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Application of iota and kappa carrageenans to traditional several food using modified cassava flour

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Abstract. Carrageenan has been known well as hydrocolloids that forming viscous dispersions and gels when dispersed in water. The carrageenan has not been widely applied to traditional foods. Therefore, the aim of this research was to determine the effect of kappa and iota carrageenans in traditional food models using modified cassava flour, sugar, and coconut milk. The textural properties, i.e. hardness, cohesiveness, springiness and adhesiveness have been measured using texture analyzer. The study indicated that traditional food models added kappa carrageenan at 2% generated remarkably higher in the hardness, cohesiveness, and springiness than those added iota carrageenan. On the other hand, the reserve result were found in the adhesiveness parameter. As conclusion, kappa carrageenan scan be potentially used for producing traditional foods based on the hard-texture-oriented foods whereas iota carrageenan can be used for the traditional foods with better adhesiveness.

Key word: Iota, kappa, carrageenan, texture.

1. Introduction

Modified cassava flour is a product derived from cassava flour that uses the principle of modifying cassava cells in fermentation [3] Modified cassava flour almost similar colour and texture like wheat flour. However, modified cassava flour has no gluten, being different from wheat, rye, barley and oat[5]. It is difficult to form elastic and chewy dough by using modified cassava flour, because only wheat gluten possesses the ability to form three-dimensional network during dough formation [20]. Generally, modified cassava flour is used for making noodles, bakery, cookies with intermediate moisture food in traditional food [16].

Traditional foods modified cassava flour play important role in local identity, consumer behavior, and the transfer of cultural heritage for future generations[1] .Popularly producing of traditional food was semi-moist food (intermediate moisture food). Intermediate moisture food can reduce to a level where most microorganisms cannot grow. Intermediate moisture food has water activity 0.65-0.90 with moisture content of 15-40% [17]. The storage affects texture of intermediate moisture food, so it will get harder along its shelf life because of decreasing in moisture content by evaporation. The texture of the traditional foods are influenced by the gluten-free content resulting from modified cassava flour and water content during its shelf life. Therefore, need to stabilizer agent such as carrageenan to aid modified cassava flour dough more springy and binding water in dough.

Carrageenan has been known one of the types of hydrocolloids that form viscous dispersions or gels when dispersed in water. Carrageenan is a water soluble sulphated polysaccharide extracted from red seaweed (Rhodophyta). Generally, carrageenan consist of sulphate ester of galactose and 3,6-anhydrogalactose polysaccharides, and D-galactose residues linked alternately in a α-1,3 and β-1,4 bonds [21]. They classified based of natural polysaccharides as kappa (k-), iota (i-) and lambda (λ). Kappa (k-) and iota (i-) has been used in this experiment because of having the ability to form thermo-reversible gels in the presence of gel-promoting cations [10]. K and i-carrageenans are widely used in the food industry for improving the texture and microstructure of gels [23]. Kappa is used for thickening, water-binding, and gelling. On the other hand, the iota shows viscoelastic properties to make a model gelled food system [2] .The use of them in concrete preparation could result in a high compressive strength, flexural strength, and impact toughness [11]. Carrageenan mainly used in meat and dairy product [21].

The formulation of the research in food products can be effective in dough texture. Carrageenan have a group of natural linear sulfated polysaccharides showing the rheological properties in solid such as thickening and gelling. The use of carrageenan has been reported to be high compressive impact toughness and flexural strength [11]. The addition of carrageenan to food products containing coconut milk and sugar, showed increasing of the viscosity of the coconut milk. Therefore it can be effect on the formulation of food product. This research will be focused on the textural changes in traditional food models using modified cassava flour, sugar, and coconut milk by the addition of iota and kappa carrageenans. The advantage from this research was to learn the effect of carrageenan for traditional food texture and know the material can influence the food texture.

2. Materials and Methods

2.1 Materials

Iota and Kappa carrageenan were purchased from CV. Karagenan Indonesia. Modified cassava flour (Mocaf), brown sugar, coconut milk were bought from local market.

2.2 Dough preparation

The dough was prepared according to the traditional receipt of basic dodol ; food traditional which have main ingredient are flour, brown sugar and coconut milk. The steps of processing are preparation of dodol (mixing the dough which is consist of mocaf, brown sugar, coconut milk and adding iota also kappa carrageenan in 2% maximally) and heating the dough (± 80° C in 5 minutes) [3].

2.3 Sample formulation and preparation

The basic recipe for each preparation sample is 10 g of mocaf, 10 ml aquadest. There's no addition of iota and kappa carrageenan in T0 as a control. But in each T0 there are slight modification such as $T0_1$ with addition 4.5 g of brown sugar, $T0_2$ with addition 4 ml of coconut milk, $T0_3$ with addition both of those ingredients. In T1 2 g of Iota carrageenan was added to basic recipe with slight modifications. $T1_1$ with addition 4.5 g of brown sugar, $T1_2$ with addition 4 ml of coconut milk, $T1_3$ with addition both of those ingredients. So the next treatment In T2 2 g of kappa carrageenan was added to basic recipe and the modifications are same as T1.

2.4 Texture analysis
The texture analyses (TPA) were performed using Brookfield Texture Analyzer. Dough compressed twice up with trigger 4,5 gram, deformation 7,5 mm, and speed 2,5 mm/s. Hardness is defined as maximum force during the first compression. Cohesiveness is determined as the ratio of the positive force area during the second compression to the first one. Springiness is associated with elasticity. Adhesiveness depends on the surface properties, particularly the wetting of properties.

2.5 Statistical analysis
All measurements were carried out to assess for any significant differences between the means with one way analysis of variance (ANOVA). It was conducted by using IBM SPSS statistics 22.0 (SPSS Inc., USA). Significant differences ($p > 0.05$) were determined by Duncan's multiple range test.

3. Result and Discussion

3.1 Hardness

Table 1. Hardness of doughs of control (T0), 2 % iota (T1) and 2 % kappa (T2) carrageenans with different ingredients

Treatment	Brown Sugar	Coconut Milk	Brown Sugar + Coconut Milk
T0	97.4375	94.8125	84.4375
T1	102.4375	104.625	62.063
T2	159.31	129.4375	74.625

Textural analysis consist in compression of the sample without breaking it. hardness is the maximum force during the first cycle of texture analyser compression [12]. The changes of the hardness were recorded in Table 1 whereas increased in brown sugar dough and coconut milk dough, whereas the hardness of brown sugar and coconut milk dough was fluctuated. in Table 1. the dough with brown sugar has higher hardness than other because the sucrose could getting back hard when its turn cooling. And sample with addition coconut milk has low hardness because incorporating of coconut milk caused the increase of water content in the sample and led to the loss of hardness [9]. In table. 1 showed higher hardness in T2 (dough with 2 % kappa), but T2 containing brown sugar and coconut milk has lower hardness. So the kappa carrageenan affected the hardness of food with certain ingredient. Aside from the carrageenan and the ingredient, another treating factors could affect on hardness such as heating time and heating temperature. Hardness was influenced by the speed of water evaporating during cooking. In general, increasing of hardness could relate to ability of mastication[18].

3.2 Cohessiveness

Table 2. Cohesiveness of doughs of control (T0), 2 % iota (T1) and 2 % kappa (T2) carrageenans with different ingredients

Treatment	Brown Sugar	Coconut Milk	Brown Sugar + Coconut Milk
T0	0.375	0.55	0.6575
T1	0.3725	0.56	0.5675
T2	0.2325	0.465	1.28

The results of cohesiveness is quite differ from hardness. The changes of cohesiveness shown in Table 2. showed that cohesiveness of control (T0), iota (T1) and kappa (T2) decreased along after the addition of brown sugar, brown sugar and coconut milk. However the cohesiveness of the dough added coconut milk alone is flactuating. Cohesiveness is defined as the extent to which a material can be deformed before it ruptures in mechanics [22]. Addition of brown sugar decreased the cohesiveness of dough containing iota and kappa, and dough containing kappa is the lowest one. Different from the addition of brown sugar, the addition of coconut milk led to higher dough cohesiveness. Higher amount of coconut milk addition induced decrease of the hardness and made it into the elastic one because the high water content [6]. A combined ingredients such as brown sugar and coconut milk has a highest cohesiveness in control, but it decreased in dough containing iota-kappa carrageenan and dough containing kappa showed the lowest one. Kappa carrageenan was a better gelling agent because it had higher thickening ability than that of iota [19].

3.3 Springiness

Table 3. Springiness of doughs of control (T0), 2 % iota (T1) and 2 % kappa (T2) carrageenans with different ingredients

Treatment	Brown Sugar	Coconut Milk	Brown Sugar + Coconut Milk
T0	4.225	6.125	6.425
T1	5.175	5.925	5.625
T2	4.49	5.725	5.3

Springiness means the level of elasticity in the dough. The addition of carrageenan, coconut milk and brown sugar had an effect on the level of elasticity in the dough. A chewy and elastic dough is obtained from the gelatinization process of starch in mocaf flour and at during heating process, and gelatinized starch can absorb water and produce a thick, chewy, and elastic dough [15]. Elasticity describes material reactions when subjected to force (action). In this case, the elasticity of the sample depends on the ingredients added in the dough [4]. The addition of sugar with relatively large amounts will result in a harder texture, while with too little then the resulting texture is soft and elastic [7]. Addition In Table 3, there is a decrease in elasticity on T2 (dough with 2% kappa). T2 always the lowest in dough with different ingredients. The dough containing iota carrageenan has an elastic gel properties compared to kappa carrageenan [13]. The elastic condition of the food product is an assessment of semi-wet texture of food with glossy, dense, and non-sticky marks to the touch.

3.4 Adhesiveness

Table 4. Adhesiveness of doughs of control (T0), 2 % iota (T1) and 2 % kappa (T2) carrageenans with different ingredients

Treatment	Brown Sugar	Coconut Milk	Brown Sugar + Coconut Milk
T0	0.8575	1.6425	2.1375
T1	1.3325	2.095	1.4
T2	0.5125	2.0975	1.165

In this study, adhesiveness is featured by surface characteristic and include viscosity or viscoelastic property as well. The addition of carrageenan, brown sugar and coconut milk to modified cassava flour gave a good effect on the adhesion in dough. The higher concentration of carrageenan addition, the higher force required for a product to break [14]. The addition of brown sugar plus coconut milk to dough has the highest adhesiveness (T0). In T1 treatment (with 2% of iota), addition of brown sugar plus coconut milk to dough has the highest adhesiveness (T0). In T2 treatment (with 2% kappa), the addition of brown sugar reduced adhesiveness. These changes show that the addition of carrageenan to the dough may affect the level of adhesion in dough [8].

4. Conclusion

The results of this study showed that addition of different ingredient and carrageenan definitely affects the hardness, springiness and adhesiveness, on the other hand, the combination of ingredients did not affect the cohesiveness. Kappa carrageenan is better for the hardness of dough, while the iota carrageenan is better for cohesiveness, springiness and adhesiveness of dough. It can be suggested that the kappa enhance thickening and the iota enhance gelling.

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