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EFFECT OF ADDITIONAL SODIUM TRIPOLYPHOSPHATE (STPP) CONCENTRATION ON PRODUCT PHYSICAL AND SENSORY CHARACTERISTICS WET NOODLES FROM LUMI-LUMI FISH (Harpodon numerous) FORTIFIED WITH RED BEET EXTRACT

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Abstract

Commercial noodles are generally made from wheat flour and eggs without adding fish, fruit, and vegetable extracts. Adding fish and red beet extract can increase the nutritional content and antioxidants in the resulting noodle product. Adding Sodium Tripolyphosphate (STPP) can improve the desired noodle texture, namely chewy and elastic. This study aims to identify the effect of the concentration of STPP addition on the physical characteristics and sensory acceptability of Lumi-lumi wet noodles fortified with red beet extract. The study used a single factorial Completely Randomized Design (RAL) with four different STTP concentration treatments (F1: 0%, F2: 0.50%, F3: 0.75%, F4: 1% STPP) with a ratio of wheat flour, Lumi-lumi fish, and red beet extract, namely 80%: 20%: 8%. The observations were physical quality tests, including rehydration, cooking time, cooking loss, and elasticity of noodle. 60 untrained panelists carried out sensory tests. There was a significant effect (P <0.05) of the addition of STPP concentration on the physical quality of noodles. Treatment F1 showed the best rehydration noodle and cooking time, 80.93% and 2.98 minutes, respectively. The best cooking loss and elasticity were obtained in F4, which were 19.93% and 27.08 mm. Sensory results significantly affected color and taste parameters (P<0.05). Aroma and texture had no significant effect (P>0.05). The highest color acceptance was obtained in F3, followed by F2, respectively 3.97 (like) and 3.80 (like). The best taste parameter was received in F2, 3.83 (like). The highest aroma was obtained in F3, followed by F2, respectively, 3.80 (like) and 3.75 (like). The highest texture assessment was in F4, followed by F3 and F2, respectively, namely, 3.55 (slightly chewy), 3.53 (slightly chewy), and 3.40 (slightly chewy). Based on the research results, to produce Lumi-lumi wet noodles with the desired physical and sensory acceptability, an STPP concentration of 0.50% is recommended.

Keywords: ***Sodium Tripolyphosphate (STPP), Lumi-lumi, Noodle, Red beet***

INTRODUCTION

Noodles have become the second staple food after rice in Indonesia, with increasing popularity among various groups, from children to older people. The characteristics of noodles that are practical and easy to process are the main reasons why noodle consumption increases by around 25% every year (Rahmi et al., 2019). According to data from the National Socio-Economic Survey (SUSENAS) in 2023, consumption of wet noodles reached 27,651 portions, making it a substitute food commodity that can function as a staple food. Noodles are generally made from wheat flour, but adding other ingredients, such as fruit and vegetable extracts, can increase the nutritional and antioxidant content of the noodles (Kusumo et al., 2022).

Noodles on the market often contain low protein, so adding local raw materials such as Lumi-lumi fish can be a solution to increase nutritional value. Lumi-lumi fish is reported to contain soluble protein that can be absorbed by the body, namely a 7678.3 mg BSA/mL sample (Safrida et al., 2022). Apart from that, Lumi-lumi fish is also reported to have various mineral contents, namely 517.2 mg Ca, 4.57 mg Fe, and 5.30 mg Zn in 100 g of Lumi-lumi fish meal (Safrida et al., 2022). The Fe mineral content in Lumi-lumi fish is even higher than the Fe content in 100 g of anchovy meal, namely 3.9 mg (Pratiwi et al., 2022). These minerals function in improving the body's physiology. Apart from that, the addition of red beet extract in making Lumi-lumi wet noodles can provide additional benefits because red beets are rich in active compounds, including flavonoids as much as 360-2760 mg/kg, betacyanin as much as 840-900 mg/kg, betanin as much as 300-600 mg/kg, ascorbic acid as much as 50-868 mg/kg, and carotenoids as much as 0.44 mg/kg, all of which act as antioxidants (Winantea, 2019). However, the challenge in producing noodles with these additional ingredients is producing a chewy texture that does not break easily. Therefore, this study aims to analyze the effect of adding Sodium Tripolyphosphate (STPP) on the physical and sensory characteristics of wet noodle products made from lumi-lumi fish fortified with red beet extract. STPP functions as a water binder and improves the texture of the noodles, so the noodles produced will be of better quality and can be accepted by the community.

RESEARCH METHODS

This research used an experimental method with a one-factor Completely Randomized Design (RAL). There were four treatments with a ratio of wheat flour, Lumi-lumi fish porridge, and beetroot extract (80%:20%:8%) and an additional concentration of Sodium Tripolyphosphate (STPP), namely F1 = 0% STPP, F2 = 0.50% STPP, F3 = 0.75% STPP, and F4 = 1% STPP.

Materials

The materials used in this research include the main ingredients for making noodles, namely wheat flour (Cakra kembar), Lumi-lumi fish, and red beets obtained from the Meulaboh traditional market. The sodium tripolyphosphate (STPP) material is food-grade and was purchased from a chemical source called sh inp, Meulaboh.

Raw Material Preparation

Preparation of raw materials includes making Lumi-lumi fish porridge and red beet extract.

1. Making Lumi-lumi Fish Porridge
   Fresh Lumi-lumi fish is cleaned and washed. Then, it is filleted and marinated with lime extract for ± 15 minutes. The fish is ground using a chopper until it resembles a fish puree.
2. Making Red Beet Fruit Extract
   First, wash the beets using water until clean. Then, cut the beet flesh into pieces and blend without using water. Finally, strain with a filter cloth to separate the juice (extract) from the dregs.

Making Wet Noodles

Wheat flour (Cakra kembar) and Lumi-lumi fish porridge (according to treatment) are mixed, and then other supporting ingredients are added, such as eggs, shallots, garlic, ground pepper, salt and STPP concentrations of 0.50%, 0.75% and 1% each treatment is different, then stir until all the ingredients are evenly mixed and add 8% beetroot extract and stir until it becomes a dough. After kneading the dough, it needs to be left for a while for ± 10 minutes, which functions to help the water react to form gluten. After that, the dough is flattened using a noodle maker until a sheet of dough 2 ± 0.5 mm thick is formed. After the noodle sheets are formed, the dough is moulded into noodle strands. After the noodle strands are formed, the raw noodles are boiled in water at a temperature of 100°C until cooked.

Data Analysis

The research data for Lumi-lumi wet noodles were analyzed using the SPSS version 25 application. The organoleptic test for Lumi-lumi wet noodles was analyzed using a non-parametric test, namely the Kruskal Wallis test, with a significance level of 5% to see significant differences in test parameters for each treatment. Then, the physical test of Lumi-lumi wet noodles was analyzed using the One-Way Analysis of Variance (ANOVA) test and continued with the Tukey Test. The significance value is determined based on a 5% level.

Procedures

Physical Properties of Wet Noodles

Rehydration Of Noodle (Gravimetric Method, Ramlah, 1997)

Rehydration noodle is the ability of noodles to absorb water after gelatinization. The rehydration noodle of Lumi-lumi wet noodles was measured using the weighing method. The measurement process involves weighing 5 g of wet noodles as the initial weight (a). The noodles are then boiled until cooked for 4 minutes. Once cooked, the noodles are drained and then weighed as the final weight (b) in grams. With the following calculation formula:

$$\text{Rehydration (\%)} = \frac{(b - a)}{a} \times 100\%$$

Cooking time (Basman & Yalcin, 2011)

The sample was weighed at 5 g and cut into 5 cm pieces. Then, it was cooked in a closed beaker in 200 mL of boiling distilled water. The optimum cooking time is determined by taking one piece of noodle every 15 seconds and pressing it between 2 watch glasses. It is determined when the middle of the sample has become transparent or there is no white colour from the middle of the sample thread.

Cooking Loss (Basman & Yalcin, 2011)

The sample weighed 5 g, then cut into 5 cm pieces. Then, the sample was cooked in a closed beaker in 200 mL of boiling distilled water for 1 minute above the optimum cooking time. Cooking is stopped by rinsing the sample with cold water and then drying using filter paper. Loss of solids due to cooking is determined by evaporating to dryness the water used for cooking and the rinse water at a temperature of 1100C in a beaker previously weighed. The residue obtained is weighed and classified as a per cent. With the following calculation formula:

$$\text{Cooking loss (\%)} = \frac{\text{sample weight after drying}}{\text{sample weight before cooking}} \times 100\%$$

Elasticity of Noodle, Length Measuring Method (Ramlah, 1997)

The elasticity of Lumi-lumi wet noodles is done by measuring the length using a ruler. The cooked sample is placed on a ruler, and its length is measured as the initial length (P1), then pulled until it breaks, and its length is measured as the final length (P2). With the following calculation formula:

$$\text{Elasticity (mm)} = \frac{(P2 - P1)}{P1} \times 100$$

Organoleptic of Wet Noodles

Organoleptic testing in this study used the hedonic test method for colour, taste and aroma parameters. The texture parameter assesses the level of elasticity of the Lumi-lumi wet noodle product, which is fortified with red beet fruit extract, with a rating scale of 1-5. The hedonic quality assessment criteria are presented in Table 1, and the sensory texture assessment criteria are presented in Table 2. The total number of panellists in this study was 60 panellists, according to Kusumawati (2021).

Table 1 *Sensory Test Assessment Criteria for Color, Taste and Aroma Parameters*

Criteria	Score
Really like	5
Like	4
Kinda Dislike	3
Do not like	2
Very Dislike	1

Source: Sucianti (2020)

Table 2
Sensory Test Assessment Criteria for Texture Parameters

Criteria	Score
Very Chewy	5
Kenya	4
Less Chewy	3
Not Chewy	2
Very Not Chewy	1

Source: Rohmalia & Dainy (2023)

RESULTS AND DISCUSSION

Physical Properties of Lumi-lumi Wet Noodles

The research results include all variable components, including physical quality analysis (rehydration, cooking time, cooking loss, and elasticity noodles) and acceptability (sensory) analysis. In this research, a Lumi-lumi wet noodle product formulation was designed, consisting of 4 treatments: F1 (STPP 0%), F2 (STPP 0.50%), F3 (STPP 0.75%), and F4 (STPP 1%).

Rehydration Noodles

Rehydration noodle is the ability of noodles to absorb water after gelatinization (Tuhumury et al., 2020). The rehydration noodle test results showed significant differences ($P<0.05$) in F1 and F2, F1 and F3, F1 and F4, F2 and F3, F2 and F4 and F3 and F4. The highest average wet noodle rehydration noodle results were found in treatment F4 (STPP 1%), followed by F3, F2 and F1, with average values of 104%, 97.37%, 88.23% and 80.93%, respectively. The average value of rehydration noodle can be seen in Image 1.

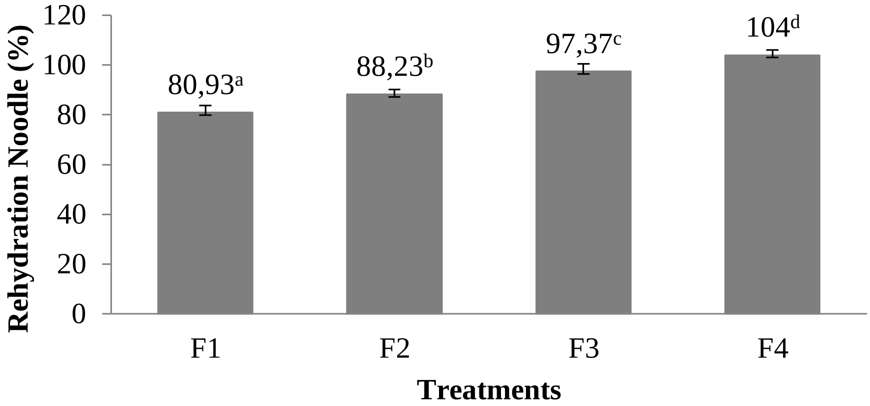

Image 1.
Rehydration noodle of Lumi-lumi wet noodles fortified with beetroot extract with the addition of STPP (F1: 0%, F2: 0.50%, F3: 0.75%, F4: 1%) The difference in notation in each picture shows a significant difference ($P<0.05$).

Image 1 shows that the higher the additional STTP concentration, the higher the rehydration noodle produced. The high value of rehydration noodle in the F4 treatment is because STPP is hygroscopic, so it can absorb water. This is in line with research conducted by Saleh et al. (2020), which showed that kwetiau with the addition of 3% STPP provided a higher water absorption value than with the addition of 1% and 2% STPP because STPP is hygroscopic (absorbs water). Water absorption capacity is related to the texture of the product; the smaller the water absorption capacity, the stronger the texture produced; this is thought to be because STPP can absorb water in starch, which is influenced by the presence of hydroxyl (OH) and amorphous groups found in starch molecules (Pyler, 1973; Muzaifah, 2014). Indrianti et al. (2014) stated that water absorption during the steaming process causes the starch particles to swell and lose bond compactness; namely, some of the amylose diffuses out due to the influence of heat.

Cooking Time

Cooking time is required for the noodles to remove the white dots in the middle of the noodle strands during cooking (Tuhumury et al., 2020). The ripening time test results showed significant differences (P<0.05) in F1 and F2, F1 and F3, F1 and F4, F2 and F3, F2 and F4 and F3 and F4. The results of the longest average cooking time for wet noodles were in treatment F4 (STPP 1%) followed by F3, F2 and F1, namely 436.2 seconds, 374.4 seconds, 297.6 seconds and 178.8 seconds. The average value of cooking time can be seen in Image 2.

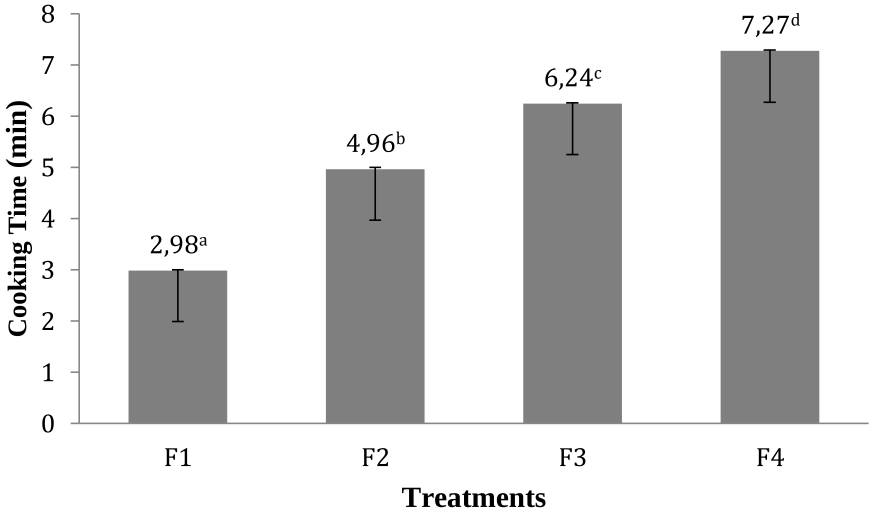

Image 2.
Cooking time of Lumi-lumi wet noodles fortified with beetroot extract with the addition of STPP (F1: 0%, F2: 0.50%, F3: 0.75%, F4: 1%) The difference in notation in each picture shows a significant difference (P<0.05).

Image 2 shows that the higher the additional STTP concentration, the more cooking time the noodles need. According to the statement of Yadav et al. (2014) and Arinachaque et al. (2023), good quality noodles generally have a short cooking time and little loss of solids in water during cooking time. The longer the cooking time, the more water content in the noodles; this can affect the texture and taste, and the resulting noodles will quickly be damaged. The gluten and protein content in food ingredients significantly affects the length of cooking time for noodles. The higher the protein content, the longer the noodle cooking process will take. This is because adding phosphate salt can increase cooking time and addition levels. Phosphate salts gradually increase the pH of the flour suspension as its concentration increases, which can cause the solubilization of some soluble proteins, such as alpha and gamma gliadin (Ulkai, Matsumura, & Urade, 2008).

Cooking Loss

Solids or cooking loss is the amount of solid substances lost with the water from cooking noodles (Tuhumury et al., 2020). The cooking loss test results show significant differences (P<0.05) in F1 and F2, F1 and F3, F1 and F4. However, no significant differences (P>0.05) existed in F2 and F3, F2 and F4, F3, and F4. The highest average cooking loss results for wet noodles were in treatment F1 (STPP 0%), followed by F2, F3 and F4 with an average of 20.92%, 20.24%, 20.06% and 19.93 respectively. %. The average value of cooking loss can be seen in Image 3.

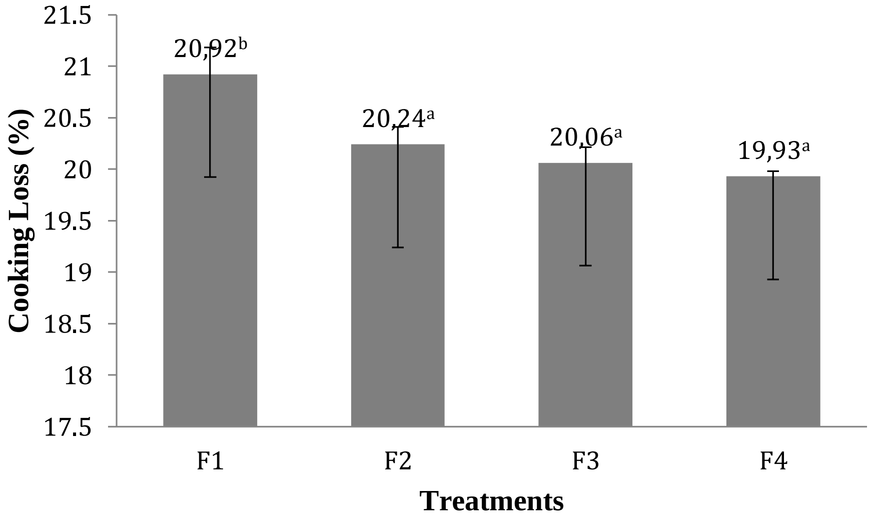

Image 3.

Cooking loss of Lumi-lumi wet noodles fortified with beetroot extract with the addition of STPP (F1: 0%, F2: 0.50%, F3: 0.75%, F4: 1%) The difference in notation in each picture shows a significant difference (P<0.05).

Image 3 shows that the higher the additional STTP concentration, the lower the resulting cooking loss. This is in line with research by Saleh et al. (2020), which showed that the STPP concentration had a real influence on the calculated F value of 7.478 > 0.05 level. The highest cooking loss value was obtained when using a 1% STPP concentration, different from the other 2% STPP and 3% STPP concentration treatments. Muhandri et al. (2011) stated that the cooking loss value for noodles is the most important parameter for wet noodle products; the lower the cooking loss value for noodles will indicate that the noodles have a good and homogeneous texture. Karneta et al. (2014) emphasized that the longer the cooking time, the more starch granules swell and cannot return to their original condition (gelatinized). The addition of STPP can affect the value of cooking loss in wet noodles. This is thought to be because STPP functions as a binder for the dough components, so when heating (boiling) occurs, these components are not separated (Safitri & Hartini, 2013).

Elasticity of Noodles

Elasticity is the ability of a material or object to return to its original shape after experiencing pressure or pulling. The elasticity test results show significant differences (P<0.05) in F1 and F4, F2 and F4, F3 and F4. However, no significant differences (P>0.05) existed in F1 and F2, F1 and F3, F2 and F3. The highest average elasticity for wet noodles was in treatment F4 (STPP 1%), followed by F3, F2 and F1 with 27.08 mm, 19.95 mm, 19.43 mm and 15.58 mm. The average value of elasticity can be seen in Image 4.

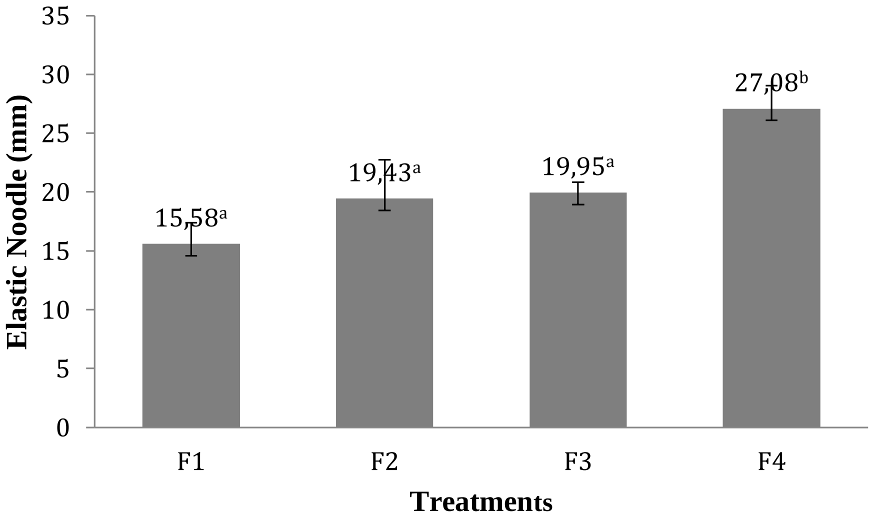

Image 4.
Elasticity of Lumi-lumi wet noodles fortified with beetroot extract with the addition of STPP (F1: 0%, F2: 0.50%, F3: 0.75%, F4: 1%) The difference in notation in each picture shows a significant difference ($P<0.05$).

Based on Image 4, it shows that the higher the additional STTP concentration, the higher the resulting elasticity. This is in line with research by Saleh et al., (2020), which showed that the addition of STPP concentration had a real influence on each treatment. The 3% STPP concentration is 34.25 mm, so the elasticity of kwetiau will be higher compared to the 1% STPP treatment of 24.60 mm and 2% STPP of 28.63% mm only has a low elasticity value. The higher the concentration of STPP added, the average value of amylose will increase, this is because the amylopectin molecule is more easily phosphorylated (cross-linked) than the amylose molecule and will cause the proportion of amylose to be higher than amylopectin Munarso et al., (2004). This is in accordance with the statement of Retnaningtyas et al., (2014) which states that, when starch reacts with STPP, phosphate groups are produced which are hydrophilic (water-loving ions).

Organoleptic Properties of Wet Noodles

Organoleptic tests are carried out by assessing the physical and sensory characteristics of the product (colour, taste, aroma and texture), and hedonic tests are carried out by determining the panellists' level of liking or satisfaction with the product. This test is carried out to determine whether there are differences between one or more treatments and the control treatment and to estimate the magnitude of the differences. In this research, a Lumi-lumi wet noodle product formulation was designed, which consisted of 4 treatments, including F1 (STPP 0%), F2 (STPP 0.50%), F3 (STPP 0.75%) and F4 (STPP 1%). The product formulation results are presented in Image 5 below.

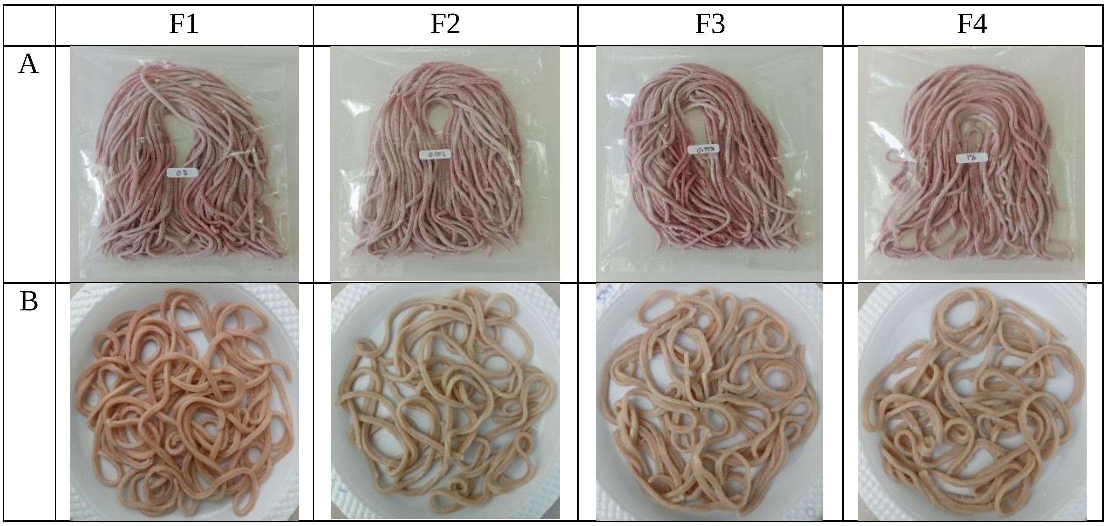

Image 5.
Lumi-lumi wet noodles were fortified with beetroot extract and an STPP concentration. (A) before cooking. (B) After cooking.

The results showed that the addition of STPP concentration had a significant effect ($P<0.05$) on colour and taste parameters, while aroma and texture had no significant effect ($P>0.05$). The average values for colour, taste, aroma and texture parameters can be seen in Table 1.

Table 1.
Average results of colour, taste, aroma and texture parameters of Lumi-lumi wet noodles fortified with beetroot extract with the addition of STPP

Parameter	**Treatment**				
	F1	**F2**	**F3**	**F4**	***P-value***
Colour	3,28±1,09^{a}	3,80±0,75^{b}	3,97±0,64^{b}	3,58±0,83^{ab}	0,000
Flavour	3,22±1,04^{a}	3,83±0,76^{b}	3,70±0,56^{b}	3,62±0,58^{ab}	0,002
Aroma	3,72±0,83^{a}	3,75±0,79^{a}	3,80±0,71^{a}	3,62±0,90^{a}	0,821
Texture	3,27±1,13^{a}	3,40±0,91^{a}	3,53±0,81^{a}	3,55±0,83^{a}	0,316

*The data presented consists of the mean ± standard deviation. Different letter notations in columns and rows show significant differences ($P<0.05$).

Based on Table 1, it can be seen that the panellists' acceptance of the colour parameter with the highest value is F3, with an average value of 3.97 (likes), followed by treatment F2, with an average value of 3.80 (likes). Meanwhile, the lowest value is F1, which has a value of 3.28 (I don't like it). The decrease in panellist acceptance of noodle colour parameters with STPP concentration and beetroot extract is likely because panellists tend not to like bright (flashy) colours. The colour of the Lumi-lumi fish wet noodles is obtained from the colour of beetroot extract. Sari (2016) states that the betalain pigment in beets is a natural colouring agent used in food systems, including polar or hydrophilic (water-soluble) compounds.

Based on Image 5, it can be seen that the higher the STPP concentration, the brightness of the resulting colour decreases. The decrease in colour brightness between treatments is thought to be due to the presence of betalain pigments, which are damaged by temperature and cooking time. This is believed to be because adding phosphate salts can increase cooking time and addition levels. The research confirms the results by Asra et al. (2019), which show that betalain tends to be stable in an acidic atmosphere with a pH of 4-6 and a heating temperature below 40. If betalain is at a high temperature and critical pH, it will undergo hydrolysis; at low pH, delocalization will occur. Supported by research by Moldovan and David (2014), data was obtained that when betalain was treated at three different temperatures, for example, at temperatures of 20oC, 25oC and 75oC, it was found that the betalain pigment treated at a temperature of 75oC would experience degradation. According to Sari (2018), the initial step in the degradation of betalain dyes is caused by water hydrolysis of betalain compounds; at this stage, it will produce cyclo-DOPA-5-O-b-glucoside and a yellow compound called betalamic acid. This compound cannot regenerate because betalamic acid cannot withstand high temperatures. This degradation process causes the betalain pigment to change from red to yellow, decreasing absorbance.

The taste parameter is important for consumers when accepting a product; if a product meets the requirements for appearance, nutritional value, price, and safety but the product's taste is not liked, then the product can be rejected (Winantea, 2019). Regarding taste parameters, results showed a significant level of panellist preference ($P<0.05$) for F1 and F2 and F3 and F1. However, there were significant differences ($P>0.05$) in F3 and F2, F4 and F2, F3 and F4, and F1 and F4. Based on Table 1, the panellists' assessment of taste parameters gave the highest score to F2 with a value of 3.83. Meanwhile, the lowest value is F4 with a value of 3.22. Adding the STPP concentration can add flavour to the noodle product, thereby increasing panellists' interest; however, if the STPP concentration is too high, the panellists' liking for the taste parameters decreases. This is shown in F3 and F4, the higher the STPP concentration, the more the liking value decreases. The results of further tests confirmed this; there were real differences between treatments. Supported by research by Ranken (2000), STPP is a synthetic product that has a self-limiting, because STPP has a slightly bitter taste at certain concentrations, so STPP is generally used in the range of 0.3-0.5%.

Aroma is the smell that comes from a food product, which the sense of smell can detect. A food product with a firm or bland aroma (not typical) will impact consumer interest, so they are not interested in trying it (Arinachaque et al., 2023). The results of the aroma parameter showed that the panellists' liking level was insignificant ($P>0.05$). Based on Table 1, the panellists' assessment of the aroma aspect gave the highest score to F3, with a value of 3.80. Meanwhile, the lowest value was in treatment F4, at 3.62. The aroma of these wet noodles comes from the Lumi-lumi fish and beets in the noodle product. This is in line with the results of research by Saleh et al., (2020) which states that STPP has no real effect on the aroma of black rice starch kwetiau. This can happen because STPP has odorless properties and is soluble in water so it does not affect the acceptability of the aroma of rice starch kwetiau. Black.

Texture is all things related to touch, sight, and hearing, and it includes an assessment of the hardness, roughness, dryness, and smoothness of a food ingredient or its preparation. In general, texture can be assessed by hand by feeling, softness and ease of chewing in the mouth (Fitria L, 2020). Regarding texture parameters, the results showed that the panellists' liking level was insignificant ($P>0.05$). Based on Table 1, the panellists' assessment of texture parameters gave the highest score to F4, with a value of 3.55. Meanwhile, the lowest value was in the F1 treatment, which had a value of 3.27. The addition of the STPP concentration gives the noodles a chewier and more elastic texture, thus attracting more interest from the panellists. It is shown that F4, with the addition of the highest STPP concentration, has the highest liking value. This is reinforced by the results of the physical quality test for elasticity, namely F4 (STPP 1%), which has the highest elasticity of 27.08 mm. The results obtained were that there was a difference between the control treatment and the treatment with the addition of STPP concentration. The higher the additional concentration of STPP, the higher the resulting elasticity. The texture is associated with touch or touch—the most important texture in soft and crunchy foods. The characteristics most often referred to are hardness, cohesiveness, and water content (Lamusu, 2021).

CONCLUSION

There was a significant effect ($P<0.05$) of the addition of STPP concentration on the physical quality of noodles, namely rehydration noodle, cooking time, cooking loss and elasticity. The F1 treatment showed the best rehydration noodle and cooking time, respectively, 80.93% and 2.98 minutes. The best cooking loss and elasticity were obtained at F4, namely 19.93% and 27.08 mm. Sensory results significantly influence colour and taste parameters ($P<0.05$). Aroma and texture had no significant effect ($P>0.05$). The highest colour acceptability was obtained at F3, followed by F2, respectively 3.97 (like) and 3.80 (like). The best taste parameter was obtained at F2, 3.83 (like). The highest aroma was obtained at F3, followed by F2 at 3.80 (like) and 3.75 (like). The highest texture rating was F4, followed by F3 and F2, namely 3.55 (somewhat chewy), 3.53 (somewhat chewy) and 3.40

(somewhat chewy). Based on the results of research to produce Lumi-lumi wet noodles with the desired physical and sensory acceptability, it is recommended to use an STPP concentration of 0.50%.

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