Effect of *Curcuma mangga* Val. Powder and Yeast Addition on the Physicochemical and Sensory Properties of MOCAF-wheat Doughnut

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Abstract. Doughnuts can be made with local ingredients, such as Modified Cassava Flour (MOCAF). The addition of *Curcuma mangga* Val. (CM) powder, known for its antioxidant properties and health benefits, may enhance the quality of doughnuts. This study aimed to develop MOCAF-wheat doughnut products with increased antioxidant activity and high sensory acceptability. The preparation process included mixing, fermentation, shaping, and frying. A two-factorial completely randomized design (CRD) was employed, with varying levels of CM powder (2.5, 5, 7.5%) and yeast (1, 1.25, 1.5%). The resulting MOCAF-wheat doughnuts were evaluated for physical, chemical, and sensory properties. Statistical analysis was performed using Analysis of Variance (ANOVA) at a significance level of 0.05, followed by Duncan Multiple Range Test (DMRT) when significant differences were found. The selected MOCAF-wheat doughnut is 15 g CM powder and 2 g yeast formulation exhibited a moisture content of 19.46%, ash content of 0.96%, protein content of 10.82%, fat content of 23.78%, carbohydrate content of 44.98%, antioxidant activity of 48.74% RSA, and total phenolic content of 93.66 mg GAE/g db.

1 Introduction

The consumption of wheat-based processed products such as cakes and bread continues to increase. However, because wheat is high in gluten, people with celiac disease are advised to avoid it. The growing reliance on wheat also contributes to challenges with imports. To address these concerns, substituting wheat with local alternatives, such as MOCAF, offers an innovative solution. MOCAF flour, a fermented cassava product made using lactic acid bacteria, undergoes a process that converts sugar into organic acids. This alters the flour's properties, increasing viscosity, improving gelling ability, enhancing rehydration capacity,

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and boosting solubility. Additionally, fermentation can reduce the characteristic flavor of cassava [1].

MOCAF possesses properties similar to those of wheat flour, making it a potential substitute in the production of various products, such as doughnuts. Doughnuts are a bakery product characterized by their round shape with a hole in the center, and are typically deep-fried. They are generally made from high-protein wheat flour, chicken eggs, yeast, margarine or fat, and granulated sugar. A doughnut is known for its golden brown color, soft texture, high volume, and sweet taste. To enhance the functional value of the doughnut, CM It can be incorporated, as it contains antioxidant compounds.

CM is a shrub with a harvesting period of approximately one year. CM has a mango-like aroma and a tuberous rhizome. Phenolic compounds such as curcumin, flavonoids, tannins, epigallocatechin gallate, and gallic acid have been identified in CM [2]. A curcuminoid content of 88.6 mg/100 ml has been reported in the primary rhizome of CM [3]. Phenolic compounds possess the ability to prevent degenerative diseases. Using MOCAF flour combined with CM powder can reduce gluten content, potentially resulting in dough that does not rise optimally. Therefore, adding an appropriate amount of yeast is necessary to improve dough expansion and achieve optimal development.

Yeast, commonly known as *Saccharomyces cerevisiae*, is a leavening agent used in bread making. *S. cerevisiae* can be applied directly or first dissolved in warm water an insufficient amount of yeast results in dense bread with a coarse texture due to suboptimal fermentation. Conversely, an excessive amount of yeast produces bread with too many cavities and a strong alcoholic aroma. Under ideal conditions, yeast converts sugars into CO_2 gas, which is trapped within the dough, allowing further expansion and the formation of air cells that create pores during frying. The effect of adding CM powder in doughnut production has not been extensively studied. Therefore, this study aims to investigate the effects of varying levels of CM powder and yeast on MOCAF-wheat-flour doughnuts to obtain products with physicochemical properties that meet quality standards and are sensorially acceptable to panelists.

2 Materials and Methods

2.1 Materials

The ingredients used for doughnut preparation included wheat flour (Cakra), MOCAF (Point), skim milk (Point), eggs, margarine (Point), powdered sugar (Point), baking soda (Bimo), yeast (GS Donut), cooking oil (Hemart), and salt (Revina), all of which were obtained from Swalayan Inti Sari. CM (*Curcuma mangga* Val.) powder was supplied by CV Windra Mekar. The chemicals used in this study were hexane, hydrochloric acid, potassium sulfate, sulfuric acid, HgO, $NaOH–Na_2S_2O_3$, H_3BO_3, MR: BCG indicator (2:1), catalyst, 95% ethanol, DPPH, BHT, and Folin–Ciocalteu reagent.

2.2 Equipment

The equipment used for doughnut preparation included a mixer, a scale, mixing bowls, a baking tray, and a deep-fryer. For analysis, the following instruments were employed: weighing bottle, desiccator, UV-vis spectrophotometer (Genesys UV minim 1240), vortex mixer (type 37600), volumetric pipettes, volumetric flasks (Pyrex Iwaki), Kjeldahl flasks, Erlenmeyer flasks, vernier caliper, Soxhlet extractor, muffle furnace, colorimeter, and texture analyzer.

2.3 Research Methods

2.3.1 Doughnut preparation

The preparation of MOCAF-wheat-flour doughnuts was carried out in several stages: mixing, fermentation, shaping, and frying. Mixing was continued until all ingredients were fully incorporated and the dough reached an elastic consistency. The first mixing consisted of 75 g of MOCAF, 25 g of wheat flour, CM powder (2.5, 5, 7.5%), and 10 ml of water. The second mixing was carried out by adding 40 g of margarine, 100 g of eggs, 20 g of skim milk powder, 1 g of baking soda, and 2 g of salt, followed by the final mixing with 40 g of powdered sugar and yeast (1, 1.25, 1.5%). The dough was then allowed to rest for 30 minutes until it expanded, covered with plastic wrap, shaped, and further rested for 10 minutes to optimize expansion. Finally, the doughnuts were fried over low heat until cooked.

2.4 Preference Level Test

The preference level test was conducted using the scoring hedonic test method to determine panelists' acceptance of the MOCAF-wheat Doughnut. The attributes assessed include color, aroma, taste, and overall. The assessment was carried out by semi-trained panelists using a scale of 1-5, where 1 = strongly disliked and 5 = strongly liked.

2.5 Chemical Analysis

2.5.1 Antioxidant activity [4]

Sample (1 g) was extracted with 10 mL of ethanol, vortexed, and macerated for 24 hours. The extract was filtered, diluted to 10 ml, and then 0.2 ml of the sample was mixed with 3.8 ml DPPH, vortexed, and stored in the dark for 30 minutes. Ethanol was used as a blank. Absorbance was measured at 517 nm.

2.5.2 Moisture content [5]

The weighing bottle and lid are dried in the oven for 5 hours, then cooled in a desiccant for 10 minutes, then weighed (= W0 g). Weigh approximately 1-2 g of the sample in such a weighing bottle, and the sample is evenly distributed (= W1 g). Place the weighing bottle with its contents and lid in the oven for 5 hours. Avoid contact between the weighing bottle and the oven wall. Remove the weighing bottle and its contents, cool it in a desiccant, then weigh it (= W2 g). Dry again in the oven and weigh until a fixed weight is obtained (at least once every 3 hours). The analysis was carried out in 2 batches of 2 repeats each.
Account:

$$\text{Moisture content (\% wet basis)} = \frac{W1-W2}{W1-W0} \times 100\% \qquad (2)$$

2.5.3 Total phenol content with the Folin-Ciocalteu method [4]

A sample (50 µl) was mixed with 250 µl of pure Folin-Ciocalteu reagent for 1 minute, then 750 µl of 20% Na_2CO_3 was added, vortexed, and diluted to 5 ml with distilled water. The solution was incubated at room temperature for 2 hours, ethanol was used as a blank, and absorbance was measured at 760 nm.

2.5.4 Carbohydrate content by difference [6]

Carbohydrate content was calculated by subtracting the sum of moisture, ash, fat, and protein percentages from 100%

2.5.5 Moisture content [5]

Weighing bottles were dried in an oven for 5 hours and cooled in a desiccator (W_0). A sample (1–2 g) was placed in the bottle (W_1) and oven-dried for 5 hours. After cooling in a desiccator, the sample was weighed. Oven-drying was repeated until a constant weight was obtained (W_2).

2.5.6 Ash content [5]

A porcelain crucible with constant weight (A) was used. A sample (2-10 g) was incinerated on an electric stove until ash formed (B), then placed in a muffle furnace at 600 °C for 30 minutes. The resulting ash was oven-dried for 5 hours and weighed at 3-hour intervals until a constant weight (C) was achieved.

2.5.7 Fat content

A sample (5 g) was weighed into a Soxhlet extraction thimble and extracted with benzene at 80 °C for 5 hours. The solvent and extracted fat were collected in a pre-weighed flask. The solvent was evaporated, and the remaining fat was oven-dried for 5 hours until constant weight.

2.5.8 Protein content [5]

Sample (0.05 g) was placed in a Kjeldahl flask, 0.05 g catalyst and 2 ml H_2SO_4 were added, and the mixture was digested until clear. After adding 15 ml distilled water and 8 ml Na-thiosulfate, the solution was distilled and collected in an Erlenmeyer flask containing 5 ml H_3BO_3 and 2–3 drops of BCG:MR indicator, diluted to 60 ml, and titrated with 0.02 N HCl.

2.5.9 Experimental Design

The experimental design used in this study was a two-factorial completely randomized design (CRD), with varying levels of CM powder (2.5, 5, 7.5%) and yeast (1, 1.25, 1.5%)

2.5.10 Data Analysis

The research data were statistically analyzed using ANOVA (Analysis of Variance). If there were significant differences, they would be further analyzed using the DMRT (Duncan Multiple Range Test) or the Duncan double distance test in SPSS (Statistical Product and Service Solutions) version 25.0.

3 Results And Discussion

3.1 Physical Properties

3.1.1 Expansion Volume

The expansion volume data of MOCAF-wheat flour doughnuts are presented in Table 1.

Table 1. Expansion volume of the MOCAF-wheat doughnut

Yeast (g)	CM Addition (g)		
	5	10	15
2	16,80±0,14^{a}	17,64±0,28^{a}	19,77±0,35^{bc}
2,5	19,44±0,42^{b}	20,53±0,28^{c}	23,09±0,17^{d}
3	24,64±0,56^{e}	22,33±0,74^{d}	25,00±0,21^{e}

Notes: Numbers followed by different letters in the same column indicate a significant difference at the 95% confidence level (α<0.05).

Table 1 The expansion volume of MOCAF-wheat flour doughnut showed a significant effect of yeast concentration and CM powder addition. The expansion percentage ranged from 16.80% to 25.00%. The highest expansion was observed with 15 g CM and 3 g yeast (25.00%), followed by 5 g CM and 3 g yeast (24.64%). Expansion volume was strongly influenced by yeast concentration, as a higher amount of yeast led to greater dough expansion. A higher expansion volume results in a softer final product texture. This finding is consistent with [7], who reported that increasing yeast levels enhances dough expansion and bread volume.

The addition of CM powder also significantly affected doughnut expansion volume. Increasing levels of CM powder resulted in higher expansion volume. CM contains antioxidant compounds such as curcumin, phenolics, and flavonoids, which may protect key enzymes involved in gluten formation and dough structure. More stable gluten networks allow better expansion during fermentation. This result aligns with ([8] who found that higher levels of antioxidants (curcumin and quercetin) improved dough expansion.

3.1.2 Color

Lightness (L*)
The lightness values of the donut samples are presented in Table 2.

Table 2. Lightness (L*) values of the MOCAF-Wheat doughnut

Yeast (g)	CM Addition (g)		
	5	10	15
2	58,48±0,35^{cd}	57,84±0,35^{bc}	55,14±0,42^{a}
2,5	59,29±1,80^{cd}	57,92±0,99^{bcd}	56,54±0,44^{ab}
3	64,10±0,48^{e}	59,80±0,23^{d}	58,99±0,37^{cd}

Notes: Numbers followed by different letters in the same column indicate a significant difference at the 95% confidence level (α<0.05).

Table 2 shows that the addition of CM powder and yeast significantly affected the L* values of MOCAF-wheat doughnuts. The highest L* value was observed in the sample with 5 g of CM powder and 3 g of yeast (64.10), while the lowest was in the sample with 15 g of

CM powder and 2 g of yeast (55.14). Increasing the amount of CM powder reduced the L*, although no significant difference was observed between the 10 g and 15 g additions. L* decreases with increasing CM addition. Higher concentrations of *Curcuma mangga* Val. resulted in a darker color in boba products. CM contains yellow-orange pigments derived from curcuminoids, which contribute to its yellowish coloration. Variations in yeast concentration showed that higher yeast additions produced brighter MOCAF-wheat doughnuts, whereas higher CM levels lowered brightness.

Redness (a*)

The redness (a*) values of the donut samples are presented in Table 3.

Table 3. Redness (a*) values of the MOCAF-wheat doughnut

Yeast (g)	CM Addition (g)		
	5	**10**	**15**
2	$3,60\pm0,55^{a}$	$3,99\pm0,05^{abc}$	$4,37\pm0,31^{bcd}$
2,5	$3,73\pm0,35^{a}$	$4,52\pm0,09^{cd}$	$4,75\pm0,22^{f}$
3	$3,86\pm0,18^{ab}$	$4,65\pm0,18^{f}$	$4,87\pm0,18^{f}$

Notes: Numbers followed by different letters in the same column indicate a significant difference at the 95% confidence level ($\alpha<0.05$).

Table 3 shows that the addition of CM powder and yeast had a significant effect on the a* values of the MOCAF-wheat doughnut. Increasing the levels of CM powder and yeast resulted in higher redness values. The higher a* values in the doughnut were influenced by the curcumin content in CM, which has a yellow-orange color, as well as non-enzymatic browning reactions that contribute to a brownish appearance [6].

Yellowness (b*)

The yellowness values of the donut samples are presented in Table 4.

Table 4. Yellowness (b*) values of the MOCAF-wheat doughnut

Yeast (g)	CM Addition (g)		
	5	**10**	**15**
2	$3,60\pm0,55^{a}$	$3,99\pm0,05^{abc}$	$4,37\pm0,31^{bcd}$
2,5	$3,73\pm0,35^{a}$	$4,52\pm0,09^{cd}$	$4,75\pm0,22^{f}$
3	$3,86\pm0,18^{ab}$	$4,65\pm0,18^{f}$	$4,87\pm0,18^{f}$

Notes: Numbers followed by different letters in the same column indicate a significant difference at the 95% confidence level ($\alpha<0.05$).

Table 4 shows that the variations in yeast and CM powder addition had a significant effect on b* values. The MOCAF-wheat donut dough supplemented with CM powder exhibited a more yellowish color. The donut is more yellowish due to the addition of white turmeric powder, which is rich in curcuminoids. According to [3], the first buds of white turmeric have a curcuminoid content of 37.5 mg/100 g of dried extract. The yellowness value of MOCAF-wheat doughnut increased with increasing CM powder addition. Similarly, [9] reported that the amount of CM powder added was proportional to the yellowness level of boba products.

3.1.3 Texture

The texture values of the doughnut with varying amounts of turmeric powder (CM) and yeast are presented in Table 5.

Table 5. Texture of the MOCAF-wheat doughnut

Yeast (g)	**CM Addition (g)**		
	5	**10**	**15**
2	$3{,}60\pm0{,}55^{a}$	$3{,}99\pm0{,}05^{abc}$	$4{,}37\pm0{,}31^{bcd}$
2,5	$3{,}73\pm0{,}35^{a}$	$4{,}52\pm0{,}09^{cd}$	$4{,}75\pm0{,}22^{f}$
3	$3{,}86\pm0{,}18^{ab}$	$4{,}65\pm0{,}18^{f}$	$4{,}87\pm0{,}18^{f}$

Notes: Numbers followed by different letters in the same column indicate a significant difference at the 95% confidence level ($\alpha<0.05$).

The texture of donut samples indicated that increasing yeast addition decreased hardness values. The higher the yeast concentration in the MOCAF-wheat doughnut, the softer the texture. Yeast not only serves as a donut-raising agent through the production of carbon dioxide gas, but it also contributes to the formation of a softer texture of the donut. During fermentation, *Saccharomyces cerevisiae* produces CO_2, which is trapped in the gluten matrix, forming pores in the dough. This pore structure makes the dough softer and holier when baked. Carbon dioxide gas produced by yeast becomes trapped within the gluten network. Protein-rich ingredients such as milk, eggs, and flour help maintain the gluten structure, thereby preventing carbon dioxide from escaping from the dough. Properly leavened dough provides a soft texture.

3.2 Preference levels

The sensory evaluation scores for donut samples, as assessed by panelists, are presented in Table 6.

Table 6. Sensory scores of the MOCAF-wheat doughnut

TreaCMents		**Parameter**				
CM Powder (g)	**Yeast (g)**	**Color**	**Aroma**	**Flavor**	**Overall**	
2.5	2	$2{,}91\pm0{,}75^{a}$	$3{,}50\pm0{,}60^{a}$	$2{,}18\pm0{,}85^{a}$	$2{,}82\pm0{,}60^{a}$	$2{,}82\pm0{,}66^{a}$
	2,5	$2{,}91\pm1{,}15^{a}$	$3{,}55\pm0{,}86^{a}$	$3{,}50\pm0{,}80^{cde}$	$3{,}55\pm0{,}80^{bc}$	$3{,}36\pm0{,}90^{abc}$
	3	$3{,}32\pm0{,}84^{a}$	$3{,}36\pm0{,}73^{a}$	$2{,}68\pm0{,}89^{ab}$	$3{,}18\pm1{,}01^{abc}$	$2{,}95\pm0{,}84^{ab}$
5.0	2	$3{,}59\pm0{,}80^{a}$	$3{,}68\pm0{,}65^{a}$	$3{,}18\pm0{,}73^{bcde}$	$3{,}59\pm0{,}91^{bc}$	$3{,}55\pm0{,}74^{bc}$
	2,5	$3{,}50\pm1{,}12^{a}$	$3{,}64\pm0{,}79^{a}$	$3{,}09\pm0{,}92^{bcd}$	$3{,}23\pm1{,}15^{abc}$	$3{,}27\pm1{,}12^{abc}$
	3	$2{,}91\pm1{,}11^{a}$	$3{,}36\pm1{,}00^{a}$	$3{,}77\pm0{,}97^{e}$	$3{,}36\pm1{,}00^{abc}$	$3{,}41\pm0{,}96^{abc}$
7.5	2	$3{,}41\pm0{,}96^{a}$	$3{,}73\pm0{,}83^{a}$	$3{,}64\pm0{,}95^{de}$	$3{,}77\pm0{,}75^{c}$	$3{,}73\pm0{,}70^{c}$
	2,5	$3{,}27\pm0{,}88^{a}$	$3{,}50\pm0{,}86^{a}$	$3{,}05\pm0{,}99^{bcd}$	$2{,}95\pm1{,}00^{ab}$	$3{,}09\pm0{,}92^{ab}$
	3	$3{,}23\pm1{,}11^{a}$	$3{,}27\pm0{,}83^{a}$	$2{,}91\pm1{,}19^{bc}$	$2{,}73\pm0{,}99^{a}$	$2{,}95\pm1{,}00^{ab}$

Notes: Numbers followed by different letters in the same column indicate a significant difference at the 95% confidence level ($\alpha<0.05$).

Variance analysis calculations show that the addition of lemon extract and CMC exerts a noticeable Influence on color, aroma, taste, and overall. The following is an elaboration of the analysis of the results of the test of the level of preference of white turmeric juice drinks that have been carried out. Sensory evaluation was conducted using human senses to measure product acceptability. The senses of sight, touch, smell, and taste were used to evaluate the product's sensory characteristics, which determine whether panelists like or dislike it. Each panelist was provided with a questionnaire containing assessment parameters, including color, aroma, texture, taste, and overall acceptability.

Color is the first attribute consumers evaluate when assessing a food product. Visual appearance plays a crucial role, as an unattractive or unusual color may reduce consumer acceptance even if the product has good nutritional value. Color is the fastest and most easily observed sensory response.

Statistical analysis indicated that the addition of CM powder and yeast did not significantly affect the color of MOCAF-wheat doughnut. The doughnut exhibited a yellowish-brown color, attributed mainly to the curcuminoid compounds in CM, which impart a yellow–orange hue. The brownish tone may also result from Maillard reactions during high-temperature frying [10].

Aroma is generally described as pleasant, sour, or rancid [6]. Sensory evaluation revealed that CM powder and yeast levels did not significantly Influence donut aroma, with scores ranging between 3.27 and 3.73. This indicates that the samples were moderately liked to liked by the panelists. Aroma is influenced not only by the raw material but also by processing conditions.

Texture refers to the physical properties of food perceived by touch and reflects the product's combined physical and chemical characteristics. Results in Table 6 demonstrated that CM powder and yeast levels significantly affected the texture of MOCAF-wheat doughnut. Doughnuts formulated with 5 g CM and 2 g yeast differed significantly from those with 10 g CM and 3 g yeast. Increasing yeast addition enhances CO_2 production, improving dough expansion and resulting in a softer texture.

Taste is a key sensory parameter assessed by the sense of taste. Balanced savory or sweet notes typically increase consumer preference. Taste is influenced by aroma, flavor compounds, and texture (mouthfeel).

Sensory results indicated that the interaction of CM and yeast significantly influenced taste acceptance. Doughnuts with 15 g CM and 2 g yeast differed significantly from those with 15 g CM and 3 g yeast. CM imparts a unique flavor and, when used in optimal amounts, increases consumer acceptability. However, excessive yeast addition may produce excessive CO_2, leading to rapid expansion and a sour aftertaste, reduced sweetness, and a coarse crumb structure. This finding is consistent with previous studies on bread, which found that excessive yeast led to a sour flavor and an undesirable texture [11].

Overall sensory scores of MOCAF-wheat doughnut ranged from 2.82 to 3.73. The most preferred formulation was a doughnut with 15 g CM and 2 g yeast, characterized by a yellowish-brown color, neutral aroma, soft texture, and a mild mango aroma. In addition, higher CM incorporation may also contribute to increased antioxidant activity in the doughnut.

3.3 Chemical Properties

The chemical composition of the selected donut formulation (15 g CM powder and 2 g yeast) is presented in Table 7.

Table 7. Chemical composition of selected MOCAF-wheat doughnuts

Component	Value (%)	SNI Donut Standard (%)
Moisture	19.4	Max 40%
Ash	0.96	Max 3.0%
Fat	23.78	Max 33%
Protein	10.82	–
Carbohydrate (by difference)	44.98	–
Antioxidant activity (%RSA)	48.74	–
Total phenolics content (mg GAE/g)	93.66	–

3.3.1 Moisture Content

The selected donut formulation had a moisture content of 19.46%. This relatively low level may be attributed to the flour's amylose content, which has a water-binding capacity. Food products with high moisture content are more susceptible to spoilage. A moisture content of 24.05% in a doughnut with 5 g puree CM and 2 g yeast [12]., slightly higher than in the present study. Increased CM addition likely reduced dough elasticity, thereby increasing water evaporation during frying.

3.3.2 Ash Content

The ash content of the selected donut was 0.96%, well below the SNI maximum of 3.0%. Ash represents the mineral fraction of food [6]; its presence indicates the level of mineral elements in the product. A higher ash content corresponds to greater mineral content. In this study, frying and the use of additional ingredients likely contributed to the increase in ash compared to raw MOCAF flour (0.30%). Similar findings were reported by [13], who reported that ash decreases during boiling but increases during frying.

3.3.3 Protein Content

The protein content of the selected MOCAF-wheat doughnut was 10.82%. The ingredients, such as wheat flour, MOCAF flour, and eggs, mainly contribute to this relatively high protein level. For comparison, [14] reported that protein content in a conventional doughnut was 5.63 g per 100 g, which is lower than that of the MOCAF-wheat donut. The addition of CM and yeast can slightly increase protein content, but the effect is not significant, as CM contains only 1–2% protein on a dry weight basis.

3.3.4 Fat Content

The fat content of the selected MOCAF-wheat donut was 23.78%, which is below the SNI maximum limit of 33% for doughnuts. The frying process increases the fat content by absorbing oil. Oil enters the donut matrix as water evaporates during frying, filling the pores left by evaporated moisture. The composition of the ingredients influences the doughnut's fat content, the dough's moisture content, and the frying process. Frying at a high temperature for a certain amount of time causes oil to enter the dough's pores, so that the longer the dough shaft, the greater the fat content produced. Fat plays an important role as an energy source in food. However, excessive consumption of fat should be limited, as high-fat content can negatively impact health. Fat is also a critical factor in food stability because it is prone to oxidation, which can lead to rancidity. Therefore, controlling the fat content of fried products is essential to maintaining shelf life and product quality.

3.3.5 Carbohydrate Content

The selected MOCAF-wheat donut contained 44.98% carbohydrates. The proximate composition of other nutrients influences the carbohydrate content by difference. The higher the proportion of other components (water, protein, fat, ash), the lower the carbohydrate content, and vice versa. The use of additional ingredients, such as MOCAF flour, also contributes to the carbohydrate content. MOCAF flour typically contains about 85.50% carbohydrates [15], which supports the relatively high carbohydrate content in the donut.

3.3.6 Antioxidant Activity

The selected MOCAF-wheat donut exhibited antioxidant activity of 48.74% RSA. Increasing the amount of CM powder significantly enhances the product's antioxidant activity. Blanching CM powder can further improve antioxidant activity [4]. CM contains high levels of total phenolics, which act as natural antioxidants.

4 Conclusion

Variations in the addition of CM powder and yeast significantly affected the physical properties of the doughnut, including color, texture, and volume expansion. The selected from the level of preference, with 15 g CM powder and 2 g yeast, exhibited the following chemical characteristics: moisture content of 19.46% (wet basis), ash content of 0.96% (dry basis), protein content of 10.82% (dry basis), fat content of 23.78% (dry basis), carbohydrate content of 44.98% (dry basis), and antioxidant activity of 48.74% RSA.

Acknowledgements. Thank you to CV Windra Mekar for funding the research until it is completed.

References

1. J. N. Setiawan and P. S. Jayendra, Penggunaan Tepung Mocaf dalam Pembuatan Glutenfree Pasta. *J. Ilm. Pariwisata Dan Bisnis*. **2,** 12, 2648–2654 (2023). doi: 10.22334/paris.v2i12.656.
2. U. Nuurachmawati, D. Pujimulyani, S. Tamaroh, and E. Windrayani, Antioxidant Compound of *Curcuma mangga* Val. with Variation in Rhizome Parts and Soil Types. *Indones. Food Nutr. Prog.*, **21,** 2, 51 (2024). doi: 10.22146/ifnp.91257.
3. D. Pujimulyani, A. W. Yulianto, A. Setyowati, Prasetyo, S. Widrayahya, and A. Maruf, White saffron (*Curcuma mangga* Val.) attenuates diabetes and improves pancreatic β-cell regeneration in streptozotocin-induced diabetic rats. *Toxicol. Rep.* **9,** 1213–1221 (2022). doi: https://doi.org/10.1016/j.toxrep.2022.05.014
4. D. Pujimulyani, U. Santoso, S. Luwihana D, and A. Maruf, Orally administered pressure-blanched white saffron (Curcuma mangga Val.) improves antioxidative properties and lipid profiles in vivo. *Heliyon*. **6,** 6, e04219 (2020). doi: 10.1016/j.heliyon.2020.e04219.
5. AOAC, *Association of officiating Analytical Chemist*, Official method of analysis (18th edn). Washington DC, (2005).
6. F. Winarno, *Kimia Pangan dan Gizi*. Jakarta: Gramedia, (2022).
7. N. Rayani, L. Darlian, L. Kolaka, and D. Triyaswati, View of Pengaruh Konsentrasi Ragi dan Proofing pada Pembuatan Adonan Roti. *AMPIBI J. Alumni Pendidik. Biol.* **9,** 1, (2024). doi: https://doi.org/10.36709/ampibi.v9i1.66.
8. T. Bojňanská, A. Kolesárová, M. Čech, D. Tančinová, and D. Urminská, Extracts with Nutritional Potential and Their Influence on the Rheological Properties of Dough and Quality Parameters of Bread. *Foods*. **13,** 3, 382 (2024). doi: 10.3390/foods13030382.
9. A. S. Dori, D. Pujimulyani, and C. L. Suryani, Pengaruh Penambahan Bubuk Kunir Putih (*Curcuma mangga* Val.) dan Carboxy Methyl CelluloseTerhadap Sifat Fisik,

Kimia dan Tingkat Kesukaan Boba. in *Prosiding Seminar Nasional Mini Riset Mahasiswa*, in 2, vol. 1. Gorontalo: Universitas Negeri Gorontalo, 2022, pp. 81–96.
10. W. Marsigit, B. Bonodikun, and L. Sitanggang, Effect of Addition Baking Powder and Water on Sensory and Physical Characteristics of Mocaf (*Modified Cassava Flour*) BISCUITS. *J. Agroindustri*. **7,** 1, 1–10 (2017). doi: 10.31186/j.agroind.7.1.1-10.
11. K. M. Sitepu, Penentuan Konsentrasi Ragi Pada Pembuatan Roti. *J. Penelit. Dan Pengemb. Agrokompleks*. **2,** 1, 71–77 (2019).
12. R. Rinayah, Pengaruh Penambahan Ragi dan Kunir Putih (*Curcuma mangga* Val.) terhadap Sifat Fisik, Kimia dan Tingkat Kesukaan Donat Mocaf-Terigu. *Program Studi Teknol. Pengolah. Has. Pertan.* (2021).
13. J. Y. Issa, A. Onyango, A. O. Makokha, and J. Okoth, Effect of Boiling and Wet Frying on Nutritional and Antinutrients Content of Traditional Vegetables Commonly Consumed in Malawi. *J. Food Res.* **9,** 1, 19 (2019). doi: 10.5539/jfr.v9n1p19.
14. M. Barikah, N. Astuti, S. Handajani, and I. Romadhoni, Pengaruh Proporsi Puree Edamame (*Glycin max* (L) Merrill) dan Terigu Terhadap Sifat Organoleptik Donat. *J. Tata Boga*. **10,** 1, 138–146 (2021).
15. I. Gusriani, H. Koto, and Y. Dany, Aplikasi Pemanfaatan Tepung Mocaf (*Modified Cassava Flour*) Pada Beberapa Produk Pangan Di Madrasah Aliyah Mambaul Ulum Kabupaten Bengkulu Tengah. *J. Inov. Pengabdi. Masy. Pendidik.* **2,** 1, 57–73 (2021). doi: 10.33369/jurnalinovasi.v2i1.19142.