

# The Effect of Emulsifier and Hydrocolloid on Baking Expansion and Texture of Bread from Modified Cassava

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**Abstract.** Indonesia has a very abundant cassava that can be used instead of wheat. Bread made from cassava is safe for celiac sufferers, in which cannot tolerate a protein called gluten found in wheat flour. However, bread from cassava has the disadvantage that it cannot inflate perfectly. Our research goal is to study the effect of emulsifier and hydrocolloid concentration as modifying agents on baking expansion and bread texture (hardness). The test level hedonic preference for bread products results from modified tapioca is also necessary to know the level of customer satisfaction. This study were conducted by three main stages, modification of cassava, baking process, and analyses. Modification of cassava starch was applied using combination of lactic acid solution and ultra violet (UV) irradiation. Emulsifier (DATEM) and hydrocolloid (xanthan gum) were used in baking process. The addition of emulsifier and hydrocolloid can improve baking expansion. The addition of 7% emulsifiers on modified cassava can increase the volume of bread, taste, and texture so it can give greater satisfaction to consumers. Hydrocolloid can replace the function of gluten so the bread can inflate perfectly. The optimal composition of modified cassava in bread making is 25% of modified cassava and 75% of wheat flour. The low value of texture (hardness) on bread made from modified cassava indicated a better performance in comparison with native cassava. Baking expansion and texture of the bread is influenced by the modification process. Furthermore, the comprehensive and optimum studies of modification need to be investigated.

## 1 Introduction

Wheat flour contains about 7-22 % protein and mostly consisted of gluten and gliadin. The existence of high gluten shows that wheat flour has excellent physicochemical properties. This component holds the gas to keep the volume, texture, and viscoelastic form of bread [1,2]. Indonesia's market year wheat import is 8.9 million tonnes. For this reason, the potential of local commodities are urgently required to replace the wheat and apply in the baking fields.

Cassava is one of staple food and is gluten free, thus secure for celiac sufferers [3]. Therefore, it does not have a good texture of bread while use in baking field. Furthermore, modification of cassava starch should be provided in order to obtain the desirable characteristics, i.e. better of paste clarity, gel stability, solubility, and freeze-thaw stability. These properties also could improve their properties as stabilizers, fillers, binders, and adhesives on specific food applications [4-12].

Fermentation, sun-drying, and UV irradiation processes might produce cassava depolymerisation which is correlated with expansion ability [13-19].

Cassava starch (*Polvilhoazedo*) is a natural fermented that shows the expansion properties during baking. However, acidification of cassava starch, using lactic, acetic, or butyric acid and followed by oven drying, was unsuccessful to produce any great expansion ability after baking [20]. Additionally, amylase depolymerisation or natural lactic fermentation also did not provide the better expansion properties [13,19]. In the other hands, some researcher suggested to modify the cassava starch using combination of fermentation and sun drying method for better expansion baking properties [13,20,21].

Acidification process followed by UV irradiation on cassava starch could improve the expansion ability during baking [13-19]. The previous studies used lactic acid solution as acidifying agent [22-24]. The combination processes of UV irradiation and lactic acid solution followed by sun drying process represented the increase of specific volume of tested biscuits [20]. However, these better properties did not show in sour cassava starch treated by oven-drying method [20]. In addition to modification, the use hydrocolloid and emulsifier agents could trap the gas inside the dough thus increase the baking expansion.

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Our research goals are to study the effect of emulsifier and hydrocolloid concentration on baking expansion and bread texture (hardness). The hedonic test for bread made from modified cassava starch is also investigated to know the level of customer satisfaction.

## 2 Materials and Method

### 2.1. Materials

The main material in this study, cassava was obtained from local market. Furthermore, DATEM, xanthan gum, wheat, and margarine were purchased from Indrasari, Bratachem, and Multi Kimia Raya, respectively.

### 2.2 Modification of cassava

Modification of cassava starch was applied using combination of lactic acid solution and ultra violet (UV) irradiation. 500 g of dried cassava starch, 1% lactic acid solution, and 1500 ml aquadest were placed and blended. This mixed solution would be irradiated using UV light for 20 minutes. Filtration process and sun drying would be conducted for final treatment.

### 2.3 Bread baking process

White bread dough is made with weight composition of 200 g of modified flour (corresponding variable), 0,6 g of bread improver, 3 g of yeast, 20 g of sugar, 4 g of milk, Xanthan Gum appropriate with variable, and 100 mL cold water. The dough is mixed using mixer at medium speed. After that, added 16 g of white margarine, 2 g of salt, and DATEM according to desired variables. The dough is mixed with a mixer again until uniform, then wait for 10-15 minutes. The dough was placed on aluminium pan that has been smeared with white margarine and wait for 1 hour. After that, it is baked in the oven at 180°C for 30 minutes. The composition of DATEM, xanthan gum, modified cassava, and wheat were shown in Table 1.

### 2.4 Baking expansion analysis

After baking process is finished, bread's volume and mass are measured one hour later. Volume of bread was calculated by deviate the bread volume before and after baking process. Volume bread was measured by the dimension volume of muffin mold. Baking expansion can be determined using formula Equation (1)

$$\text{Baking expansion} \left( \frac{\text{cm}^3}{\text{g}} \right) = \frac{\text{Volume of bread (cm}^3\text{)}}{\text{Dough weight (g)}} \quad (1)$$

### 2.5 Texture analysis

Texture analysis was analyzed using texture profile analyzer (TPA). Hardness will be presented as texture values.

## 2.6 Preference hedonic analysis

This test is carried out by conducting a quantitative survey toward 10 samples of consumer. The survey includes taste, colour, texture, aroma, and the satisfaction of bread product from modified cassava.

Table 1. Distribution of Experimental Method

Variable	Composition (%)			
	DATEM	Xanthan Gum	Modified Cassava	Wheat
A	3.5%	0.5%	0%	100%
B	3.5%	0.5%	25%	75%
C	3.5%	0.5%	50%	50%
D	3.5%	0.5%	75%	25%
E	3.5%	0.5%	100%	0%
F	3.5%	1%	0%	100%
G	3.5%	1%	25%	75%
H	3.5%	1%	50%	50%
I	3.5%	1%	75%	25%
J	3.5%	1%	100%	0%
K	7%	0.5%	0%	100%
L	7%	0.5%	25%	75%
M	7%	0.5%	50%	50%
N	7%	0.5%	75%	25%
O	7%	0.5%	100%	0%
P	7%	1%	0%	100%
Q	7%	1%	25%	75%
R	7%	1%	50%	50%
S	7%	1%	75%	25%
T	7%	1%	100%	0%

## 3 Results and Discussions

### 3.1 The effect of overall parameter to baking expansion

Modification of cassava was conducted using lactic acid solution followed by UV radiation. This modified starch would be used as substitute material of wheat in the baking process. The effect of hydrocolloid and emulsifier on baking expansion depicts on Figure 1.

Generally, the use of 25% substitute modified cassava starch and 7% emulsifier has a better performance on baking expansion properties in comparison with the substitution by modified cassava 50%, 75%, and 100%. However, the application of 100% wheat had the best value of baking expansion (3.50 ml/g). It is in agreement with Gillian Eggleston (1992) that the value of baking expansion is volume 3.98 mL/g [25]. The high percentage of modified cassava composition indicates lower gluten concentration in the

dough. Thus, the values of baking expansion were lower than the low percentage. Gluten could provide elastic texture properties which can improve bread's volume.

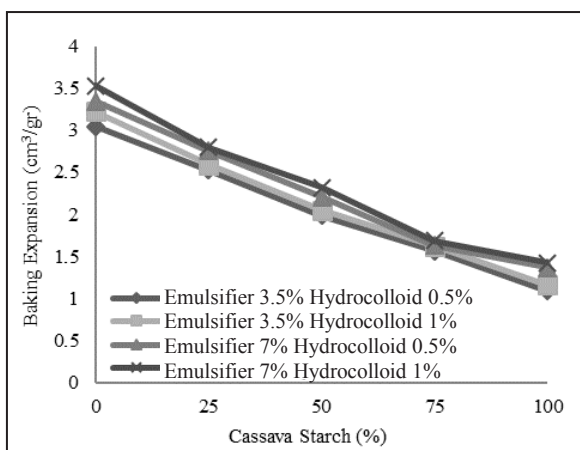


Fig. 1 Correlation between overall parameter to baking expansion

The addition of 7% and 3.5% emulsifier are more efficient for increasing baking expansion. Emulsifier might create a thin layer which can entrap carbon dioxide and strengthen the dough, thus the bread has a strong ability to expand [26]. Hydrocolloid is also has the similar function for improving baking expansion due to its role as a gluten substitute.

### 3.2 Texture analysis (hardness)

Texture analysis was conducted using texture profile analysis (TPA). Hardness is one of the texture test parameters. It is the force in the form of pressure or stress which is required to change the physical form of the any food material. Table 2 represents the value of hardness from native cassava, modified cassava, and wheat flours. The analyses were taken from the centre and side (wall) of breads.

Table 2 shows that there were a significant difference in rheological properties of native cassava, modified cassava, and wheat. The decreasing value of hardness on bread made from modified cassava indicated a better performance in comparison with native cassava [1,14]. Breads made from modified cassava have a delicate texture. The hardness value of modified cassava on centre and wall of bread were 169.02 and 305.35 gf, respectively. This values approach the hardness level of wheat (Table 2).

Table 2 Hardness values of native cassava, modified cassava, and wheat.

Component	Hardness (gf) (centre)	Hardness (gf) (wall)
Native cassava	213.69	338.03
Modified cassava	169.02	305.35
Wheat	148.64	215.10

### 3.3 The effect of overall parameter to hedonic test

Hedonic test was conducted on bread made from modified cassava. Ten respondents would participate on this test. The survey includes taste, colour, texture, aroma, and satisfaction of bread parameters (Figure 2-6). The values of each parameter were ranging from 1-10.

Figure 2 shows that the addition of emulsifier and hydrocolloid will improve taste of the bread. The high level of emulsifier and hydrocolloid has the positive respond which is indicate from the higher respondent value. The addition of 7% emulsifier and 1% hydrocolloid has the best value on both modified cassava composition. Figure 2 also indicates that respondent were more appetizing on bread which is made from 100% of wheat or the minimum composition of modified cassava (25%).

Figure 3 depicts that the high level of modified cassava composition has the uninteresting bread's colour. The use of 0% and 100% of modified cassava has the value 10 and 5.79, respectively. Based on this hedonic test, colour of food might be the important parameter which influences consumer appetite.

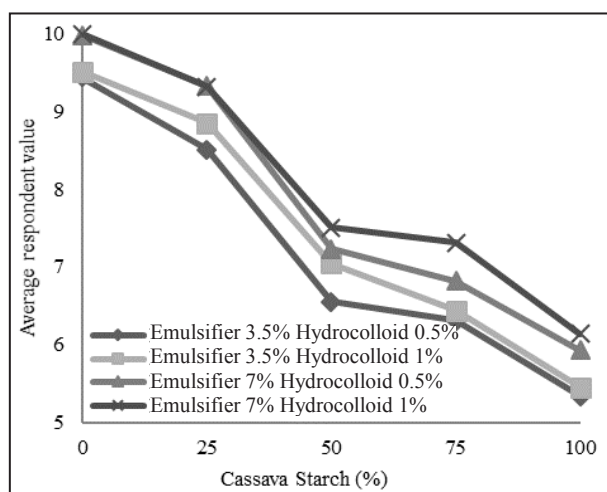


Fig. 2 Correlation between overall parameter to taste

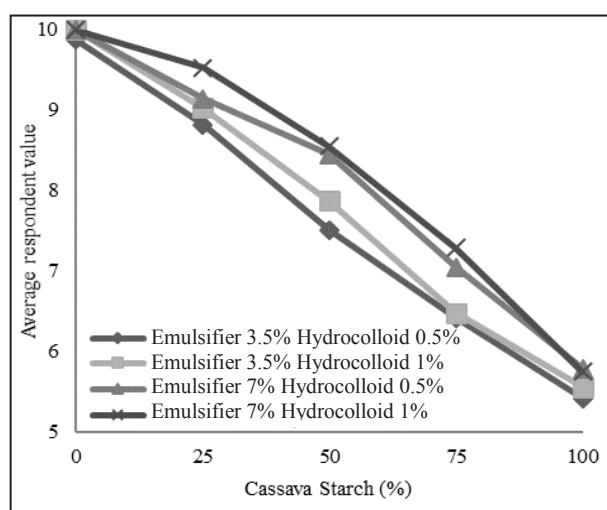


Fig. 3 Correlation between overall parameter to colour

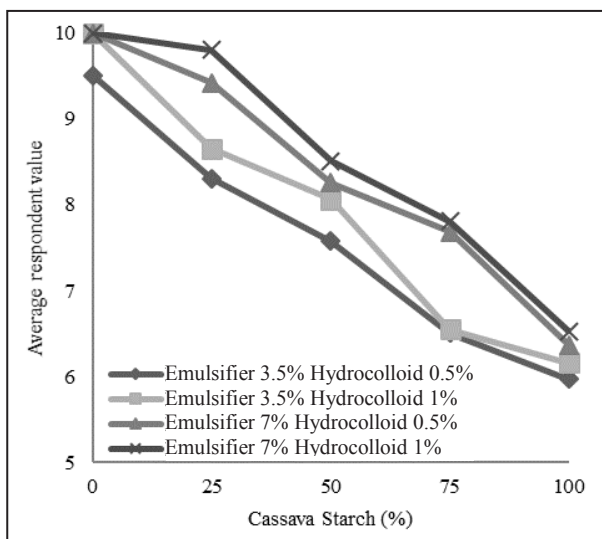


Fig. 4 Correlation between overall parameter to texture

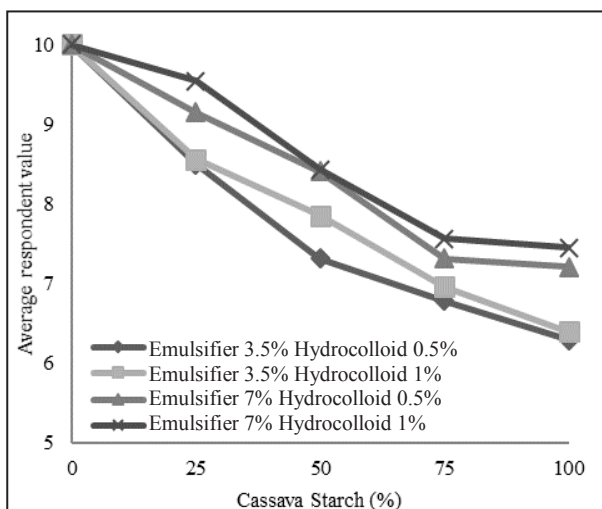


Fig.5 Correlation between overall parameter to aroma

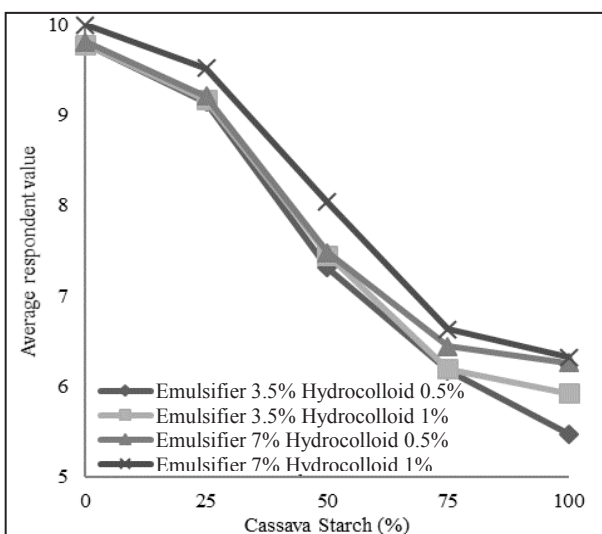


Fig. 6 Correlation between overall parameter to satisfaction

Based on Figure 4, we can see that the bread texture is better and delicate on the addition 7% emulsifier and 1% hydrocolloid. Emulsifiers could improve the texture of bread, while hydrocolloid stabilizes the dough. These results were in agreement with aroma parameter. Aroma of bread is influenced by emulsifier addition and modified cassava composition (Figure5). The hedonic test of 1% hydrocolloid and 7% emulsifiers on 25% modified cassava get average respondent value 9.54. This value is very close with aroma value of bread from 100% wheat with value 10.

Figure 6 shows that modified cassava composition on baking dough determines the bread quality. Bread with 25% modified cassava have similar baking expansion, taste, colour, and aroma parameters with bread from 100% wheat. Based on hedonic test, bread with 25% modified cassava get satisfaction value of consumer above 9 (scale 0-10), while 50%, 75%, 100% of modified cassava get average value under 8. The ideal composition of modified cassava in bread is 25% from the total of flour needed because it can produce bread which very similar with wheat bread. Bread which consist of 50% modified cassava still have a better texture rather than 75% and 100% composition.

Emulsifier and hydrocolloid addition also increase baking expansion, taste, texture, and aroma of bread made from modified cassava. Bread will have higher value of customer satisfaction and getting closer to bread satisfaction from 100% wheat.

#### 4 Conclusions

The addition of 7% emulsifiers on modified cassava can increase the volume of bread, taste, and texture so it can give greater satisfaction to consumers. Hydrocolloid can replace the function of gluten so the bread can inflate perfectly. The optimal composition of modified cassava in bread making is 25% of modified cassava and 75% of wheat flour. Baking expansion and texture of the bread is influenced by the modification process. Furthermore, the comprehensive and optimum studies of modification need to be investigated.

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