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Study of Types of Tuber Flours and the Addition of Sodium Tripolyphosphate on the Chemical Characteristics of Milkfish Burger Patties (*Chanos chanos*)

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A B S T R A C T

The use of tuber flours (potato flour, taro flour, yellow sweet potato flour), which contains high starch content as a filler, requires the addition of sodium tripolyphosphate (STPP) as a binding agent to improve the characteristics of milkfish burger patties. STPP can reduce product shrinkage, increase water binding capacity, and improve texture. This study aimed to determine the optimal combination of tuber flour type and STPP addition to produce mackerel fish burger patties with the best chemical characteristics. This study used a completely randomized design (CRD) with a factorial pattern consisting of two factors and two replications. Factor 1 was tuber flour (potato flour, taro flour, and yellow sweet potato flour), and Factor 2 was the addition of STPP (0.2%, 0.3%, and 0.4%). Data were analyzed using ANOVA and DMRT post-hoc tests at the 5% level. The best treatment was the use of potato flour and STPP addition of 0.4%, which produced mackerel fish burger patties with a moisture content of 61.66%, an ash content of 2.52%, a protein content of 20.25%, a fat content of 1.58%, and starch content of 11.05%.

Contribution to Sustainable Development Goals (SDGs):
SDG 6: Clean Water and Sanitation
SDG 11: Sustainable Cities and Communities
SDG 13: Climate Action
SDG 15: Life on Land

1. INTRODUCTION

1.1. Research Background

Patties are processed meat made from minced meat, binding agents, fillers, and seasonings. The meat commonly used in making burger patties is beef, which is very expensive and unaffordable for some segments of society. Fish has the potential to be used as a raw material for making burger patties. One type of fish with potential is milkfish. The nutritional value of fresh milkfish is rich in omega-3 fatty acids at 19.56%; omega-6 at 7.47%, and omega-9 at 19.24% [1]. The milkfish used in this study is milkfish from brackish water habitats. According to [2], brackish water milkfish has a higher protein content (24.175%) compared to freshwater milkfish (20.496%). Fillers and binders are required to improve the chemical characteristics of milkfish burger patties. Fillers enhance water absorption, reduce product formulation costs, and increase product volume.

The fillers used in this study were potato flour, taro flour, and yellow sweet potato flour. The starch content in potato flour ranged from 43.60% to 50.62% [3], taro flour from 62.73% to 76.98% [4], and yellow sweet potato flour at 80.8% [5]. Generally, flour is added at a rate of 5–10% of the meat weight [6]. Potato flour has the following characteristics: high absorbency, smooth texture, mild sweetness, and the distinctive aroma of potato flour [7]. Its ability to bind a significant amount of water allows potato flour to expand to a larger size, resulting in products with a high moisture content [8]. Potato flour contains higher phosphorus content compared to other flours. Phosphorus in potato flour forms phosphate esters. Phosphate

can open protein structures, helping to retain more water [9]. According to [10], 5% tapioca flour and 5% potato flour ratio yields the best quality for catfish meatballs. According to [8], 5% concentration of potato flour produces catfish meatballs with a firm, compact, and slightly chewy texture. Potato flour at a 5% level is considered optimal for making buffalo meat sausages [11]. The use of taro flour as a filler is expected to enhance its economic value and utilization as a local food ingredient [12]. The crude fiber content in taro flour is 2.72%. Taro flour contains gum-like polysaccharide components, namely glucomannan. The glucomannan content in taro flour is 3.87%. Glucomannan is a material with high water solubility, can absorb water, and form a gel. According to [13], the high mucilage or gum content in taro is an important factor in the structure of patties. Increasing the amount of taro flour can enhance the Water Holding Capacity (WHC) of sausages [12]. According to [14], adding taro flour up to 5% allows for an increase in WHC and the tenderness of beef meatballs while maintaining cooking losses.

The addition of yellow sweet potato flour as a filler is necessary to improve texture. The fiber content in yellow sweet potato flour is 2.15% [15]. According to [16], the best formulation between yellow sweet potato flour and tapioca flour in tilapia fish balls was obtained at a concentration of 5% yellow sweet potato flour and 20% tapioca. Additionally, according to [17], the addition of yellow sweet potato flour at concentrations of 0–10% resulted in a smoother texture in burgers compared to burgers with 15% and 20% yellow sweet potato flour.

A good quality burger patty is one that has a texture that is neither soft nor hard [18]. The use of binding agents is very important in producing the desired texture in restructured meat products [13]. Phosphate is one of the additives used in the manufacture of processed meat products [19]. The most commonly used phosphate in processed meat products is sodium tripolyphosphate (STPP). When starch reacts with STPP, hydrophilic phosphate groups (which are more easily bound to water) are formed. The higher the concentration of STPP added, the more phosphate groups bind to water. This study used STPP additions at different concentrations 0.2%, 0.3%, and 0.4% aiming to achieve the desired product texture. The addition of STPP can produce good texture in processed products. This is because STPP can increase water-binding capacity [20].

1.2. Research Objective

The objectives of this study were to determine the effect of the type of tuber flours and the addition of STPP on the chemical characteristics of milkfish burger patty and to determine the best treatment combination between the type of tuber flours and the addition of STPP to produce milkfish burger patty with good characteristics and consumer preference.

2. MATERIALS AND METHOD

2.1 Material and Tools

The ingredients used in making burger patties are milkfish, eggs, garlic, onions, salt, pepper, ginger, ice cubes, potato flour, taro flour, yellow sweet potato flour and STPP. Materials used for chemical analysis include H_2SO_4, selenium, H3BO3, methyl red indicator, methyl blue indicator, HCl, NaOH, H2SO4, K2SO4, petroleum benzene, petroleum ether, alcohol, and distilled water.

2.2 Methodology

This research used a completely randomized design (CRD) factorial pattern with two factors and two replications. Factor 1 is the type of tuber flour including potato flour, taro flour and yellow sweet potato flour. Factor 2 is the addition of Sodium Tripolyphosphate 0.2%, 0.3%, 0.4%. If there is a significant difference, it will be continued with the DMRT 5% further test. The samples in this study from the treatment of the type of tuber flour with the addition of Sodium Tripolyphosphate obtained 9 samples from the combination of the two treatments.

Description:

A1B1 = Potato flour and the addition of Sodium Tripolyphosphate 0.2%
A1B2 = Potato flour and the addition of Sodium Tripolyphosphate 0.3%
A1B3 = Potato flour and the addition of Sodium Tripolyphosphate 0.4%
A2B1 = Taro flour and the addition of Sodium Tripolyphosphate 0.2%
A2B2 = Taro flour and the addition of Sodium Tripolyphosphate 0.3%
A2B3 = Taro flour and the addition of Sodium Tripolyphosphate 0.4%
A3B1 = Yellow sweet potato flour and the addition of Sodium Tripolyphosphate 0.2%
A3B2 = Yellow sweet potato flour and the addition of Sodium Tripolyphosphate 0.3%
A3B3 = Yellow sweet potato flour and the addition of Sodium Tripolyphosphate 0.4%

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.

2.3 Making of Burger Patties

100 grams of milkfish meat is placed in a blender, then 5% bread flour, 10% egg white, 5% garlic, 5% shallots, 2% salt, 1% pepper, 2% ginger, 15% ice cubes, and 7% palm oil (w/w) are added. The mixture is then ground using a blender until it becomes homogeneous. The mixture is then added with tuber flour according to treatment (potato flour, taro flour, or yellow sweet potato flour at 5% (w/w)) and STPP according to treatment, namely 0.2%, 0.3%, or 0.4% (w/w). The mixture is molded into patties weighing 45 grams, with a diameter of 6.5 cm and a thickness of 1.5 cm. The patties are then steamed at 80°C for 20 minutes. The burger patties are then baked at 100°C for 4 minutes.

2.4 Research Analysis

The parameters analyzed include water, ash, protein, fat, and starch content [21].

3. RESULT AND DISCUSSION

3.1 Water Content

Based on the analysis of variance, there was a significant interaction ($p \leq 0.05$) between the type of tuber flour and the addition of STPP on the moisture content of the patty product. The average moisture content of milkfish burger patties (Table 1) ranged from 60.09 to 61.66%. Figure 1 shows that the treatment using yellow sweet potato flour and 0.2% STPP addition resulted in the lowest moisture content (60.09%), while the treatment using potato flour and 0.4% STPP addition resulted in the highest moisture content (61.66%). Higher STPP addition caused an increase in moisture content for each type of flour used (potato flour, taro flour, and yellow sweet potato flour), where the moisture content with potato flour as a filler was higher than that with taro flour and yellow sweet potato flour. This is because potato flour has a higher initial moisture content (10.05%) compared to taro flour (7.46%) and yellow sweet potato flour (7.37%). The increase in moisture content also occurs because STPP plays a role in absorbing and binding water.The moisture content of food products is influenced by the initial moisture content of the ingredients [22]. Potato flour has a relatively high water-binding capacity, which can result in the final product having a high moisture content [8]. Research findings [23] indicate that the moisture content of chicken nuggets can be influenced by the type of flour used in their production. Potato flour contains 31.32% amylose [8], higher than cassava flour and yellow sweet potato flour. Flour contains amylose, which affects the starch material's ability to absorb more water due to amylose's water-absorbing properties and its presence as a fraction in starch. As STPP concentration increases, more phosphate groups replace the -OH groups in starch. This replacement of phosphate groups weakens the hydrogen bonds in starch, allowing water to more easily enter the starch granules.

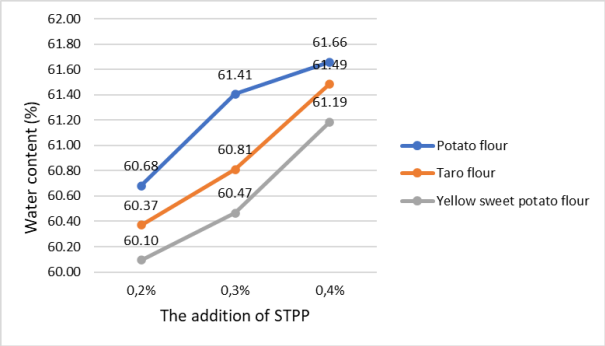

Figure 1. The relationship between the treatment of tuber flour types and the addition of STPP on the water content of milkfish burger patties

3.2. Ash Content

Based on the results of the variance analysis, there was no interaction ($p \geq 0.05$) between the type of tuber flour and the addition of STPP on the ash content of milkfish burger patties. Tuber flour contains low ash content, so its contribution to the ash content of milkfish burger patties is limited. [24] states that the ash content of a material is greatly influenced by the raw materials used, the process, and the processing method. Ash content is a chemical component that does not burn during combustion. There was an increase in the ash content of milkfish burger patties with the addition of STPP, but this was not statistically significant. This is because the difference in STPP addition is too small to affect the ash content. According to [25], the higher the STPP addition, the higher the ash content. Phosphorus penetration occurs from STPP into the starch granules and binds with the starch polymer chains to form phosphate bridges between starch molecules.

Table 1. Chemical Characteristics of Milkfish Burger Patties

Samples	Water (%)	Ash (%)	Protein (%)	Lipid (%)	Starch (%)
A1B1	60.68 ± 0.04^{b}	2.40 ± 0.07	20.93 ± 0.03	1.70 ± 0.07	12.41 ± 0.01^{c}
A1B2	61.40 ± 0.07^{c}	2.47 ± 0.04	20.71 ± 0.17	1.69 ± 0.10	11.46 ± 0.02^{b}
A1B3	61.66 ± 0.12^{c}	2.52 ± 0.04	20.25 ± 0.06	1.58 ± 0.01	11.05 ± 0.02^{a}
A2B1	60.37 ± 0.07^{b}	2.61 ± 0.09	19.96 ± 0.04	1.93 ± 0.07	13.20 ± 0.19^{d}
A2B2	60.81 ± 0.05^{b}	2.68 ± 0.02	19.74 ± 0.06	1.90 ± 0.05	12.39 ± 0.04^{c}
A2B3	61.48 ± 0.07^{c}	2.79 ± 0.04	19.40 ± 0.12	1.79 ± 0.01	11.34 ± 0.06^{b}
A3B1	60.09 ± 0.12^{a}	2.50 ± 0.07	19.42 ± 0.04	1.84 ± 0.04	13.96 ± 0.04^{e}
A3B2	60.46 ± 0.13^{b}	2.61 ± 0.01	19.32 ± 0.07	1.82 ± 0.01	13.40 ± 0.16^{d}
A3B3	61.18 ± 0.04^{c}	2.63 ± 0.01	19.18 ± 0.06	1.71 ± 0.02	12.21 ± 0.03^{c}

3.3. Protein Content

Based on the analysis of variance, there was no significant interaction ($p \geq 0.05$) between the type of tuber flour and the addition of STPP on the protein content of milkfish burger patties. The difference in protein content was due to the difference in protein content in each type of flour used. The results of the raw material analysis showed that potato flour had a higher protein content than taro flour and yellow sweet potato

flour. The protein content of the raw materials affects the nutritional value of the final product; the higher the protein content of the raw materials, the higher the product's protein content. The protein content of the milkfish burger patties

produced met the protein content standard for meat burgers set by [26], which is a minimum of 13%. The addition of STPP does not significantly affect the protein content of the milkfish burger patty. STPP is a binding agent that does not contain protein. Research results [27] show that the higher the addition of STPP, the lower the protein content in fish crackers.

3.4. Fat Content

Based on the results of the variance analysis, there was no significant interaction ($p \geq 0.05$) between the type of tuber flour and the addition of STPP on the fat content of milkfish burger patties. The results of the raw material analysis showed that the fat content in taro flour (1.33%) was higher than that in potato flour (0.38%) and yellow sweet potato flour (0.57%), so the use of taro flour as a filler resulted in milkfish burger patties with the highest fat content. The fat content of the produced milkfish burger patties met the standard set by [26], which is a maximum of 20%. STPP causes fat to be trapped in the protein gel matrix during heating, resulting in nearly identical fat loss across all treatments. Research findings [28] indicate that the addition of STPP causes a decrease in the fat content of kwetiau.

3.5. Starch Content

The results of the analysis of variance showed a significant interaction ($p \leq 0.05$) between the type of tuber flour and the addition of STPP, and each treatment had a significant effect ($p \leq 0.05$) on the starch content of milkfish burger patties. Figure 2 shows that higher STPP addition causes a decrease in the starch content of milkfish burger patties for all types of flour (potato, taro, yellow sweet potato). Based on raw material analysis, the highest starch content was found in yellow sweet potato flour (76.92%) compared to taro flour (73.63%) and potato flour (55.05%). The decrease in starch content occurs because higher STPP addition increases water content, leading to a decrease in starch content. Additionally, the reaction between STPP and the –OH groups in the three types of fillers used causes part of the starch to be modified, resulting in lower original starch content and remaining –OH groups. \

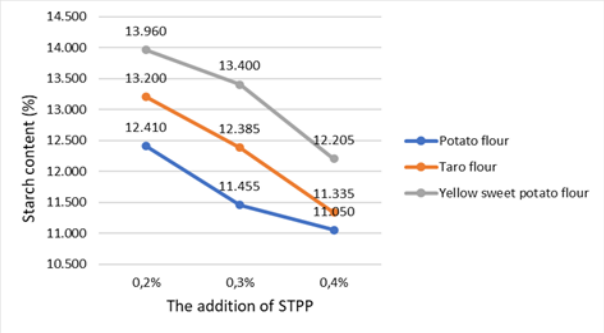

Figure 2. The relationship between the treatment of tuber flour types and the addition of STPP on the starch content of milkfish burger patties

The addition of higher STPP caused a decrease in starch content in milkfish burger patties in each type of flour used (potato flour, taro flour, and yellow sweet potato flour). Fish burger patties made with yellow sweet potato flour as a filler have a higher starch content compared to potato flour and taro flour. This is because yellow sweet potato flour has a higher initial starch content (76.92%) compared to taro flour (73.63%) and potato flour (55.05%). Similarly, the addition of STPP caused a decrease in starch content in milkfish burger patties in all three types of flour. This is likely because the more STPP added, the greater the likelihood of a reaction with the -OH groups in the three types of flour, causing some of the starch to

be modified, resulting in lower levels of original starch and remaining -OH groups. [29] Hydrogen bonds in the starch molecules are replaced by phosphate compounds, forming phosphate bonds in the starch molecules. These phosphate bonds are not detected as starch compounds during analysis, leading to a decrease in starch content as the number of phosphate bonds formed increases [30].

4. CONCLUSION

A high-quality burger patty has a texture that is neither soft nor hard. Binding agents are very important in producing the desired texture in patty products. The most commonly used phosphate in processed meat products is sodium tripolyphosphate (STPP). Starch reacts with STPP to form hydrophilic phosphate groups (more easily bind water), so the higher the STPP concentration added, the more phosphate groups bind water. The best treatment was achieved with potato flour treated with 0.4% STPP, resulting in a milkfish burger patty with a moisture content of 61.66%, ash content of 2.52%, protein content of 20.25%, fat content of 1.58%, and starch content of 11.05%.

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