e-ISSN 2581-0405
Asian Journal of Applied Research for Community Development and Empowerment
Journal home page: http://ajarcde-safe-network.org ISSN 2581-0405

The Characteristics of Tortilla Chips Made from Proportions of White Corn Flour and Tapioca, and $NaHCO_3$ Addition

Balqis Rosalinda[1], Rosida [2], Andre Yusuf Trisna Putra[3]*

[1,2,3]Food Technology Department, Faculty of Engineering, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya, Indonesia

ARTICLE INFO

Article History:
Received: 03 December 2024
Final Revision: 07 December 2024
Accepted: 19 January 2025
Online Publication: 22 January 2025

KEYWORDS

White corn flour, tapioca flour, NaHCO3, tortilla chips, SDGs

CORRESPONDING AUTHOR

*E-mail: rosidaupnjatim@gmail.com

A B S T R A C T

Tortilla chips are snacks with thin and crispy characteristics made from the main ingredient of corn flour. This study used white corn flour, tapioca flour, and NaHCO3. In this study, white corn flour was used as the main ingredient for making tortilla chips, tapioca flour was used as a binder, and sodium bicarbonate was used to add texture. The purpose of this study was to determine the effect of the proportion of white corn flour: tapioca flour, and the addition of $NaHCO_3$ on the characteristics of tortilla chips and to obtain the best treatment based on good physical, chemical, and organoleptic properties, and preferred by panelists. The design of this study was a Completely Randomized Design (CRD) with two factors, namely the proportion of white corn flour: tapioca flour (90:10, 80:20, 70:30) and the addition of sodium bicarbonate (0.2%, 0.4%, 0.6%). The best treatment was tortilla chips with a proportion of white corn flour: tapioca flour (70:10) with the addition of sodium bicarbonate (0.2%). The treatment resulted in a moisture content of 8.89%, ash content of 6.00%, protein content of 11.02%, lipid content of 4.64%, starch content of 60.40%, amylose content of 12.25%, amylopectin content of 48.15%; and the average organoleptic results showed a color preference score of 3.76 (like); aroma 3.84 (like); taste 4.16 (like); and texture 3.88 (like), total dietary fiber content of 4.71%, and calcium content of 493.85 mg/100g.

Contribution to Sustainable Development Goals (SDGs):
Goal 2: Zero Hunger
Goal 3: Good Health and Well-being|
Goal 8: Decent Work and Economic Growth
Goal 12: Responsible Consumption and Production
Goal 17: Partnerships for the Goals

1. INTRODUCTION

1.1. Research Background

Tortilla is a type of chip food made from corn, not consistently round, flat, or triangular with a certain thickness [1]. Based on the Central Bureau of Statistics in 2022 regarding the global tortilla market analysis, it is estimated that it will record an increase in the 2022-2027 period of 4.9%. This food is well-known by Indonesians, who have a savory taste and crunchy texture, so it is often chosen as a snack [2].

Tortillas are generally made using only corn as the essential ingredient and a few additional ingredients to add flavor [3]. White corn was chosen as the object of this study because it has unique characteristics that distinguish it from other corn varieties. White corn contains nutrients that exceed the nutrients of yellow corn, has a soft texture, is delicious, and is resistant to drought [4].

The physicochemical properties of tortillas are determined by the properties of corn and the addition of flour used as a binder in its manufacture [5]. In this regard, combining it with other flours that can increase product density, one of which is tapioca flour is necessary.

This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License
Published under licence by SAFE-Network

Tapioca flour can be one solution for flour that functions as a gluten-free binder. This follows the statement [6] that adding tapioca flour functions to help improve the product's texture.

Corn flour without pretreatment has a high setback viscosity, so it tends to experience retrogradation, resulting in food products hardening after cooling [7]. Therefore, it is necessary to have food additives in the form of sodium bicarbonate or baking soda, which can increase the texture of tortilla products for a long time [8].

Based on this, it is necessary to study the factors that affect the texture of tortilla chip products so that it can produce quality tortilla chip products with good sensory properties and characteristics, including those related to the comparison of the proportion of white corn flour and tapioca flour and the addition of sodium bicarbonate to find out the best formulation and treatment so that it can meet the sensory characteristics of the panelists (hedonic) of the resulting tortilla chips products.

1.2. Literature Review

Tortilla is one of the snack products that is quite popular among the people and is a typical Mexican food [9]. Tortilla is a type of chip or chip food made from corn; the shape is not always round, flat, or triangular, and it has a specific thickness [1]. The characteristics of tortillas are yellow, crunchy, thin, have a distinctive smell, are easy to break, and have a relatively long shelf life due to their low moisture content [10].

Corn is one of the plants rich in nutritional content, including dietary fiber needed by the body, minerals (Ca, Mg, K, Na, P, Ca, and Fe), essential amino acid composition, and others [11]. White corn is rich in functional food components, namely dietary fiber, starch, amylose, and amylopectin [11], and based on data [12], every 100 grams of white corn flour contains 7.2 grams of fiber. The starch content in white corn is around 73%, with an amylose content of 27.04% and an amylopectin of 45.96% [13].

Tapioca is a starch derived from the extraction of cassava tubers (Manihot utilizing POHL) that have been washed and dried [14]. Add tapioca to manufacture tortillas to improve the final product's appearance and develop the product so that the tortilla becomes crispy, increases adhesive power due to the high starch content, and produces a crispy texture. Starch contributes to creating a crispy tortilla texture and product color brightness, and it has adhesive power [15]. The amylopectin content in tapioca flour affects the texture and volume development in the manufacture of chips. Tapioca flour has a reasonably high amylopectin content of 80% [6].

Sodium bicarbonate ($NaHCO_3$) is a leavening agent widely used for making chips, crackers, cakes, and cookies [16]. Sodium bicarbonate in flake-making ranges from 0.5% to 2.0% [17]. At high temperatures, $NaHCO_3$ causes carbon dioxide bubbles to enlarge, so the food will expand and produce crispy food [18]. The higher the addition of $NaHCO_3$, the higher the volume of tortilla expansion. This is because CO_2 and water vapor from the decomposition of $H2CO_3$ have accumulated in air bubbles and expanded and pressed against the surrounding walls [19].

1.3. Research Objective

This study aims to determine the effect of the proportion of white corn flour, tapioca flour, and the addition of $NaHCO_3$ on the characteristics of tortilla chips and to obtain the best treatment based on suitable physical, chemical, and organoleptic properties preferred by panelists.

2. MATERIALS AND METHODS

2.1. Materials and Tools

The raw materials used in the manufacture of tortilla products are white corn purchased from farmers in Tuban, tapioca flour, sodium bicarbonate, anchovies, salt, water, garlic powder, refined sugar, margarine, pepper powder, and mineral water purchased at Wonokromo Market Surabaya. The materials for analysis are distilled water, NaOH, boric acid, bromocresol green solution, methyl red solution, alcohol, HCl, petroleum ether (PE), ethanol, I2 2%, acetic acid, methanol, HNO_3, perchloric acid, DPPH solution, KCL, sodium acetate, alpha-amylase enzyme distilled water, pepsin enzyme, alpha-amylase enzyme, beta-amylase enzyme, ethanol, acetone.

The equipment used to make tortilla products includes stoves, cabinet dryers, blenders, 80 mesh sieves, scales, dough mixers, baking pans, spoons, knives, and ovens. The tools used for analysis are porcelain cups, measuring cups, desiccators, hotplates, electric furnaces, Kjeldhal flasks, destruction, distillation apparatus, soxhlet, fat flasks, Erlenmeyer flasks, measuring flasks, pipettes, UV-Vis spectrophotometers, texture analyzers, 250 ml volumetric tubes.

Table 1. Treatment Combinations of Tortilla Chips

White Corn Flour: Tapioca Flour	$NaHCO_3$		
	N1	N2	N3
T1	T1N1	T1N2	T1N3
T2	T2N1	T2N2	T2N3
T3	T3N1	T3N2	T3N3

Description:

T1N1 = Proportion of corn flour : tapioca (90:10) and 0.2% $NaHCO_3$ addition
T2N1 = Proportion of corn flour : tapioca (80:20) and 0.2% $NaHCO_3$ addition
T3N1 = Proportion of corn flour : tapioca (70:30) and 0.2% $NaHCO_3$ addition
T1N2 = Proportion of corn flour : tapioca (90:10) and 0.4% $NaHCO_3$ addition
T2N2 = Proportion of corn flour : tapioca (80:20) and 0.4% $NaHCO_3$ addition
T3N2 = Proportion of corn flour : tapioca (70:30) and 0.4% $NaHCO_3$ addition
T1N3 = Proportion ofcorn flour : tapioca (90:10) and 0.6% $NaHCO_3$ addition
T2N3 = Proportion of corn flour : tapioca (80:20) and 0.6% $NaHCO_3$ addition
T3N3 = Proportion of corn flour : tapioca (70:30) and 0.6% $NaHCO_3$ addition

The data obtained were processed using Analysis of Variance (ANOVA) and continued with Duncan's Multiple Range Test (DMRT) to determine the differences between treatments. The results of all tests were analyzed using the De Garmo method to determine the product with the best treatment results.

Making of Tortilla Chips

Making tortilla chips begins with preparing ingredients, such as white corn flour, which must be washed clean and dried for 2 hours at 50ºC. The dried corn is then milled and sieved with an 80-mesh sieve. Tortillas in this study were added with anchovy flour as a fixed factor. Anchovy flour is made from anchovies that have been washed and steamed for 20 minutes. The anchovies are then dried for 9 hours and ground with a blender.

https://doi.org/10.29165/ajarcde.v9i1.603

The process of making tortilla chips in this study was modified from previous research [20]. Initially, the ingredients were weighed, mixing all the raw materials (corn flour, tapioca, $NaHCO_3$) and other supporting materials such as anchovy flour, salt, water, garlic, pepper, powdered sugar, margarine, and water. The mixed ingredients were then kneaded until smooth and steamed for 20 minutes. After steaming, the dough was flattened into a thin shape and cut into a triangle shape. The dough formed was heated in an oven at 60°C for 2 hours and fried for 8 seconds.

2.2. Research Analysis

2.2.1. Raw Material Evalution

The raw materials analyzed were white corn flour and tapioca flour. The analysis included moisture content, ash content, protein content, lipid content, starch content, amylose content, and amylopectin content.

2.2.2. Physicochemical Evalution of Tortilla Chips

The parameters assessed encompassed moisture content, ash content, protein content, starch content, lipid content, amylose content, and amylopectin content. For the best treatment, calcium content and dietary fiber content were analyzed.

2.2.3. Evaluation Sensory of Tortilla Chips

The sensory characteristics chosen for evaluating the quality of the tortilla chips included aroma, taste, color, and texture. A total of 25 panelists were tasked with assessing the product's acceptability utilizing a 5-point scale ranging from "strongly prefer" to "strongly dislike." The data analysis encompassed the utilization of the Friedman tests.

3. RESULT AND DISCUSSION

Raw Material Analysis

Raw material analysis in this study was conducted on white corn flour and tapioca flour. The results of the raw material analysis can be seen in **Table 2.**

Table 2. Chemical Composition of white corn flour and tapioca flour

Analysis	Raw material	
	White corn flour	Tapioca flour
Moisture Content (%)	7.37	9.80
Ash content (%)	0.55	1.83
Lipid content (%)	0.75	0.07
Protein content(%)	8.77	0.19
Starch content (%)	71.96	85.74
Amylose content (%)	15.72	13.72
Amylopectin content (%)	56.24	72.02

Based on **Table 2.** The moisture content of white corn flour from the analysis results is 7.37% higher than the previous study by [13] of 5.72%. The analysis results show tapioca flour's moisture content is 9.80% higher than [12]. The moisture content of tapioca flour is 9.1%. The difference in air content is caused by different drying times and temperatures. The ash content of white corn flour from the analysis results is 0.55% higher than the study [13] of 0.26%. The ash content of tapioca flour from the analysis results is 1.83% higher than the literature, which is 1.1% [12]. According to [23], the ash content value depends on the type of material, ashing method, time, and temperature used during drying [24].

The lipid content of white corn flour from the analysis results is 0.75%, higher than the study [13], which is 0.39%. The lipid content of tapioca flour from the analysis results is 0.07% lower than the literature, which is 0.5% [12]. The protein content of white corn flour from the analysis results was 8.77%, higher than that of the study [13], which was 8.01%. The protein content of tapioca flour from the analysis results was 0.19% higher than the literature, which was 1.1% [12]. This difference is caused by different drying processes related to the temperature and time used. [25] stated that heating too long at high temperatures will cause protein denaturation.

The starch content of white corn flour from the analysis results was 71.96% lower than the previous study, which was 73% [13]. Based on the analysis results, the starch content of tapioca flour was 85.74%, which followed the literature, namely that the tapioca starch content must be more than 75% [21].

Differences in starch content can be influenced by variety, harvest age, genetic factors, environment, and processing methods [22]. The starch content will affect the amylose and amylopectin content of a material. The percentage of amylose and amylopectin in the starch flour will affect the solubility and degree of starch gelatinization.

3.1. Physicochemical Analysis of Tortilla Chips

Physicochemical analysis of tortilla chips includes analysis of moisture content (%), ash content (%), lipid content (%), protein content (%), starch content (%), amylose content (%), and amylopectin content (%).

3.1.1. Moisture Content

The results of the ANOVA analysis showed a significant interaction ($P \leq 0.05$) between the treatment of the white corn flour: tapioca flour and the addition of $NaHCO_3$ on the moisture content of tortilla chips. Figure 1 shows that the higher the proportion of tapioca flour or the lower the proportion of white corn flour and the lower the addition of NaHCO3, the higher the moisture content increases.

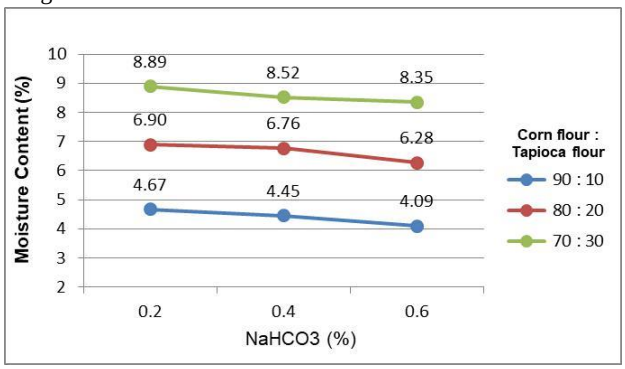

Figure 1. The Relationship Between the Proportion of White Corn Flour: Tapioca Flour and the Addition of $NaHCO_3$ on the Moisture Content of Tortilla Chips

The starch content influences the moisture content in the ingredients used. The higher the starch content in a product, the higher the moisture content. This follows the statement [26] that starch has a high water binding capacity because the number of hydroxyl groups in starch is high, so water is challenging to evaporate during drying. Adding $NaHCO_3$ also affects the moisture content in tortilla chips because the $NaHCO_3$ compound can bind water. The higher the concentration of $NaHCO_3$ in the dough, the more water is bound, so during the baking process, there is a release of CO_2 gas, and the process of releasing bound water is easier [27].

3.1.2. 3.2.2 Ash Content

Ash content is the inorganic residue left after the organic material has burned out, where the higher the ash content in food, the higher the mineral content [28]. The results of the ANOVA analysis showed a significant interaction ($P \leq 0.05$) between the treatment of the proportion of white corn flour: tapioca flour and the addition of $NaHCO_3$ on the ash content of tortilla chips. Based on **Figure 2.** shows that the higher the proportion of tapioca flour or the lower the proportion of white corn flour and the higher the addition of $NaHCO_3$, the ash content increases.

Table 3: Physicochemical Characteristics of Tortilla Chips

Treatment	Moisture (%)	Ash (%)	Lipid (%)	Protein (%)	Starch (%)	Amylose (%)	Amylopectin (%)
T1N1	4.67±0.04	4.45±0,04	7.88±1.92	13.67±0.61	58.42±0.04	13.32±0.13	45.10±0.17
T1N2	4.45±0.07	4.71±0,02	7.46±1.42	14.26±1.97	58.62±0.04	13.21±0.04	45.41±0.00
T1N3	4.09±0.04	4.93±0,08	7.07±1.61	14.26±0.39	58.88±0.12	13.27±0.11	45.61±0.01
T2N1	6.90±0.01	5.15±0,04	6.69±0.98	12.68±0.61	59.57±0.14	13.27±0.20	46.30±0.34
T2N2	6.76±0.06	5.28±0,04	6.63±0.86	13.27±1.97	59.82±0.09	12.53±0.97	47.29±1.06
T2N3	6.28±0.11	5.41±0,03	6.42±0.16	13.13±0.39	59.84±0.07	12.44±0.89	47.40±0.82
T3N1	8.87±0.06	6.00±0,07	4.64±0.20	11.02±0.52	60.40±0.05	12.25±0.57	48.15±0.62
T3N2	8.52±0.02	6.16±0,01	5.58±0.42	11.30±0.35	60.54±0.05	12.16±0.78	48.38±0.76
T3N3	8.35±0.07	6.23±0,04	5.01±0.09	10.84±0.12	60.63±0.22	11.73±0.20	48.90±0.02

The land area has a calculated t value > t table, 3.057 > 1.991, which means the land area has a real effect on rice production in Madang Suku I District, East OKU Regency, at a 95% confidence level. The land area coefficient value is 0.642, meaning that if the land area used by farmers to carry out rice farming activities increases by 0.642%, then rice production in Madang Suku I District, East OKU Regency, will increase by 0.642% with the assumption that other variables are considered zero or constant. These results align with research by [14] and [15], which states that land area factors directly influence rice production.

Labor has a value of t calculated < t table, namely 4,816 < 1.991, which means that labor has a real influence on rice production in Madang Suku I District, East OKU Regency, at a 95% confidence level. The labor regression coefficient is 0.594, meaning that if the labor used by farmers to carry out rice farming activities increases by 0.594%, then rice production in Madang Suku I District, East OKU Regency, will increase by 0.594% with the assumption that other variables are considered zero or constant.

The labor variable significantly affects Madang Suku I District, East OKU Regency rice production. These results align with research by [16], which states that labor influences rice production. When the workforce decreases, rice production will decrease in Madang Suku I District, East OKU Regency. This is because the number of workers producing rice plants in Madang Suku I District, East OKU Regency, is much needed due to the high rice productivity in Madang Suku I District, East OKU Regency.

This is proven by the theory of the law of diminishing returns, which means that if we add one factor of production, in this case, labour. At the same time, if the land area is considered constant, then productivity will decrease. This theory comes from David Ricardo's theory. According to Ref. [17], research shows that labour significantly affects rice production. These results align with the findings of [18] and [19], which stated that labour factors directly influence rice production.

Tapioca flour has a high ash content, and NaHCO3 also has a high ash content. Based on **Table 2.** it can be seen that the ash content of tapioca flour (1.83%) is higher than the ash content of white corn (0.55%), so that the formulation with a higher amount of tapioca flour produces a product with a higher ash content than other treatments. The ash content of the raw materials influenced the ash content in this study. According to [29] $NaHCO_3$ contains quite high inorganic or mineral components. In 100 grams of $NaHCO_3$ contains an ash content of 63.1%, so the greater the concentration of $NaHCO_3$ in a food ingredient made, the higher the minerals contained in the food ingredient.

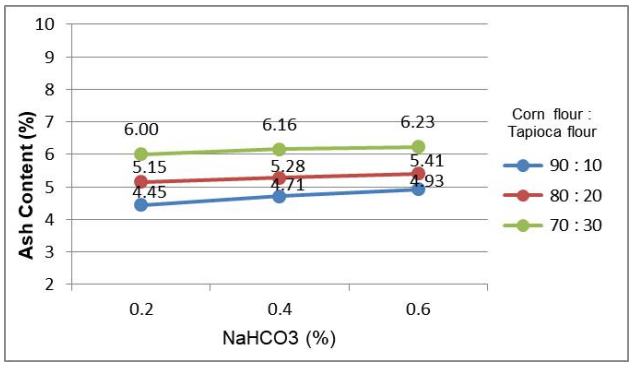

Figure 2. The Relationship Between the Proportion of White Corn Flour: Tapioca Flour and the Addition of $NaHCO_3$ on the Ash Content of Tortilla Chips

3.1.3. Lipid Content

The results of the ANOVA analysis showed a significant interaction ($P \geq 0.05$) between the treatment of the proportion of white corn flour: tapioca flour and the addition of $NaHCO_3$ on the lipid content of tortilla chips. However, the treatment of the proportion of white corn flour: and tapioca flour showed a very significant effect ($P \leq 0.05$) on the lipid content of tortilla chips. The lipid content values in **Table 3.** show that the average lipid content of tortilla chips with the treatment of the proportion of white corn flour and tapioca flour ranged from 5.01% to 7.88%. The higher the proportion of white corn flour or the lower the proportion of tapioca flour, the higher the lipid content. Corn flour has a higher lipid content than tapioca flour, as seen in **Table 2**—the lipid content of white corn flour (5.15%) and tapioca flour (0.07%).

The addition of $NaHCO_3$ in the manufacture of tortilla chips did not significantly affect the lipid content of tortilla chips. This is because $NaHCO_3$ is a food additive that does not contain lipids. The quality requirements for snacks in [30] state that the maximum lipid content of snack products is 30% without frying and 38% with frying. Compared to the standard, all treatments have a lipid content that follows the established standard, below 38%.

https://doi.org/10.29165/ajarcde.v9i1.603

3.1.4. Protein Content

The results of the ANOVA analysis showed a significant interaction ($P \geq 0.05$) between the treatment of the white corn flour: tapioca flour and the addition of $NaHCO_3$ on the protein content of tortilla chips. However, the treatment of the proportion of white corn flour: tapioca flour showed a significant effect ($P \leq 0.05$) on the protein content of tortilla chips. The protein content values in **Table 3.** show that the average protein content of tortilla chips with the treatment of the proportion of white corn flour: tapioca flour ranged from 10.84% to 14.26%. The higher the proportion of white corn flour or the lower the proportion of tapioca flour, the higher the protein content. This is because white corn flour has a higher protein content than tapioca flour, as shown in **Table 2. The** protein content of white corn flour (8.77%) and tapioca flour (0.19%).

The addition of $NaHCO_3$ in the manufacture of tortilla chips did not significantly affect the protein content of tortilla chips. This is because $NaHCO_3$ is a food additive that does not contain protein. The high or low protein content can also be influenced by the amount of moisture lost from the material during manufacturing. The protein content value is greater if the moisture content lost is greater [31]. This follows the statement [32] that during drying, there is a decrease in moisture content, which can increase the nutrients in the remaining mass, so the amount of protein in cooked food is higher than in raw food. The quality requirements for snacks in [30] stipulate a protein content of more than 5%. Compared to the standard, all treatments have a protein content that follows the standard set, namely more than 5%.

3.1.5. Starch Content

Starch is a type of carbohydrate in the form of a glucose polymer consisting of amylose and amylopectin [33]. In the treatment of the proportion of white corn flour: tapioca flour, there was a very significant effect ($P \leq 0.05$) on the starch content of tortilla chips. The starch content values in **Table 3.** show that the average starch content of tortilla chips with the treatment of the proportion of white corn flour tapioca flour ranged from 58.42% to 60.63%. Based on **Table 2.**, it can be seen that the starch content of tapioca flour (85.74%) is higher than the ash content of white corn (71.96%), so the formulation with a higher amount of tapioca flour produces a product that has a higher starch content than other treatments. This follows the statement Ref. [34] that the starch content of the product is influenced by the starch content of the raw materials; the more ingredients containing high starch are added, the higher the starch content of the product. The addition of $NaHCO_3$ in the manufacture of tortilla chips has no significant effect on the starch content of tortilla chips. This is because $NaHCO_3$ is a food additive that does not contain starch.

3.1.6. Amylose Content

The amylose content can affect the product's texture; the higher the amylose content is added, the lower the product's texture. This is because amylose has a water absorption capacity, and the product's elasticity decreases, increasing the hardness [35]. In treating the proportion of white corn flour: tapioca flour showed a significant effect ($P \leq 0.05$) on the amylose content of tortilla chips. Based on **Table 3.** it can be seen that the higher the proportion of white corn flour, the amylose content in tortilla chips increases, this is because the amylose content in white corn flour is 15.72% higher than tapioca flour, 13.72%, as can be seen in **Table 2.** The results of the anova analysis showed that the addition of $NaHCO_3$ had no significant effect on the amylose content in tortilla chips. This is because $NaHCO_3$ does not contain amylose.

3.1.7. Amylopectin Content

The higher the amylopectin content in the product, the higher the product's texture level. This is because amylopectin stimulates the process of blooming (puffing) in the product, so the resulting food product has crispy, light, porous and crunchy properties [35]. In treating the proportion of white corn flour, tapioca flour showed a significant effect ($P \leq 0.05$) on the amylopectin content of tortilla chips. Based on **Table 3.** it can be seen that the higher the proportion of tapioca flour or the lower the proportion of white corn flour, the higher the amylopectin content in tortilla chips; this is because the amylopectin content in tapioca flour is higher than that of white corn flour which can be seen in **Table 2.** The results of the anova analysis showed that the addition of $NaHCO_3$ had no significant effect on the amylopectin content in tortilla chips. This is because $NaHCO_3$ does not contain amylopectin.

3.2. Sensory Analysis

3.2.1. Aroma

The highest aroma preference was obtained in Tortilla chips with the proportion of white corn flour: tapioca flour (70:30) with the addition of 0.6% $NaHCO_3$, getting an average value of 3.84 (like). Aroma preference in tortilla chips decreased along with the increasing proportion of white corn flour and the decreasing percentage of $NaHCO_3$. This is because white corn flour has a distinctive aroma that the panelists do not like. This follows the statement [38] that corn flour has a unique smell; the more corn flour is added to a product, the more dominant the corn aroma will be.

3.2.2. Color

The highest color preference was obtained in Tortilla chips with the proportion of white corn flour: tapioca flour (70:30) with the addition of 0.2% $NaHCO_3$, getting an average value of 3.76 (like). The color preference of tortilla chips decreased with the increase in tapioca flour and the addition of $NaHCO_3$. The more tapioca flour was added, the more the color of the tortilla chips produced. The color change occurred due to the Maillard reaction in the frying process of tortilla chips. This Maillard reaction occurs because of the high carbohydrate content. The carbohydrate content in tapioca flour is higher than white corn flour, so the color produced by tortilla chips with higher tapioca flour will be darker. Based on the statement Ref. [39], the Maillard reaction is a reaction that occurs between carbohydrates containing reducing sugars with primary amine groups which will produce brown or melanoidin. The addition of $NaHCO_3$ also affects the color of tortilla chips. The more $NaHCO_3$ was added, the browner the tortilla chips became. This is because $NaHCO_3$ reacts with carbohydrates, according to Ref.[40] the addition of sodium bicarbonate causes an increase in the reaction between $NaHCO_3$ and carbohydrate polymers so that the color of the tortilla chips becomes increasingly brown.Taste

The highest taste preference was obtained in tortilla chips with the proportion of white corn flour: tapioca flour (70:30) with the addition of 0.2% $NaHCO_3$ getting an average value of 4.16 (like). Taste preference in tortilla chips decreased along with the increasing proportion of white corn flour. This is thought to be because the taste of white corn flour, which is too dominant, is not liked by the panelists.

According to Ref. [41], adding corn flour increases the taste and aroma of the corn flour produced, so the more corn flour is added, the more flavor will be felt. The panelists did not like the addition of NaHCO3 at a concentration of 0.6% because it gave a less pleasant taste. According to [42], adding too much $NaHCO_3$ causes a bitter taste.

3.2.3. Texture

The highest texture preference was obtained in tortilla chips with the proportion of white corn flour: tapioca flour (90:10) with the addition of 0.2% $NaHCO_3$, getting an average value of 3.96 (like). The texture preference of tortilla chips decreased along with the increasing proportion of tapioca flour and $NaHCO_3$. This is thought to be because the panelists did not like the texture of tortilla chips that were too crispy or easily crumbled. The amylopectin content influences the texture of tortilla chips in the raw materials. Tapioca flour has a higher amylopectin content than white corn flour. According to [22], starch with high amylopectin content tends to produce products with characteristics that are easily crumbled and crunchy. The addition of $NaHCO_3$ also affects the texture of the product. The higher the concentration of $NaHCO_3$, the higher the amount of CO_2 produced, so the resulting product will also be crispier and more easily crumbled [36].

4. CONCLUSION

There is significant interaction between moisture content, ash content, color, taste, and texture, but no interaction on the protein content, lipid content, starch content, amylose content, amylopectin content, and the aroma preference score of tortilla chips. The best treatment is the proportion of white corn flour: tapioca flour 70:30 with the addition of $NaHCO_3$ 0.2% which has a moisture content of 8.89%, ash content of 6.00%, protein content of 11.02%, a lipid content of 4.46%, the starch content of 60.40%, amylose content of 12.25%, amylopectin content of 48.15%, texture of 312.85 gf, total dietary fiber content of 4.71%, the calcium content of 493.85

REFERENCE

[1] Karneta, R., Kahfi, A. N., & Aluyah, C. (2019). Fortifikasi Dari Kedelai (Glicine max l merr) Pada Formula Tortilla Jagung. *Seminar Nasional Lahan Suboptimal*, 465–472.

[2] Syarifah, A. N., & Amrih, D. (2021). Pengaruh Penambahan Variasi Tepung Sayuran Pada Karakteristik Keripik Tortilla. *Jurnal Agercolere*, 3(1), 14–20.

[3] Andriyani, Y., Syahrumsah, H., & Marwati. (2017). Studi Formulasi Jagung (Zea mays l.) Dan Tempe Terhadap Nilai Gizi Dan Sifat Mutu Sensoris Tortilla Chips. *Jurnal Teknologi Pertanian Universitas Mulawarman*, 12(2), 64–69.

[4] Yusuf, A. Pohan, Syamsuddin. (2013). Jagung makanan pokok untuk mendukung ketahanan pangan di provinsi Nusa Tenggara Timur. 2013 Jun 10. Sulawesi Selatan. Indonesia. *Seminar Nasional Serealia*. 543–549.

[5] Bulotio, N., Engelen, A., & Lateka, N. (2021). Physical And Chemical Quality Characteristics Of Corn Tortillas With Substitute Purple Sweet Potato Flour. *Jurnal Technopreneur (JTech)*, 9(1), 54–62.

[6] Rosida, R., & Pamungkas, O. W. (2016). Sifat Fisikokimia Dan Organoleptik Keripik Simulasi Talas (Kajian Proporsi Talas: Tepung Tapioka Dan Penambahan Nahco3): Similarity Dan Peer Review. *J.Rekapangan*, 11(2).

[7] Khomsatin, S., & Haryanto, B. (2012). Kajian Pengaruh Pengukusan Bertekanan (Steam Pressure Treatment) Terhadap Sifat Fisikokimia Tepung Jagung. *Jurnal Teknologi Dan Industri Pangan*, 23(1), 86.

[8] Febrianto, A., Basito, B., & Anam, C. (2014). Kajian Karakteristik Fisikokimia Dan Sensoris Tortilla Corn Chips Dengan Variasi Larutan Alkali Pada Proses Nikstamalisasi Jagung. *Jurnal Teknosains Pangan*, 3(3).

[9] Saputra, J. M., Syafutri, M. I., & Syaiful, F. (2019). *Karakteristik Fisik, Kimia, Dan Sensoris Tortilla Dengan Penambahan Tepung Kacang Merah*. Universitas Sriwijaya.

[10] Okfrianti, Y., Kamsiah, K., & Veli, D. G. (2013). Pengaruh Penambahan Tepung Ikan Sidat (anguilla spp) Pada Pembuatan Tortilla Chips Terhadap Nilai Gizi, Kadar Air Dan Daya Terima Organoleptik. *Jurnal Sain Peternakan Indonesia*, 8(2), 139–152.

[11] Suarni, S. (2009). Prospek Pemanfaatan Tepung Jagung Untuk Kue Kering (Cookies). Jurnal Penelitian Dan Pengembangan Pertanian, 28(2), 178792.

[12] Kemenkes RI. (2020). Kementerian Kesehatan Republik Indonesia. *Tabel Komposisi Pangan Indonesia*. Departermen Kesehatan. Jakarta.

[13] Augustyn, G. H., Tetelepta, G., & Abraham, I. R. (2019). Physicochemical analysis of several corn flour from Moa Island South West Moluccas Regency. Agritekno. *Jurnal Teknologi Pertanian*, *8*(2), 58-63.

[14] Wahyuni, L. (2008). *Komposisi Kimia Dan Karakteristik Protein Tortilla Corn Chips Dengan Penambahan Tepung Putih Telur Sebagai Sumber Protein*. IPB University

[15] Pratiwi, K. W. (2016). *Formulasi Tepung Ubi Jalar Cilembu (Ipomoea batatas (L.) Dan Tepung Jagung (Zea mays) Terfermentasi Terhadap Sifat Kimia Dan Sensori Flakes*. Universitas Lampung. Bandar Lampung.

[16] Latifah, I., Susilowati, T., & Erlita, T. R. (2013). Flake Labu Kuning (Cucurbita Moschata) Aroma Rasa Kuliner Indonesia. Kue Kering Klasik Dengan Kadar Vitamin A Tinggi Pumpkin (Cucurbita moschata) Flake With High- Vitamin A Content). *Jurnal Teknologi Pangan*, 4(1).

[17] Agustia, F. C., Rosyidah, S., Subardjo, Y. P., Ramadhan, G. R., & Betaditya, D. (2019). Formulation Of Flakes Made From Mocaf-Black Rice-Tapioca High In Protein And Dietary Fiber By Soy And Jack Bean Flour Addition. *IOP Conference Series: Earth and Environmental Science*, 255(1), 012019.

[18] Subarna. (1992). *Baking Technology*. Pusat Antar Universitas Pangan dan Gizi, IPB.

[19] HP, S., Mulyani, T., & Setiawan, E. B. (2013). Kajian Subtitusi Ampas Tahu Dan Penggunaan Natrium Bikarbonat Pada Pembuatan Tortilla. *Jurnal Teknologi Pangan*, 6(1).

[20] Nurani, F. P., Jariyah, J., Rosida, R., & Susanti, R. A. (2018). Addition of Anchovy Flour and Sodium Bicarbonate to Characteristics of High Calcium. *In: ICST*, 18-19.

[21] BSN. (2011). Badan Standarisasi Nasional. *SNI 3451- 2011 tentang Tepung Jagung. Badan Standarisasi Nasional*. Jakarta.

[22] Imam, R. H., Primaniyarta, M., & Palupi, N. S. (2014). Konsistensi mutu pilus tepung tapioka: identifikasi parameter utama penentu kerenyahan. *Jurnal Mutu Pangan: Indonesian Journal of Food Quality*, 1(2), 91-99

[23] Sudarmadji, S., B. Haryono, dan Suhardi. (1997). *Prosedur Analisis untuk Bahan Makanan dan Pertanian. Liberty*. Yogyakarta

[24] Muchtadi, T. R. (1997). *Teknologi Proses Pengolahan Pangan. Fakultas Pangan dan Gizi IPB*. Bogor.

[25] Yuniarti, D. W., Sulistiyati, T. D., & Suprayitno, H. E. (2013). *Pengaruh suhu pengeringan vakum terhadap kualitas serbuk albumin ikan gabus.*Ophiocephalus striatus. Doctoral dissertation, Brawijaya University.

[26] Kurniasari, E., Waluyo, S., & Sugianti, C. (2015). Mempelajari laju pengeringan dan sifat fisik mie kering berbahan campuran tepung terigu dan tepung tapioka. *Jurnal teknik pertanian Lampung*, *4*(1), 1-8.

 https://doi.org/10.29165/ajarcde.v9i1.603

[27] Herpandi, I. Widiastuti, Wulandari, dan C. A. Sari. (2019). Efektivitas Natrium Bikarbonat ($NaHCO_3$) terhadap Karakteristik Fisikokimia dan Sensori Keripik Tulang Ikan Putak (Notopterus notopterus). *JPHPI* 22(2):263-272.

[28] Karneta, R., Kahfi, A. N., & Aluyah, C. (2018). Fortifikasi dari kedelai (Glicine max L Merr) pada formula tortilla jagung. *Paper presented at Seminar Nasional Lahan Suboptimal*, Palembang, Indonesia.

[29] Walawska, B., Szymanek, A., Pajdak, A., Nowak, M., & Hala, B. (2012). Sorption Properties Of Sodium Bicarbonate. *Chemik*, 66(11), 1169–1176.

[30] BSN. (2002). *Badan Standardisasi Nasional. SNI 01-6630:2002 tentang Makanan Ringan*. Badan Standar Nasional. Jakarta.

[31] Ratnaningtyas, S., Soeprijadi, L., & Ambarwati, L. (2024). Mutu Sensori Dan Kimia, Serta Penentuan Umur Simpan Tempe Kedelai Dengan Penambahan Tepung Tulang Ikan Lele (Clarias sp.). *Media Teknologi Hasil Perikanan*, 12 (1)

[32] Fajri M, Sulasmi. (2014). Pengaruh pengepresan dan penggorengan terhadap zat gizi pada tempe kacang tanah. *In: Prosiding Seminar Hasil Penelitian Tanaman Aneka Kacang dan Umbi*.

[33] Rahayu, R., Yuliani, S., & Haryani, S. (2023). Perbandingan Karakteristik Pati Modifikasi Heat Moisture Treatment, Asetilasi dan Kombinasi Ganda. *Jurnal Ilmiah Mahasiswa Pertanian*, 8(3).

[34] Winarti, S., Sudaryati., & Lestari, F. (2018). Substitusi Tepung Ubi Jalar Ungu dan Penambahan NaHCO3 pada pembuatan Tortilla Chips. *Jurnal Teknologi Pangan*, 2(1).

[35] Hersoelistyorini, W. Sri S.D dan Andri C.K. (2015). Sifat Fisikokimia dan Organoleptik Tepung Mocaf (Modified Cassava Flour) dengan Fermentasi Menggunakan Ekstrak Kubis. *Prosiding URECOL*. ISSN 2407-9189.

[36] Harahap, S. E., Purwanto, Y. A., Budijanto, S., & Maharijaya, A. (2017). Karakterisasi Kerenyahan Dan Kekerasan Beberapa Genotipe Kentang (Solanum tuberosum l.) Hasil Pemuliaan. *Jurnal Pangan*, 26(3).

[37] Fadhil, R., & Nurba, D. (2018). Penilaian organoleptik keripik ubi jalar ungu (Ipomoea batatas L.) pasca penggorengan menggunakan metode nonnumeric MP- MCDM. *Jurnal Keteknikan Pertanian*, 6(2), 165-170.

[38] Hardiyanti, (2016). Pengaruh Subtitusi Tepung Jagung (Zea mays L) Dalam Pembuatan Cookies. Bogor: *Jurnal Pendidikan Teknologi Pertanian*, Vol. 2 (2016) : 123-128

[39] Ridhani, M. A., & Aini, N. (2021). Potensi penambahan berbagai jenis gula terhadap sifat sensori dan fisikokimia roti manis. *Pasundan Food Technology Journal (PFTJ)*, 8(3), 61-68.

[40] Suarti, B., Fuadi, M., & Rasih, W. D. (2015). The Effect Of Natrium Bicarbonate (NaHCO3) And Temperature On The Quality Of Durian Seed Tortilla (Durio Zibethinus Murr). *AGRIUM: Jurnal Ilmu Pertanian*, 19(2).

[41] Gozaly, T., & Garnida, Y. (2021). Pengaruh Perbandingan Tepung Jagung Nikstamal dan Tepung terigu Terhadap Karakteristik Roti Tawar Manis. *Pasundan Food Technology Journal* (PFTJ), 8(3), 78-84.

[42] Panghal A, Navnidhi C V, Khatkar BS. (2011) .Effects of minor ingredients on quality of cookies. *Ann Agri-Bio Res*;16(1):79–84

[43] Rohmayanti, T., Novidahlia, N., & Damayanti, I. (2019). Karakteristik tortilla chips dengan penambahan tepung ampas kecap. *Jurnal Agroindustri Halal*, 5(1), 113-121.

[44] Herdiana, R.M., Y. Marchal., R. Dewanti dan Sudiyono. (2014). Pengaruh penggunaan ampas kecap terhadap pertambahan bobot badan harian, konversi pakan, rasio efisiensi protein dan produksi karkas itik lokal jantan umur delapan minggu. *Buletin Peternakan.* 38 (3): 157-162.

[45] Oktalidya, S. P. (2023). *Pengaruh Proporsi Tepung jagung : Tepung Sagu Dan Penambahan Tepung Udang Rebon Terhadap Karakteristik Fisikokimia dan Organoleptik Tortilla Chips Jagung Tambin (Zea mays L.).* Skripsi, UPN Veteran Jawa Timur.