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Antioxidant Activity and Organoleptic Quality of Crackers with Differences in the Addition of Black Glutinous Tape and Baking Powder

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Abstract

Tapioca flour-based crackers are a popular dry snack in Indonesia, characterized by their high starch content. However, recent developments have focused on creating crackers that are not only tasty but also have high nutritional value. One way to achieve this is by fortifying crackers with fermented products like black glutinous rice tape. This ingredient is known for its excellent nutrition and high antioxidant content, making it a healthy addition to crackers. The expansion of the volume of crackers is the primary factor that affects the crispness and quality of the crackers. This study aims to determine the proportion of the addition of black glutinous rice tape and baking powder concentration to the characteristics of crackers and determine the best crackers that can produce good quality and are acceptable in terms of sensory. The research design was a randomized complete block design with two factors. The first factor of black glutinous rice tape percentage (20, 30, 40%) and the second factor of baking powder concentration (0.1, 0.2, 0.3%) repeated three times resulted in 27 attempts. The ANOVA two-way statistics was utilized by the researchers to evaluate the chemical data, followed by the Tukey test to detect any significant differences among the treatments. Moreover, they employed Friedman's method to carry out organoleptic testing. The Effectiveness Index method identified the best treatment for chemical and organoleptic analysis, which was T3B2 (0.2% baking powder and 40% black glutinous rice tape). This treatment resulted in an antioxidant activity of 141.15 ppm, a water content of 9.05%, and an ash content of 1.71%. In addition, the organoleptic scores for color, aroma, taste, and texture were rated 4.66, 4.66, 3.40, and 3.70, respectively (3=least liked, 4= liked).

Keywords: *Crackers, black glutinous rice, tape, antioxidant*

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INTRODUCTION

For some Indonesians, crackers are very popular and considered a mandatory snack consumed daily. Crackers are classified as crackers, which are types of dry, crispy, and thin-slab foods made from ingredients that contain high enough starch (D. Oleh & Koswara, 2009). Various efforts to diversify processed cracker products are being carried out to improve the quality and quality of crackers in line with the demands of increasingly savvy consumers. To improve the quality and diversity of crackers, manufacturers are exploring new ingredients and flavors. One way to achieve this is by adding fermented products like tape to the basic tapioca flour recipe.

Using tape as a fortifying ingredient not only enhances the taste and nutritional value of crackers but also introduces new and distinctive flavors. Tape that is often developed in Indonesia is a type of cassava tape and glutinous tape. Research on processed tape-fortified crackers has been carried out from tuber types including crackers from cassava tape (Palastri, 2020) and taro tuber tape crackers (Agustia, 2016), while tape crackers from glutinous rice types are still rarely carried out. Black glutinous rice tape (made from *Oryza sativa var. glutinosa*) is a highly nutritious alternative to white glutinous rice, with high fiber content and beneficial active substances.

Black glutinous rice tape is made from black glutinous rice through a fermentation process. Black glutinous rice tape is beneficial for improving gut health due to the presence of probiotics containing non-pathogenic, live microbes that help maintain a healthy balance of gut bacteria (Yulianto et al., 2022). Anthocyanins, found in black glutinous rice tape, provide blue, red, and purple colors while also offering numerous health benefits. These bioactive compounds have antioxidant activity and are known to have cholesterol-lowering and antitumor properties, according to Suhartatik* et al. (2013a). The unique texture of black glutinous rice tape can be attributed to its abundant amylopectin content, particularly in the fluffy sticky rice variety. By fortifying this tape, one can elevate the quality of crackers, enhancing their nutritional value, taste, and texture. As a result, black glutinous rice tape has the potential to serve as an appealing ingredient in the creation of healthier and more delectable snacks.

The texture of crackers is closely related to the development and development mechanism of crackers. Consumers tend to prefer crackers that rise perfectly compared to crackers that are less than optimal development or some parts do not experience perfect development (Rosiani & Widowati, 2015). Consumers generally tend to prefer crackers that have a high level of crunch and tight pores. This is because the texture heavily influences the quality of crackers. As noted by Rosiani and Widowati (2015), crackers made from tapioca alone tend to be less popular due to their tendency to become soggy. This is because tapioca contains amylose and amylopectin, which create air cavities during high-temperature frying (Jamaluddin, 2020). To achieve the desired texture and flavor, manufacturers include additional ingredients like black glutinous tape and baking powder.

The addition of baking powder aims to produce good dough development. Baking powder can produce gas in the form of CO_2 gas, through this expansion the penetration of spices in the dough will be more even. In this study, we will examine the variations in the addition of baking powder and the addition of black glutinous tape to the quality of the crackers produced. Crackers are chemically and organoleptically examined for suitability before being produced, looking for the optimal combination of results.

MATERIALS AND METHODS

The *tape* material used in this study is black sticky rice *tape* obtained from Sukorejo market tape sellers, Pasuruan with the same brand and grade. Ingredients for making crackers such as wheat flour, tapioca flour, sugar, salt, and baking powder (*koepoe-koepoe*) obtained from Sukorejo afternoon market, Pasuruan, ingredients for antioxidant analysis include 1,1-diphenyl-2-picrylhydrazil (Sigma Aldrich, USA), ethanol pro analysis, HCl, petroleum benzene (Merck), distilled water and iodine 0.01 N.

Making Black Glutinous Tape Crackers

Making black glutinous rice tape crackers begins with making dough from “wheat” flour and tapioca flour mixed in a ratio of 4: 1 with a total weight of 100 gr, mashed black sticky rice tape with a blender. Fine black

glutinous tape with a concentration of (20, 30, 40% w/w) is added to the dough Added 1% sugar, and 1% salt and baking powder with a concentration (0.1;0.2;0.3% w/w), and 100 cc water. The dough is put into molds and then steamed until cooked. Cooled at room temperature for 12 hours, then thinly sliced. Dried in the sun for approximately 2 – 3 days and then fried.

Cracker quality testing

The quality of crackers can be assessed using a combination of chemical and organoleptic testing methods. Chemical tests include antioxidant activity tests using the DPPH method (Okokon *et al*. 2019), moisture content tests using the oven method (Horwitz, 2006), and ash content tests using the oven method (Horwitz, 2006). Consumer acceptability included organoleptic tests of color, aroma, taste, and texture of crackers (hedonic) scores using 30 untrained panelists aged 20 – 50 years.

Statistical analysis

Statistical analysis on chemical and antioxidant test data using ANOVA two ways with a confidence level of 95%. If a significant difference is found, conduct Tukey's post-test using Minitab software. Additionally, analyze the organoleptic test data of crackers using the Friedman method with a significance level of 5%, and statistically analyze the results using Excel 2010. The best treatment of chemical and organoleptic test results was sought using the modified De Garmo Effectiveness Index test by Susrini (2003).

RESULTS AND DISCUSSION

Antioxidant Activity

The degree of antioxidant activity is commonly assessed through a parameter known as Inhibition Concentration 50%, abbreviated as IC_{50}. This parameter denotes the concentration needed to inhibit 50% of oxidation. The smaller the value indicates the higher the antioxidant activity of a compound.

Table 1 shows the average value of IC_{50} antioxidant activity of black glutinous rice crackers in various treatment combinations ranging from 141.15–405.97 ppm. Based on the study results, the T3B3 treatment with 40% black glutinous tape and 0.3% baking powder had the highest antioxidant activity with a value of 141.15 ppm. On the other hand, the T1B1 treatment that had 20% black glutinous tape and 0.1% baking powder had the lowest antioxidant activity, with a value of 405.97 ppm.

Table 1. Results of the mean antioxidant activity of crackers

Treatment Code	Black Glutinous Tape (%)	Baking Powder (%)	IC_{50} (ppm)
T1B1	20	0.1	405.97± 0.556[a]
T1B2		0.2	342.45± 0.595[b]
T1B3		0.3	338.29± 0.506[c]
T2B1	30	0.1	220.49± 0.430[d]
T2B2		0.2	214.87± 0.586[e]
T2B3		0.3	198.59± 0.642[f]
T3B1	40	0.1	148.13± 0.321[g]
T3B2		0.2	147.52± 0.275[g]
T3B3		0.3	141.15± 0.215[h]

The study found that higher percentages of black glutinous tape and baking powder led to increased antioxidant activity, indicating a high antioxidant content in black glutinous tape. Trinovani et al. (2020) found that black sticky rice fermented for 2 days had an antioxidant activity of 46.313 ppm due to anthocyanin compounds.

Water content

Testing the water content of glutinous tape cracker products aims to see the quality of crackers by SNI No. 0272-1999. The exact water content is related to the shelf life and durability of the cracker product.

Table 2 shows the average moisture content of black glutinous rice crackers in various treatment combinations ranging from 6.36 – to 11.95%. The T3B1 treatment, which added 40% black glutinous rice tape and 0.1% baking powder, had the highest water content, with a value of 11.95%, while the T1B3 treatment, which added 20% black glutinous rice tape and 0.3% baking powder, had the lowest water content, with a value of 6.36%.

Table 2. Mean Yield of Water Content of Crackers

Treatment Code	Black Glutinous Tape (%)	Baking Powder (%)	Water Content (%)
T1B1	20	0.1	8.8000 ± 0.0200^{cd}
T1B2		0.2	8.3567 ± 0.0208^{d}
T1B3		0.3	6.3667 ± 0.0153^{e}
T2B1	30	0.1	10.0567 ± 0.0404^{bc}
T2B2		0.2	8.7067 ± 0.0208^{cd}
T2B3		0.3	8.4533 ± 0.0252^{d}
T3B1	40	0.1	11.9567 ± 0.0115^{a}
T3B2		0.2	10.7533 ± 0.0737^{b}
T3B3		0.3	9.0500 ± 0.0200^{cd}

The results of variety analysis showed that there was a real influence on the treatment of adding black glutinous rice tape and a real effect on the addition of baking powder. The moisture content of crackers decreases when given more and more addition of baking powder. Baking powder, which is used in the production of crackers, contributes to this by causing part of the water present in the starch granules to evaporate under the influence of high temperatures, which causes the skeletal structure of the crackers to expand in size. According to Kusuma (2017) the addition of baking powder to the manufacture of crackers functions in volume development, regulating aroma, controlling spread and production results become lighter. Following the growth of volume, some water molecules are lost from the crackers' starch granules.

Inversely proportional to the addition of more and more black glutinous tape, the moisture content of crackers is getting bigger. This happens because black glutinous tape itself has watery characteristics which means the amount of water produced is high. According to Agustia (2016), the larger the tape added to crackers, the greater the water content because the tape is high in water. This happens because there are water molecules that are chemically bound to other molecules such as carbohydrates through hydrogen bonds that have great energy so that it is difficult to remove during the drying process.

According to SNI, the maximum water content of non-protein crackers has a value of 12%. All treatments of black glutinous rice tape cracker products from research have met SNI standards.

Ash content

Ash content testing is carried out with the aim of determining the inorganic or mineral components found in crackers with the addition of black glutinous tape. The average value of ash content of black glutinous rice crackers in various treatment combinations ranged from 0.89–1.71%. The ash content value of all treatments in accordance with SNI No. 0272-1999 is a maximum of 2%. The highest ash content was shown in the T3B3 treatment with a value of 1.71%, namely crackers with the addition of 40% black glutinous rice tape and 0.3% baking powder, while the lowest ash content in the T1B1 treatment with the addition of 20% black glutinous rice tape and 0.1% baking powder.

Table 3. Mean Yield of Cracker Ash Content

Treatment Code	Black Glutinous Tape (%)	Baking Powder (%)	Ash Content (%)
T1B1	20	0.1	0.89 ± 0.01^{a}
T1B2		0.2	1.02 ± 0.13^{b}
T1B3		0.3	1.25 ± 0.13^{d}
T2B1	30	0.1	1.01 ± 0.02^{b}
T2B2		0.2	1.30 ± 0.02^{d}
T2B3		0.3	1.50 ± 0.17^{e}
T3B1	40	0.1	1.05 ± 0.02^{c}
T3B2		0.2	1.22 ± 0.01^{d}
T3B3		0.3	1.71 ± 0.02^{f}

Table 3 shows that the greater the addition of black glutinous tape, and baking powder, the ash content increases. This is supported by the findings of variety analyzers, who indicate how the addition of black glutinous tape and baking powder alters the parameters of cracker ash content.

The increase in ash content is due to the large amount of minerals obtained from the source of black glutinous tape. This is consistent with Fauziyah's research (2020), black sticky rice tape can increase fiber and minerals in ice cream products by 45 mg. Baking powder treatment can also increase ash content. Baking powder itself in terms of chemical structure is a mixture of $NaHPO_3$ salts bonded to phosphate groups. The phosphate group and sodium ions present in baking powder may cause an increase in the concentration of minerals in crackers. According to Manik et al.'s research (2020), the addition of baking powder can raise the ash level of saga seed flour.

Organoleptic Quality

In order to evaluate the amount of panelists' response to the organoleptic preferences induced by black glutinous tape crackers, tests of color, aroma, taste, and texture on fried black glutinous tape cracker products were conducted.

Color

Based on the results of organoleptic tests, it was found that the panelists' favorability value for the color of black glutinous tape crackers

ranged from 2.23 to 4.66, which was between dislikes to the very liking (Figure 1).

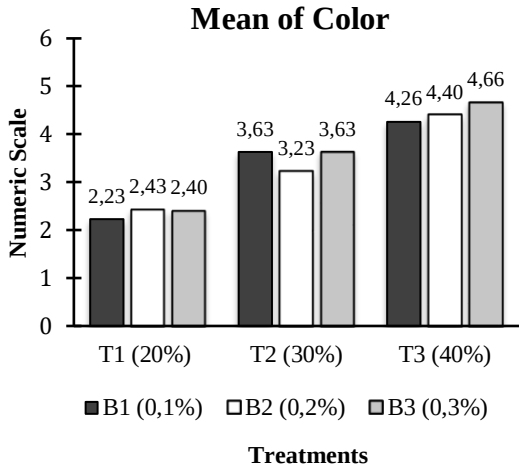

Figure 1. Bar Chart of panelists' level of liking for color on black glutinous tape crackers

Panelists' preference for the color of glutinous rice tape crackers was highest in B3T3 treatment (addition of 40% black glutinous rice tape and 0.3% baking powder) with an average value of 4.66 (very like) and the lowest in T1B1 treatment (addition of 20% black glutinous rice tape and 0.1% baking powder). The results showed that the panelists' preference for the color of crackers increased along with the addition of the concentration of black glutinous tape. The addition of black glutinous rice tape is getting bigger, the crackers produced are getting blacker. The anthocyanin pigments found in black glutinous rice or black glutinous tape contribute to the crackers' blackish hue.

Aroma

Based on the results of organoleptic tests, it was found that the panelists' favorability value for the aroma of black glutinous rice tape crackers ranged from 2.20 to 3.43, namely between dislike to like (Figure 2).

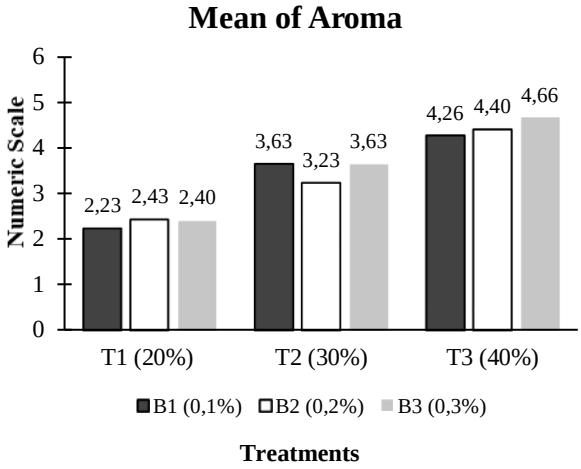

Figure 2. Bar Chart of panelists' level of liking for the aroma on black glutinous tape crackers

Panelists' preference for the aroma of glutinous rice tape crackers was highest in the B3T3 treatment (adding 0.3% baking powder and 40% glutinous tape) with a value of 3.43 and the lowest value was found in the B2T1 treatment (adding 0.2% baking powder and 20% glutinous tape) with a value of 2.20. The addition of black sticky rice tape made the cracker fragrance more appealing to the panelists. This is because the panelists like the aroma of black glutinous rice tape crackers much more when the concentration of black glutinous rice tape was added. Black sticky tape smells distinctly of tape. The aroma of black glutinous tape is caused by aromatic compounds such as acetaldehyde, diacetyl, acetoin, ethanol formed by tape fermentation from glutinous rice (Wongsa et al., 2018).

Taste

Based on the results of organoleptic tests, it was found that the panellists' favourability value for the taste of black glutinous rice tape crackers ranged from 3.33 to 3.70, which was between dislike to like (Figure 3).

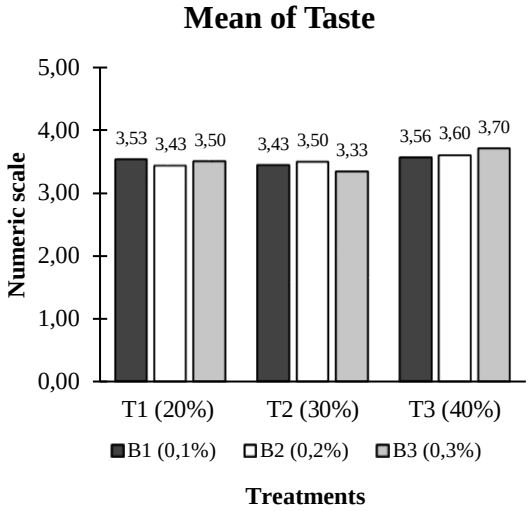

Figure 3. Bar Chart of panelists' level of liking for taste on black glutinous tape crackers

Panelists' preference for the aroma of glutinous rice tape crackers was found in the T3B3 treatment (addition of 40% glutinous rice tape and 0.3% baking powder) with a value of 3.70 and the lowest was found in the T2B3 treatment (addition of 30% glutinous rice tape and 0.3% baking powder) with a value of 3.33.

Based on Figure 3. The higher the concentration of black glutinous rice tape, the value of the taste score of black glutinous rice tape crackers increases. This is because black glutinous rice tape has a distinctive taste, so the more concentration of black glutinous rice tape, it can give a more tape-flavoured taste to the resulting black glutinous tape crackers.

Texture

Based on the results of organoleptic tests, it was found that the panelists' favourability value for the aroma of black glutinous rice tape crackers ranged from 3.40 to 4.40, which was between like and like.

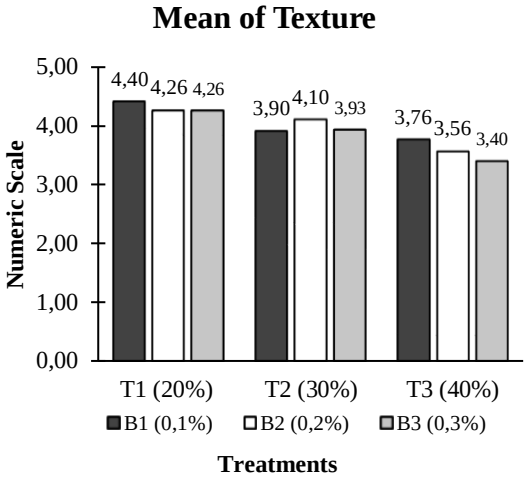

Figure 4. Bar Chart of panelists' level of liking for texture on black glutinous tape crackers

Panelists' preference for the texture of glutinous rice tape crackers was found in the T1B1 treatment (adding 0.1% baking powder and 20% glutinous tape) with a value of 4.4 and the lowest in the B3T3 treatment (adding 0.3% baking powder and 40% glutinous tape) with a value of 3.40.

The higher the concentration of black glutinous rice tape, the lower the texture score value of glutinous rice tape crackers. This is as a result of the sticky tape's high-water content. High water content will cause food components to have a softer texture (Suhartatik*, 2013b). The less water content, the harder the texture of foodstuffs. This causes the panelists' liking for the texture of crackers to decrease as the sticky rice tape increases.

Best Treatment

Effectiveness testing with De Garmo modified Susrini (2003) was used to identify the study's best therapy. Figure 5 illustrates how to determine the optimum way to treat black glutinous rice tape crackers.

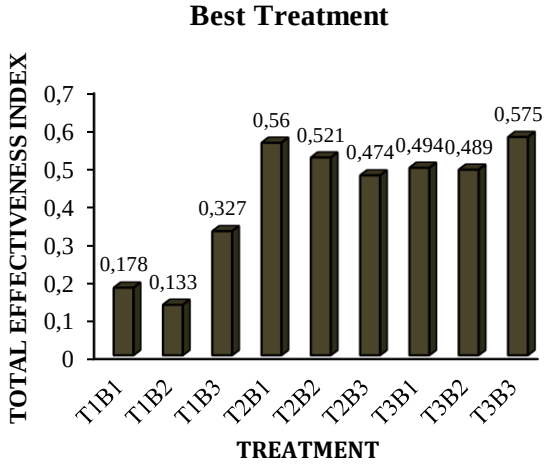

Figure 5. Bar Chart of Black Glutinous Tape Crackers Best Treatment

The results of the calculation of the effectiveness of the best treatment combination in research on making black glutinous tape crackers are crackers with T3B3 treatment with a percentage of adding 40% glutinous rice *tape*, and 0.2% baking powder with the following characteristics: antioxidant IC_{50} 141.15 mg / mL; moisture content 9.05; ash content 1.71%. The panelists' average color favorability rate of 4.66; aroma 4.66; texture 3.40; and taste 3.70 (3=least liked; 4= liked), respectively.

Cracker products from the best combination treatment research results in accordance with SNI 0272-1999 which states that the maximum moisture content is 12% and the maximum ash content is 2%. According to the best treatment in bar chart, the T3B3 treatment combination (40 percent black glutinous rice tape and 3 percent baking powder) received the top rating from the panelists for the characteristics of taste, color, and aroma.

Conclusion

Based on the study's findings, it can be said that the treatment's concentration of black glutinous tape and baking powder has a substantial impact on tests for antioxidant activity, moisture content, and organoleptic taste, color, and aroma. However, it has no noticeable effect on the parameters of ash content, organoleptic texture. The best combination of chemical and organoleptic test treatments is found in T3B3 treatment (40% black glutinous rice tape and 0.2% baking powder) with antioxidant activity (141.15 ppm), water content (9.05%), ash content (1.71%) color 4.66; aroma 4.66; texture 3.40 and taste 3.70. Black glutinous tape crackers produced are in accordance with SNI for non-protein type crackers so that they are suitable for consumption and production.

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