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Examining dried noodle characteristics made from modified *Xanthosoma sagittifolium* flour and xanthan gum

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ABSTRACT

Gluten allergy has raised concerns due to its impact on health, especially as wheat noodles are widely consumed. The growing demand for gluten-free alternatives highlights the need for suitable substitutes. This study investigates the effects of fermentation modification on the amylose and protein content of tannia cocoyam flour and evaluates the impact of modified tannia flour and xanthan gum on the physicochemical and sensory properties of noodles. Fermentation of tannia cocoyam (Xanthosoma sagittifolium) corm flour using 9% Lactobacillus plantarum starter over 48 hours enhanced the characteristics of tannia cocoyam noodles. However, despite these improvements, the noodles remained brittle and lacked the desired chewiness compared to conventional noodles. The introduction of xanthan gum as a binding agent was used to improve noodle attributes. Various xanthan gum concentrations (0%, 1%, and 2%) were assessed for their impact on physicochemical parameters (color, optimal cooking time, rehydration capacity, cooking loss, and elongation) and sensory preferences. The findings revealed that modification of tannia cocoyam flour using the fermentation method influenced noodle color, while different xanthan gum concentrations had no discernible effect. Furthermore, modification of tannia cocoyam corm flour and the specific xanthan gum formulations influenced cooking loss, elongation, and the preferences of the panelists.

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INTRODUCTION

Gluten allergy in Indonesia has gained popularity due to its potential to cause health problems for gluten-sensitive individuals, resulting in immune system disturbances (Berawi and Puspitha 2016). However, gluten is commonly found in staple foods made from wheat flour. In the last decade, the millennial generation has increasingly adopted a gluten-free lifestyle, leading to a rising demand for gluten-free food products. Based on data obtained in 2016 shows that millennial preferences for gluten-free products in Java Island have increased by 63% (Rayesa and Ali 2022). One of the staple foods widely consumed is noodles. According to World Instant Noodles Association 2022, Indonesia is the second-highest consumer of instant noodles, consuming 13.7 billion servings in 2021. Typically, noodles are made from wheat flour, which can contain high levels of gluten. Therefore, noodle production can explore alternatives to wheat flour.

Noodle products made with alternative wheat flour substitutes have also been widely developed. Developing these flours involves utilizing local food commodities such as tannia cocoyam corm flour, mung bean flour (Sukamto et al. 2019), cornstarch flour, and sago flour (Mukti and Elida 2019). One of these commodities with the potential to be used as the base ingredient for flour in noodle production is tannia cocoyam (*Xanthosoma sagittifolium*) because its use is underutilized due to its lack of popularity. The characteristics of native tannia cocoyam corm flour (TCF) differ from wheat, particularly in gluten production, as TCF does not contain gluten. Gluten is a protein commonly found in wheat flour and is typically helpful for forming product structures (Sugiharto et al. 2022).

The selection of TCF as the base material is due to its lack of gluten content, unlike wheat flour. Gluten influences the characteristics of noodle products, especially in forming a resilient and crisp texture. Consequently, noodle products made from TCF tend to have a texture that is prone to breakage due to the absence of gluten. Therefore, modifying TCF through fermentation using the *Lactobacillus plantarum* bacterial culture is an alternative to (Sugiharto et al.increasing the amylose content, contributing to the elasticity and texture of the product (Sugiharto et al. 2022). *Lactobacillus plantarum* produces pullulanase enzymes that break down glycosidic bonds in starch, optimizing at growth temperatures of 40-45°C and pH 4.0-4.5 (Kim et al. 2009). Modified mbote flour with Lactobacillus plantarum exhibits higher amylose content and swelling power, enhancing product structure, hardness, and elasticity, while fermentation reduces calcium oxalate levels (Bolarin et al. 2018, Rosida et al. 2022). However, modified tannia cocoyam corm flour (MTF) alone is insufficient to produce noodle products with suitable physicochemical characteristics, necessitating binding agents to achieve the desired characteristics (Sugiharto et al. 2022).

Binding agents are crucial in the production of gluten-free noodles. There are many suitable binding agents for noodles, such as xanthan gum, carboxymethyl cellulose, and guar gum. Research on noodle production using carboxymethyl cellulose as a binding agent yielded a resilient but firm texture (Mulyadi et al. 2014). Meanwhile, guar gum can produce a resilient texture but affects the product's color (Muhandri et al. 2013). Research has shown that making noodles with modified rice flour and adding xanthan gum produces a resilient and crispy texture. Thus, xanthan gum allows for supporting the physicochemical characteristics of MTF noodles.

This research aims to analyze the effects of fermentation modification on the amylose and protein content of TCF and MTF and to evaluate the impact of using MTF and xanthan gum on the physicochemical characteristics (color, optimal cooking time, elongation, and cooking properties) and sensory quality of noodles.

MATERIAL AND METHODS

Flour Production and Modification

The method used for tannia flour production and modification was described by Krisbianto and Minantyo (2024) and Sugiharto et al. (2022).

Tannia cocoyam corms were obtained from Malang, Indonesia. Tannia corms were peeled, thinly sliced size 1 mm, then soaked in a 2% (w/v) NaCl solution (Dolphin, Indonesia) for 30 minutes, drained, and dried using a food dehydrator (GETRA ST-32, China) at 60^{o}C for 24 hours. The dried tannia chips were ground and sieved into TCF through an 80-mesh sieve.

TCF was modified through fermentation with *Lactobacillus plantarum* starter (Agrotekno, Indonesia). TCF was soaked in water (Aqua, Indonesia) with a 1:3 (w/v) ratio and 9% *L. plantarum* starter, which is the best treatment from previous research Sugiharto et al. (2022). The suspension was incubated (Memmert IN55, German) at 37°C for 48 hours. After incubation, the suspension was washed until it reached a neutral pH, measured by a pH meter (Thermo Scientific, America), and then dried at 60°C for 24 hours. The dried suspension was ground with an herb grinder (Formac ZT-300, China) and sieved through an 80-mesh sieve into MTF.

Flour Analysis

Amylose and protein content of native TCF and MTF was conducted based on the AOAC 2005 method. Amylose was analyzed using a DLab SP-UV1100 UV-Vis spectrophotometer. Protein content was calculated using the Kjeldahl method, which calculates the protein based on nitrogen (N).

Dry Noodle Production

According to the formula, all ingredients were mixed to form a dough. The dough is then steamed at 100°C for 15 minutes and shaped into noodle strands using a noodle extruder (Multiuse Mincher, China). The noodles were then steamed at 100°C for 15 minutes and dried at 60°C for 6 hours. The formulation is shown in Table 1.

Table 1 Formulation of tannia cocoyam corm noodle

Treatment	TCF (g)	MTF (g)	W (g)	XG (g)
AK	100	-	80	0
AP1	100	-	80	1
AP2	100	-	80	2
BK	-	100	80	0
BP1	-	100	80	1
BP2	-	100	80	2

Note: TCF = native tannia cocoyam corm flour; MTF = modified tannia cocoyam flour; W = water; XG = xanthan gum. AK = TCF noodles as control; AP1 and AP2 = TCF noodles with 1 and 2 grams of XG, respectively. BK = MTF noodles; BP1 and BP2 = MTF noodles with 1 and 2 grams of XG, respectively.

Noodle Analysis

Optimum cooking time

The method follows five grams of samples cooked with 150 mL of boiled RO water. The noodles were cooked using Gastove (Philips HD4932) for 5 minutes, and then one strand of noodles was taken, rinsed, and pressed to observe the center part of the noodles. The process is repeated until the center of the noodle becomes transparent. The optimum cooking time was determined based on the time required for the noodles to cook thoroughly (Koh et al. 2022).

Elongation

Dried noodles were cooked based on the optimum cooking time. One noodle strand was wound around a texture analyzer (Imada ZTS-500N, Japan) probe with a distance of 2 cm between two probes. The probe automatically pulled at a 0.3 cm/second speed. The process was stopped when the noodle strand broke. Elongation was measured using Equation 1 (Litaay et al. 2022).

$$Elongation\ (\%) = \frac{\text{time to break}\ (s) \times 0.3\ \frac{cm}{s}}{2\ cm} \times 100\% \quad (1)$$

Rehydration

Five grams of sample were cooked with 150 mL of boiled water based on the optimum cooking time. Noodles were drained, and the weight of cooked noodles was measured using the Equation 2 (Kang et al. 2017).

$$Rehydration\ (\%) = \frac{\left(\begin{matrix}W\ cooked \\ noodle\ (g)\end{matrix}\right) - \left(\begin{matrix}W\ dried \\ noodle\ (g)\end{matrix}\right)}{W\ dried\ noodle\ (g)} \times 100\% \quad (2)$$

Cooking loss

Five grams of sample were cooked using 150 ml of boiled water based on the optimum cooking time. Noodles were drained, and the water residue was poured into a constant aluminum dish. The residue was dried at 105°C until the water was fully evaporated. Cooking loss was measured using Equation 3 (Litaay et al. 2022).

$$Coooking\ loss\ (\%) = \frac{W\ dried\ residue\ (g)}{W\ dried\ noodle\ (g)} \times 100\% \quad (3)$$

Color

Color analysis of the noodles was conducted using a colorimeter. The color values were expressed in L*, a*, and b* and represented in the segmentation of the CIELAB color space using the Nix Tool App Kit on Android. The L*, a*, and b* values were utilized to determine chroma (Equation 4), hue (Equation 5), and whiteness index (Equation 6) values, which were then used to map color names based on standards (Bala et al. 2020).

$$Chroma = \sqrt{a^2 + b^2} \quad (4)$$

$$Hue\ (°) = arc\ tan\frac{a}{b} \quad (5)$$

$$Whiteness\ Index = 100 - \sqrt{(100 - L)^2 + a^2 + b^2} \quad (6)$$

Sensory test

A hedonic test was conducted on 30 non-trained panelists using a Likert scale of 1 (very dislike) to 7 (very like), according to SNI 8217:2015 (BSN, 2015). The noodles were cooked at a ratio of 1:10 (w/v) with potable water until it reached optimal cooking time. After draining and rinsing for 5 minutes, three 10 cm strands of noodles were served in a container for sensory evaluation. The parameters assessed include color, aroma, hardness, chewiness, taste, and aftertaste. The sensory data were analyzed using two-way ANOVA followed by Tukey's HSD post hoc test.

RESULTS AND DISCUSSION

Amylose and Protein Content of Flour

Amylose and protein content analysis was conducted to assess the impact of fermentation modification on the levels of amylose and protein content of MTF compared to TCF. Both components are the most influential factors in the physicochemical characteristics of noodles (Obadi et al. 2021). The results are shown in Table 2.

The notable rise in amylose levels during fermentation suggests the enzymatic activity of *Lactobacillus plantarum*, particularly the enzyme pullulanase (Kim et al. 2009, Setiarto et al. 2015). Bacteria such as *Lactobacillus plantarum* are mesophilic bacteria capable of producing pullulanase enzymes (Winarti et al. 2019). Pullulanase enzyme is an exoenzyme that catalyzes the hydrolysis of α-1,6-linkages in pullulan and other polysaccharides, leading to increased amylose levels due to the disruption of branches in the amylopectin chain, resulting in starch with straight chains or amylose (Woo et al. 2020). It should be noted that the enzymes of *Lactobacillus plantarum* also exhibit amylase activity, which hydrolyzes the α-1,4-glycosidic bonds. However, the activity of the pullulanase enzyme in debranching amylopectin was higher than that of amylase in degrading the alpha-1,4-glycosidic linkage, leading to an increase in amylose content (Setiarto et al. 2015).

Table 2 Amylose and Protein Content

Content	TFC	MTF
Amylose (%)	24.15 ± 0.11[a]	28.06 ± 0.33[b]
Protein (%)	8.02 ± 0.30[a]	7.58 ± 0.21[a]

Note: Different notations in the same column indicate a significant difference between treatments (p≤0.05).

Nevertheless, the results indicated no significant difference in protein contents of TCF and MTF due to fermentation. Although *Lactobacillus plantarum* has proteolytic ability and protease enzyme activity, its metabolism did not significantly affect the protein content (Sugiharto et al. 2022). Another possible reason for the lack of difference in protein levels between TCF and MTF samples could be the Kjeldahl method used for protein analysis, which measures protein content indirectly based on nitrogen (N) (Mangalisu et al. 2015). This method's limitation is that it measures total protein content equally, regardless of whether the protein is intact or denatured.

Table 3 Result of Physicochemical Characteristic

Treatment	Cooking time (min)	Elongation (%)	Rehydration (%)	Cooking loss (%)
AK	15.17 ± 0.25[a]	12.72 ± 0.31[a]	55.62 ± 0.48[a]	32.56 ± 0.12[e]
AP1	15.28 ± 0.36[a]	14.03 ± 0.24[b]	66.59 ± 0.64[b]	21.89 ± 0.10[d]
AP2	15.28 ± 0.26[a]	15.28 ± 0.30[c]	75.38 ± 1.04[c]	17.89 ± 0.14[c]
BK	15.44 ± 0.46[a]	15.78 ± 0.32[c]	77.98 ± 0.61[d]	11.80 ± 0.21[b]
BP1	15.57 ± 0.17[a]	21.75 ± 0.52[d]	82.14 ± 0.63[e]	11.79 ± 0.47[b]
BP2	15.57 ± 0.39[a]	26.82 ± 0.50[e]	87.80 ± 0.69[f]	11.12 ± 0.26[a]

Note: Different notations in the same column indicate a significant difference between treatments (p≤0.05). AK = TCF noodles as control; AP1 and AP2 = TCF noodles with 1 and 2 grams of XG, respectively. BK = MTF noodles; BP1 and BP2 = MTF noodles with 1 and 2 grams of XG respectively.

Physicochemical Characteristics

The physicochemical analysis conducted in this study includes optimum cooking time, elongation, rehydration capacity, and cooking loss. The analysis results for cooking time, elongation, rehydration capacity, and cooking loss are presented in Table 3.

Optimum cooking time

Noodle cooking time is influenced by various factors, including thickness, freshness, and shape, as well as external factors like water quantity and temperature. In this study, these variables were controlled as all treatment samples had the same size, shape, dryness, and cooking method. It is also noteworthy that Krisbianto and Minantyo (2024) found native tannia cocoyam flour to have the highest water absorption capacity compared to various other flours or starches, including wheat flour, with a swelling capacity of around 300%, while other flours have a swelling capacity of about 100-200%, and some starches even lower than 50%. This indicates that boiling tannia noodles requires a substantial amount of water.

The composition of starch, rather than protein, primarily affects the optimal cooking time. Heating and the presence of water disrupt the gelatinized starch's crystalline structure, causing it to swell. However, overcooking can break down this gelatinized starch matrix, which typically needs the support of a protein matrix like gluten. This is undesirable for gluten-free noodles, which lack gluten to help maintain their structure (Yao et al. 2020, Guo et al. 2023).

The findings of this research indicate that although cooking time might be prolonged with MTF and a high xanthan gum concentration, no significant difference was observed in the optimal cooking time during boiling for noodle preparation. Despite the insignificant difference in the results, the prolonged cooking time for MTF noodles was correlated with the increased (Jeong et al. 2017), amylose content of MTF (Jeong et al. 2017; Sofi et al. 2020). Additionally, using xanthan gum also affects cooking time as it can form complexes with amylose, making it more difficult for amylose to absorb water into the flour and consequently causing slower swelling (Kaur et al. 2015). Higher water absorption prolongs the cooking time because starch granules require more time to swell (Rosida et al. 2022). However, these factors did not appear to affect the overall optimal cooking time significantly. This was likely because the addition of xanthan gum was minimal, at only 1-2% w/w of the flour weight. Even though there was a significant increase in amylose content in MTF, this did not substantially extend the optimal cooking time compared to TCF noodles.

Elongation

The elongation value of noodles indicates the elasticity of the noodles by measuring the change in length of the noodles when subjected to maximum tensile force until breakage (Murdiati et al. 2015). The amylose and protein contents influence noodle elongation. However, in this research, the protein content might not have been a factor because the contents were not significantly different, as shown in Table 2. Nevertheless, protein is able to form a matrix that binds the flour and other ingredients, providing structural integrity (Low et al. 2020). The addition of xanthan gum also influences noodle elongation by forming a structure with proteins and starch, enhancing noodle complexity (Kaur et al. 2015).

The elongation analysis results revealed significant impacts from both MTF and the addition of xanthan gum on noodle elongation. Notably, the AK noodle sample exhibited the shortest elongation due to its use of TCF without additional xanthan gum. Conversely, the BK treatment, utilizing MTF without xanthan gum, displayed significantly higher elongation compared to AK. Similarly, comparisons between AP1 and AP2 versus BP1 and BP2, respectively, indicated notable differences. Higher xanthan gum additions in both TCF (AK, AP1, and AP2) and MTF (BK, BP1, and BP2) treatment groups also corresponded to significantly varied elongations. The highest elongation was observed in BP2, utilizing MTF, with the highest xanthan gum addition at 2% w/w.

Rehydration

According to Table 3, the results of the noodle rehydration test indicate a significant difference between treatments. The generated data shows that the use of MTF and the addition of xanthan gum increases the rehydration of the noodles.

The research findings indicate that the use of modified flour and the utilization of xanthan gum result in increased rehydration capacity of noodles. Moreover, higher concentrations of xanthan gum used also lead to increased rehydration capacity of the noodles. The flour modification process causes structural changes in the flour, thereby enhancing its water absorption capabilities. Flour with higher amylose content increases the ability to bind water due to heightened hydrogen bonding (Rosida et al. 2022). The water absorption capacity of modified tannia cocoyam flour with *L. plantarum* is higher compared to the unmodified flour (Sugiharto et al. 2022). Additionally, adding xanthan gum as a binding agent can boost rehydration capacity by having a water absorption ability, which is influenced by hydrogen bonding (Elella et al. 2021).

Cooking Loss

The cooking loss results for noodles indicated a significant difference among each treatment. According to Table 3, the cooking loss in noodles decreased notably in samples using MTF and xanthan gum. The findings suggest that the higher the concentration of xanthan gum, the lower the cooking loss. Nevertheless, the most influential factor in reducing cooking loss was the fermentation modification process using *Lactobacillus plantarum* starter, as indicated between treatments AK, AP1, and AP2 compared to BK, BP1, and BP2. While the addition of xanthan gum also contributes to reducing cooking loss, the modification factor was not as significant.

Cooking loss in noodles refers to the quantity of dissolved solids during cooking, which leads to a sticky surface on the noodles (Obadi et al. 2021). The amylose content affects the reduction in cooking loss. High amylose levels influence increased hydrogen bonding, resulting in a firmer dough and, thus, lower cooking loss (Kaur et al. 2015). Moreover, using xanthan gum also reduces cooking loss. Xanthan gum operates by forming bonds with starch, causing starch granules to adhere to xanthan gum, thereby reducing dissolved solids. Additionally, xanthan gum can bind with proteins, forming a network that binds ingredients like flour granules and other dissolved solids (Widelska et al. 2019).

Color

According to Table 4, noodles produced using TCF have a standard dark brown color with the standard name Zeus. Meanwhile, noodles with modified tannia cocoyam corm flour have a grayish-brown color with the standard name Cactus. The standard description of color is based on the relationship between brightness, intensity, or saturation (chroma) and hue. The color produced by modified tannia cocoyam corm flour has a higher brightness due to the influence of fermentation (Sugiharto et al. 2022). The incorporation of xanthan gum did not notably influence the color of MTF noodles, whereas it significantly darkened the color of TCF noodles.

Krisbianto and Minantyo (2024) discovered that native tannia cocoyam flour tends to have a darker color compared to other flours and starches. The color of the raw material affects the color of the resulting product, in this case, the color of the noodles produced.

Table 4 Result of Noodle Color

Treatment	Chroma	Hue	Whiteness Index	Color
AK	7.64 ± 0.53[a]	62.82 ± 4.85[a]	22.53 ± 1.50[a]	Zeus
AP1	7.82 ± 0.55[a]	61.42 ± 3.28[a]	21.16 ± 0.89[ab]	Zeus
AP2	7.59 ± 0.28[a]	63.18 ± 5.07[a]	20.67 ± 0.86[b]	Zeus
BK	14.88 ± 0.75[b]	97.87 ± 1.57[b]	39.03 ± 0.98[c]	Cactus
BP1	14.93 ± 0.51[b]	98.23 ± 1.06[b]	39.63 ± 0.88[c]	Cactus
BP2	14.89 ± 0.40[b]	97.78 ± 1.97[b]	39.60 ± 0.62[c]	Cactus

Notes: Different notations in the same column indicate a significant difference between treatments ($p \leq 0.05$). AK = TCF noodles as control; AP1 and AP2 = TCF noodles with 1 and 2 grams of XG respectively. BK = MTF noodles; BP1 and BP2 = MTF noodles with 1 and 2 grams of XG respectively.

Table 5 Result of Sensory Test

Treatment	Color	Aroma	Hardness	Chewiness	Taste	Aftertaste
AK	4.00 ± 1.71[a]	4.20 ± 1.19[b]	2.40 ± 0.81[a]	2.80 ± 0.99[ab]	2.80 ± 0.76[a]	2.80 ± 1.49[a]
AP1	3.60 ± 1.77[a]	3.60 ± 1.52[ab]	2.00 ± 0.64[a]	2.60 ± 0.81[ab]	3.00 ± 1.11[a]	3.20 ± 1.35[a]
AP2	3.60 ± 1.22[a]	4.00 ± 0.91[b]	4.40 ± 1.38[c]	3.40 ± 1.52[bc]	3.20 ± 1.44[ab]	3.80 ± 1.63[a]
BK	3.60 ± 1.04[a]	3.00 ± 1.14[a]	3.60 ± 1.04[b]	2.40 ± 1.04[a]	3.40 ± 1.38[ab]	3.60 ± 1.38[a]
BP1	3.40 ± 1.38[a]	2.80 ± 1.19[a]	3.40 ± 1.38[b]	2.80 ± 1.19[ab]	4.00 ± 0.91[b]	3.40 ± 1.38[a]
BP2	3.40 ± 0.62[a]	3.00 ± 1.14[a]	4.60 ± 1.38[c]	3.80 ± 1.19[c]	4.00 ± 1.00[b]	3.00 ± 1.58[a]

Notes: Different notations in the same column indicate a significant difference between treatments ($p \leq 0.05$). AK = TCF noodles as control; AP1 and AP2 = TCF noodles with 1 and 2 grams of XG respectively. BK = MTF noodles; BP1 and BP2 = MTF noodles with 1 and 2 grams of XG respectively.

It is known that the cut tissue of tannia cocoyam corm undergoes oxidative browning, believed to be caused by the polyphenol oxidase enzyme acting on the phenolic content in cocoyam corm (Calle et al. 2021, Opadotun et al. 2021). Further research is needed to understand why the browning process in native tannia cocoyam flour was quite significant compared to other flours, including wheat and cassava flour, but not potato flour, which has a darker color (Krisbianto and Minantyo 2024). This could be due to the relatively high content of phenolic compounds or other supportive factors, such as the presence of glucomannan compounds, which can also cause browning under alkaline conditions (Zhang et al. 2023). Tannia cocoyam contains approximately 3% glucomannan (Cahyanti et al. 2024). If this suggestion is correct, it may explain why the fermentation modification process results in MTF noodles (BK, BP1, and BP2) being brighter in color compared to TCF noodles (AK, AP1, and AP2).

Sensory Test

The result of sensory test is shown in Table 5. The noodles tested were cooked without seasoning and rated on a scale from 1 (dislike extremely) to 7 (like extremely). The sensory evaluation used was a hedonic test, assessing the noodles' color, aroma, hardness, elasticity, taste, and aftertaste.

Color preference was influenced by the perception that noodles typically have brighter colors (Koh et al. 2022). There was no statistically significant difference ($p \geq 0.05$) in the color preferences among the panelists. However, there was a tendency for panelists to favor darker brown noodles of TCF noodles over MTF noodles with a grayish-brown hue, as per the feedback from some of the panelists.

Native tannia cocoyam flour had a distinctive sweet aroma that emerged in TCF noodles, which was unfamiliar to panelists but quite appealing. Regarding aroma analysis, panelists favored the aroma of TCF noodles (AK, AP1, AP2) over MTF noodles (BK, BP1, BP2), which was plainer. However, the preference for aroma in noodles made from the same flour did not significantly differ ($p \geq 0.05$). Decreased aroma preference in noodles was due to fermentation, during which other aromas might also develop, primarily organic acids that create a sour scent (Rosida et al. 2022). Although the sour scent did not emerge in MTF flour and MTF noodles, the fermentation process also reduced the distinctive sweet aroma of TCF flour and TCF noodles.

In gluten-free noodles, the texture is supported by the amylose content. The higher the amylose content, the firmer and harder the texture. This preference made panelists favor MTF noodles over TCF noodles. The addition of xanthan gum made the noodles firmer and less sticky to each other, as also evidenced by the decrease in cooking loss as shown in Table 3. The high cooking loss resulted in noodles sticking together and being less preferred. However, a significant finding was the addition of 2% xanthan gum, which increased panelists' liking for noodle hardness, both in TCF (AP2) and MTF (BP2) noodles.

For noodle chewiness, panelists favored chewy textures, and the analysis indicated that adding 2% xanthan gum influenced noodle chewiness positively. Data showed that noodles with 2% xanthan gum addition were preferred. Chewiness correlates with the elongation value, indicating tougher noodles when the elongation is higher, signifying chewiness. Moreover, the amount of bound water also affects elasticity—too little or too many results in less elastic noodles (Kaur et al. 2015).

The taste and aftertaste of the noodles reflect the unique flavor profile derived from the use of cocoyam taro flour. The analysis results indicate no significant differences as the panelists' preferences varied for each sample. This variation occurred because the distinct taste of cocoyam taro initially captured the panelists' attention upon first tasting. The cocoyam taro noodles exhibited a distinct taste for the panelists. The strong and distinct taste is due to the lingering acidic aftertaste from fermentation (Sugiharto et al. 2022). The MTF noodles yielded lower data due to their sour taste. Future research needs to map specific components contributing to the taste and aftertaste of tannia cocoyam flour.

CONCLUSION

MTF can influence noodles' physicochemical and sensory properties due to increased amylose levels. Adding hydrocolloids like xanthan gum significantly increased elongation and rehydration while decreasing cooking loss. MTF significantly improves rehydration and reduces cooking loss compared to adding xanthan gum. The addition of xanthan gum on either TCF or MTF did not impact color preference but affected its aroma, hardness, elasticity, taste, and aftertaste.

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