

Characteristics of french fries from cocoyam (*Xanthosoma Sagittifolium*) using various edible coating and concentration of calcium chloride (CaCl_2)

L Hudi, F A Ismayanti, S R Nurbaya

Program Studi Teknologi Hasil Pertanian, Universitas Muhammadiyah Sidoarjo, Jl. Raya Gelam No. 250 Candi, Sidoarjo, Jawa Timur, Indonesia

E-mail: lukmanhudi@gmail.com

Abstract. French fries is one of the most favourite foods, usually made of potato. Cocoyam has similar characteristics with potato, so it may substitute potato, as it price much cheaper than potato. This study aims to determine the effect of various edible coating (CMC, maltodextrin, and carrageenan) and calcium chloride (CaCl_2) concentration (0%, 1%, 2%) on characteristics of cocoyam french fries. Randomized block design that arranged as factorial was used in this experiment. The difference between the mean values were analyses using Tukey test ($p < 0.05$). The results of this study showed that kinds of edible coating and concentration of calcium chloride significantly influenced texture and texture organoleptic characteristics of new cocoyam french fries. The best treatment was obtained from concentration of calcium chloride 0% and maltodextrin as edible coating. French fries from this treatment had moisture content 39.00%, hardness value 17.67 cm/g sec, and weight loss value 36.47 g. On the organoleptic characteristics had score of taste 4.90 (like slightly), aroma 5.60 (like), color 6.20 (like) and texture 4.95 (like slightly). Based on the results, french fries from cocoyam that coated with maltodextrin had preferred characteristics.

1. Introduction

Utilization of the cocoyam for now in the community is still lacking. Some people make cocoyam as an alternative staple food, usually only boiled, steamed, or fried. Cocoyam can be improved to another product. It can used as an alternative raw material to others tuber (i.e potato, sweet potato, and yam) [1]. French fries are usually made of potatoes, fried in half-cooked, and then freeze [2]. Cocoyam has a greater carbohydrate content, about 70-88% [3, 4]. Besides that, cocoyam contained other nutrition such as: fat, protein, flavonoid, and saponin compound [5]. Cocoyam also has low glycemic index value [6]. It potential as antihyperglycemic food ingredient. Carbohydrate sources with low glycemic index are needed as an effort to control degenerative diseases like diabetes mellitus because carbohydrate absorption will be very slow, causing a slow and gradual increase in blood glucose and insulin [6]. With the amount of this carbohydrate content and the beneficial of nutrition content, cocoyam can be used as a substitute ingredient for french fries. It will increase the value of cocoyam in the community.

French fries from potatoes certainly has different taste with french fries made from cocoyam. The problem which found in cocoyam french fries are the products looks greasy and not crisp. Soaking in CaCl_2 solution and use of edible coating can improve crispness and reduce oil absorption [2]. Using edible coating to french fries can get any benefits, such as: preventing in change texture quality, better taste, better sensory properties, and decrease



frying loss [7, 8, 9]. This study aims to determine the effects of various edible coatings and calcium chloride (CaCl_2) concentration on the characteristics of cocoyam french fries.

2. Experimental Method

Randomized block design that arranged as factorial (three replication) was used in this experiment with two factor, various type of edible coating (CMC, maltodextrin, and carrageenan) and calcium chloride (CaCl_2) concentration (0%, 1%, 2%) The difference between the mean values were analysed using HSD 5%. Cocoyam (var. Belitung) purchased at traditional market in Sidoarjo. Cooking oil, CaCl_2 , CMC, maltodekstrin, carrageenan, sorbitol powder purchased at traditional market in Surabaya.

Cocoyam was peeled and soaked in water to prevent browning. Then washing and cutting with size 1x5 cm (during cutting soaked in water). Cocoyam was washed again to remove mucilage and soaked in 1% salt solution for 20 minutes, drained, and washed again with water. Furthermore, cocoyam soaked with treatment of calcium chloride (CaCl_2) concentration (0%, 1%, 2%) for 20 minutes. It was steam blanched at temperature 85 °C for 3 minutes. Then it was pre-frying at 135 °C for 1 minute. After that, it was dipped in an edible coating solution for 10 seconds. Edible coating solution made from various edible coating (maltodextrin, CMC, carrageenan), water, and sorbitol. 1 g of each type of edible coating (CMC, maltodextrin, carrageenan) was weighed and dissolved in 200 ml water. Then sorbitol 1% (v/v) was added. The ingredients was mixed until homogeneous.

Coated cocoyam was packed in plastic, each treatment was stored in the freezer for 18 hours. After that, the freeze cocoyam was removed from the freezer. The freeze cocoyam was thawed in ambient temperature Then the cocoyam was fried until cooked at 160°C for 3 minutes. The analysis of cocoyam french fries were include: moisture content, texture (hardness), weight loss, and organoleptic test (color, flavor, aroma, texture).

Moisture content

Moisture content was analyzed using gravimetric method [10].

Organoleptic evaluation

Organoleptic evaluation was analyzed using panelists [11]. Samples (cocoyam french fries) were tested by 10-member. Untrained panel consisting of graduate students from Agricultural Product Technology Department at Universitas Muhammadiyah Sidoarjo. Panelists were asked to evaluate random samples for taste, aroma, color, and texture acceptability on a seven-point hedonic scale (7=like very much, 6=like, 5=like slightly, 4=neutral, 3=slight dislike, 2=dislike, 1=very much dislike).

Texture (hardness) analysis

Hardness of cocoyam french fries were evaluated with penetrometer (PNR 6) [9]. The needle (31,5 g) was used in this analysis. Penetration time of needle to sample was determined (10 s). The needle depth was measured in millimeters.

Weight loss analysis

Weight loss was determined by measuring the weight of the french fries before coating (A) and the weight of the coated french fries (B) [9]. Calculations of the weight loss were as follows:

$$\text{Weight loss} = \left(\frac{A-B}{A} \right) \times 100$$

3. Results and Discussion

Table 1. Moisture content of cocoyam french fries with treatment concentration of CaCl_2 and various type of edible coating

Treatment	(%)
E1 (CMC)	44.94 B
E2 (Maltodextrin)	37.61 A
E3 (Carrageenan)	40.67 Ab

The values in the columns followed by different letters show significant difference ($p < 0.05$)

Maltodextrin edible coating showed the lowest moisture content (37.61%) and significantly different with CMC (Table 1). It because maltodextrins have low hygroscopicity so that the moisture content in this material is also low [1].

Table 2. Texture value of cocoyam french fries with treatment concentration of CaCl_2 and various type of edible coating (cm /g sec).

Concentration of CaCl_2	Various type of edible coating		
	1 (CMC)	2 (Maltodextrin)	3 (Carrageenan)
1 (0%)	12,70 aa	17,67 bb	11,55 aa
2 (1%)	15,00 aa	13,57 aa	9,88 aa
3 (2%)	12,98 aa	12,43 aa	18,28 bb

The values in the columns followed by different letters show significant difference ($p < 0.05$)

In table 2 the treatment of CaCl_2 2% and carrageenan as the edible coating gives the highest of texture value (18.28 cm /g second) and it significantly different with the concentration of CaCl_2 1% and 2%. This is because CaCl_2 is a salt with strong electrolyte, so easily soluble in water and Ca ions easily absorbed into tissues that will lead to stronger cell walls, which will inhibit hydrolysis [7]. This result is accordance with literature [7]. The higher concentration of CaCl_2 , the higher texture value of french fries. This is due to the higher concentration of CaCl_2 , the more crosslinks between calcium and pectin are formed so that at the time of further processing the cell wall's rigidity can be maintained and after frying process the product will be more crunchy [7].

While the treatment of CaCl_2 0% and maltodextrin as edible coating gives high value of texture because maltodextrin has high solubility, has fast dispersion properties, able to form film, able to form texture, has low hygroscopicity, has low browning reaction, capable of inhibiting the crystallization process and has a strong binding power [1]. Maltodextrin is an effective type of edible coating for producing crispy french fries. Maltodextrin may be used as a thickening and feeding agent and has the ability to form stable films during frying. When frying, the presence of a film coating on the surface of the material will causing the oil difficult to entry the material. This suggests that the decreasing permeability of films makes it difficult to penetrate the film layer so that the french fries produced are crispness [2].

Table 3. Weight loss value of of cocoyam french fries

Treatment (Concentration of CaCl_2 : Edible Coating)	Weight loss after pre frying (g)	Weight loss after second frying (g)
C1E1 (CaCl_2 0% : CMC)	18.23	35.33
C1E2 (CaCl_2 0% : maltodextrin)	23.90	36.47
C1E3 (CaCl_2 0% : carrageenan)	16.03	32.57
C2E1 (CaCl_2 1% : CMC)	22.87	39.57
C2E2 (CaCl_2 1% : maltodextrin)	19.20	39.67
C2E3 (CaCl_2 1% : carrageenan)	23.87	40.97
C3E1 (CaCl_2 2% : CMC)	23.73	38.77
C3E2 (CaCl_2 2% : maltodextrin)	20.47	43.00
C3E3 (CaCl_2 2% : carrageenan)	17.57	32.33

The weight loss also affects hardness values. The loss of some free water in solid material causes the change of texture properties from soft to the hard. The use of heat in the process of cooking materials affect the nutritional value of food. Dry processing (frying and roasting) can reduce the weight of fresh food more than wet processing (steaming and boiling). This is because in the wet processing, the temperature used is 90 °C - 100 °C while in dry processing the temperature is used more than 100 °C [11].

Organoleptic Characteristics

Table 4. The mean taste value of cocoyam french fries with treatment concentration of CaCl_2 and various type of edible coating

Treatment (Concentration of CaCl_2 : Edible Coating)	Mean	Total Rank	Notation
C1E1 (CaCl_2 0% : CMC)	4.60	46.00	ns
C1E2 (CaCl_2 0% : maltodextrin)	4.90	49.00	ns
C1E3 (CaCl_2 0% : carrageenan)	4.40	44.00	ns
C2E1 (CaCl_2 1% : CMC)	3.60	36.00	ns
C2E2 (CaCl_2 1% : maltodextrin)	6.70	67.00	ns
C2E3 (CaCl_2 1% : carrageenan)	6.05	60.50	ns
C3E1 (CaCl_2 2% : CMC)	4.30	43.00	ns
C3E2 (CaCl_2 2% : maltodextrin)	6.40	64.00	ns
C3E3 (CaCl_2 2% : carrageenan)	4.05	40.50	ns

Critical value: 20.15; ns: not significant

The highest score of preference (6.70 – like very much) is the treatment of CaCl_2 1% and maltodextrin as edible coating but not significantly different with other treatment (Table 4). This is because each edible coating has no taste so that the flavor is relatively similar. According to [13], the taste is influenced by several factors: chemical compounds, temperature, concentration and interaction with other components of taste.

Table 5. The mean aroma value of cocoyam french fries with treatment concentration of CaCl_2 and various type of edible coating

Treatment (Concentration of CaCl_2 : Edible Coating)	Mean	Total Rank	Notation
C1E1 (CaCl_2 0% : CMC)	5.50	55.00	ns
C1E2 (CaCl_2 0% : maltodextrin)	5.60	56.00	ns
C1E3 (CaCl_2 0% : carrageenan)	4.80	48.00	ns
C2E1 (CaCl_2 1% : CMC)	5.65	56.50	ns
C2E2 (CaCl_2 1% : maltodextrin)	5.25	52.50	ns
C2E3 (CaCl_2 1% : carrageenan)	5.40	54.00	ns
C3E1 (CaCl_2 2% : CMC)	3.80	38.00	ns
C3E2 (CaCl_2 2% : maltodextrin)	4.75	47.50	ns
C3E3 (CaCl_2 2% : carrageenan)	4.25	42.50	ns

Critical value: 20.15; ns: not significant

The highest score of aroma preference (5.65 - like) is the treatment of CaCl_2 1% and CMC as edible coating but not significantly different with other treatments (table 5).

Table 6. The mean color value of cocoyam french fries with treatment concentration of CaCl_2 and various type of edible coating

Treatment (Concentration of CaCl_2 : Edible Coating)	Mean	Total Rank	Notation
C1E1 (CaCl_2 0% : CMC)	5.05	50.50	ns
C1E2 (CaCl_2 0% : maltodextrin)	6.20	62.00	ns
C1E3 (CaCl_2 0% : carrageenan)	5.50	55.00	ns
C2E1 (CaCl_2 1% : CMC)	4.75	47.50	ns
C2E2 (CaCl_2 1% : maltodextrin)	5.15	51.50	ns
C2E3 (CaCl_2 1% : carrageenan)	5.20	52.00	ns
C3E1 (CaCl_2 2% : CMC)	4.00	40.00	ns
C3E2 (CaCl_2 2% : maltodextrin)	4.50	45.00	ns
C3E3 (CaCl_2 2% : carrageenan)	4.65	46.50	ns

Critical value: 20.15; ns: not significant

The highest score of color preference (6.20 - like) is the treatment of CaCl_2 0% and maltodextrin as edible coating but not significantly different with other treatment (Table 6). Giving CaCl_2 1% improves crispness and color, while edible coating from maltodextrin gives a better appearance on french fries [2].

The highest score of texture preference (7,55 - very like) is the treatment of CaCl_2 1% and carrageenan as edible coating (Table 7). It not significantly different with treatment of CaCl_2 1% and maltodextrin as edible coating (6.35 - like) but significantly different from other treatments.

The texture and crispness of cocoyam french fries also influenced by the interaction between edible coating type and CaCl_2 added. According to [13], the concentration of CaCl_2 1.5% with steam blanching method resulted in moisture content 61.38%, ash content 1.92%, fat

content 16.14% and organoleptic test including: color (golden yellow), aroma (slightly strong-strong), taste (rather sweet - sweet), texture (rather crisp - crispness), and preference (rather like – like). In another study [2], concentration of CaCl_2 1.5% and maltodextrin had moisture content 32.58%, fat content 15.17%, ash content 1.79%, and organoleptic test of texture (crisp), color (gold) and taste (rather sweet).

Table 7. The mean texture value of cocoyam french fries with treatment concentration of CaCl_2 and various type of edible coating

Treatment (Concentration of CaCl_2 : Edible Coating)	Mean	Total Rank	Notation
C1E1 (CaCl_2 0% : CMC)	4.80	48.00	ab
C1E2 (CaCl_2 0% : maltodextrin)	4.95	49.50	ab
C1E3 (CaCl_2 0% : carrageenan)	4.65	46.50	ab
C2E1 (CaCl_2 1% : CMC)	3.75	37.50	a
C2E2 (CaCl_2 1% : maltodextrin)	6.35	63.50	bc
C2E3 (CaCl_2 1% : carrageenan)	7.55	75.50	c
C3E1 (CaCl_2 2% : CMC)	4.10	41.00	a
C3E2 (CaCl_2 2% : maltodextrin)	4.85	48.50	ab
C3E3 (CaCl_2 2% : carrageenan)	4.00	40.00	a

The values in the same columns followed by different letters show significant difference ($p < 0.05$)

Table 8. The value of each treatment based on the calculation of the best treatment

Treatment	Moisture content	Weight loss	Texture Analysis	Taste	Aroma	Color	Texture	Result
C1E1	43.50	35.33	12.70	4.60	5.50	5.05	4.80	0.47
C1E2	39.00	36.47	17.67	4.90	5.60	6.20	4.95	0.70**
C1E3	41.50	32.57	11.55	4.40	4.80	5.50	4.65	0.34
C2E1	44.67	39.57	15.00	3.60	5.65	4.75	3.75	0.34
C2E2	35.99	39.67	13.58	6.70	5.25	5.15	6.35	0.68
C2E3	39.33	40.97	9.88	6.05	5.40	5.20	7.55	0.58
C3E1	46.67	38.77	12.98	4.30	3.80	4.00	4.10	0.50
C3E2	37.83	43.00	12.43	6.40	4.75	4.50	4.85	0.45
C3E3	41.17	32.33	18.28	4.05	4.25	4.65	4.00	0.46

The best treatment is cocoyam french fries with treatment of CaCl_2 0% concentration and maltodextrin type as edible coating (Table 8).

4. Conclusion

- The interaction of CaCl_2 with edible coating type has significant effect on texture and texture organoleptic of cocoyam french fries. The type of edible coating has significant effect on moisture content and texture organoleptic of cocoyam french fries.
- The best treatment was obtained from CaCl_2 0% with maltodextrin edible coating with moisture content 39.00%, texture 17.67 cm /g sec, the weight loss 36.47 g, and the organoleptic properties including: taste 4.90 (like slightly) , aroma 5.60 (like), color 6.20 (like) and texture 4.95 (like slightly).

5. Acknowledgements

Thanks to the laboratory of Agricultural Product Technology, Faculty of Agriculture, Universitas Muhammadiyah Sidoarjo which has facilitated this research.

6. References

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