acid, which is needed to optimize the brain work [1]. Sweet potato has a potential to be developed for many food consumption. French fries are snacks which prioritize in appearance, colour, and shape. By frying as the preliminary cooking of this snack and then freeze it, the preparation for consumption is faster and easier. Sweet potatoes can also be processed into French fries as a form of food diversification development. Of course the appearance, colour, shape, and taste are different from French fries potatoes. Tubers which are processed by frying will usually cause problems in the change of colour due to browning reactions. In addition, tubers will absorb oil during frying so that it affects the appearance become oily and the texture is not crispy [2]. To overcome this problem the authors made two additional steps to make French fries; first the application of cassava starch edible coating which will coat the material surface. The second step was immersion in calcium chloride solution, where calcium will form bonds with pectate to calcium pectate which is insoluble in water so that the material texture is still maintained [3].

2. Material and methods
The research was conducted at Universitas Sumatera Utara, from October- December 2018. Materials used were orange sweet potatoes Beta 2 varieties and cassava were purchased from Pancur Batu, Medan,
Indonesia. Other ingredients were glycerol, CMC, ascorbate acid, calcium chloride, and aquades. The processes of cooking orange sweet potatoes French fries were washing the orange sweet potatoes, then peeling it and washing it again. After that, the sweet potatoes were cut in a long form with 1 cm thick. Then, the sweet potato chop was blanched in 100°C for 2 minutes then removed and chilled. Calcium chloride (0.5%, 1.0%, 1.5%, 2.0%) was dissolved into water and the sweet potatoes chop was put into the solution and soaked for 20 minutes. Edible coating was done by putting the material to the edible coating solution with various starch concentrations (0.5%, 1.0%, and 1.5%) for 10 seconds and then chilled. The first frying of sweet potatoes was in 150°C for 2 minutes; then removed, drained, and chilled. The sweet potatoes chop was then pack, put it at -20°C, 18 hours. After that, fry the sweet potatoes chop in oil at 160°C temperature for 3 minutes.

Analysis consists of moisture content [4], ash content [5], fat content [4], colour index [6], and texture score [7] and De Garmo method [8].

3. Results and discussion
This study shows that edible coating application based on cassava starch in cooking French fries gave an effect to the water content and fat content. The effect of edible coating application based on cassava starch in cooking French fries in the observed parameter is shown in Table 1.

| Parameters            | Concentration of cassava starch (CCS) | CCS1 | CCS2 | CCS3 |
|-----------------------|--------------------------------------|------|------|------|
| MC (%)                | CCS1                                 | 26.822 | 26.688 | 26.299 |
| AC (%)                | CCS2                                 | 1.752 | 1.731 | 1.719 |
| FC (%)                | CCS3                                 | 17.948 | 18.365 | 19.190 |
| CI (°Hue)             | CCS1                                 | 63.162 | 63.142 | 63.063 |
| TS                    | CCS2                                 | 3.054 | 3.029 | 3.038 |

Note : * = significant, in = not significant, MC=Moisture Content, AC=Ash Content, FC=Fat Content, CI=Colour Index, TS=Texture Score

This study shows that calcium chloride concentration in cooking French fries gave effects on parameters.

| Parameters            | Concentration of calcium chloride (CCC) | CCC1 | CCC2 | CCC3 | CCC3 |
|-----------------------|----------------------------------------|------|------|------|------|
| MC (%)                | CCC1                                   | 23.506 | 25.994 | 27.518 | 29.393 |
| AC (%)                | CCC2                                   | 1.351 | 1.583 | 1.901 | 2.101 |
| FC (%)                | CCC3                                   | 19.370 | 18.871 | 18.129 | 17.634 |
| CI (°Hue)             | CCC1                                   | 60.827 | 62.836 | 63.791 | 65.036 |
| TS                    | CCC2                                   | 2.795 | 2.872 | 3.205 | 3.288 |

Note : ** = very significant, = significant

3.1. Moisture content
The lowest moisture content was from French fires which was made using cassava starch concentration of 1.5% and the highest moisture content was on French fries with cassava starch concentration of 0.5%. Immersion treatment in edible coating solution to the material caused surface layer so that the water was difficult to get out when fried [9].
Figure 1. Concentration of cassava starch (CCS) on moisture content

Figure 2 showed that calcium chloride concentration had effect on moisture content. The highest moisture content was at the immersion in CaCl₂ solution (2.0%). The lowest moisture content was at calcium chloride concentration of 0.5%. Calcium on CaCl₂ will be formed on pectate which will add protopectin so that strengthen the function of pectin compound as adhesive bonds between cells which caused the cell walls become stronger so that it can maintain the water in cassava chops [10].

Figure 2. Concentration of calcium chloride (CCC) on moisture content

3.2. Ash content

According to Table 1, concentration of cassava starch had no effect on the French fries ash content. The ash content was similar across the different concentration of cassava starch, ranging from 1.719%-1.752% and thus the LSR (Least Significant Range) test was discontinued. Concentration of calcium chloride had effect on ash content. The highest ash content was found in the French fries with the concentration of calcium chloride of 2.0%. Concentration of calcium chloride of 0.5% had the lowest ash content. With the addition concentration of calcium chloride on material will increase the amount of minerals which will enter the tissue [10].
3.3. Fat content

We can see in Figure 4 concentration of cassava starch had effect on fat content. The lowest fat content was from edible coating with cassava starch concentration of 0.5%, while the highest French fries fat content was from cassava starch concentration of 1.5%. The increasing of the fat content was due to starch will create thin layer on cassava surfaces which will prevent the evaporation from sweet potatoes during frying so that empty cavity and fat absorbed on the sweet potatoes will be decreased [11].

As we can see in Figure 5, concentration of calcium chloride can make effect on fat content. The highest French fries fat content was from calcium chloride concentration of 0.5%, while the lowest fat content was from calcium chloride concentration of 2.0%. The higher of calcium chloride concentration, caused sweet potatoes have stronger compound structure and gave an effect to the texture to become harder. The hard texture can prevent the water evaporation when fried so that the forming of crust happened faster, and caused the amount of oil absorbed will be lower.
According to Table 1, cassava starch concentration had no a significant effect on French fries colour index. Colour index was similar across the different concentration of cassava starch, ranging from 63.063°Hue-63.162°Hue and thus the LSR (Least Significant Range) test was discontinued. The highest colour index was found in the French fries with calcium chloride concentration of 2.0%, while calcium chloride concentration of 0.5% created the lowest colour index. °Hue value which reach 90° would create the reddish yellow product [6].

According to Table 1, cassava starch concentration had no a significant effect on French fries texture score. Texture score was similar across the different concentration of cassava starch, ranging from 3.029-3.054 and thus the LSR (Least Significant Range) test was discontinued. The highest French fries texture score was from calcium chloride concentration of 2.0%, while the lowest texture score was from calcium chloride concentration of 0.5%. The higher calcium chloride concentration, increased the value of texture score. This was due to Ca$^{2+}$ ion formed salt with carbonyls from galakturonat acid, so the cross bond will happen between those carbonyls. If there are a lot of cross
bond formed, the pectin compound formed will be difficult to dissolve and the texture will be harder [12].

![Graph showing texture score vs calcium chloride concentration (CCC)](image)

**Figure 7.** Concentration of calcium chloride (CCC) on texture score.

The best edible coating was from cassava starch concentration of 0.5% and calcium chloride concentration of 2.0% of French fries.

4. Conclusions

French fries with edible coating application based on cassava starch with various cassava starch concentration resulted in significant differences in terms of water and fat contents. Immersion treatment in calcium chloride with various concentrations gave significant difference effect in regard to the moisture, fat, and ash content, colour, and texture score. The best edible coating was cassava starch concentration 0.5% and calcium chloride concentration 2.0% of French fries.

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