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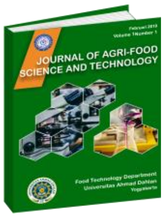

Effect of Wheat Flour and Yellow Pumpkin Flour Ratios on The Physical, Chemical Properties, and Preference Level of Cookies

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ABSTRACT

Cookies are made from flour, eggs, vanilla, margarine, and baking powder ingredients. The weakness of standard cookies is their low antioxidant content. Therefore, innovation is needed to increase the antioxidant level of these cookies. This study contributes to determining the effect of adding yellow pumpkin flour on selected cookies' physical, preference level, chemistry properties, and antioxidant activity. The proportion of adding pumpkin flour consists of 0%, 10%, 20%, 30%, 40%, and 50%. The physical analysis included color, texture, expansion volume, and the level of preference, including flavour, color, taste, texture, and overall, which are used to select the most preferred cookies by panelists. The chemical analysis includes moisture, ash, protein, carbohydrate contents, and IC_{50} *value for the most preferred cookies by panelists. The findings indicated that the selected formula by the panelist was cookies with 20% pumpkin flour substitution. The physical characteristics of cookies are a lightness color of 54.15, a texture of 1572.7 gF, and an expansion volume of 46.2%. The chemical elements are as follows moisture content of 4.68%, ash content of 1.53%, protein content of 8.15%, fat content of 26.10%, carbohydrate content by the difference of 59.54%, and* IC_{50} *as much as 84.84 ppm, which means that the selected cookies have intense antioxidant activity. The experiment's contribution was that increasing antioxidant intake through dietary choices can positively impact overall health and potentially reduce the need for medicinal intervention.*

1. INTRODUCTION

According to SNI 01-2973-1992, cookies are a form of dry confection prepared from soft dough that is dense in structure, high in fat content, and comparatively crunchy when cracked. Snacks like cookies are highly popular with familiar people. Cookies are created with the same materials used to make cakes: flour, poultry eggs, vanilla, margarine, and baking powder (Xu et al., 2020). Cookies don't shatter as readily as cakes and have a crunchy structure. The poor antioxidant concentration of cookies is one of their usual weaknesses. Innovation is therefore required to raise the antioxidant level of these biscuits (Anitha et al., 2020).

One of the local foods that can be used is pumpkin because it contains high levels of antioxidants with an IC_{50} value of 30.75 ppm. This can be interpreted that the antioxidant content in pumpkins is very strong because the more significant the antioxidant activity, the lower the IC_{50} amount. A material with an IC_{50} value <50 contains powerful antioxidants. If the IC_{50} value of a compound is 50-100 ppm, it can be said that the compound is strong. Then, for a value of 100-150 ppm, it is called moderate, and a value of 151-200 ppm is weak (Aziz et al., 2023; Lismawati et al., 2021)

Pumpkin is a local plant whose price is relatively low and easy to obtain in Indonesia but could be more attractive to the public. Even though the level of pumpkin production in Indonesia is relatively high and varies, its production continues to increase yearly. In 2021, the production of yellow pumpkins on the islands of Java (270,000 tons/year), Sumatra (94,000 tons/year), and Bali (70,000 tons/year) (Himawan et al., 2022). However, the use of pumpkin in Indonesia could be more optimal; therefore, to optimize this, it is necessary to develop more attractive food products, such as processing pumpkin into biscuits, like cookies.

Pumpkin flour is one of the products produced by pumpkin. This fruit can be processed into flour because it has a high enough carbohydrate content of 78.77% in every 100 g of fruit flesh. Pumpkin flesh that has been sliced into bits and ground, dried, or cooked in an oven is used to make pumpkin flour (Aziz et al., 2023; Kumari et al., 2021; Yok et al., 2016). Yellow pumpkin has a yellow pigment made from carotenoids because it contains 160 mg/100 g of carotenoids. Carotenoids are plants' yellow, red, and orange pigments, functioning as vitamin A and antioxidants (Mehditabar et al., 2020; Wahyuni & Widjanarko, 2015). The body uses antioxidants to lower its chance of heart disease and cancer (Anitha et al., 2020).

According to research conducted by Utami & Prasetyawati, (2020), the best addition of pumpkin flour to making Kastengel cookies is 20% pumpkin flour and 80% wheat flour with a total weight of 265 grams of flour because the added ratio produces Kastengel cookies that have a thick texture, the aroma and taste that the liked by panelists. Based on research conducted by Rismaya et al. (2018), the best addition of pumpkin flour favored by panelists in making muffins is 25% pumpkin flour and 75% wheat flour with a total weight of 525 grams of flour, because it has the best sensory assessment and contains high dietary fiber. From these data, it is hoped that adding pumpkin flour to food products is acceptable and can meet the nutritional food needs of the community (Kaur et al., 2019). This study contributes to determining the effect of adding yellow pumpkin flour on the physical and preference levels, chemistry properties, and antioxidant activity of selected cookies. The experiment's contribution was that increasing antioxidant intake through dietary choices can have a positive impact on overall health and potentially reduce the need for medicinal intervention.

2. MATERIALS AND METHODS

2.1. Materials

The materials used in this study to manufacture cookies used ingredients such as yellow pumpkin flour, low-protein flour, margarine, baking powder and milk powder, sugar, salt, and eggs. The materials used for analysis are aquades, Na_2SO_4, TiO_2, $CuSO_4$, H_2SO_4, NaOH, H_3BO_3 4%, indikator BCG-MR, HCl 0,02 N, n-heksan, DPPH (2,2-difenil-1-pikrilhidrazil) powder and methanol pro analysis.

The tools used in this research were a toaster oven (Kirin), hand mixer (Philips), blender (Philips), digital kitchen scale (SF-400), and a round cookie cutter with a diameter of 3 cm. Tools used for analysis were chromameter (Konica Minolta CR-400), texture analyzer (Brookfield), caliper, oven, cup, desiccator, electric stove, muffle furnace, analytical balance, Kjeldahl flask, and UV spectrophotometer.

2.2. Research Methods

2.2.1. The Process of Making Cookies

To initiate the cookie-making process, the butter and sugar are vigorously mixed using a mixer for a duration of 15 minutes. Subsequently, incorporate the egg yolks, baking powder, and powdered milk into the mixture while maintaining a low beating speed for a duration of 5 minutes. Afterward, combine it with wheat flour and pumpkin flour to create a cohesive dough. The dough is shaped into a circular form with a diameter of 3 cm and a thickness of around 0.7 cm. After that, the shaped dough is subjected to a baking process for a duration of 15 minutes at a temperature of 180 degrees Celsius. Figure 1 displays the flow diagram illustrating the process of producing cookies.

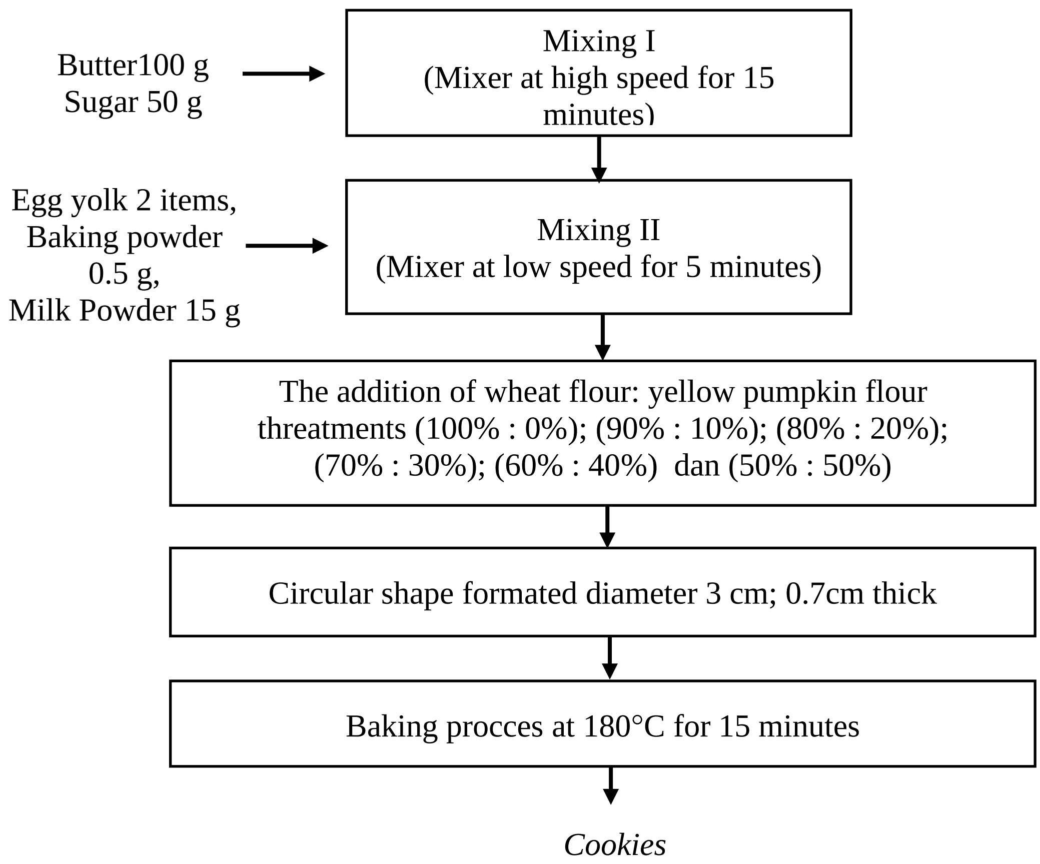

Figure 1. Cookies production

2.2.2. Formulation

The comparison between wheat flour and yellow pumpkin flour is 100%:0%, 90%:10%, 80%:20%, 70%:30%, 60%:40%, and 50%:50%. Cookie dough formulation consist of: 250 g wheat flour (butter 100g, sugar 50 g, egg yolk two items, baking powder 0.5g, and milk powder 15g). The dough is then baked for 15 minutes at 180°C.

2.2.3. Physical Analysis

The physical analysis carried out in this study included color analysis with a chromameter (Saricoban & Yilmaz, 2010), texture analysis with a texture analyzer (Smewing, 1999), and expansion power analysis with calipers based on the method Koswara, (2009).

2.2.4. Preference Level Test

The test that is most commonly used for evaluating consumer choice for a product's color, flavor, aroma, and texture is the preference level test using the hedonic test technique, which consists of five levels: like very much, like, neutral, rather dislike, do not like, really dislike, and so on. This test is used to test the panelist's reaction to a sample being tested. The results obtained in this test were then followed by chemical analysis, analysis of antioxidant activity, and IC_{50} (Kartika dan Bambang, 2001).

2.2.5. Chemical Analysis

Chemical analysis was carried out on the selected samples the panelists liked the most in the preference level test. Chemical analyses performed include the gravimetric method of water content analysis (AOAC, 2005), ash content analysis (AOAC, 2005), total protein content analysis using the Kjeldahl method (Apriyantono, 1989), fat content analysis using soxhlet (AOAC, 2005), analysis of carbohydrate levels (by difference), analysis of antioxidant activity and IC_{50} (Aini et al., 2021)

2.3. Research Design

In order to perform this study, a fully randomized design (CRD) was used, which was set up in a factorial design with just one variable (the amount of pumpkin flour added). Three different instances were given to the exercise. Then, data processing in this research used ANOVA analysis of variance at = 5% to ascertain whether the therapy had a notable impact. A differentiating test using the DMRT was performed on the data to determine if there was a significant effect.

3. RESULT AND DISCUSSION

3.1. Color Parameter

3.1.1. Lightness (L*)

Based on Table 1, it can be seen that the level of brightness (L*) of cookies substituted for pumpkin flour in the first treatment to the last treatment decreased. The highest intensity was found in cookies with the first treatment with a ratio of 100% wheat flour and 0% pumpkin flour at 66.22, and the lowest brightness level was found in cookies with 50% wheat flour and 50% pumpkin flour treatment at 51.28. The greater the value of L*, the brighter the color of the cookies produced. Meanwhile, the lower the L* value, the darker the color of the cookies created. The results of this study are the same as the research conducted by Budoyo et al. (2014), who used pumpkin flour as a substitute for making muffins. The results of his study showed that the L* value tended to decrease with the addition of pumpkin flour concentration, in the range of 73.7 - 59.4, from the addition of 0% - 30% pumpkin flour. The compounds formed due to the Maillard reaction affect the lower brightness value. The Maillard reaction occurs due to the reaction between carbonyl sugar groups, especially those derived from reducing sugars, with amino acids and peptides, which causes the formation of a crust or brown skin during the roasting process (Kusnandar, 2010).

3.1.2. Redness (a*)

Based on the results of the cookies' redness (a*) test in Table 1, the value of a* increases with the increase in the percentage of pumpkin flour. This condition is the same as research conducted by Asmaraningtyas (2014), who used pumpkin flour substitution in biscuit production, which showed the same a* value. His study showed that the* value increased with the increase in the percentage of pumpkin flour, which ranged from 5.47 to 14.30 from the addition of 0% - 30% pumpkin flour. The increase in a* value in cookies with pumpkin flour substitution is related to the presence of carotenoid pigments owned by pumpkin. This pigment causes cookies to turn reddish and brown after the roasting process, increasing the (a)* value in cookies (Liubych et al., 2023).

Table 1. Color analysis results

Treatments (WF:PF%)	Color		
	L*	a*	b*
100:0	66.22 [e]	5.73 [a]	22.50 [e]
90:10	56.88 [d]	6.29 [b]	20.90 [de]
80:20	54.15 [c]	7.26 [c]	19.65 [cd]
70:30	52.19 [b]	7.49 [d]	17.80 [bc]
60:40	52.00 [b]	7.56 [d]	16.65 [ab]
50:50	51.28 [a]	8.74 [e]	14.30 [a]

Noted: Values followed by the same letter in one parameter are not significantly different at the significant level p < 0,05. WF: Wheat Flour, PF: Pumpkin Flour

3.1.3. Yellowness (b*)

The b* value in this study ranged from 22.50 to 14.30. The yellowness value (b*) in the first to last treatment decreased, the lowest b* value was obtained from the 50% pumpkin flour substitution treatment with a value of 22.50, and the highest value was obtained from the control treatment with 0% pumpkin flour substitution with a value of 14.30. Table 1 shows that the value of b* decreased with the increasing percentage of pumpkin flour. This is due to the non-enzymatic browning process (caramelization), which is caused by a browning reaction without the influence of enzymes and occurs when the processing occurs. The browning process is caused by the meeting of reducing sugars and amino acids (the building blocks of protein) at a specific temperature and time (Arsa, 2016).

3.2. Texture

This study obtained texture values with an average of 1485.7 – 1927.1 gF. Table 2 shows that the lowest texture value was in the first treatment cookies, which was 1485.7 gF with 0% pumpkin flour substitution. In contrast, the highest texture value was in the cookies with the last treatment, which was 1927.1 gF with 50% pumpkin flour substitution. In Table 2, it can be seen that there is an increase in the texture value with the increasing percentage of pumpkin flour added. Pumpkin flour does not contain gluten like wheat flour, which can make the texture of the bread smoother. The gluten in cookies may not be strong enough to produce a smooth, hollow surface, resulting in tougher cookies (Susilawati et al., 2013).

Table 2. Cookies texture analysis results

Treatments (WF:PF%)	Texture (gF)
100:0	1485.7[a]
90:10	1499.3[ab]
80:20	1572.7[b]
70:30	1732.0[c]
60:40	1888.0 [d]
50:50	1927.1[d]

Noted: Values followed by the same letter in one parameter are not significantly different at the significant level p < 0,05. WF: Wheat Flour, PF: Pumpkin Flour

In addition, this is because yellow pumpkin flour has a fiber content ranging from 10-15% (AlJahani & Cheikhousman, 2017; Aziz et al., 2023). Fiber is a compound that does not dissolve in water and strengthens the material network; it functions as a texturizer in foodstuffs. So, the higher the fiber content in the raw material, the product with a more rigid, firmer, and more robust texture will be produced (Anitha et al., 2020).

3.3. Volume Expansion

Based on the analysis of the volume of cookies development, the results ranged from 65.8 – 14.3%. The lowest swelling volume value was obtained in the treatment with 50% pumpkin flour substitution, namely 14.3%. The highest swelling volume value was obtained in the treatment with 0% pumpkin flour substitution, namely, 65.8%.

Table 3. The results of the volume expansion analysis

Treatments (WF:PF%)	Volume expansion (%)
100:0	65.8[f]
90:10	62.5[e]
80:20	46.2[d]
70:30	40.3[c]
60:40	28.6[b]
50:50	14.3[a]

Noted: Values followed by the same letter in one parameter are not significantly different at the significant level $p < 0,05$. WF: Wheat Flour, PF: Pumpkin Flour

In Table 3, the percentage of the swelling volume shows a significant difference that is affected by pumpkin flour substitution. The more portion of pumpkin flour added, the smaller the value of the swelling volume. This is the same as the research conducted by (2018), who used pumpkin flour as a substitute for making muffins. In his study, the expansion volume value decreased with the increase in the percentage of addition of pumpkin flour. The decrease in swelling volume resulted from an increase in the concentration of pumpkin flour, which was related to a reduction in the gluten network in wheat flour, which was formed due to an increase in the dietary fiber content of pumpkin flour in the dough. The gluten network of gliadin and glutenin proteins includes a layer that can hold CO_2 gas. This causes the dough's ability to retain gas during baking to decrease so that the volume of expansion produced is low (Wulandari & Lembong, 2016).

3.4. Preference Level Analysis

Based on Table 4, the panelists' assessment of the aroma of pumpkin flour substitute cookies ranged from 2.15 to 4.15, with a dislike to like level. Cookies with the lowest rating were cookies in the fifth treatment with 40% pumpkin flour substitution, while cookies with the highest aroma rating were in the third treatment with 20% pumpkin flour substitution. The panelist's preference level for the aroma of pumpkin flour substitution cookies, namely cookies with 20% pumpkin flour substitution, is a value of 4.15, expressed as a liking level. According to (Montesano et al., 2018), pumpkin flour has a distinctive and fragrant aroma. The aroma of pumpkin flour is influenced by its sugar content, which is relatively high, so the drying process will produce food products that smell of caramel.

The cookies that the panelists liked the most were cookies with the slightest addition of pumpkin flour, namely 10%, because they had a bright yellow color and were not pale. The results of statistical tests showed that adding pumpkin flour to cookies had a significant effect on the resulting color. The cookies that the panelists disliked the most were cookies with 50% pumpkin flour substitution because they had a dark color and were unattractive. According to Hartaty et al., (2017), the greater the pumpkin flour added to the cookies, the more carotenoid content would increase. Hence, a large amount of pumpkin flour causes the color of the cookies to darken during the baking process. This is because pumpkin has carotenoid pigments, which give yellow, orange, and red-orange colors.

Table 4. Results of preference level analysis

Treatments (WF:PF%)	Score				
	Flavor	Color	Taste	Texture	Overall
100:0	3.00^{b}	3.25^{cd}	3.30^{bc}	3.00^{bc}	3.00^{cd}
90:10	2.60^{b}	3.85^{e}	2.90^{b}	3.55^{d}	3.30^{de}
80:20	4.15^{c}	3.65^{de}	3.70^{c}	3.70^{d}	3.60^{e}
70:30	3.85^{c}	3.10^{bc}	3.10^{b}	3.20^{cd}	2.60^{bc}
60:40	2.15^{a}	2.70^{b}	2.75^{ab}	2.55^{ab}	2.50^{ab}
50:50	2.85^{b}	2.05^{a}	2.35^{a}	2.40^{a}	2.15^{a}

Noted: Values followed by the same letter in one parameter are not significantly different at the significant level p < 0,05. WF: Wheat Flour, PF: Pumpkin Flour. Score: 1 (Very dislike), 2 (Dislike), 3 (Kinda like it), 4 (Like), 5 (Really like)

The taste of food is one of the determining factors of food. The panelists will like food that tastes good and is enjoyable. Based on Table 4, the taste assessment of cookies ranges from 2.35 to 3.70, with a level of dislike to somewhat like. Cookies with the lowest taste assessment were cookies with the last treatment with 50% pumpkin flour substitution with a value of 2.35. According to panelists, cookies with 50% pumpkin flour gave a slightly bitter aftertaste. According to Liubych et al., (2023), a bitter taste occurs due to the hydrolysis of amino acids during the manufacture of flour and roasting (maillard reaction), giving a bitter taste to food. The panelists shared the best assessment of the third treatment cookies with the addition of 20% pumpkin flour because the cookies still had a flavor that was acceptable to the tongue, not too flashy, and still normal.

Cookies with the lowest texture rating were the cookies with the last treatment with the addition of 50% pumpkin flour. In comparison, the highest texture value was in cookies with 20% pumpkin flour substitution, with a value of 3.70 and a slightly like level. The texture assessment values in the treatment with 10% and 20% pumpkin flour substitution were not significantly different in the DMRT test analysis because they had almost the same texture. In contrast, the physical study of cookies with a texture analyzer treatment of 20% pumpkin flour substitution had a higher value, which could mean that the cookies with this treatment had a firmer texture than cookies with 10% pumpkin flour substitution. The lowest panellist rating was the cookies with the most pumpkin flour substitution because the more pumpkin flour was added to the cookies, the more the texture became denser and more rigid. This is due to the higher fiber content in cookies (Kuchtová et al., 2016; Rismaya et al., 2018).

Based on the results of the preference level test in Table 4, the overall score ranges from 2.15 to 3.60, with a level of dislike to somewhat like. Cookies with the lowest overall rating were cookies with 50% pumpkin flour substitution, and cookies with the highest overall rating were cookies with 20% pumpkin flour substitution. The comprehensive evaluation of aroma, color, taste, and texture influences the panellist's assessment of overall preference. According to (Lismawati et al., 2021), panellist's differences in liking or disliking depended on their preferences for each treatment because each panellist's priority level was a relative matter. The overall assessment can reference the acceptance level of pumpkin flour substitute cookies. Adding a lot of pumpkin flour made the panellists dislike it because the color became increasingly brown and unattractive, the aroma was unpleasant, the taste left a bitter aftertaste, and the texture was tough. Based on the overall preference level test results, it can be concluded that cookies with 20% pumpkin flour are acceptable to the panellists. So, cookies with 20%

pumpkin flour are the best samples for further analysis.

3.5. Chemical Analysis of Selected Treatment Cookies

This analysis was carried out for samples in the previous sensory test, namely samples with 20% pumpkin flour. Chemical analysis in this study consisted of testing the content of water, ash, protein, fat, and carbohydrates by difference and antioxidant activity. The results of the chemical analysis of cookies are shown in Table 5.

Table 5. Chemical analysis of selected treatment cookies

Components (%wb)	score	*SNI (%)
Moisture content	4.68	Max. 5
Ash content	1.53	Max. 1,6
Protein content	8.15	Min. 5
Fat content	26.10	Min. 9,5
Carbohydrate *by difference*	59.54	Min. 70

*SNI 01-2973-2011

The moisture content results in this study were 4.66%, with 75% pumpkin flour substitution. The cookies added to 20% pumpkin flour in this study fulfilled the quality requirements in SNI 01-2973-2011. The resulting water content is the result of adding pumpkin flour to cookies due to the lumpy characteristics of pumpkin flour, which has a high-water content due to its hygroscopic characteristics. Hygroscopic characteristics mean that the sample is easy to absorb water due to the high content of simple sugars in pumpkin flour (Minarovičová et al., 2018; Wulandari & Lembong, 2016).

Based on Table 5, the selected cookies have an ash content of 1.53%, with the quality requirements of the Indonesian National Standard (SNI) 01-2973-2011 being a maximum of 1.6%. Meanwhile, according to the Food and Drug Supervisory Agency (2012) the maximum ash content in food is no more than 4%. The cookies selected in this study are safe for consumption because they meet the quality requirements of SNI. The ash content value of these selected cookies is almost the same as the ash content value in eggroll with 25% pumpkin flour substitution as a result of research by Tkachenko & Pakhomova, (2016) of 1.83%. The mineral content influences the ash content of cookies in pumpkin flour, including calcium, copper, iron, magnesium, manganese, phosphorus, selenium, and zinc (Hussain et al., 2022; Santoso et al., 2013).

The protein content in the selected cookies is 8.15%. These results meet the requirements of SNI 01-2973-2011. The protein content in cookies is at least 5%. The results of this study have a higher protein content than the results of research conducted by (Manurung et al., 2021), which used pumpkin flour substitution in the process of making cookies, with a protein content of 6.89%. This is because the cookie formulation in this study used two chicken eggs, and in the study, Manurung et al. (2021) did not use eggs at all because the protein content in eggs is relatively high at 12.8% (Sarifudin et al., 2015).

Based on Table 5, the fat content in cookies with 20% pumpkin flour substitution can be seen, which is 26.10%. The quality requirements of SNI 01-2793-2011 state that the minimum quality requirement for fat content is at least 9.5%. The fat content of fresh pumpkin is 1.34% per 100 g. In this study, the fat content in cookies was higher than the fat content in fresh pumpkins, and this was due to adding other ingredients, such as margarine, eggs, and milk, which could affect the high-fat content in cookies

The quality requirements for carbohydrate content, according to SNI 01-2973-2011, state that the minimum carbohydrate content in cookies is 70%. In this study, the carbohydrate content of the cookies produced was 59.54% and did not meet the SNI quality requirements.

Meanwhile, the carbohydrate content in fresh pumpkins is relatively high, namely 78.77%. This is the same as research conducted by Tkachenko & Pakhomova, (2016), which uses pumpkin flour for the eggroll manufacturing process. These results did not meet the SNI quality requirements. Other nutritional components influence the low carbohydrate content. The higher the nutritional content of different components, the lower the carbohydrate content produced. Carbohydrates in food are essential in determining the characteristics of food ingredients, such as color, taste, and texture. The primary function of carbohydrates is to produce energy in the body. The carbohydrate content is calculated by difference, so other nutritional components influence the carbohydrate content. The lower the other dietary components, the higher the carbohydrate content.

3.6. Antioxidant Activity

This study's antioxidant activity analysis was the IC_{50} antioxidant activity test using the DPPH (2,2-diphenyl-1-pikrylhidrazyl) method. The results of the antioxidant analysis in this study amounted to 84.84 ppm. This means that the IC_{50} antioxidant activity in 20% pumpkin flour substitution cookies has a strong antioxidant activity because it is between 50-100 ppm. A substance or compound is said to have an antioxidant activity value very strong if the IC_{50} value is less than 50 ppm, strong antioxidant if the IC_{50} value between 50 to 100 ppm, moderate antioxidant if IC_{50} is 100 to 250 ppm, weak antioxidant if IC_{50} is 250 to 500 ppm, and antioxidant is not active if IC_{50} is more than 500 ppm (Susanti et al., 2020).

Meanwhile, in the research conducted by Lismawati et al. (2021), pumpkin extract has an antioxidant activity of up to 18.43 ppm, which is very strong. The difference in antioxidant activity in this study was affected by heating because most of the antioxidants in pumpkin flour are vitamin C and beta-carotene, which cannot stand the heat (Aljahani, 2022; Hartaty et al., 2017).

4. CONCLUSIONS

Based on the study results, it was concluded that panellists preferred cookies with pumpkin flour substitution, with variations of adding 20% pumpkin flour and 80% wheat flour. The selected cookies have physical characteristics: a lightness color of 54.15, a texture of 1572.7 gF, and an expansion volume of 46.2%. The chemical characteristics of the selected cookies were as follows: moisture content of 4.68%, ash content of 1.53%, protein content of 8.15%, fat content of 26.10%, carbohydrate content by difference of 59.54%, and IC_{50} of 84.84 ppm, which means the selected cookies contain strong antioxidants activity.

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