

Effect of Comparison of Sweet Potato (*Ipomoea batatas* L.) with Tapioca (*Manihot utilissima* POHL.) and Egg Concentration on Characteristics of Sweet Potato Snack

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Article Info

Article history:

Received : Apr 12, 2023

Revised : May 14, 2023

Accepted : Jul 24, 2023

Keywords:

Sweet potato

Tapioca

Egg Concentration

Sweet Potato Snacks.

ABSTRACT

The purpose of this research is to determine the extent of the influence of the ratio between the sweet potato (*Ipomoea batatas* L.) with tapioca (*Manihot utilissima* POHL.) and the concentration of the eggs so that the sweet potato snack produced good characteristic. The benefit of this research is to increase the economic value of sweet potato, as the use of food product diversification, utilization of sweet potato as a snack raw material so as to create economy productive. The experiment design used in this research is a randomized block design (RAK) with 3x3 factorial three times repeated, followed by Duncan's test. Variables experimental consisted of sweet potato comparison with tapioca (U) with variations 1:1, 1:1, 2:1 and the concentration of eggs (T) with a variation of 5%, 10%, 15%. Response in this research include water content, starch content, protein content, fat content, volume expansion and organoleptic test for color, scent, taste and crispness. The results showed that the ratio of sweet potato with tapioca impact on volume expansion, water content, starch content, and the taste of sweet potato snack. The eggs in concentration effect on protein content, taste and crispness sweet potato snack. Interaction comparison with tapioca and the egg concentrations effect on the color of sweet potato snack. u1t1 treatment (sweet potato with tapioca amounting to 1: 1 and the egg concentration of 5%) gave the best results with the sample a water content of 7.49%; the starch content of 36,29%, 2,44% protein content, fat content of 20,24% and amounted to 192,15% volume expansion.

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1. INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is the fourth alternative source of carbohydrates from foodstuffs after rice, corn and cassava (Zuraida, 2003). Sweet potato has a relatively high nutritional composition, namely in 100 grams of material weight contains 27.9 grams of carbohydrates, 1.8 grams of protein, 0.7 grams of fat, 0.09 mg of vitamin B1, 22 mg of vitamin C, 49 mg of phosphorus, iron 0.7 mg, water 68.5 grams and vitamin A 7700 SI (Directorate of Nutrition MOH, 1996).

One of the tubers that is easy to find in Indonesia is sweet potato. In 2012 West Java is a potential sweet potato producing area, in fact it is the first province in the largest sweet potato

producer in Indonesia with a total of 436,577.00 tons/year 2012 (Central Bureau of Statistics, 2013).

The availability of large food ingredients for the diversification of food sources of carbohydrates is still difficult to implement, even though this constitutes the largest portion of the food consumed by Indonesian people. One of the food sources of carbohydrates, namely sweet potatoes, has very high advantages and benefits for Indonesian people, including the way of serving sweet potato dishes that are easy, practical and very diverse, and compatible with other foods served (Krisno, 2011).

One of the uses of sweet potatoes, namely snacks, aims to increase economic value, improve the quality and productivity of sweet potatoes (Zuraida, 2003). Snacks are products that are generally low in protein and high in fat, usually considered a low-value product. Much has been done to increase the nutritional value of snack food products by incorporating protein sources of plant or animal origin (Bhattacharya and Bose, 1990).

One of the processed products of sweet potato in snack food diversification is crackers, because sweet potato is a starchy material so it can be processed into snacks (Huda, 2001). Another starchy ingredient that is often used as a snack ingredient is tapioca. The reason for using tapioca, besides being cheap and easy to obtain, tapioca also has a high binding capacity and forms a strong structure (Widowati, 1987).

In addition to the starchy ingredients in the processing of snacks, emulsifying agents are needed, one of the ingredients that is often used is eggs. Eggs added to the manufacture of snacks are intended as an emulsifier and binder for dough components as well as to improve nutrition and taste. The egg also acts as a binder for air and holds it in as a bubble. The use of eggs in snacks will affect the development of snacks when they are fried (Kakashi, 2011).

2. METHOD

2.1 Materials and Research Tools

The raw materials used in the manufacture of Sweet Potato Snacks are juice variety sweet potatoes which have orange flesh color with red skin, tapioca, chicken eggs, table salt, granulated sugar, garlic, cooking oil and clean water. The chemicals used for analysis were aquadest, Luff Schrool solution, sulfuric acid (H₂SO₄) 6N, KI, sodium thiosulfate (Na₂S₂O₃) 0.1N, starch solution, hydrochloric acid (HCl) 9.5N, NaOH 0.1N, Kjeldahl salt, boiling stones, concentrated sulfuric acid (H₂SO₄), 30% NaOH, Zn granules, 0.1N HCl, litmus paper, phenolphthalein indicator, N-hexane, quartz sand and filter paper.

The tools used for this study were digital scales, tunnel dryer, food processor, 80 mesh sieve, steamer, knife, spoon, basin, measuring cup, small plate, pestle, heat-resistant plastic, boiler, sample plastic, cutting board, printer, stove, pan, spatula. The tools used for analysis were an electric balance, a watch glass, a 500 ml and 100 ml measuring cup, a 100 ml measuring flask, a beaker (500 ml and 250 ml), a burette, a boiling flask, a desiccator, an Erlenmeyer (500 ml and 250 ml), bath, oven, dropper pipette, goiter pipette (5 ml, 10 ml and 25 ml) and stative.

2.2 Research methods

Preliminary research was carried out, namely the determination of making the selected formula from sweet potato snacks to be used in the main research. The ratio of sweet potato to tapioca used was 1:1 and the egg concentration was 10%. The formula used can be seen in Table 1.

Table 1. Sweet Potato Snack Preliminary Research Formula

Material	Formulas			
	FI (%)	FII (%)	FIII (%)	FIV (%)
Sweet potato	Steam	36	36	
	Flour			36
Tapioca	36	36	36	36
Egg	10	10	10	10
Sugar		3		3
Salt	2		2	
Garlic	2		2	
Water	14	15	14	15
Total	100	100	100	100

Notes: FI = Steamed sweet potato; salty snacks

FII = Steamed sweet potato; sweet tasting snacks

Fill = Sweet potato flour; salty snacks
 FIV = Sweet potato flour; sweet tasting snacks
 Base = 250 grams

The four formulas were selected based on the organoleptic response using the hedonic test method (favorability test) which included color, aroma, taste and crunchiness of sweet potato snacks.

2.3 Research methods

The treatment design in the main study determined the ratio of sweet potato to tapioca (U) and egg concentration (T). The ratio of sweet potato to tapioca used is 1:1; 1.5:1 and 2:1 and the concentration of eggs with variations of 5%, 10% and 15%. The experimental design used was a 3x3 factorial pattern in a randomized block design (RBD) with 3 replications, so that a total of 27 combinations were obtained. Comparison of sweet potato with tapioca is factor U and egg concentration is factor T. Comparison of sweet potato : tapioca (U): u1 = 1 : 1; u2 = 1.5 : 1; u3 = 2 : 1. Egg concentration (T): t1 = 5%; t2 = 10%; t3 = 15%.

2.4 Observation parameters

Observations made in this study included chemical responses, physical responses and organoleptic responses.

2.4.1 Chemical Response

Chemical responses to sweet potato snack products include the analysis of water content by Gravimetric method (AOAC, 1995) and starch content by the Luff Schrool method (AOAC, 1995) for raw sweet potato snacks, protein content by the Kjeldhal method (AOAC, 1995) and fat content by the Soxhlet Extraction method. (AOAC, 1995) for cooked sweet potato snacks.

2.4.2 Physical Response

The physical response to the sweet potato snack product used is the expansion volume analysis (Zulfiani, 1992).

2.4.3 Organoleptic Response

The organoleptic response used is the hedonic test (favorability test) as an acceptance test with the hedonic scale transformed into a numerical scale. Responses tested on cooked sweet potato snacks included color, taste, crispness and aroma. The results of further research were processed statistically.

2.5 Data analysis

To determine the effect of treatment, the data were analyzed by analysis of variance (Anova). and continued with the Duncan Multiple Range Test (DNMRT) at α level of 5%.

3. RESULTS AND DISCUSSION

3.1 Research results

Responses in the main research included physical responses, namely swelling volume, chemical responses, namely water content, and organoleptic responses to color, aroma and taste.

3.1.1 Development Volumes

The results of the analysis of variance showed that the ratio of sweet potato to tapioca and egg concentration had an effect, but the interaction had no effect on the volume of sweet potato snack development. The effect of the ratio of sweet potato to tapioca and the effect of egg concentration on development volume can be seen in Table 2 and Table 3.

Table 2. Effect of Comparison of Sweet Potatoes with Tapioca on Developmental Volume (%) of Sweet Potato Snacks

Comparison of Sweet Potatoes with Tapioca (U)	Development Volume Average Value (%)
u1 (1:1)	154.26(b)
u2 (1.5:1)	139.28(b)
u3 (2:1)	103.37(a)

Note: The average value marked with the same letter is not significantly different at the 5% level according to Duncan's advanced test

Based on Table 2, it shows that the development volume of sweet potato snacks in the u3 treatment (2:1) was significantly different from the u2 treatment (1.5:1) and u1 (1:1) and between the u2 treatment (1.5:1) and u1 (1:1) was not significantly different from the development volume of sweet potato snack. Development volume tends to decrease with increasing use of sweet potato.

Table 3. Effect of Egg Concentration on Development Volume (%) of Sweet Potato Snack

Egg Concentration (T)	Development Volume Average Value (%)
t1(5%)	181.27(b)
t2(10%)	118.90(a)
t3(15%)	96.75(a)

Note: The average value marked with the same letter is not significantly different at the 5% level according to Duncan's advanced test

Based on Table 3, it shows that the t1 treatment (5%) was significantly different and the t2 treatment (10%) and t3 (15%) were not significantly different from the volume of sweet potato snack development. The highest swelling volume value was obtained in snacks made with a ratio of sweet potato to tapioca, namely 1:1 (w/w) and using a chicken egg concentration of 5%.

3.1.2 Water content

The results of the analysis of variance showed that the ratio of sweet potato to tapioca had an effect on the water content of the raw sweet potato snack, but the egg concentration and its interaction had no effect. The effect of the ratio of sweet potato to tapioca on water content can be seen in Table 4.

Table 4. Effect of Comparison of Sweet Potatoes with Tapioca on Water Content (%) Raw Sweet Potato Snacks.

Comparison of Sweet Potatoes with Tapioca (U)	Average Value of Moisture Content (%)
u1 (1:1)	7.77(a)
u2 (1.5:1)	8.65(ab)
u3 (2:1)	9.52(b)

Note: The average value marked with the same letter is not significantly different at the 5% level according to Duncan's advanced test.

Table 4 shows that the water content of sweet potato snacks in treatment u1 (1:1) was not significantly different from treatment u2 (1.5:1), but significantly different from treatment u3 (2:1) and treatment u3 (2:1) not significantly different from the u2 treatment (1.5:1).

3.1.3 Color

The results of the calculation of variance analysis showed that the interaction between sweet potato and tapioca comparisons and egg concentration also had a significant effect on the color of cooked sweet potato snacks. The interaction between sweet potato and tapioca comparisons and egg concentration on the color of sweet potato snacks can be seen in Table 5.

Table 5. Interaction between sweet potato and tapioca starch and egg concentration on the color of sweet potato snacks.

Sweet Potato Comparison: Tapioca (U)	Egg Concentration (T)		
	5% (t1)	10% (t2)	15% (t3)
u1 (1:1)	4.98 A b	4.70 B a	3.15 A a
u2 (1.5:1)	5.10 A b	4.38 B a	4.17 C a
u3 (2:1)	4.90 A b	3.70 A a	3.72 B a

Note: The average value marked with the same letter is not significantly different at the 5% level according to Duncan's advanced test.

Based on Table 5, it can be seen that the interaction in treatment u1 (1:1) to treatment t1 (5%) and t2 (10%) was not significantly different in terms of the color of the sweet potato snack because it had an intensity scale in the range of 5, namely liking, for treatment u2 (1.5:1) and u3 (2:1) the lower the concentration of egg color sweet potato snacks are preferred with the intensity scale of the t1 treatment (5%) is in the range of 5 i.e. like and with t2 treatment (10%) and t3 (15%) was not significantly different.

3.1.4 Flavor

The results of the calculation of variance analysis showed that egg concentration had a significant effect on the flavor of cooked sweet potato snacks, but the comparison of sweet potatoes and tapioca and their interactions had no effect. The effect of egg concentration on the flavor of sweet potato snacks can be seen in Table 6.

Table 6. Effect of Egg Concentration on the flavor of Sweet Potato Snack

Egg Concentration (T)	Aroma Average Value
t1(5%)	4.18(b)
t2(10%)	3.89(a)
t3(15%)	3.77(a)

Note: The average value marked with the same letter is not significantly different at the 5% level according to Duncan's advanced test.

Based on Table 6, it shows that the flavor of sweet potato snacks at the concentration of egg treatment t1 (5%) is significantly different from t2 (10%) and t3 (15%), both of which are not significantly different from each other. The higher the concentration of the eggs used, the lower the flavor chosen in the sweet potato snack. This is because the rancid flavor produced from eggs in the t3 treatment (15%) is stronger than the other treatments so that the distinctive flavor of sweet potato in the t3 treatment (15%) does not smell and creates an unpleasant impression so that sweet potato snacks with t3 (15%) was not selected which was not significantly different from the t2 treatment (10%).

3.1.5 Savor

The results of the calculation of the analysis of variance showed that the ratio of sweet potato to tapioca and egg concentration had an effect, but the interaction of the two had no effect on the taste of cooked sweet potato snacks. The effect of the ratio of sweet potato to tapioca and the effect of egg concentration on taste can be seen in Table 7 and Table 8.

Table 7. Effect of Comparison of Sweet Potatoes with Tapioca on the Taste of Ripe Sweet Potato Snacks

Comparison of Sweet Potatoes with Tapioca (U)	Taste Average Rating
u1 (1:1)	4.29(a)
u2 (1.5:1)	4.68(b)
u3 (2:1)	4.57(b)

Note: The average value marked with the same letter is not significantly different at the 5% level according to Duncan's advanced test.

Table 8. Effect of Egg Concentration on the Taste of Ripe Sweet Potato Snacks

Egg Concentration (T)	Taste Average Rating
t1(5%)	4.86(c)
t2(10%)	4.46(b)
t3(15%)	4.23(a)

Note: The average value marked with the same letter is not significantly different at the 5% level according to Duncan's advanced test

Based on Table 7, it shows that the taste of sweet potato snacks in the comparison of sweet potatoes with tapioca, treatment u1 (1:1) is significantly different from treatment u2 (1.5:1) and u3 (2:1), both of which are not significantly different from each other. The taste of sweet potato snacks showed different results, so it was known that the panelists' preference level preferred the taste of sweet potato snacks with a ratio of sweet potatoes and tapioca of 1.5:1 based on the average value.

Apart from the influence of the ratio of sweet potato to tapioca, sweet potato snacks were affected by the treatment of egg concentration. Based on Table 8. the t1 (5%), t2 (10%) and t3 (15%) treatments were significantly different from each other on the taste of sweet potato snacks. The higher the concentration of eggs used, the preferred average value for the taste of sweet potato snacks is lower. This is because the flavor with the highest concentration of egg produced a taste that was too rancid for the panelists' expectations of the taste of snacks in general and the taste of sweet potato became less pronounced.

3.2 Discussion

The volume of snack development is influenced by the starch content of the ingredients. The starch content in tapioca is 89.9% and in sweet potato is 32.3% (Directorate of Nutrition, Ministry of Health, 1996). The starch component that can affect the swelling power of the snack is the ratio of amylose and amylopectin. A higher amylopectin content can produce a higher texture and swelling power (Harper, 1981). Amylopectin and amylose in tapioca were 83% and 17% (Rosdiana, 2007), therefore the swelling volume of the biggest sweet potato snack was the ratio of sweet potato to

tapioca in u1 treatment, namely 1:1 (w/w), because a number of the starch in sweet potatoes that joins tapioca gives a greater tendency for snack development.

The volume of sweet potato snack development decreased with increasing egg concentration used. Lavlinesia (1995) in Setiawan, et al (2013), states that one of the factors that can affect the volume of snack development is protein content. The high protein content tends to reduce the swelling power of the snack, this is presumably because the resulting snack air pockets are getting smaller due to the density of the air pockets filled with other ingredients, namely protein. Chicken egg protein content is quite high, namely 12.9% (Muchtadi et al, 2010).

The swelling power of the snack is influenced by several factors, including the quality of starch, the ratio between starch and fillers, the degree of dryness, the thickness of the snack, the homogeneity of the dough and the steaming time which will affect the moisture content of the raw snack. The development of snack volume occurs in the frying process. This development can occur due to the formation of air cavities in fried snacks, causing water bound in the gel (raw snacks) to evaporate (Nurhayati, 2007 in Anindita. et al, 2013).

The water content tends to increase as the use of steamed sweet potatoes increases. This can be caused by the water content in sweet potatoes and tapioca because based on the Directorate of Nutrition of the Ministry of Health (1996) the water content in yellow sweet potatoes is 68.5/100 g and tapioca is only 12/100 g, so the higher the ratio of sweet potatoes, the water content which is incorporated in the sweet potato snack is getting bigger.

In addition, according to Winarno (2002), water content can be affected by the presence of starch content in the material, the higher the starch content, the water content can decrease due to the formation of hydrates, because the hydroxyl groups in starch molecules are very large, the ability to absorb water will be very high. big. The water absorption capacity depends on the type of starch, high amylose content in starch will increase water absorption but cause a decrease in starch swelling during cooking (Widowati, 2002 in Nisviaty, 2006). In this case the addition of tapioca (starch) can cause a change in free water to bound water which is caused by the water absorption capacity of starch in tapioca to bind water (water holding capacity).

The color of the sweet potato snack in the ratio of sweet potato and tapioca to the concentration of eggs in the t1 treatment (5%) has a yellow color (golden fries) while the color of the sweet potato snack in the t2 (10%) and t3 (15%) treatments is brownish yellow and yellow. -chocolate (more concentrated). This is caused by the use of eggs which can give color to the product, this property is owned by egg yolks, namely the presence of yellow pigments from xanthophyll, lutein, beta carotene and cryptoxanthin (Muchtadi, et al., 2010).

The yolk content is 30.7/90.7 g of whole eggs, so the greater the concentration of the eggs used, the more concentrated the color of the sweet potato snack will be, besides that it is affected by the frying process where a non-enzymatic browning reaction occurs, namely the Maillard reaction which is influenced Due to the carbohydrate content, especially reducing sugar contained in sweet potato, it reacts with the primary amine groups of egg protein to produce melanoid pigments which cause brown color in foodstuffs (Winarno, 1994).

The interaction of egg concentration with the ratio of sweet potato and tapioca in treatment t1 (5%) to treatments u1 (1:1), u2 (1.5:1) and u3 (2:1) was not significantly different because the intensity scale was in range 5 which likes and has a brownish yellow color. The interaction in the t2 treatment (10%) to the u1 (1:1) and u2 (1.5:1) treatments was not significantly different, the color of each sweet potato snack was somewhat preferred with an intensity scale ranging from 4 because the resulting color was yellow- brown, while in the t3 treatment (15%) the ratio of sweet potato and tapioca factors was significantly different, where the interaction with the u2 treatment (1.5:1) the color of the sweet potato sanck was preferred compared to other treatments because in u2 (1, 5:1) is yellow-brown in color.

The difference in color in the interaction between egg concentration and the ratio of sweet potato and tapioca is caused apart from the non-enzymatic browning reaction, namely the Maillard reaction, also from the beta carotene content in sweet potato. The content of beta carotene in yellow sweet potato is 380.9 mkg/100 g and can give a yellow color to sweet potato snacks.

Based on the results of the organoleptic test on the color of sweet potato snacks with u2t1 treatment is the most preferred treatment based on the color of sweet potato snacks, the color of this snack is brownish yellow and can give an attractive impression so that it assumes this snack has a good taste compared to sweet potato snacks another.

Color is a material property that is thought to originate from the spread of the light spectrum. Color is not a substance or object but a person's sensation due to stimulation from a beam of radiation energy that falls on the senses or the retina of the eye. The emergence of color is limited by the presence of a light source, this effect is visible when a material is viewed in a dim place and in a dark place it will give a striking difference (Kartika, et al., 1988)

Aroma is one of the parameters in determining the quality of a food product. A distinctive aroma can be felt by the sense of smell depending on the ingredients and ingredients added to the food. Smell (aroma) can be defined as something that can be observed with the sense of smell. The aroma in a food ingredient determines the delicacy of the product. In addition, testing of aroma in the food industry is considered important because it can be used as a parameter for consumers to accept or not the product and aroma can be used as an indicator of the product (Kartika, et al., 1988).

The unfavorable aroma of this sweet potato snack is also influenced by its high fat content, which comes from chicken eggs. Chemical reactions that occur during processing, such as mixing other ingredients or heating, cause the fat to be hydrolyzed into fatty acids and glycerol. These fatty acids bind with other compounds to give rise to a distinctive aroma. According to Winarno (1997) chemical changes that occur during the processing process can affect the aroma and taste of food ingredients as a result of the decomposition of fat.

11.9% of chicken egg fat is mostly unsaturated fatty acids, namely 7.0% (Muchtadi, et al., 2010). Heat treatment in processing processes such as steaming, drying and frying can cause the breaking of the double bonds in unsaturated fatty acids so that they turn into saturated fatty acids (Winarno, 1997). Termination of this double bond will affect the aroma of the product. The aroma of food caused by saturated fatty acids changes with increasing chain length. The longer the chain, the stronger and more unpleasant the aroma (deMan, 1997).

The difference in taste in sweet potato snacks based on the comparison of sweet potatoes and tapioca is due to the large comparison of the two ingredients because sweet potatoes and tapioca contain carbohydrates, where carbohydrates with their sugar content can cause a sweet taste, but because tapioca contains a lot of starch and starch has a neutral taste then the taste of sweet potato snack is influenced by the taste of steamed sweet potato.

Taste is the most important factor in making the consumer's final decision to accept or reject a food, even though the color, aroma and texture are good, if the taste is not good then the consumer will reject the food. Taste is assessed by the response to chemical stimulation by the senses of taste where the unity of interaction between aroma, taste and texture constitutes the overall taste of the food being assessed.

The difference in taste in each treatment is influenced by the composition of the ingredients and changes during the processing process, such as mixing the dough which is less smooth, steaming, drying and frying which can affect changes in the chemical composition of sweet potato snacks. The reaction between the chemical compositions in the dough gives its own taste. Carbohydrates, proteins and fats with heating processes such as steaming, drying and frying can provide a pleasant taste. However, if the process is not carried out properly, the taste will not be so obvious because the volatile compounds that affect the taste will evaporate and be damaged more.

4. CONCLUSION

Based on the research results, the following conclusions can be drawn: Preliminary research results show that the selected sweet potato snack formula is F1 formula, namely steamed sweet potato formula; salty taste. Comparison of sweet potato with tapioca has an effect on swelling volume, water content, and taste of sweet potato snacks. The concentration of eggs affects the development volume, aroma and taste of sweet potato snacks. The interaction between sweet potato and tapioca comparisons and egg concentration affected the color of sweet potato snacks. The results of the analysis of the observed responses showed that the u1t1 treatment (1:1 ratio of sweet potato to tapioca and 5% egg concentration) was the best sample with a water content 7.49%; and development volume of 192.15%.

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