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The quality of non-gluten biscuits during storage with different types of packaging

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Abstract: *Non-gluten biscuits products utilize local raw material from Indonesia, namely purse-cowpea composite and sago flour. Cowpea flour was used to increase the protein content of biscuits, while to increase crispness, sago flour and carrageenan are used. As a new product, it is necessary to know how the product quality during storage. Therefore, research was carried out with the aim of knowing the quality of non-gluten biscuit during storage. The study was conducted using a single factor randomized block design namely the packaging type, namely aluminum foil pouch and polyethylene pouch, where each treatment was repeated three times. Observations was carried out every 10 days from the 0, 10, 20, 30, and 40 days during storage. The result showed that the sensory test of aroma was significantly different between the days of observation and decreased levels of preference, but not significantly different between the types of packaging, as well as the sensory test of texture. The content of water, carbohydrates, ash, crude fiber and the number of microbes were not significantly different between the packaging types during storage, but the quality tends to decrease. Protein and fat contents decreased in quality and showed significant differences between the packaging types during storage.*

Keywords: *Non-gluten biscuits, cowpea flour, purse-cowpea composite.*

1. Introduction

Kimpul is one type of taro which is known by the name of Talas Belitung by the scientific name *Xanthosoma sagitifolium.* Kimpul can be developed as a potential producer of non-rice carbohydrates (Azwar and Erwanti, 2010). In fact, the use of kimpul is still very limited to chips, and there has been no further processing of kimpul flour into a product that is ready for consumption.

The advantage of kimpul flour as a raw material is its abundant availability, so the possibility of product scarcity can be avoided because it does not depend on imports such as wheat. Besides that, the price of kimpul flour is relatively cheaper compared to the price of wheat flour and rice flour, so that it can reduce the cost of producing biscuits, as well as having a nutrient of gluten free and high-fiber content.

According to research of Puspitasari *et al.* (2015), cowpea-kimpul composite flour can be processed into biscuits. Cowpea-kimpul composite flour produce from kimpul flour which has been treated reduction oxalate content to reduce itching. Nurani and Yuwono (2014) has conducted research on the use of kimpul flour as a material for cookies. Other than that, Tidore *et al.* (2017) investigated the processing of biscuits

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from kimpul flour. However, there has not been research that analyzes the shelf life of biscuits from kimpul flour, especially cowpea-kimpul composite flour biscuits.

Biscuit is one of type of processed product that has advantages such as long-lasting because of low water content, also easy to consume and easy to digest. As a product with a low water content that has a relatively long shelf life, it is necessary to know the product shelf life before it is marketed. Therefore, this study aimed to determine the quality of kimpul biscuit during storage in different types of packaging materials.

2. Theoretical Framework

Research on the processing of kimpul has been carried out by processing kimpul flour by treating itching by Ayu and Yuwono (2013). Puspitasari *et al.* (2015) conducted research with a treatment of itching, which in turn was an attempt to increase the nutritional content, especially protein, made of cowpea-kimpul composite flour. Kimpul in the form of flour has broad opportunities for further processing into products that are ready and easy to consume. Research on kimpul processing, especially kimpul biscuits has been by Indrasti (2004), Nurani and Yuwono (2014), Tidore *et al.* (2017), serta Puspitasari *et al.* (2015), followed by processing into non-gluten biscuits by Puspitasari *et al.* (2019). However, as a product ready for consumption, before it is marketed, research is needed to determine the shelf life of biscuits produced.

3. Research Method

This research used a randomized block design with single factor namely the packaging type, with two level namely aluminum foil pouch (P1) and polyethylene pouch (P2), where each treatment was repeated three times. Observations was carried out every 10 days from the 0, 10, 20, 30, and 40 days during storage.

The parameters tested include chemichal analysis (carbohydrate, protein, fat, water, crude fiber, and ash content), total plate count, sensory test (aroma and texture). Data processing was carried out by analysis of variance. If there were significant differences, Duncan test was carried out with 95% confidence level.

4. Results and Discussion

Chemical parameters tested on cowpea-kimpul composite flour biscuit products include moisture content, ash content, fat content, protein content, carbohydrate content, crude fiber content, and sensory test aroma and texture.

4.1. Water Content

Water is a major component in food. The presence of water in foodstuffs will affect the texture, taste, appearance and storability. Water content in food is also very influential on the stability and durability of cookies (Indrasti, 2004). Based on the result of chemical analysis, the water content of the kimpul biscuits during storage has increased both in P1 and P2. The initial condition of the biscuits produced already meet the water content requirement for biscuits that is <5%, so as to prevent mold growth (Winarno, 2004). Starting to store the 30th day, the water content exceeds the specified requirements, so it does not meet SNI requirements both in P1 and P2. The trend of increasing water content of kimpul biscuits during storage can be seen in Figure 1. Packaging with high permeability and longer storage time causes greater water absorption so that the water content increases. This is consistent with statement of Kusnandar (2010), that the higher the permeability value of the packaging (k/x), the greater the diffusion of water and gas through the packaging, so that the product water content increases. This is supported by Herawati (2008), which states that a factor that is very influential on the decline in the quality of food products is the change in water content in the product. Changes in water content in the product can be affected by temperature, room humidity, and length of storage.

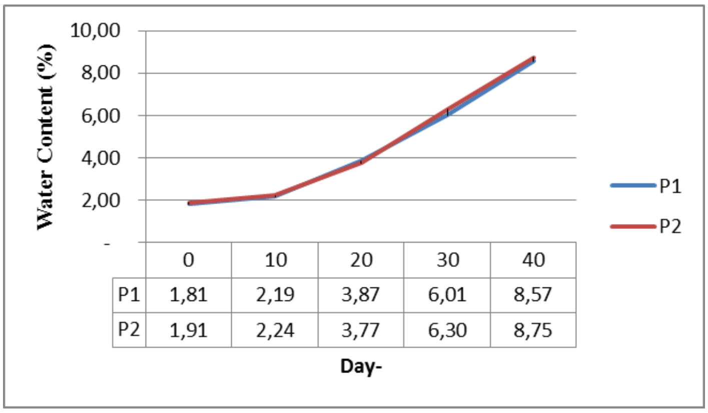


Figure 1. Water content during storage (%)

4.2. Ash Content

Ash is an inorganic substance produced by combustion of an organic material, which is related to the amount of minerals present in a substance (Sudarmadji *et al.*, 1984). The ash content of an ingredient shows the amount of minerals in it, but it cannot be identified whether the mineral is essential or not (Indrasti, 2004). Ash content in food can be an indicator of mineral content in food. According to Desroiser (2008), ash content is inorganic minerals which have a high enough resistance to both temperature and storage time, so that their presence in food may change even though it tends to remain. Biscuit quality requirement based on SNI 01-2973-1992, the maximum ash content in biscuits is 1.5% (bb). The data in Figure 2 shown that the ash content of the biscuits produced still meets SNI requirements even until the 40th day storage, both for P1 and P2.

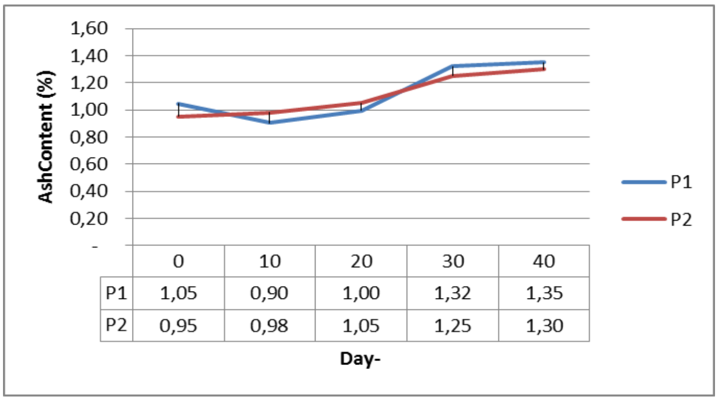
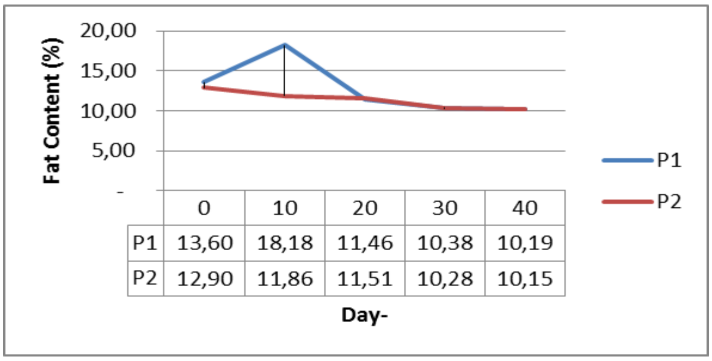


Figure 2. Ash content during storage (%)

4.3. Fat content

Based on the results of chemical analysis, the fat content of kimpul biscuits during storage decreased in both P1 and P2, as shown in Figure 3. According to Marsh and Bugusu (2007), to decelerate product damage, packaging can be done which serves to extend shelf life, and maintain or improve food quality and safety, and protect products from three external influences namely chemical, biological, and physical. Nevertheless, this really depends on the type of packaging material used that has certain properties. In addition, a decrease in fat content during storage can occur due to oxidation reactions (Nadarajah and Mahendran, 2015).

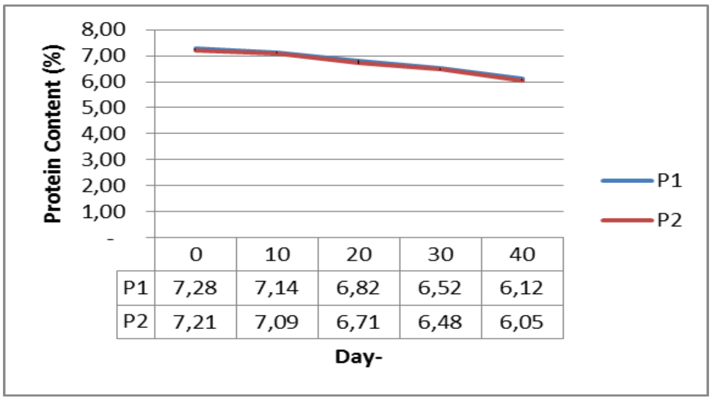


	0	10	20	30	40
P1	13,60	18,18	11,46	10,38	10,19
P2	12,90	11,86	11,51	10,28	10,15

Figure 3. Fat content during storage (%)

4.4. Protein content

Based on the results of chemical analysis, the protein content of kimpul biscuits during storage decreased in both P1 and P2, as shown in Figure 4. However, the protein content during storage ranged from 6.05% - 7.28%, which still fulfilled the SNI 2971-2011 requirements, at least 5%. Decreased protein content during storage was associated with an increase in Total Plate Count (TPC) during storage. An increase in TPC during storage effects in protein decay by microorganisms which cause a decrease in protein content.



	0	10	20	30	40
P1	7,28	7,14	6,82	6,52	6,12
P2	7,21	7,09	6,71	6,48	6,05

Figure 4. Protein content during storage (%)

4.5. Carbohydrate Content

Based on the results of chemical analysis, the carbohydrate content of kimpul biscuits during storage decreased in both P1 and P2, as shown in Figure 5. This is due to an increase in water content, while the carbohydrate calculation was calculated by the diference method.

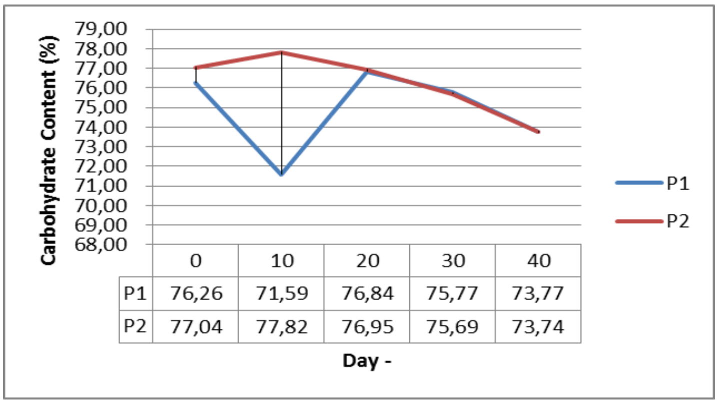


Figure 5. Carbohydrate content during storage (%)

4.6. *Crude fiber content*

Based on the results of chemical analysis, the crude fiber content of kimpul biscuits during storage decreased in both P1 and P2, as shown in Figure 6.

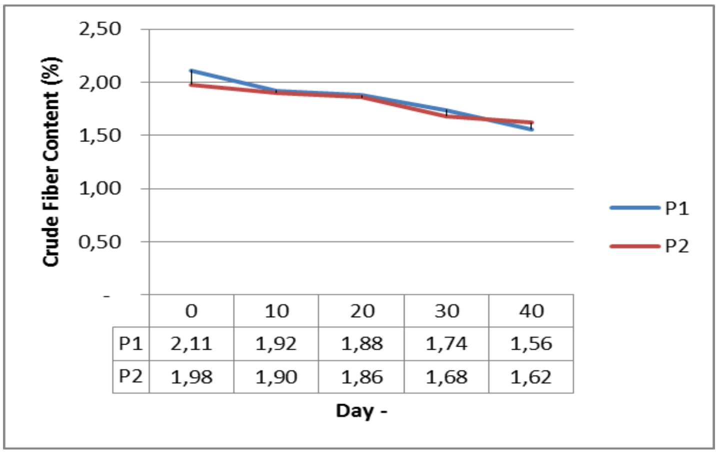
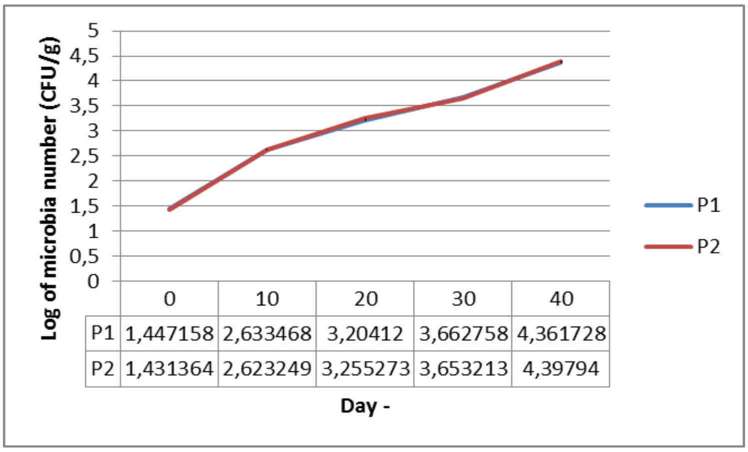


Figure 6. Crude fiber content during storage (%)

4.7. Total Plate Count (TPC)

Based on the results of the TPC test, the number of microbial of kimpul biscuits during storage increased, both P1 and P2, as shown in Figure 6. Total Plate Count of biscuits up to 30 days storage still meets SNI 2973-2011 requirements, maximum TPC 1x104, but at 40 days storage there was an increased to exceed SNI 2973-2011 requirements. This was related to moisture and oxygen availability which depends on the characteristics of the package. Packaging that has a high translucency to water vapor causes the higher amount of water content in food product that was packaged in line with the storage time. High water content causes easy growth of bacteria, mold, and yeast (Winarno, 2004). Data on the number of microbes that have increased during storage was consistent with data on the water content of kimpul, biscuits (Figure 1) which increased during storage. The increase of water content during storage is thought to be caused by the nature of the packaging which is less impervious to oxygen (Robertson, 2006), thus allowing microorganisms to growth. In addition, the protective properties of the packaging materials are also influenced by the thickness of the packaging materials (Syarief *et al.*, 1989). According to Dewita and Syahrul (2014), storage time affects the increase in the number of bacteria during storage, this is due to an increase in the water content into the product so that bacteria can grow.



	0	10	20	30	40
P1	1,447158	2,633468	3,20412	3,662758	4,361728
P2	1,431364	2,623249	3,255273	3,653213	4,39794

Figure 7. TPC during storage (CFU/g)

4.8. Aroma

Results of score obtained percentage of aroma (Table 1), showed that in observation I (day 0) the acquisition of aroma scores ranged from scores 4 and 5 for P1 and P2 treatnents, which means that panelists tended to like the aroma of kimpul biscuits products at shelf life day 0. Furthermore, the observations of the 10th day and 20th day showed the aroma scores of the panelists ranged from score 3, 4, and 5, but for score 3 it was higher in P2 treatment. The observations of the 30th day and 40th day showed the aroma scores of the panelists ranged from score 2, 3, and 4, but for score 2 it was higher in P2 treatment.

The type of packaging gives an effect on the free fatty acids of the product, where the preferred level of aroma of kimpul biscuit products was higher in products that was packaged with aluminum foil packaging rather than PE plastic. This is related to the nature of packaging permeability, where the smaller the permeability, the lower the absorption of water content in the product so that the formation of microorganisms that produce unpleasant aroma can be prevented. This is consistent with the statement of Zuhra (2006) that the change in aroma in the product is inseparable from the activity of microorganisms, usually in products that contain high water content.

In addition, a decrease in the level of aroma preference on kimpul biscuits during storage is thought to be related to an increase in fat content during storage. According to Ketaren (1986) during fat storage there will be changes in flavor and taste accompanied by the formation of undesirable components and marked by the appearance of rancid odor, but also influenced by the state of the fat storage environment, namely Relative Humidity (RH) storage space, temperature, ventilation, pressure and transportation problems. The properties and resistance of fat to damage greatly depend on its constituent components, especially the content of fatty acids.

Table 1.
Scores acquisition of aroma parameter (%)

Score	Day 0		10th Day		20th Day		30th Day		40th Day	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	3.30	-	13.30	20.00
3	-	-	6.70	26.70	20.00	36.70	56.70	70.00	76.70	70.00
4	46.70	56.70	70.00	63.30	56.70	53.30	40.00	30.00	10.00	10.00
5	53.30	43.30	23.30	10.00	23.30	10.00	-	-	-	-

4.9. Texture

Results of score obtained percentage of texture (Table 2), showed that in observation I and II (day 0 and day 10), the texture score obtained by panelists ranged from score 4 and score 5 for treatments P1 and P2, which means panelists tend to like the texture of kimpul biscuits at the shelf life of day 0 and day 10. Furthermore, on the observation of the 20th day the texture scores of the panelists ranged from score 3, 4, and 5, but for score 3 it was higher in P2 treatment. On the 30th day observation showed texture scores ranging from score 3 and 4, but for score 3 it was higher in P2 treatment. Whereas the observation on the 40th day showed that the texture scores ranged from score 2, 3, and 4, with a score of 3 being higher in the P2 treatment.

Table 2.
Scores acquisition of texture parameter (%)

Score	Day 0		10th Day		20th Day		30th Day		40th Day	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	10.00	10.00
3	-	-	-	-	-	3.30	30.00	43.30	53.30	70.00
4	50.00	53.30	56.70	63.30	73.30	70.00	70.00	56.70	36.70	20.00
5	50.00	46.70	43.30	36.70	26.70	26.70	-	-	-	-

Total score of 4 and 5 was higher in the treatment of P1 (aluminum foil) than P2 (PE plastic). This is thought to be caused by polyethylene packaging having a high vapor permeability value which causes the rate of absorption of water vapor from the air to the product to be higher, resulting in reduced crispness of biscuit products. This was supported by Trisyulianti *et al.* (2001) which states that the density of the product is affected by its ability to absorb water. The higher the product's ability to absorb water, the texture will be less dense. In addition, according to Solihin *et al.* (2015) the texture of the product changes from solid to softer. This is because during storage there is water absorption from the environment into the product, so that the product experiences an expansion and when pressed it will have a dense texture due to increased cavities in the product

5. Conclusion, Implication and Limitation

5.1. Conclusion

The content of water, carbohydrates, ash, crude fiber and the number of microbes were not significantly different between the packaging types during storage, but the quality tends to decrease. Protein and fat contents decreased in quality and showed significant differences between the packaging types during storage.

The result showed that the sensory test of aroma was significantly different between the days of observation and decreased levels of preference, as well as the sensory test of texture.

5.2. Implication and Limitation

The implication of this research is that in determining the type of packaging a product must consider the characteristics of the product and the packaging material itself. It is intended that food products can be stored within a certain time while maintaining their quality.

The limitation of this study is the selection of two types of packaging. Future research can be further investigated by the use of more diverse packaging materials.

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