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The Effect of Milkfish Bone Meal (*Chanos chanos*) Addition and Sodium Bicarbonate ($NaHCO_3$) Concentration on the Physicochemical and Organoleptic Characteristics of Tortilla Chips

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A B S T R A C T

Tortillas are a corn-based snack, yellow, and have a thin shape and crunchy texture. The addition of fish bone meal can increase calcium levels but also decrease the texture of the tortilla. The addition of sodium bicarbonate aims to improve the texture by increasing the swelling power and crispness of the product. This research aims to determine the effect of the substitution of milkfish bone meal with the addition of sodium bicarbonate on the physicochemical and organoleptic characteristics of tortilla chips. This study used a Completely Randomized Design (CRD) with two factors and two replications, factor I was the concentration of milkfish bone meal (10%, 15%, and 20%) and factor II was the concentration of sodium bicarbonate (0.25%, 0.50 %, and 0.75%). The data obtained were analyzed using ANOVA and continued with the Duncan Multiple Range Test (DMRT) at the 5% level. The results of the research show that there is a real interaction with ash content, protein content, fat content, and calcium content. The research results of the best treatment based on physicochemical parameters were tortilla chips with the addition of a fish bone meal 10% and a sodium bicarbonate concentration of 0.75%. This is the best-treated tortilla chip product with a water content value of 5.080%; ash content of 2.995%; protein content 5.87%; fat content 5.380%; carbohydrates 82.521%, calcium 3.396%, expansion volume 19.912%; breaking power 278,350 gf; amylose 37.750%; and starch content 62.516%.

1. INTRODUCTION

1.1. Research Background

Nowadays, people are increasingly aware of the importance of consuming food that not only fulfils hunger needs but also fulfils the nutritional requirements of the body. *Tortilla chips* circulating on the market have high energy content but are low in calcium. It is recorded that the calcium content in tortilla chips currently sold is only around 1.26 ppm [1]. Tortilla chip products have a main consumption target among children and teenagers. Meanwhile, during the growth and development period, children need calcium. Calcium requirements are 500 mg/day for ages 1-9 years, 700 mg/day for ages 10-15 years, 600 mg/day for ages 16-19 years and 500-800 mg/day for adults. adults (aged 20 to over 60 years) [2].

Based on these conditions, it is necessary to add ingredients that are high in calcium. Increasing the nutritional value, especially calcium, in making tortilla chips can be done by adding fish bone meal.

1.2. Literature Review

Fish bones are a fairly large solid waste originating from the fishing industry and household processing businesses. Fish bones are usually thrown away or buried in the ground, even though fish bones are rich in mineral content [3].

Fish bone meal has been widely applied in the processing of food products, especially as a substitute ingredient, such as in the processing of crackers with snakehead fish bones [4], biscuits with tuna bone meal [5], cookies with catfish bone meal [6] and making plain bread with red tilapia bone meal [7].

The advantage of calcium that comes from fish is that it is easily absorbed by the body, this happens because calcium that comes from vegetable materials binds to oxalate which can bind

to salt and is water insoluble so it is more difficult for the body to absorb. Meanwhile, calcium in fish (especially in bones) forms a phosphorus complex in the form of apatite which can be absorbed well by the body [8]. However, the addition of fish bone meal apart from increasing the calcium content of the product also has a negative impact, namely causing a decrease in the texture of the tortilla chips. This happens because the higher ash content of fish bone flour added can cause a decrease in the resistance of the dough to rise. After all, the minerals in the flour will weaken the structure formed in the dough [9]. So it is necessary to add food additives that can increase the swelling power and crispness of the product, such as $NaHCO_3$ (Sodium Bicarbonate). The addition of Na Bicarbonate will produce gas in the dough and make the dough light and porous because the air trapped in the dough and water vapor will expand. The results of organoleptic tests showed that the addition of 0.25% $NaHCO_3$ with 10% tofu dregs flour produced tortillas with a water content of 9.016%, protein content of 7.924%, yield of 62.718%, starch content of 74.884%, volume expansion 20.346%, crispness 1.069 kg/ cm^2 and organoleptic value with a total ranking of color 205, taste 215, aroma 147 and crispness 204.5 [10].

Based on these conditions, this research is needed to determine the effect of skim milk and CMC concentrations on the physicochemical and organoleptic characteristics of tamarillo Velva.

1.3. Research Objective

This research aims to investigate the effect of milkfish bone meal (*Chanos chanos*) addition and sodium bicarbonate ($NaHCO_3$) Concentration on the physicochemical and organoleptic Characteristics of Tortilla Chips and determine the best treatment based on physicochemical parameters

2. MATERIALS AND METHODS

2.1. Materials and Tools

The ingredients used in this research were nixtamalized cornmeal made from corn kernels purchased at Wadungasri Waru Market, salt, sugar, garlic, pepper and baking powder.

Materials used in the analysis include Petroleum ether (Smart Lab), Selenium (Merck), H_2SO_4 (Smart Lab), $Ca(OH)_2$ (Merck), NaOH 40% (Merck), 1N acetic acid (Smart Lab), Iodine (Merck), NaOH 1N (Merck), Boric acid 2% (Merck), Bromine Indicator Cresol Green Methyl Red (Merck), Methyl Red Indicator (Merck), HCL 0.1 N (Smart Lab), Naphoshat Buffer 0.1M, Thermamyl enzyme, Ethanol 95% (Merck), Acetone (Merck), Pure glucose powder, Alcohol 70%, Aquades, and Aluminum foil.

Tools used for the flour-making process include basins, pans, spoons, 60 and 80-mesh flour sieves, baking pans, plastic containers, knives, spatulas, stoves, cabinet dryers, analytical scales, and blenders.

Tools used for analysis include electric ovens, Kjedahl flasks, dilators, Soxhlets, analytical scales, desiccators, spectrophotometers, test tubes, 100ml volumetric flasks, porcelain cups, clamps, fat flasks, biurets, dropper pipettes, furnaces, pH meters, and water bath.

2.2. Research Design and Analysis

The research design used in this research was a Completely Randomized Design (CRD) with a 2-factor factorial pattern with 2 replications. The treatment used was the addition of milkfish bone meal (10%, 15%, 20%) and $NaHCO_3$ concentration (0.25%, 0.50%, 0.75% (w/w)). The observation variable data was tested statistically using analysis of variance at $\alpha = 5\%$ using the DMRT follow-up test.

2.3. Research Implementation

2.3.1. Preparation of nixtamalized cornmeal

Prepare 2 kg of corn kernels, wash thoroughly with running water, boil the corn kernels in 1% calcium hydroxide solution ($Ca(OH)_2$) at 90° for 30 minutes in 6 litres of water, soak the corn for 24 hours using the remaining calcium hydroxide solution ($Ca(OH)_2$), Rinsing with water, Grinding, Drying (cabinet dryer) at 60°C, 6 hours, Crushing using a blender, Sifting 60 mesh.

2.3.2. Making Fish Bone Meal.

Preparing fresh milkfish, Boiling at a temperature of 100° C, for 1 hour and draining, Washing with running water until clean, Boiling again at a temperature of 100°C, for 1 hour, Softening the milkfish in a pressure cooker for 1 hour, Doing drying in an oven at 105°C, for 2 hours, grinding with a blender, sieving 100 mesh.

2.3.3. Making Tortillas

Make the dough by adding nixtamal cornmeal; milkfish bone meal as much as (10%; 15%; and 20%); cornstarch; water; garlic powder, salt, $NaHCO_3$ (0.25%; 0.50%; and 0.75%), Make thin sheets and cut, Dry using an oven at 150°C, for 35 minutes, raw Tortilla chips The results are analyzed for water content, ash content, protein content, fat content, carbohydrate content, starch content, amylose and calcium content. Fry the tortilla chips at 180°C for 10 seconds. Cool at room temperature. Tortilla chips are cooked. Fracture strength analysis, swelling volume, and organoleptic tests including taste, color, aroma and crispness were carried out.

2.4. Observation

2.4.1. Chemical analysis

Analysis parameters include water content analysis, ash content analysis, protein content analysis, Kjeldahl method, fat content analysis, carbohydrate analysis, starch analysis, amylose analysis, and calcium analysis.

2.4.2. Physical analysis

Analysis parameters include fracture strength analysis and developer volume analysis.

3. RESULTS AND DISCUSSION

3.1. Chemical Analysis

Tortilla chip's chemical analysis, protein content, ash content, water content, fat content, starch content, amylose content, calcium content, carbohydrate content, breaking strength, and expansion volume.

3.1.1. Water content

Based on the results of the analysis of variance, it was found that there was no significant interaction ($p \geq 0.05$) between the treatment with the addition of milkfish bone meal and the concentration of sodium bicarbonate on the water content of tortilla chips. However, there were significant differences ($p \leq 0.05$) in each treatment. The average value of water content for tortilla chips with the addition of milkfish bone meal can be seen in Table 1.

Table 1. Average value of water content of tortilla chips with the addition of milkfish bone meal

Addition of milkfish bone meal (%)	Average level water (%) ± SD	DMRT (5%)
10	5.51 ± 0.446 [c]	0.215
15	3.97 ± 0.421 [b]	0.206
20	2.83 ± 0.432 [a]	-

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

Table 1 shows that the average water content of tortilla chips ranges from 2.83% - 5.51%. The higher the addition of milkfish bone flour, the resulting water content will decrease, this is because the water contained in the tortilla dough will be bound by the Ca^{2+} particles contained in the fish bones, thereby reducing the water content. The addition of fish bone meal will increase Ca^{2+} particles which will bind OH^- particles which are part of the water elements or H_2O so that the water content decreases along with the addition of fish bone meal. Apart from that, research shows that the addition of catfish bone meal does not cause an increase in water content but causes a decrease in water content. Milkfish bone meal has high levels of calcium, so if the proportion of milkfish bone meal is As more is added, the resulting water content also decreases [3].

Table 2. Average value of water content of tortilla chips with sodium bicarbonate concentration treatment

Sodium Bicarbonate Concentration (%)	Average level water (%) ± SD	DMRT (5%)
0.25	3.66 ± 1.355 [a]	-
0.50	4.12 ± 1.304 [b]	0.206
0.75	4.53 ± 1.372 [c]	0.215

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

Table 2 shows that the higher the addition of sodium bicarbonate, the more the water content of the tortilla chips will increase. This is because $NaHCO_3$ can bind water [11].

3.1.2. Ash Content.

Based on the results of the analysis of variance, it can be seen that there is a significant interaction ($p \leq 0.05$) between the addition of milkfish bone meal and sodium bicarbonate concentration on the ash content of tortilla chips. Each treatment had a significant effect on the ash content of tortilla chips. The average value of ash content for tortilla chips with the addition of milkfish bone meal and sodium bicarbonate concentration can be seen in Table 3.

Table 3. Shows that the average ash content of tortilla chips ranges from 3.820-5.126%. The treatment with the addition of 10% milkfish bone meal and 0.25% $NaHCO_3$ concentration produced the lowest ash content value, namely 3.820%, while the addition of 20% milkfish bone meal and 0.75% $NaHCO_3$ concentration produced the highest ash content value, namely 5.126%.

Processing tortilla chips using snakehead fish bone flour produces an ash content percentage of between 2.73% to 7.95%. The differences in results with the literature could be caused by differences in components and mineral concentrations between snakehead fish and milkfish [1]. This statement is by research showing that snakehead fish meal has an ash content of 2.94% [12]. The results of the analysis of milkfish bone meals show an ash content of 2.35% to 11.09% [3], which causes differences in results with the literature.

Table 3. The average value of ash content for tortilla chips with the addition of milkfish bone meal and NaHCO3

Treatment		Average ash content (%) ± SD	DMRT (5%)
Addition of milkfish bone meal (%)	Sodium bicarbonate concentration (%)		
10	0.25	3.820 ± 0.030[a]	-
	0.50	4.200 ± 0.015[b]	0.065
	0.75	4.226 ± 0.050[b]	0.068
15	0.25	4.556 ± 0.026[c]	0.069
	0.50	4.548 ± 0.032[cd]	0.070
	0.75	4.641 ± 0.008[d]	0.071
20	0.25	5.068 ± 0.036[e]	0.071
	0.50	5.073 ± 0.026[e]	0.072
	0.75	5.126 ± 0.004[e]	0.072

Note: Average values accompanied by different letters mean significantly different ($p \leq 0.05$).

3.1.3. Protein Content.

Based on the results of variance analysis, it can be seen that there is a significant interaction ($p \leq 0.05$) between the addition of milkfish bone meal and sodium bicarbonate concentration on protein content. Each treatment had a significant effect on the protein content of tortilla chips.

Table 4. showed that the average protein content value of tortilla chips with the addition of milkfish bone meal and sodium bicarbonate concentration ranged from 5.78% - 7.16%. The highest value of protein content in the treatment with the addition of 20% milkfish bone meal with a sodium bicarbonate concentration of 0.75% was 7.16%, while the addition of 10% milkfish bone meal and a sodium bicarbonate concentration of 0.25% had the lowest value of 5.78%. The higher addition of sodium bicarbonate causes an increase in the protein content of tortilla chips. This is thought to be because sodium bicarbonate ($NaHCO_3$) plays a role in binding water molecules.

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The molecular structure formed by $NaHCO_3$ can trap water so that the proteins in the water molecules are also trapped, this causes the protein in food to be maintained [14].

Table 4. Average value of protein content tortilla chips with the addition of milkfish bone meal and sodium bicarbonate concentration

Treatment		Average protein (%) ± SD	DMRT (5%)
Addition of milkfish bone meal (%)	Sodium bicarbonate concentration (%)		
10	0.25	5.78 ± 0.028[a]	-
	0.50	5.80 ± 0.014[a]	0.057
	0.75	5.87 ± 0.028[a]	0.059
15	0.25	6.35 ± 0.028[b]	0.061
	0.50	6.38 ± 0.014[b]	0.062
	0.75	6.46 ± 0.014[b]	0.062
20	0.25	6.93 ± 0.028[b]	0.063
	0.50	7.03 ± 0.014[b]	0.063
	0.75	7.16 ± 0.042[b]	0.063

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$.

3.1.4. Fat level.

Based on the results of the analysis of variance, it was discovered that there was no significant interaction between the treatment of adding milkfish bone meal and the sodium bicarbonate concentration on the fat content of tortilla chips ($p \geq 0.05$). The treatment with the addition of milkfish bone meal affected the fat content of tortilla chips ($p \leq 0.05$) while the sodium bicarbonate concentration treatment did not affect the fat content of tortilla chips. The average value of fat content for tortilla chips with the addition of milkfish bone flour can be seen in Table 5.

Table 5. The average value of fat content of tortilla chips with the addition of milkfish bone meal.

Addition of milkfish bone meal (%)	Mean fat content (%) ± SD	DMRT (5%)
10	5.34 ± 1.365 [a]	5.473
15	7.05 ± 1.410 [b]	7.189
20	8.71 ± 1.364 [c]	-

Note: Average values accompanied by different letters mean significantly different ($p \leq 0.05$).

Table 5 shows that the average fat content of tortilla chips treated with milkfish bone flour ranges from 5.34 – 8.71%. Where the higher the addition of milkfish bone flour, the fat content of the tortilla chips will increase. The results of this analysis are inversely proportional to the addition of sodium bicarbonate concentration. According to Table 3. Regarding the nutritional content of a fish bone meal, this occurs due to the influence of the fat content of the material used, namely milkfish bone meal which has a high-fat content, namely 23.06% [13]. So there is an increase in the concentration of milkfish bone meal in Making tortilla chips can increase the fat content produced. The average value of fat content in the sodium bicarbonate concentration treatment can be seen in Table 6.

Table 6. Average value of fat content for tortilla chips treated with sodium bicarbonate concentration.

Sodium bicarbonate concentration (%)	Mean fat content (%) ± SD	DMRT (5%)
0.25	7.03 ± 0.046 [a]	7.157
0.50	7.05 ± 0.081 [a]	7.193
0.75	7.02 ± 0.024 [a]	-

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

Table 6 shows that the average fat content of tortilla chips with the addition of sodium bicarbonate ranges from 7.02 – 7.05%. This statistically shows that there is no real effect this is because sodium bicarbonate does not contain fat content.

Based on SNI, the maximum fat content limit for tortilla chips as an extruder snack product is 38%, so the fat content of tortilla chips meets SNI standards.

3.1.5. Carbohydrate Levels

Based on the results of the analysis of variance, it was discovered that there was no significant interaction between the treatment with the addition of milkfish bone meal and the concentration of sodium bicarbonate on the carbohydrate content of tortilla chips ($p \geq 0.05$). The treatment with the addition of milkfish bone meal affected the carbohydrate content of tortilla chips ($p \leq 0.05$) while the sodium bicarbonate concentration treatment did not affect the fat content of tortilla chips. The average value of carbohydrate content for tortilla chips with the addition of milkfish bone meal can be seen in Table 7.

Table 7. The average value of carbohydrate content in tortilla chips after adding milkfish bone meal

Addition of milkfish bone meal (%)	Average carbohydrate content (%) ± SD	DMRT (5%)
10	82.68 ± 0.150[a]	-
15	81.79 ± 0.508[b]	0.329
20	80.37 ± 0.356[c]	0.345

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

Based on Table 7, it is known that the greater the concentration of milkfish bone meal, the resulting carbohydrate content decreases. This is because carbohydrate analysis uses a by-difference calculation method where proximate content such as high levels of ash, protein and fat causes the carbohydrate content to be lower because higher protein and fat content results in lower levels of carbohydrates produced.

Carbohydrate analysis only uses the carbohydrate by difference calculation method. If the average nutrient content such as water, ash, protein and fat shows an increase, the nutrient content such as carbohydrates will decrease [15]. Apart from that, it can be caused by analysis of carbohydrate calculations by difference, the decrease in carbohydrates can also be caused by processing processes such as drying and roasting above a temperature of 150^{o}C, causing Maillard reactions to occur in the material.

The higher the temperature, the more carbohydrate (starch) levels will decrease. This is because high-temperature treatment will cause damage to some carbohydrate molecules during the processing process [24]. The average value of

carbohydrate content in the sodium bicarbonate concentration treatment can be seen in Table 8.

Table 8. The average value of carbohydrate content for tortilla chips treated with sodium bicarbonate concentration

Sodium bicarbonate concentration (%)	Average carbohydrate content (%) ± SD	DMRT (5%)
0.25	81.31 ± 1.039[b]	0.329
0.50	81.55 ± 0.918[b]	0.345
0.75	81.97 ± 0.909[a]	-

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

Based on Table 8, it can be seen that the addition of sodium bicarbonate at a concentration of 0.25% and 0.50% does not affect the carbohydrate content of tortilla chips, however, the addition of sodium bicarbonate at a concentration of 0.75% can affect the carbohydrate content of tortilla chips. This is thought to be related to the water content in the tortilla chip product. As is known, the percentage of carbohydrate content is calculated based on the difference in the amount of nutrients that produce energy.

During drying, food ingredients will lose water content which can increase the concentration of nutrients in the remaining mass per dry weight [16]. The gases released by sodium bicarbonate will be trapped in the material matrix and will quickly widen the matrix area or cause expansion of the matrix volume in the resulting material, resulting in the development of a larger volume and causing the cavities in the product will get bigger, resulting in a decrease in carbohydrates [25].

3.1.6. Starch Content.

Based on the results of the analysis of variance, there was no significant interaction between the treatment with the addition of milkfish bone meal and the concentration of sodium bicarbonate on the starch content of tortilla chips ($p \geq 0.05$). Likewise, each treatment did not have a significant effect on the starch content of tortilla chips. The average value of starch content for tortilla chips with the addition of milkfish bone flour can be seen in Table 9.

Table 9. The average value of starch content of tortilla chips with the addition of milkfish bone flour.

Milkfish bone meal concentration(%)	Average starch content (%) ± SD	DMRT (5%)
10	62.65 ± 0.190[a]	0.998
15	62.47 ± 0.034[a]	1.042
20	62.36 ± 0.136[a]	-

Note: Average values accompanied by different letters indicate significant differences at $p \geq 0.05$.

Table 9 shows that the milkfish bone meal concentration treatment had no significant effect on the starch content produced. This is thought to be because adding ingredients to a product, in this case, milkfish bone meal, will reduce the content of other components in a food product. Apart from that, the heating process when making tortilla chips will cause the starch content in the product to decrease. Increasing the temperature will increase the speed of starch hydrolysis so that it will break down into simple compounds [17]. Carbohydrate levels in fish are very low because their digestibility is low and carbohydrates are used as the main energy source, this causes the level of carbohydrates stored in the fish's body to be very low or almost zero [18].

Table 10. Average value of starch content of tortilla chips with sodium bicarbonate addition treatment.

Sodium bicarbonate concentration (%)	Average starch content (%) ± SD	DMRT (5%)
0.25	62.65 ± 0.229[a]	1.042
0.50	62.44 ± 0.068[a]	0.998
0.75	62.39 ± 0.175[a]	-

Note: Average values accompanied by different letters indicate significant differences at $p \geq 0.05$.

Table 10 shows that the addition of sodium bicarbonate did not show any real differences between the three concentrations of sodium bicarbonate added. The starch content in tortilla chips is closely related to the water content of the product. This is due to the bonds between water molecules and various other components in the material, including starch. Processing tortilla chips using the substitution of tofu dregs flour and cornmeal produces starch levels between 56.44% and 78.93% [10]. The differences in results with the literature can be caused by differences in the main raw materials used. This is because one of the components that influences the starch content of tortilla chips is the starch content of the raw material. According to the research, the starch component contained in cornmeal is relatively high (the results of analysis of the starting material have a starch content of 70.115%) so if the added tofu dregs flour is lower than cornmeal, the starch content of the resulting tortilla will increase [10].

3.1.7. Amylose Content

Based on the results of the analysis of variance, it was found that there was no significant interaction between the treatment with the addition of milkfish bone meal and the concentration of sodium bicarbonate on the amylose content of tortilla chips ($p \geq 0.05$). Likewise, for each treatment, there was no real interaction with the amylose content of the tortilla chips. The average value of amylose content for tortilla chips with the addition of milkfish bone meal can be seen in Table 11.

Table 11. The average value of amylose content of tortilla chips after adding milkfish bone meal

Addition of milkfish bone meal (%)	Mean amylose content (%) ± SD	DMRT (5%)
10	37.75 ± 0.028[a]	-
15	37.65 ± 0.076[a]	0.601
20	37.37 ± 0.268[a]	0.627

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

Based on Table 11, it is known that the addition of milkfish bone flour to making tortilla chips does not show any real difference. This is because milkfish bone meal does not contain amylose, so there is no addition of amylose to the tortilla chips. The amylose content comes from nixtamal cornmeal which is the main ingredient in making tortilla chips in this research. According to research, the nixtamalization process by soaking causes the amylose content of cornmeal to increase. This is thought to be because the longer soaking in an alkaline solution will reduce the percentage of particles such as protein and fat

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contained in corn so that the amylose content contained therein becomes high [19]. The average value of amylose content for the sodium bicarbonate concentration treatment can be seen in Table 12.

Based on Table 12, it can be seen that the addition of sodium bicarbonate does not show any real effect on amylose levels. This is because sodium bicarbonate does not contain carbohydrates. In 100 g of sodium bicarbonate, the carbohydrate content is 0g [20].

Table 12. Average value of amylose content *tortilla chips* sodium bicarbonate concentration treatment

Sodium bicarbonate concentration (%)	Mean amylose content (%) ± SD	DMRT (5%)
0.25	37.64 ± 0.103[a]	-
0.50	37.63 ± 0.108[a]	0.691
0.75	37.51 ± 0.316[a]	0.627

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

3.1.8. Calcium Levels.

Based on the research results, the treatment with the addition of milkfish bone meal had a significant effect on the calcium content of tortilla chips ($p \leq 0.05$) while the sodium bicarbonate concentration treatment did not affect the calcium content of tortilla chips (Table 13).

Table 13. Average value of calcium levels *tortilla chips* with the addition of milkfish bone meal

Addition of milkfish bone meal (%)	Mean calcium levels (%) ± SD	DMRT (5%)
10	3.42 ± 0.317 [a]	-
15	3.69 ± 0.291 [b]	0.038
20	4.15 ± 0.291 [c]	0.040

Note: Mean values accompanied by different letters indicate significant differences at $p \leq 0.05$.

Table 13. Shows that the addition of milkfish bone meal has a real influence on the calcium levels of tortilla chips. Where the higher the addition of milkfish bone flour, the calcium content of the tortilla chips increases. This is because the milkfish bone meal used contains high calcium of 20.83%. So, the higher the concentration of milkfish bone meal added, the higher the calcium level will be. The addition of different concentrations of milkfish bone meal shows an increase in calcium due to the influence of the addition of bone meal.

Tthe addition of sodium bicarbonate has no significant effect on the calcium content of tortilla chips, this is because the addition of $NaHCO_3$ functions to provide crunch to the tortilla. Sodium bicarbonate functions to help the dough become more porous, thus making the dough bloom more by producing CO_2 [21].

Table 14. Average value of calcium levels *tortilla chips* with the addition of sodium bicarbonate treatment

Sodium bicarbonate concentration (%)	Mean calcium levels (%) ± SD	DMRT (5%)
0.25	3.72 ± 0.037[a]	-
0.50	3.74 ± 0.023[a]	0.038
0.75	3.80 ± 0.067[a]	0.042

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$.

3.2. Physical Analysis

3.2.1. Fracture Power.

Based on the analysis of variance, it can be seen that there is a significant interaction ($p \leq 0.05$) between the addition of milkfish bone meal and sodium bicarbonate concentration, and each treatment had a significant effect ($p \leq 0.05$) on the breaking strength value of tortilla chips. The average value of breaking strength of tortilla chips with the addition of milkfish bone meal and sodium bicarbonate concentration can be seen in Table 15.

Table 15. Average value of breaking strength of tortilla chips with treatment with the addition of milkfish bone meal and sodium bicarbonate concentration

Treatment		Average breaking strength (gf) ± SD	DMRT (5%)
Addition of milkfish bone meal (%)	Sodium bicarbonate concentration (%)		
10	0.25	378.90 ± 0.565[i]	0.990
	0.50	362.86 ± 0.127[h]	0.987
	0.75	353.48 ± 0.141[g]	0.984
15	0.25	340.74 ± 0.311[f]	0.978
	0.50	327.53 ± 0.735[e]	0.969
	0.75	315.63 ± 0.254[d]	0.955
20	0.25	303.14 ± 0.169[c]	0.932
	0.50	289.89 ± 0.169[b]	0.983
	0.75	278.35 ± 0.537[a]	-

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$.

Table 15. showed that the average breaking strength value of tortilla chips with the addition of milkfish bone meal and sodium bicarbonate concentration ranged from 278.35% - 378.90%. The highest fracture strength value in the treatment with the addition of 20% milkfish bone meal with a sodium bicarbonate concentration of 0.25% was 378.90, while the addition of 10% milkfish bone meal and a sodium bicarbonate concentration of 0.75% had the lowest value of 278.35.

The decreasing breaking strength shows that the tortilla chips produced are crispier. This is because more and more cavities are formed due to the presence of carbon dioxide gas (CO_2) which is produced from the addition of sodium bicarbonate resulting in increasingly crispy tortilla chips so that the breaking strength value is low. When the leavening agent is mixed into the dough carbon dioxide gas will be formed. The greater the $NaHCO_3$ concentration, the more CO_2 gas will be generated in the ingredients during the frying process [22].

3.2.2. Swelling Volume.

Based on the analysis of variance, it was found that there was no significant interaction between the treatment of adding milkfish bone meal and the sodium bicarbonate concentration on the volume of tortilla chips expansion ($p \geq 0.05$). However, the treatment with the addition of sodium bicarbonate concentration

influenced the volume of tortilla chips swelling ($p \leq 0.05$) while the treatment with the addition of milkfish bone meal did not affect the volume of expansion of tortilla chips. The average value of the expansion volume of tortilla chips with the addition of milkfish bone flour can be seen in Table 16.

Table 16. The average value of swelling volume tortilla chips with the addition of milkfish bone meal.

Milkfish bone meal concentration (%)	Mean expansion volume (%) ± SD	DMRT (5%)
10	17.56 ± 0.774^{a}	0.069
15	17.54 ± 0.702^{a}	0.067
20	17.53 ± 0.774^{a}	-

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$.

Table 16. Shows that the addition of milkfish bone flour does not show any real influence on the volume of tortilla chips swelling. It can be concluded that the higher the addition of milkfish bone meal, the higher the volume of swelling on tortilla chips. This is thought to be due to the addition of a large amount of bone meal, which causes a decrease in the starch and amylopectin content of cornmeal. It can be concluded that the addition of milkfish bone meal reduces the expansion volume value of tortilla chip products. The volume of tortilla expansion is influenced by the amylopectin content, where milkfish bone meal does not contain amylopectin [23].

Table 17. Shows that the addition of sodium bicarbonate does not show any real effect on the expansion volume of tortilla chips. The higher the addition of sodium bicarbonate be lower the volume swelling of tortilla chips. This is due to the ability of sodium bicarbonate to bind water, thus causing the formation of large cavities which will result in the expanding power of the tortilla chips increasing. CO_2 and water vapor resulting from the decomposition of H_2CO_3 which have accumulated in air bubbles expand and push against the surrounding walls when tortilla chips are fried in hot oil. Processing tortilla chips using the substitution of tofu dregs flour and cornmeal resulted in a volume expansion percentage of between 13% and 20.91% [10]. The differences in results with the literature can be caused by differences in the raw materials used. This is because one of the component that influence the expansion volume is starch and tortilla.

Table 17. The average value of the expansion volume of tortilla chips with the addition of sodium bicarbonate concentration

Sodium bicarbonate concentration (%)	Mean expansion volume (%) ± SD	DMRT (5%)
0.25	17.16 ± 0.034^{a}	-
0.50	17.58 ± 0.031^{b}	0.067
0.75	17.90 ± 0.037^{c}	0.069

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$.

4. CONCLUSION

Treatment of skim milk and Carboxy Methyl concentrations. Based on the results of research on the addition of milkfish bone meal and the concentration of Sodium Bicarbonate ($NaHCO_3$) on the Physicochemical and Organoleptic Characteristics of Tortilla Chips, it can be concluded that: (1). There was a real interaction between the treatment of adding milkfish bone meal and sodium bicarbonate to ash content, protein content, fat content, and calcium content; (2) The research results of the best treatment based on physicochemical parameters were tortilla chips with the addition of 10% fish bone meal and a sodium bicarbonate concentration of 0.75%, which was the best treatment tortilla chip product with a water content value of 5.080%; ash content 2.995%; protein content 5.87%; fat content 5.380%; carbohydrates 82.521%. calcium 3.396%. expansion volume 19.912%; breaking power 278.350 gf; amylose 37.750%; and starch content 62.516%;

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