The formulation of edamame flour and tuna fish protein hydrolyzate biscuit as an alternative supplementary feeding for stunting

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ABSTRAK

Latar Belakang: Stunting keadaan kurang gizi paling umum yang terjadi di Indonesia dan masih menjadi permasalahan yang harus ditangani saat ini. Salah satu upaya untuk memperbaiki kondisi stunting pada balita yaitu dengan memenuhi kebutuhan protein melalui PMT yang tinggi protein. Biskuit dapat menjadi salah satu media dalam perbaikan zat gizi apabila ditambahkan dengan bahan tertentu. Pangan lokal yang dapat ditambahkan dalam bahan pembuatan biskuit adalah kacang kedelai edamame yang dioah menjadi tepung edamame dan ikan tuna yang dijadikan hidrolisat protein ikan (HPI).

Tujuan: Tujuan dari penelitian ini adalah untuk mengetahui formulasi terbaik dari biskuit tepung edamame dengan tambahan HPI tuna untuk memperbaiki kondisi stunting pada balita.

Metode: Penelitian ini menggunakan Rancangan Acak Lengkap (RAL) faktor tunggal dengan tiga sampel, yaitu perbandingan formulasi tepung edamame dengan HPI tuna dengan 3 taraf (F1 30:10, F2 25:15, dan F3 20:20). Penelitian dimulai dengan pembuatan tepung edamame, HPI tuna, dan biskuit tepung edamame dan HPI tuna. Selanjutnya biskuit tepung edamame dan HPI tuna diuji organoleptik yang meliputi kesukaan warna, rasa, aroma, tekstur, dan keseluruhan pada 25 panelis semi terlatih. Formulasi terpilih akan dianalisis kadar protein, lemak, dan karbohidrat.

Hasil: Berdasarkan uji organoleptik dan total hasil pembobotan didapatkan bawah formulasi biskuit terpilih adalah F3. Hasil uji Kruskal Wallis menunjukkan bahwa penambahan tepung edamame dan HPI tuna berpengaruh nyata terhadap kesukaan warna (p<0,05). Berdasarkan uji laboratorium diketahui jika formula biskuit terpilih (F3) memiliki kandungan gizi per 100 gram: protein 16,81±0,07 gram; lemak 19,66±0,14 gram; karbohidrat 49,05±0,06 gram.

Kesimpulan: Penelitian ini menunjukkan bahwa formulasi biskuit terpilih adalah F3 dengan kandungan tepung edamame 20% dan HPI tuna 20%. Kandungan protein dan lemak pada biskuit terpilih (F3) lebih tinggi dibandingan dengan biskuit PMT Pabrikan.

KATA KUNCI: *biskuit; hidrolisat protein ikan; ikan tuna; tepung edamame; stunting*

ABSTRACT

Background: *Stunting is the most common malnutrition condition that occurs in Indonesia and is still a problem that has to be solved today. One of the efforts to improve stunting conditions in toddlers is by fulfilling the protein needs through supplementary feeding which has high protein. Biscuits can be a medium for improving nutrition if they are added with certain ingredients. Local foods that can be added to biscuits are edamame soybeans which are processed into edamame flour and tuna which is made into fish protein hydrolyzate (FPH).*

Objectives: *To find out the best formulation of edamame flour biscuits with the addition of tuna FPH to improve stunting conditions in toddlers.*

Methods: *This research used a single factor Completely Randomized Design (CRD) with three samples, which were a comparison of edamame flour formulation with tuna FPH with 3 levels (F1 30:10, F2 25:15, and F3 20:20). The research began with making edamame flour, FPH tuna, and the biscuits. Furthermore, edamame flour and tuna FPH biscuits were tested organoleptically which included color, taste, aroma, texture, and overall preferences of 25 semi-trained panelists. The selected formulation will be analyzed for protein, fat, and carbohydrate levels.*

Results: *Based on organoleptic tests and the total weighting results obtained the selected biscuit formulation was F3. The results of the Kruskal Wallis test showed that the addition of edamame flour and tuna FPH had a significant effect on color preference ($p<0.05$). Based on laboratory tests, it is known that the selected biscuit formula (F3) has nutritional content per 100 grams: protein 16.81 ± 0.07 g; fat 19.66 ± 0.14 g; carbohydrate 49.05 ± 0.06 g*

Conclusions: *The selected biscuit formulation is F3 with 20% edamame flour content and 20% tuna FPH. The protein, fat, and carbohydrate content of the selected biscuits (F3) is higher than the supplementary feeding manufactured biscuits.*

KEYWORD; *biscuit; edamame flour; fish protein hydrolyzate; stunting; tuna*

INTRODUCTION

Stunting is the most common malnutrition condition in Indonesia. Stunting is a condition where the children have developmental and growth disorders which are the result of a lack of food intake (1). It is identified by a height-for-age index with a z-score of below -2 SD (2). Stunting can cause various growth and development disorders, including impaired physical growth, impaired brain development, and intelligence, and cause children to be vulnerable to various diseases. This makes stunting a major threat to the quality of human resources in Indonesia (1). In 2022, the prevalence of stunting in Indonesia will be 21.6% (3). This figure is still far from the target (14%) of Indonesia's National Medium-Term Development Planning in 2024 (4). Based on The Indonesian Nutritional Status Survey data (2022), the prevalence of stunting in East Java is 19.2% with the highest prevalence of stunting in the Jember Regency which reaches 34.9% (5). The

high rate of stunting in Indonesia, especially in Jember Regency, is still a top priority that must be immediately resolved by various parties including the government, health workers, and the community because stunting can hurt Indonesia's future.

One effort to improve stunting conditions in toddlers is by meeting protein needs through supplementary feeding which is high in protein based on local food. The Jember Regency is one of the largest producers of edamame beans in East Java, however, the use of edamame beans is still not widely known to the general public so the level of consumption is still not optimal even though it has a high nutritional content (6). In addition to abundant edamame bean production, Jember Regency as a coastal area is also rich in marine products, one of which is tuna. Edamame beans and tuna are local foods with a high protein content. The protein content in 100 g of fresh

edamame beans is 12.4 g (7), while the protein content in 100 g of fresh tuna is 28.34 g (8). One of the nutritional improvement media that can be modified is biscuits. Biscuits can be a medium for improving nutrition if certain ingredients are added (9). Edamame beans can be processed into flour as a raw material for cookies, pudding, meatballs, and other food products. In 100 grams, edamame flour has a protein content of 37.41%, which is higher than in its fresh form (10). On the other hand, tuna can be processed into fish protein hydrolyzate (FPH). Fish protein hydrolyzate is a form of dry protein with a protein content exceeding 60%, the result of the breakdown of fish protein through hydrolysis by enzymes, acids, or bases. The addition of FPH to various products is expected to increase protein consumption and nutritional quality (11). The addition of edamame flour and tuna fish protein hydrolyzate to biscuits is expected to be an effective solution in overcoming stunting. Therefore, this study aims to determine the best formulation of edamame flour and tuna fish protein hydrolysate biscuit to improve stunting conditions in toddlers.

MATERIALS AND METHODS

This research used a single factor Completely Randomized Design (CRD) with three samples, that were a comparison of edamame flour formulations with tuna FPH. Each treatment was repeated three times. The formulation of edamame flour and tuna FPH can be seen in **Table 1**. This research was done in three stages, that were making edamame flour, making powdered tuna FPH, and making edamame flour and tuna FPH biscuits. The composition of these biscuits is detailed in **Table 2**. The next step is to test the characterization of the chemical and organoleptic properties of biscuit products formulated with edamame flour and FPH tuna.

Table 1. The Formulation of Edamame Flour and Tuna FPH

Formulation	Wheat flour (%)	Edamame flour (%)	Tuna FPH (%)
F1	60	30	10
F2	60	25	15
F3	60	20	20

This research was done at the Laboratory of Chemical and Biochemical Agricultural Product and Agricultural Product Engineering Laboratory, Faculty of Agricultural Technology, Universitas Jember.The research was conducted using a variety of tools, including digital analytical balances, freeze dryers, mixers, beaker glasses, water bath shakers, food processors, 80 mesh Tyler sieves, centrifuges, pots, stoves, knives, measuring cups, baking trays, baking ovens, bowls, and spoons. In addition, glassware, Soxhlet extraction equipment, Kjeldahl flasks, burettes, ovens, furnaces, desiccators, porcelain cups, iron spatulas, measuring pipettes, measuring flasks, erlenmeyers, glass funnels, and drop pipettes were used for analysis.

Table 2. Composition of Edamame Flour and Tuna FPH Biscuits

Materials	F1	F2	F3
Wheat flour (g)	27	27	27
Edamame flour (g)	13.5	11.25	9
Tuna FPH (g)	4.5	6.75	9
Refined sugar (g)	18	18	18
Skim milk (g)	4.74	4.74	4.74
Vanilla (g)	0.06	0.06	0.06
Baking powder (g)	0.2	0.2	0.2
Margarine (g)	14	14	14
Egg yolk (g)	11	11	11
Water (g)	7	7	7
Total (g)	100	100	100

The materials used in this study consisted of tuna fish sourced from fishermen in Puger District, Jember, East Java, Indonesia, and edamame flour obtained from Mitra Tani 27. The chemicals used included distilled water, petroleum benzene, papain enzyme, HCl, selenium, NaOH, H_2SO_4, H_3BO_3, methyl red methyl blue indicators, aluminium foil, and filter paper.

Procedure for Making Edamame Flour

The procedure for making edamame flour is based on research by Siregar et al. (2023) with modification (10). The edamame soybeans are soaked in water (3:1) for eight hours. After soaking, the epidermis will easily peel off and separate from the edamame soybean seeds. Next, the edamame soybeans are boiled for 20 minutes. The drying process is done 2 times. First in the sun for 4 hours and then in the oven for 24 hours at a temperature of 60°C. After drying, the edamame soybean seeds are ground and sifted using an 80-mesh Tyler sieve to obtain edamame flour.

Procedure for Making Tuna FPH

The procedure for making FPH is based on research by Witono et al. (2020) (12). Tuna fish is filleted until boneless tuna meat is obtained. After that, the fish flesh is weighed and crushed using a food processor with a ratio of distilled water to fish flesh of 2:1 to the weight of the fish until a suspension is produced. Next, papain enzyme (% v/w) was added in a total of 5% of the weight of the fish meat. Then hydrolysis was done at a temperature of 55°C for 3 hours and continued with enzyme inactivation at a temperature of 85°C for 20 minutes which aimed to stop the hydrolysis process. Next, the tuna fish protein hydrolyzate was centrifuged at 3500 rpm at 10°C for 30 minutes until supernatant and residue were produced. The supernatant obtained was dried using a freeze dryer to obtain dry tuna protein hydrolyzate. The dried tuna protein hydrolyzate is then ground into powder. Based on previous research, the papain enzyme has very high activity in hydrolyzing protein in fish. The papain enzyme has an enzyme activity of 86.32 units/mL, while the calotropin enzyme is only 15.04 units/mL (12).

The best concentration for using the papain enzyme in hydrolyzing protein in fish is 5% (13). The papain enzyme can catalyze the hydrolysis process well at temperature and pH conditions within a certain time range because the activity of the papain enzyme is quite specific. The active side of papain consists of amino acids, namely cysteine and histidine. One of the two amino acids, cysteine, is active because it contains a thiol group (-SH) (14).

Organoleptic and Chemical Properties Test

Organoleptic tests include colour, taste, aroma, texture, and overall. The testing method is done by using a liking test using seven scales (very dislike, dislike, somewhat dislike, neutral, somewhat like, like, and very like). The liking test assessment used 25 semi-trained panelists. Chemical properties testing is performed for edamame flour, tuna FPH, and all biscuit formulas. Testing of chemical properties, including proteins (Semimicro-Kjehldal Method, BSN1992), fats (Soxhlet Method, AOAC 2005), and carbohydrates (Carbohydrate by Difference Method).

Data Analysis

The data obtained was analyzed using SPSS version 26. The organoleptic test result data was analyzed using the ANOVA method with a 95% confidence level and if there is a real effect, it will be continued with the post hoc test if there are significant differences between groups.

RESULTS AND DISCUSSIONS
Organoleptic Test

Kruskal Wallis was used to test the results for the organoleptic tests as the data was not normally distributed. If a real difference is found, the Mann-Whitney test is used. The tests cover colour, texture, aroma, taste, and overall results, with the organoleptic test ratios for edamame flour biscuits and FPH of tuna formulas presented in Table 3. Statistical testing shows that only colour parameters have significant differences in at least two groups, while other parameters such as taste, aroma, texture, and overall have no statistically significant differences.

Table 3. Average value of organoleptic test results for edamame flour and tuna fph biscuits

Parameter	F1	F2	F3	p
Colour	4.60±0.25[a]	5.68±0.22[b]	5.40±0.21[b]	0.004
Taste	4.64±0.26	4.04±0.32	4.72±0.26	0.218
Aroma	4.28±0.26	3.92±2.58	4.76±0.25	0.053
Texture	4.68±0.31	4.08±0.35	4.44±0.27	0.387
Overall	4.88±0.22	4.36±0.23	5.00±0.20	0.123

Note: The difference annotation letter indicates a significant difference ($p<0.05$), [a,b] Post Hoc Tamhanes

Scale: 1 = very dislike; 2 = dislike; 3 = somewhat dislike; 4 = neutral; 5 = somewhat like; 6 = like; 7 = very like

Preference for Colour

Table 3 shows a significant distinction in colour preference between edamame flour and tuna FPH when utilized in biscuit production. This contrast was observed with a high confidence level of 95%. The preferred colour weighting chosen was F2. The F1 yielded a darker colour with 30% edamame flour and 10% FPH, whereas F2 produced a brighter shade. On the other hand, F3 produced the brightest hue among all formulas. Based on the panelists' evaluation, F2 is the most visually pleasing due to its balanced shade, which is not overly dark or bright. The previous study demonstrates that edamame flour concentration notably impacts snack bar brightness. As the amount of edamame flour increases, the colour becomes darker due to the processing technique, particularly during drying and baking (16). During these procedures, the Maillard reaction can occur, causing the protein's primary amine and the reducing sugar's carboxyl group to react, resulting in a black colour (8).

Preference for Taste

Table 3 displays the statistical analysis of the different formulations of edamame flour and tuna protein hydrolysate, indicating that they do not match the taste preference of edamame flour biscuits and tuna protein hydrolysis at a 95% confidence level. The F3 treatment was used to evaluate the preference level of the chosen flavour. Changes in taste result from several factors, such as chemical compounds, temperatures, concentrations, and interactions with other flavour components (17). During the biscuit-making process, margarine is added (18). Moreover, our study shows that the panels preferred the F3 treatments with higher concentrations of added tuna FPH over other treatments. Tuna fish protein hydrolyzate causes a stronger savory taste due to its protein content. One of the amino acids contained in tuna hydrolyzate is glutamic acid. Glutamic acid is the dominant amino acid in tuna with a content of 12.45% (19). According to previous research, glutamic acid in rebon shrimp hydrolyzate has a role in forming flavor (20).

Preference for Aroma

The statistical test results in **Table 3** showed that the formulations of edamame flour and tuna protein hydrolyzate are not significantly different in terms of preference for the aroma of edamame flour biscuits and tuna protein hydrolyzate at the 95% confidence level. The weighting for the level of preference for the selected aroma is the F3 treatment. In the F3 treatment, there was a higher addition of tuna protein hydrolyzate than in other treatments, resulting in a distinctive aroma. This is in line with previous research that biscuits with the addition of reborn shrimp protein hydrolyzate have a distinctive aroma of reborn shrimp so the higher concentration of reborn shrimp protein hydrolyzate added causes the resulting biscuit aroma to be stronger (21). This is due to the content of amino acids that affected in aroma, which were phenylalanine and tyrosine. The highest essential amino acids contained in tuna fish include lysine (21.04 ± 1.75 mg/g), leucine (17.96 ± 1.11 mg/g), and the lowest is phenylalanine (10.34 ± 1, 63 mg/g) (22).

Preference for Texture

The statistical test results in **Table 3** showed that the formulations of edamame flour

and tuna fish protein hydrolyzate are not significantly different in terms of texture preference for edamame flour biscuits and tuna protein hydrolyzate at the 95% confidence level. The selected weighting for the level of texture preference is the F1 treatment. The texture in treatment F1 was preferred by panelists because in this treatment there was a lower addition of protein hydrolyzate than in other treatments. Biscuits with the addition of protein hydrolyzate have a texture that is not crunchy or reduces the crispness of the product (21). The texture of biscuits can be influenced by the raw materials used, baking temperature, and water content (23).

The statistical test results in **Table 3** show that the edamame flour formulation and tuna fish protein hydrolyzate are not significantly different in the texture preferences of edamame flour biscuits and tuna protein hydrolyzate at the 95% confidence level. The weighting chosen for the level of texture preference is the F1 treatment. F1 biscuits have the crunchiest texture among all the treatments. The crunchy texture of F1 biscuits is due to the addition of the least amount of FPH. The addition of FPH to biscuits can affect the crispness of the biscuits. This is in line with previous research which states that the more FPH added to biscuits, the less crispy the product can be (21). In addition, changes in texture can be caused by loss of water or fat content, emulsion breakdown, carbohydrate hydrolysis, and protein coagulation or hydrolysis (24). Other

factors that influence the texture are the water content which makes the texture soft, the materials used, the thickness of the mold, and high oven temperatures (22).

Overall

The statistical test results in **Table 3** showed that the formulations of edamame flour and tuna protein hydrolyzate are not significantly different in terms of overall preference for edamame flour biscuits and tuna protein hydrolyzate at the 95% confidence level. Sensory attributes in overall liking include color, aroma, taste, and texture. Based on the results of organoleptic tests on the overall preference of biscuits, it shows that the highest value is F3 biscuits and the lowest value is F2. Overall, the average score of the three biscuit formulations was above 4. This shows that all biscuit formulations were acceptable to the panelists.

Nutritional content of edamame flour and Tuna FPH biscuits

Chemical analysis was done on all formulations, including protein, fat, and carbohydrate levels, while energy level is obtained from the sum of protein, fat, and carbohydrates. Normality test results for protein, fat, carbohydrates, and energy are normally distributed. Based on statistical tests with ANOVA of energy, protein, fat, and carbohydrates in all groups, it shows a p-value<0.001.

Table 4. Comparison of Nutritional Content of Edamame Flour and Tuna FPH Biscuits with Supplementary Feeding Manufactured (100 g)

Parameter	F1 (mean±SD)	F2 (mean±SD)	F3 (mean±SD)	*p*	Supplementary Feeding Manufactured (15)
Energy (kcal)	448.75±0.39[a]	443.37±1.51[b]	440.34±0.76[c]	<0.001	464.50
Protein (g)	14.28±0.02[a]	15.72±0.05[b]	16.81±0.07[c]	<0.001	8.45
Fat (g)	21.44±0.05[a]	20.26±0.11[b]	19.66±0.14[c]	<0.001	16.74
Carbohydrate (g)	49.68±0.02[a]	49.54±0.07[a]	49.05±0.06[b]	<0.001	70.00

p < 0.05 significant difference
Note: The difference annotation letter indicates a significant difference (*p*<0.05), [a,b,c] Post Hoc Bonferroni Test

It indicates that there are significant differences in all groups. A comparison of the nutritional content between all formulas of edamame flour and tuna FPH biscuits and supplementary feeding manufactured can be seen in **Table 4**. Based on **Table 4**, all formulas of edamame flour and tuna FPH biscuits have a higher protein and fat content than the supplementary feeding manufactured. This is due to the use of edamame flour and tuna FPH in the biscuits which are known to contain high protein, while the high fat content comes from the added margarine and egg yolk. The carbohydrate content in the edamame flour and tuna FPH biscuits is lower than supplementary feeding manufactured because the wheat flour composition is lower compared to supplementary feeding manufactured. Wheat flour has a higher carbohydrate content than edamame flour (25,26). In the edamame flour and tuna FPH biscuits, wheat flour is substituted with edamame flour so that the carbohydrate content in all formula biscuits is lower when compared to the supplementary feeding manufactured. Meeting the need for adequate energy intake is very important for children. This energy comes from macronutrients such as carbohydrates, fat, and protein. Carbohydrates are the most important energy source for the body. Carbohydrates provide energy for all tissues in the body, especially the brain (27). Protein is an important macronutrient because it contains essential components that cannot be replaced by other nutrients. Apart from its role in supporting children's growth, protein also determines body composition, neurocognitive development, immune system maturity, and organ function. An imbalance between protein needs and protein intake causes stunting in children (28). Fats consumed in food are used as a source of energy and essential fatty acids. Structural fatty acids are an important part of cell membranes, nerve fibers, and cell structure in general. Fat reserves, especially in adipose tissue, are a long-term energy source for the body. Children who receive sufficient energy intake will experience growth and development appropriate to their age, but if there is a lack of energy intake during childhood, this will have an impact on the child's nutritional status (27)

Treatment Selection

The selected formula was determined using the Exponential Comparison Method (ECM). This method aims to determine the priority order of decision alternatives with multiple parameters. The weight is determined based on the featured components of the biscuit.

Table 5. Selected formulas of edamame flour and Tuna FPH biscuits

Parameters	Weight	Component Alternative Scores					
		F1		F2		F3	
		Rank	Score	Rank	Score	Rank	Score
Protein	20%	3	0.6	2	0.4	1	0.2
Fat	15%	1	0.15	2	0.3	3	0.45
Energy	15%	1	0.15	2	0.3	3	0.45
Colour	10%	3	0.3	1	0.1	2	0.2
Taste	10%	2	0.2	3	0.3	1	0.1
Aroma	10%	2	0.2	3	0.3	1	0.1
Texture	10%	1	0.1	3	0.3	2	0.2
Overall	10%	2	0.2	3	0.3	1	0.1
Total	100%		1.9		2.3		1.8
Rank			2		3		1

Rank 1 = highest
Rank 3 = lowest

The parameters considered are protein content (20%), fat and energy (15%, respectively), and all parameters in the organoleptic test (10%, respectively). After that, the weight value is multiplied by the ranking of each parameter in each biscuit formula. The scores for each parameter are then added up to determine the ranking for each formula (29). Based on this description and the calculations carried out for each formula, the formula chosen in this research is the F3 formula. Details can be seen in **Table 5.**

CONCLUSIONS AND RECOMMENDATIONS

The conclusion of this study was the treatment chosen was F3 biscuits with a proportion of 60% wheat flour, 20% edamame flour, and 20% tuna FPH. Based on the chemical properties test, it was found that the protein and fat content of the selected biscuits, F3, was higher than the supplementary feeding manufactured. It is recommended to continue further research to find the right formulation to add local food ingredients as a source of vegetable and animal protein as an alternative for preventing stunting.

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Physicochemical and sensory properties of Lumi-lumi (Harpodon nehereus) fresh noodles fortified with natural flavours

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ABSTRAK

Latar Belakang: Ikan endemik Lumi-lumi (Harpodon nehereus) mengandung zat gizi makro dan mikro mineral yang berpotensi memperbaiki kandungan gizi mie. Fortifikasi aneka flavor alami bertujuan memperkaya kandungan mineral dan fungsional mie.

Tujuan: Penelitian ini bertujuan untuk mengidentifikasi formulasi terpilih mie basah Lumi-lumi yang difortifikasi aneka flavor alami berdasarkan mutu fisik dan daya terima, serta mengidentifikasi kandungan gizi, mineral Fe, dan aktivitas antioksidan tertinggi pada perlakuan terbaik.

Metode: Penelitian ini bersifat eksperimen menggunakan Rancangan Acak Lengkap (RAL) satu faktor yaitu fortifikasi aneka flavor labu kuning, wortel, brokoli dan bit pada mie basah Lumi-lumi. Penentuan produk terpilih berdasarkan uji mutu fisik dan sensori tertinggi, selanjutnya identifikasi kandungan gizi, mineral Fe dan aktivitas antioksidan produk terbaik. Data mutu fisik dianalisis menggunakan uji One way ANOVA, data sensori menggunakan uji Kruskal Wallis, data kandungan gizi, mineral Fe dan aktivitas antioksidan menggunakan uji Independent Sample T-test.

Hasil: Hasil uji mutu fisik dan sensori produk terpilih yaitu pada mie basah Lumi-lumi yang difortifikasi ekstrak wortel dan bit. Hasil identifikasi kandungan protein, serat kasar, mineral Fe, dan aktivitas antioksidan tertinggi diperoleh pada perlakuan fortifikasi ekstrak bit, berturut-turut yakni 14,47%, 16,04%, 4.46 mg/100 g, dan 42,90%.

Kesimpulan: Formulasi produk terbaik diperoleh pada perlakuan mie basah Lumi-lumi yang difortifikasi ekstrak bit dengan perolehan nilai kandungan protein, serat kasar, mineral Fe, dan aktivitas antioksidan tertinggi. Produk ini berpotensi sebagai produk pangan lokal fungsional..

KATA KUNCI: *lumi-lumi; harpodon nehereus; mie basah; flavor; antioksidan*

ABSTRACT

Background: *Endemic fish Lumi-lumi (Harpodon nehereus) contains macronutrients and minerals that can potentially improve the nutritional content of noodles. Fortification of various natural flavours aims to enrich noodles' mineral and functional content.*

Objectives: *This study aims to identify selected formulations of Lumi-lumi fresh noodles fortified with various natural flavours based on physical quality and acceptability, as well as identify the highest nutritional content, Fe mineral, and antioxidant activity in the best treatment.*

Methods: *This experimental study uses a single factor Complete Randomized Design (CAD), fortifying various flavours of yellow pumpkin, carrots, broccoli, and beets in Lumi-lumi fresh noodles. Determination of selected products based on the highest physical and sensory quality tests, then identification of nutritional content, Fe mineral, and antioxidant activity on the best product. Physical quality data were analyzed using the ANOVA test, sensory data using the Kruskal Wallis test, and data on nutrient content, Fe mineral, and antioxidant activity using the Independent Sample T-test.*

Results: *The results of physical and sensory quality tests of selected products are on Lumi-lumi fresh noodles fortified with carrot and beet extract. The results of the identification of the highest protein, crude fiber, Fe mineral, and antioxidant activity were obtained in the fortification treatment of beet extract, including 14.47%, 16.04%, 4.46 mg/100 g, and 42.90%.*

Conclusions: *The best product formulation was obtained in treating fresh noodles Lumi-lumi fortified with beet extract with the highest protein, crude fiber, Fe mineral, and antioxidant activity. This product has the potential to be a functional local food product.*

KEYWORD*: Lumi-lumi; Harpodon nehereus; fresh noodles; flavour; antioxidant*

INTRODUCTION

Lumi-lumi fish (Harpodon nehereus), commonly called Bombay duck, is a demersial fish with a good chance of being developed in Meulaboh, West Aceh. The abundant availability of Lumi-lumi fish in the waters of the South West (Barsela) makes this fish one of the characteristics of Meulaboh City. Lumi-lumi fish contains various crude proteins, namely 50.64%, 81.97%, and 59.00% (1), (2), (3). It also contains dissolved protein that can be absorbed by the body at 7678.3 mg/mL and contains various macro minerals Ca, Mg, P, Fe, and Zn. However, conversely, there are challenges in processing Lumi-lumi fish. The soft texture and fishy smell cause the selling value of Lumi-lumi fish to be relatively low and less attractive to the public. Lumi-lumi fish contain 89.1% - 90% water (4) (5).

The people of Indonesia favor noodles as an alternative to rice because of their easy, fast presentation, varied side dishes, and good taste. According to World Instant Noodles Association (WINA) data in 2022, Indonesia is ranked second as the country with the most noodles consumption globally after China, reaching 14,26 billion packs (6). In general, noodles are sold with a low protein content that only comes from flour and eggs. Thus, adding Lumi-lumi fish meat and fortifying various natural flavours is expected to increase nutritional and mineral value and have antioxidant benefits for health.

This study used noodle product formulations from flavour extracts: yellow pumpkin, carrots, broccoli, and beets. The choice of yellow pumpkin (Curcubita moschata) as the flavour of Lumi-lumi fresh noodles is due to the content of nutrients, complex minerals, and β-carotene components that can function as natural yellow dyes as well as antioxidants (7). Carrots (Daucus carota L.) have a distinctive aroma, slightly more concentrated color (betasantin) than yellow pumpkin, and contain high β-carotene and carotene content (vitamin A), which is more easily absorbed after

cooking (8). Then broccoli (Brassica oleracea L.) contains a variety of important vitamins and minerals such as vitamin C, calcium, iron, and selenium, as well as other mineral content; broccoli's green color is generally used as a natural dye (9). Meanwhile, the selection of beets (Beta vulgaris L.) in the Lumi-lumi fresh noodle formulation because they contain active compounds such as carotenoids, glycine betaine, saponins, betacyanin, betanin, polyphenols, and flavonoids, the high content of beta-carotene in beets which not only acts as a natural purple dye but also acts as an antioxidant at the same time (10).

Thus, the results of this study are expected to produce the formulation of Lumi-lumi fresh noodle products with the best natural flavour extract fortification based on scoring tests with physical and sensory quality parameters of the product and fresh noodle products with the best nutritional value, Fe mineral, and antioxidants.

MATERIALS AND METHODS

This study used the Experiment method with a Single Factor Complete Randomized Design (CRD), fortifying various natural flavours in Lumi-lumi fresh noodles. There are four treatments with a ratio of wheat flour and Lumi-lumi fish composition (80%: 20%) and natural flavour extract fortification, namely: F1 = yellow pumpkin fruit extract, F2 = carrot extract, F3 = broccoli extract, F4 = beet extract. Each treatment was repeated 3 times so that 12 experimental units were obtained. Physical quality tests include rehydration power and cooking time. A total of 60 untrained panelists assessed sensory tests. Nutritional content tests include water content, ash content, protein content, fat content, crude fiber content, and carbohydrate content, then analyze Fe mineral content and antioxidant activity. The formulation of Lumi-lumi fresh noodles is as **follows:**

F1 = 80% wheat flour: 20% lumi-lumi fish + 8% yellow pumpkin extract
F2 = 80% wheat flour: 20% lumi-lumi fish + 8% carrot extract
F3 = 80% wheat flour: 20% lumi-lumi fish + 8% broccoli extract
F4 = 80% wheat flour: 20% lumi-lumi fish + 8% beet extract

The physical quality test of Lumi-lumi fresh noodles includes rehydration power and cooking time by a modified procedure (11). The measurement of rehydration power involves weighing 5 g of raw noodles as an initial weight of A (g), then boiling for ± 5 minutes after cooking, draining, and measuring the weight as B (g). Then, it is calculated using the formula:. Rehydration Force (%) = (B - A)/A x 100%, information: A (raw noodle weight (g)); B (cooked noodle weight (g)).

The cooking time of fresh noodles uses the principle of time analysis by measuring the duration until the noodles form a white line when pressed using two sheets of glass. As much as 5 g of raw noodles are weighed, then 150 ml of water is brought to a boil in a beaker glass and boiled for 3 minutes. The sample is inserted into a beaker glass, and the stopwatch is activated while the sample is in boiling water. Every one minute, a string of noodles is taken, which is then pressed with two pieces of glass. Cooking is optimal if a white line has formed when the noodles are packed using two sheets of glass.

The receptivity (sensory) test of Lumi-lumi fresh noodles using the hedonic method with a rating scale on the organoleptic test form (1-5), namely: 1 = very dislike, 2 = dislike, 3 = somewhat dislike, 4 = like, and 5 = very like. In hedonic testing, this study refers to previous research, which is modified; the parameters tested include appearance, color, taste, aroma, texture, and overall acceptance (12). The organoleptic (hedonic) test form is referred to by previous researchers and is modified (13). The number of untrained panelists was 60.

The nutritional content test of fresh noodles Lumi-lumi refers to the Official Methods of Analysis of AOAC International 20th.ed (2016), which includes water, ash, protein, fat, fiber, and carbohydrate content (14). Test the Fe mineral content of Lumi-lumi fresh noodles using the ICP OES method with Fe wavelength = 238.204 nm and Y wave = 371.029 nm. Samples were prepared as much as 0.5 g using HNO3 and 7.5 mL HCl solutions, internal addition of yttrium standard 100 mg/L in a 50 mL measuring flask,

filtering the solution with a 0.20 µm RC / GHP syringe filter. The comparison standards are Iron Standard Solution 1000 mg/L. Calculation of metal/mineral levels in the sample using the following formula: Mineral Metal Content (ppm, mg L, mg Kg) = $^{Aspl-a}$/b $\times$ V $\times$fp/ W^{spl} or V^{spl}, information: Aspl : Sample intensity; a : Intercept of standard calibration curves; b : Slove from the standard calibration curve, fp: Dilution factor; V : Volume end of test solution (mL); Wspl : Test portion weighing weight (g); Vspl : Test portion pipetting volume (mL).

The antioxidant activity content test using the 1,1 diphenyl-2-picrylhydrazyl (DPPH) method (15). Lumi-lumi fresh noodle samples of as much as 1 g were prepared in a blank solution consisting of a mixture of 0.2 mL ethanol and 3.8 mL DPPH, then vortexed and incubated for 30 minutes. Measurement of antioxidant activity using a 515 nm wavelength UV-VIS spectrophotometer. The results of the Lumi-lumi fresh noodle antioxidant activity test will be calculated using the following formula: % Antioxidant activity = Absorbance of the stamp – Absorbance of the sample/Stamp absorbance x 100%.

Data Analysis

The research data was analyzed using SPPS version 20. Physical quality data were analyzed using analysis of variance (ANOVA) with a significance value (P<0.05), if there is a significant difference, the Tukey test continues. Sensory data were analyzed using the Kruskal Wallis test with a significance value (P<0.05); if there is a significant difference, the Mann-Whitney test continued to see significant differences in sensory parameters of each treatment. The nutritional content, Fe mineral, and antioxidant activity data results were analyzed using the Independent Sample T-test with a significance value (P<0.05) to identify the best formulation.

RESULTS AND DISCUSSIONS
Physical quality of Lumi-lumi fresh noodles

The results of the analysis of the rehydration power of noodles and fresh cooking time of various natural flavours between treatments were not significantly different (P>0.05) presented in **Table 1**

Table 1. Physical quality analysis of fresh noodles Lumi-lumi fortification of various natural flavours

Parameter	Treatment				P value
	F1	F2	F3	F4	
Rehydration Power (%)	68.96±3.07ᵃ	73.50±2.38ᵃ	67.20±7.00ᵃ	65.20±7.47ᵃ	0.353
Cooking Time (minutes)	2.06±0.04ᵃ	2.07±0.05ᵃ	2.12±0.04ᵃ	2.11±0.03ᵃ	0.293

*The data presented consists of mean ± standard deviation. Different letter notations in the same row show a noticeable difference (P<0.05).

Rehydration power is the ability of noodles to absorb water after a gelatinization event (16). The highest average result of fresh noodle rehydration power was carrot extract treatment with an average of 73.50%, followed by yellow pumpkin extract treatment with an average of 68.96%, broccoli extract with an average of 67.20%, and the lowest in beet extract treatment with an average of 65.20%. The high rehydration power of fresh noodles Lumi-lumi fortification of various flavours is caused by the use of high-protein wheat flour and protein content in Lumi-lumi fish, the protein content in the constituent ingredients of noodles affects the ability of noodle dough to bind water during the boiling process. This is reinforced

by the statement by previous researchers (7) that the higher protein content in noodles causes the formation of a complex bond between protein and starch, which affects the water absorption process. Cooking time is needed for noodles to be fully cooked by removing the white dot in the middle of the noodle strands during the cooking process (16). The shorter the cooking time, the less solids are lost in the water during cooking. Conversely, the longer the cooking time, the more water content contained in the noodles; this affects the texture and taste, and the resulting noodles are easily damaged (17).

The results of the identification of cooking time showed that the cooking time was shorter,

namely in the treatment of yellow pumpkin extract for 126 seconds, followed by carrot extract for 127 seconds, beet extract for 131 seconds, and broccoli pull for 132 seconds. However, statistically, it shows no real difference. This is thought to be due to the composition of flour, fish, and eggs that are added equally between treatments. The gluten content present in wheat germ, as well as protein in the raw materials for making noodles contribute to the ripening time.

This is reinforced by the statement by previous researchers (16) that the content of gluten and protein in food has a real effect on the length of noodle cooking; the higher the protein content, the longer the noodle cooking process. Fresh noodles with various natural flavours before and after cooking can be seen in **Figure 1**; raw noodles are shown in Figure (a), and cooked noodles are shown in Figure (b).
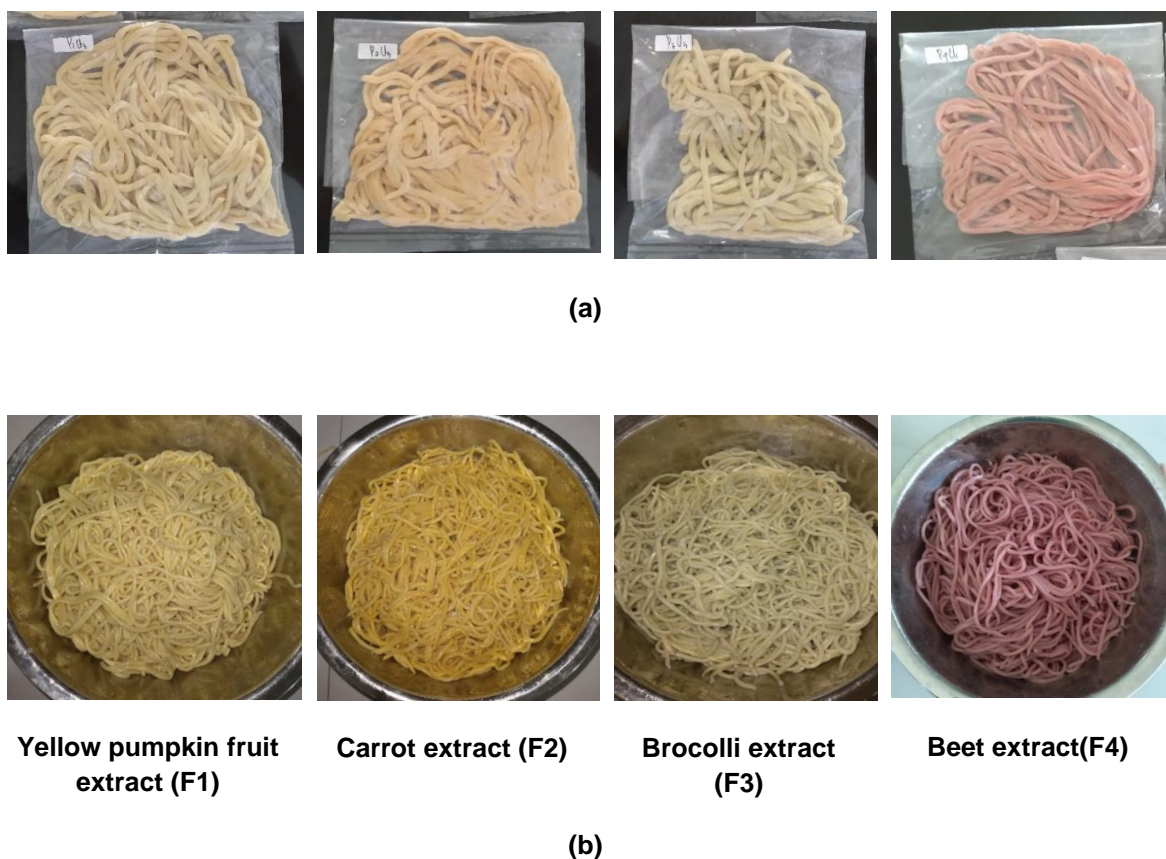

(a)

| Yellow pumpkin fruit extract (F1) | Carrot extract (F2) | Brocolli extract (F3) | Beet extract(F4) |

(b)

Figure 1. Lumi-lumi fresh noodles before cooking (a) and after cooking (b)

Acceptability (sensory)

The results of the analysis of the acceptability of Lumi-lumi fresh noodles fortified with various natural flavours are presented in **Table 2**. In terms of appearance parameters, significant differences were obtained between treatments ($p < 0.05$). The appearance of the formulation most preferred by panelists was found in the carrot extract fortification treatment with an average value of 4.21 with the criteria of liking, followed by beet extract with an average value of 3.71 (like),

broccoli extract with an average value of 3.51 (somewhat like) and yellow pumpkin extract with an average value of 3.43 (somewhat like). Overall, fresh noodles with various fortified flavours have a normal appearance like fresh noodles in general, without any significant difference compared to fresh noodles, so panelists can accept it when choosing their preferred formulation. In the color parameter, significant differences were obtained between treatments ($p < 0.05$). The color aspect assessment of the panelists gave the highest

score on carrot extract fortification treatment with an average value of 4.31 with like criteria, followed by beet extract with an average value of 3.71 (like), broccoli extract with an average value of

3.50 (somewhat like) and yellow pumpkin extract with an average value of 3.38 (somewhat like). The color of the noodles favored by the panelists was light orange (not thick and not pale).

Table 2. Sensory analysis of fresh noodles Lumi-lumi fortification of various natural flavours

Parameter	Treatment				P value
	F1	F2	F3	F4	
Appearance	3.43±0.93[a]	4.21±0.88[b]	3.51±1.17[a]	3.71±1.18[a]	
Color	3.38±1.02[a]	4.31±0.77[b]	3.50±1.04[a]	3.71±1.19[a]	
Aroma	3.68±1.03[a]	4.15±0.65[c]	3.13±1.34[b]	3.68±1.17[a]	0.000
Taste	2.85±1.07[a]	3.50±1.15[c]	3.05±1.17[b]	3.45±1.18[b]	
Texture	3.23±1.11[a]	4.00±0.92[b]	3.95±1.12[b]	3.95±1.04[b]	
Overall	3.15±0.95[a]	3.93±0.97[b]	3.73±1.17[b]	3.68±1.06[b]	

[*]The data presented consists of mean ± standard deviation. Different letter notations in the same row show a noticeable difference (P<0.05).

So, the fresh noodles of carrot extract are preferred by panelists compared to the fresh noodles of yellow pumpkin extract; this is due to the color in the formulation of fresh noodles Lumi-lumi fortification of pale yellow pumpkin extract. This is in line with the research of the hedonic test of fresh noodles, the addition of mackerel fish meal and carrot juice that was most liked by panelists, the more the addition of carrot juice, the increasing panelists' preference for noodles (18).

In the aroma parameter, significant differences were obtained between treatments (p<0.05).

The aroma aspect assessment from the panelists gave the highest score on carrot extract fortification treatment with an average value of 4.15 with like criteria, followed by beet extract with an average value of 3.68 (likes), yellow pumpkin extract with an average value of 3.68 (likes), and broccoli extract with an average value of 3.13 (somewhat likes). The aroma of fresh noodles with the fortification of various flavours that the panelists least liked was the fresh noodles of broccoli extract; this was caused by the distinctive aroma of broccoli and unpleasant so that it masked the distinctive Aroma of fish that the panelists tended to dislike. This result is in line with the research of the distinctive smell of broccoli can dominate the Aroma of cat tongue cake and beat the Aroma of fat from flour; the more substitution of broccoli powder, the stronger the Aroma of broccoli cookie dough (19). In the Taste parameters, significant differences were obtained between treatments (p<0.05). The assessment of taste aspects from the panelists gave the highest

score on the carrot extract fortification treatment with an average value of 3.50 with the criteria of liking, followed by beet extract with an average value of 3.45 (somewhat like), broccoli extract with an average value of 3.05 (somewhat like) and yellow pumpkin extract with an average value of 2.85 (somewhat like). Lumi-lumi fresh noodles have a taste like fresh noodles in general, carrot extract is preferred by panelists because of the sweet taste produced by sugar in carrots (12).

In the Texture parameters, significant differences were obtained between treatments (p<0.05). The assessment of texture aspects from panelists gave the highest score on carrot extract fortification treatment with an average value of 4.00 with the criteria of likes, followed by beet extract with an average value of 3.95 (likes), broccoli extract with an average value of 3.95 (likes) and yellow pumpkin extract with an average value of 3.23 (somewhat likes). In the overall acceptance parameters, significant differences were obtained between treatments (p<0.05). The assessment of the overall aspect from the panelist gave the highest score on the carrot extract fortification treatment with an average value of 3.93 with the criteria of likes, followed by broccoli extract with an average value of 3.73 (likes), beet extract with an average of 3.68 (likes), and yellow pumpkin extract with an average value of 3.15 (somewhat likes).

Scoring test

Determination of the best product of Lumi-lumi fresh noodles fortified with various flavours

based on the best results from physical and organoleptic quality parameters presented in **Table 3**. The determination is carried out by the scoring method. The score starts from numbers 1 to 4, with the highest score value of 4, which shows the parameter value better.

Table 3. Selection of the best formulation based on the results of the hedonic test of fresh noodles Lumi-lumi fortification of various flavours

Organoleptic	Treatment			
	F1	F2	F3	F4
Appearance	1	4	2	3
Color	1	4	2	3
Aroma	2	4	1	3
Taste	1	4	2	3
Texture	1	4	2	3
Overall	1	4	3	2
Total	**7**	**24**	**12**	**17**

*Remarks: (F1) yellow pumpkin extract, (F2) carrot extract, (F3) broccoli extract and (F4) beet extract. Numbers 1-4 mean that the higher the number, the higher the value of fresh noodles Lumi-lumi based on predetermined parameters.

Based on the results of the **Table 3** scoring test, the best products were obtained, namely the treatment of fresh noodles Lumi-lumi carrot extract (F2) and fresh noodles Lumi-lumi beet extract (F4), with a total score of 24 and 17, respectively. Next, the identification of nutritional value, Fe mineral, and antioxidant activity was carried out.

Nutrition content

The results of the nutritional content analysis of Lumi-lumi fresh noodles fortified with various natural flavours are presented in **Table 4.** The results of the statistical test of the moisture content of fresh noodles are a significant difference ($P<0.05$). The average water content in the best formulations of F2 and F4 is 45.46% and 54.29% which meet the requirements for maximum moisture content in cooked fresh noodles according to SNI 2987 of 2015, which is a maximum of 65%.

The results of statistical tests showed a significant difference in ash content ($P<0.05$), the average ash content in the best formulations of F2 and F4 was 0.68% and 0.46%. The ash content test is the total ash content of Lumi-lumi fresh noodle products.

Table 4. Analysis of the nutritional content of fresh noodles in the best formulations

Parameter	F2	F4	*P value*
Water content (%db)	45.46±1.07[a]	54.29±0.39[b]	0.003
Ash content (%db)	0.68±0.02[b]	0.46±0.00[a]	0.001
Fat content (%db)	5.60±0.47[a]	8.43±0.21[b]	0.006
Protein content (%db)	11.81±0.75[a]	14.77±0.03[b]	0.003
Crude fiber content (%db)	8.65±0.77[a]	16.04±0.46[b]	0.001
Carbohydrate content (%db)	27.79±1.73[b]	6.02±0.67[a]	0.000

Information:
The data presentation in the table is the average of 3x repetitions ± standard deviations
Different letter notations in the same column and row show a noticeable difference ($P<0.05$).

Furthermore, the results of statistical tests showed a significant difference in fat content ($P<0.05$), the average fat content in the best formulations of F2 and F4 was 5.60% and 8.43%. According to SNI 01-2987-1992, the maximum fat content requirement for fresh noodles is around 7%. Based on this, the fat content in Lumi-lumi beet extract fresh noodles (F4) exceeds the

requirements of the existing fat content. This is in line with previous researchers with the results of research on high-fat content in control formulation fresh noodles (F0), which is 9.55% (20). The high-fat content in Lumi-lumi fresh noodles occurs because of the fat content in eggs and fish in the noodle dough-making process and the cooking oil in fresh noodles after boiling so that the noodles do not clump or stick when served.

The results of statistical tests showed a significant difference in protein levels (P<0.05), the average protein levels in the best formulations of F2 and F4 were 11.81% and 14.77%. According to SNI 2987 of 2015, the minimum protein content contained in cooked noodles is 6.0%, so the results of the protein content test in Lumi-lumi fresh noodles meet the requirements for protein levels in fresh noodles. The protein content in fresh noodles is influenced by the ingredients used, especially high-protein flour (21). In addition, Lumi-lumi fresh noodles also use animal protein in the form of chicken eggs and Lumi-lumi fish meat, which are rich in macro and micronutrients (minerals). Using high-protein ingredients (fish meat) can improve the nutritional quality of fresh noodles in terms of their protein content (22).

Protein plays a vital role in the human body, namely in the growth and maintenance of cells and tissues, as the main source of energy after carbohydrates and fats, and as a building agent and regulator. In addition, protein also plays an essential role in regulating enzymes in the body's metabolic processes and body hormones from the dangers of toxic substances (23). In children, protein plays a role in physical activity; the more active, the higher the need for protein. Protein intake is the most impactful factor on children's activities in elementary school; less protein intake in high-risk children is 2,623 times as low physical activity compared to adequate protein intake (24). Protein also increases hemoglobin levels; the higher the protein intake, the higher the hemoglobin levels, thus preventing anemia in adolescent girls (25). The study's results by previous researchers stated a significant relationship between protein intake and the incidence of KEK in brides-to-be; this is illustrated by the size of a person's LiLA (26). Protein intake is also closely related to stunting in Baduta; infants with a history of nutrient intake (protein) that is less than needed have a 20 times greater risk of stunting (27). The fiber and carbohydrate content analysis showed a significant difference (P<0.05) between the treatment of F2 and F4 formulations, respectively, 8.65% and 16.04% of crude fiber values. Then, by 27.79% and 6.02% carbohydrate value

.

Fe Mineral

Analysis of iron (Fe) mineral content was carried out on formulations F2 (Lumi-lumi fresh noodles carrot extract) and F4 (Lumi-lumi fresh noodles beetroot extract) presented in the graph below
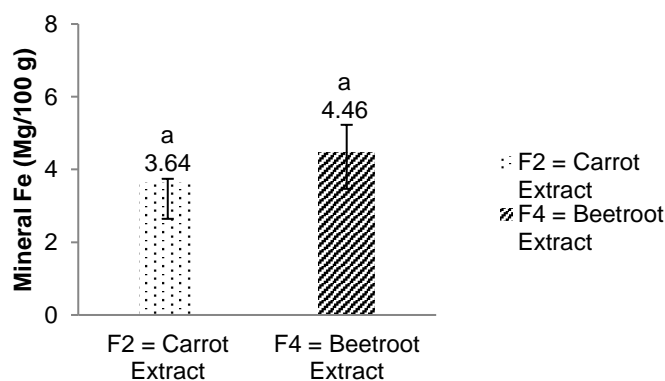

Figure 2. Graph the average iron (Fe) mineral content in the best-formulated Lumi-lumi fresh noodles.

The results of the Fe mineral analysis between F2 and F4 treatments showed no significant difference ($P>0.05$), as presented in Figure 2. The average iron (Fe) levels of F2 and F4 were 3.64% and 4.46%.

Iron in the body has essential functions for the nervous system, including myelination, neurotransmitters, dendrithogenesis, and nerve metabolism. Iron deficiency in infants affects growth, cognitive function, and behavior. In adolescents, iron becomes a source of energy for muscles that impact physical endurance and ability to work. Iron deficiency during pregnancy can increase the risk of perinatal and infant mortality (28).

Antioxidant activity

Antioxidant activity content was analyzed on formulations F2 (Lumi-lumi fresh noodles carrot extract) and F4 (Lumi-lumi fresh noodles beetroot extract), presented in the graph below.
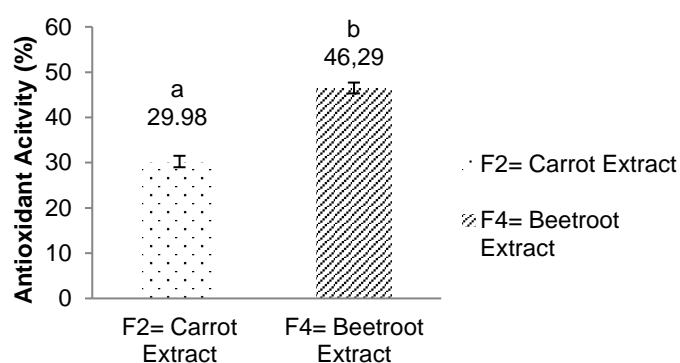

Figure 3. Graph the average antioxidant activity content in the best-formulated Lumi-lumi fresh noodles.

In the results of antioxidant activity (Figure 3), there was a significant difference ($P<0.05$) between treatments with F2 and F4 respectively, namely 29.98% and 42.90%. High levels of antioxidant activity in F4 (beet extract) are thought to contain many bioactive components that act as antioxidants. Beets contain flavonoids 360-2760 mg/kg, betacyanin 840-900 mg/kg, betanin 300-600 mg/kg, ascorbic acid 50-868 mg/kg, and carotenoids 0.44 mg/kg (29). Such compounds act as antioxidants.

Antioxidant compounds are reported to be effective in inhibiting the development of colon cancer cells (30) and hypertension in the elderly (31), and the flavonoid content in beets is known to prevent cognitive disorders and neurodegenerative diseases (32).

CONCLUSIONS AND RECOMMENDATIONS

The results of the physical and sensory quality tests of selected products are on fresh noodles fortified with carrot and beet extract. Then the results of identifying protein content, crude fiber, Fe mineral, and the highest antioxidant activity were obtained in the fortification treatment of beet extract, covering 14.47%, 16.04%, 4.46 mg / 100 g, and 42.90%.

Thus, Lumi-lumi fresh beetroot noodles are recommended as functional local food products because they contain Fe mineral and high antioxidant activity.

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Physicochemical and sensory properties of Lumi-lumi (Harpodon nehereus) fresh noodles fortified with natural flavours

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ABSTRAK

Latar Belakang: *Ikan endemik Lumi-lumi (Harpodon nehereus) mengandung zat gizi makro dan mikro mineral yang berpotensi memperbaiki kandungan gizi mie. Fortifikasi aneka flavor alami bertujuan memperkaya kandungan mineral dan fungsional mie.*

Tujuan: *Penelitian ini bertujuan untuk mengidentifikasi formulasi terpilih mie basah Lumi-lumi yang difortifikasi aneka flavor alami berdasarkan mutu fisik dan daya terima, serta mengidentifikasi kandungan gizi, mineral Fe, dan aktivitas antioksidan tertinggi pada perlakuan terbaik.*

Metode: *Penelitian ini bersifat eksperimen menggunakan Rancangan Acak Lengkap (RAL) satu faktor yaitu fortifikasi aneka flavor labu kuning, wortel, brokoli dan bit pada mie basah Lumi-lumi. Penentuan produk terpilih berdasarkan uji mutu fisik dan sensori tertinggi, selanjutnya identifikasi kandungan gizi, mineral Fe dan aktivitas antioksidan produk terbaik. Data mutu fisik dianalisis menggunakan uji One way ANOVA, data sensori menggunakan uji Kruskal Wallis, data kandungan gizi, mineral Fe dan aktivitas antioksidan menggunakan uji Independent Sample T-test.*

Hasil: *Hasil uji mutu fisik dan sensori produk terpilih yaitu pada mie basah Lumi-lumi yang difortifikasi ekstrak wortel dan bit. Hasil identifikasi kandungan protein, serat kasar, mineral Fe, dan aktivitas antioksidan tertinggi diperoleh pada perlakuan fortifikasi ekstrak bit, berturut-turut yakni 14,47%, 16,04%, 4.46 mg/100 g, dan 42,90%.*

Kesimpulan: *Formulasi produk terbaik diperoleh pada perlakuan mie basah Lumi-lumi yang difortifikasi ekstrak bit dengan perolehan nilai kandungan protein, serat kasar, mineral Fe, dan aktivitas antioksidan tertinggi. Produk ini berpotensi sebagai produk pangan lokal fungsional..*

KATA KUNCI*: lumi-lumi; harpodon nehereus; mie basah; flavor; antioksidan*

ABSTRACT

Background: *Endemic fish Lumi-lumi (Harpodon nehereus) contains macronutrients and minerals that can potentially improve the nutritional content of noodles. Fortification of various natural flavours aims to enrich noodles' mineral and functional content.*

Objectives: *This study aims to identify selected formulations of Lumi-lumi fresh noodles fortified with various natural flavours based on physical quality and acceptability, as well as identify the highest nutritional content, Fe mineral, and antioxidant activity in the best treatment.*

Methods: *This experimental study uses a single factor Complete Randomized Design (CAD), fortifying various flavours of yellow pumpkin, carrots, broccoli, and beets in Lumi-lumi fresh noodles. Determination of selected products based on the highest physical and sensory quality tests, then identification of nutritional content, Fe mineral, and antioxidant activity on the best product. Physical quality data were analyzed using the ANOVA test, sensory data using the Kruskal Wallis test, and data on nutrient content, Fe mineral, and antioxidant activity using the Independent Sample T-test.*

Results: *The results of physical and sensory quality tests of selected products are on Lumi-lumi fresh noodles fortified with carrot and beet extract. The results of the identification of the highest protein, crude fiber, Fe mineral, and antioxidant activity were obtained in the fortification treatment of beet extract, including 14.47%, 16.04%, 4.46 mg/100 g, and 42.90%.*

Conclusions: *The best product formulation was obtained in treating fresh noodles Lumi-lumi fortified with beet extract with the highest protein, crude fiber, Fe mineral, and antioxidant activity. This product has the potential to be a functional local food product.*

KEYWORD*: Lumi-lumi; Harpodon nehereus; fresh noodles; flavour; antioxidant*

INTRODUCTION

Lumi-lumi fish (Harpodon nehereus), commonly called Bombay duck, is a demersial fish with a good chance of being developed in Meulaboh, West Aceh. The abundant availability of Lumi-lumi fish in the waters of the South West (Barsela) makes this fish one of the characteristics of Meulaboh City. Lumi-lumi fish contains various crude proteins, namely 50.64%, 81.97%, and 59.00% (1), (2), (3). It also contains dissolved protein that can be absorbed by the body at 7678.3 mg/mL and contains various macro minerals Ca, Mg, P, Fe, and Zn. However, conversely, there are challenges in processing Lumi-lumi fish. The soft texture and fishy smell cause the selling value of Lumi-lumi fish to be relatively low and less attractive to the public. Lumi-lumi fish contain 89.1% - 90% water (4) (5).

The people of Indonesia favor noodles as an alternative to rice because of their easy, fast presentation, varied side dishes, and good taste. According to World Instant Noodles Association

(WINA) data in 2022, Indonesia is ranked second as the country with the most noodles consumption globally after China, reaching 14,26 billion packs (6). In general, noodles are sold with a low protein content that only comes from flour and eggs. Thus, adding Lumi-lumi fish meat and fortifying various natural flavours is expected to increase nutritional and mineral value and have antioxidant benefits for health.

This study used noodle product formulations from flavour extracts: yellow pumpkin, carrots, broccoli, and beets. The choice of yellow pumpkin (Curcubita moschata) as the flavour of Lumi-lumi fresh noodles is due to the content of nutrients, complex minerals, and β-carotene components that can function as natural yellow dyes as well as antioxidants (7). Carrots (Daucus carota L.) have a distinctive aroma, slightly more concentrated color (betasantin) than yellow pumpkin, and contain high β-carotene and carotene content (vitamin A), which is more easily absorbed after

cooking (8). Then broccoli (Brassica oleracea L.) contains a variety of important vitamins and minerals such as vitamin C, calcium, iron, and selenium, as well as other mineral content; broccoli's green color is generally used as a natural dye (9). Meanwhile, the selection of beets (Beta vulgaris L.) in the Lumi-lumi fresh noodle formulation because they contain active compounds such as carotenoids, glycine betaine, saponins, betacyanin, betanin, polyphenols, and flavonoids, the high content of beta-carotene in beets which not only acts as a natural purple dye but also acts as an antioxidant at the same time (10).

Thus, the results of this study are expected to produce the formulation of Lumi-lumi fresh noodle products with the best natural flavour extract fortification based on scoring tests with physical and sensory quality parameters of the product and fresh noodle products with the best nutritional value, Fe mineral, and antioxidants.

MATERIALS AND METHODS

This study used the Experiment method with a Single Factor Complete Randomized Design (CRD), fortifying various natural flavours in Lumi-lumi fresh noodles. There are four treatments with a ratio of wheat flour and Lumi-lumi fish composition (80%: 20%) and natural flavour extract fortification, namely: F1 = yellow pumpkin fruit extract, F2 = carrot extract, F3 = broccoli extract, F4 = beet extract. Each treatment was repeated 3 times so that 12 experimental units were obtained. Physical quality tests include rehydration power and cooking time. A total of 60 untrained panelists assessed sensory tests. Nutritional content tests include water content, ash content, protein content, fat content, crude fiber content, and carbohydrate content, then analyze Fe mineral content and antioxidant activity. The formulation of Lumi-lumi fresh noodles is as **follows:**

F1 = 80% wheat flour: 20% lumi-lumi fish + 8% yellow pumpkin extract
F2 = 80% wheat flour: 20% lumi-lumi fish + 8% carrot extract
F3 = 80% wheat flour: 20% lumi-lumi fish + 8% broccoli extract
F4 = 80% wheat flour: 20% lumi-lumi fish + 8% beet extract

The physical quality test of Lumi-lumi fresh noodles includes rehydration power and cooking time by a modified procedure (11). The measurement of rehydration power involves weighing 5 g of raw noodles as an initial weight of A (g), then boiling for ± 5 minutes after cooking, draining, and measuring the weight as B (g). Then, it is calculated using the formula:. Rehydration Force (%) = (B - A)/A x 100%, information: A (raw noodle weight (g)); B (cooked noodle weight (g)).

The cooking time of fresh noodles uses the principle of time analysis by measuring the duration until the noodles form a white line when pressed using two sheets of glass. As much as 5 g of raw noodles are weighed, then 150 ml of water is brought to a boil in a beaker glass and boiled for 3 minutes. The sample is inserted into a beaker glass, and the stopwatch is activated while the sample is in boiling water. Every one minute, a string of noodles is taken, which is then pressed with two pieces of glass. Cooking is optimal if a white line has formed when the noodles are packed using two sheets of glass.

The receptivity (sensory) test of Lumi-lumi fresh noodles using the hedonic method with a rating scale on the organoleptic test form (1-5), namely: 1 = very dislike, 2 = dislike, 3 = somewhat dislike, 4 = like, and 5 = very like. In hedonic testing, this study refers to previous research, which is modified; the parameters tested include appearance, color, taste, aroma, texture, and overall acceptance (12). The organoleptic (hedonic) test form is referred to by previous researchers and is modified (13). The number of untrained panelists was 60.

The nutritional content test of fresh noodles Lumi-lumi refers to the Official Methods of Analysis of AOAC International 20th.ed (2016), which includes water, ash, protein, fat, fiber, and carbohydrate content (14). Test the Fe mineral content of Lumi-lumi fresh noodles using the ICP OES method with Fe wavelength = 238.204 nm and Y wave = 371.029 nm. Samples were prepared as much as 0.5 g using HNO3 and 7.5 mL HCl solutions, internal addition of yttrium standard 100 mg/L in a 50 mL measuring flask,

filtering the solution with a 0.20 µm RC / GHP syringe filter. The comparison standards are Iron Standard Solution 1000 mg/L. Calculation of metal/mineral levels in the sample using the following formula: Mineral Metal Content (ppm, mg L, mg Kg) = $^{Aspl-a}/b \times V \times fp/ W^{spl}$ or V^{spl}, information: Aspl : Sample intensity; a : Intercept of standard calibration curves; b : Slove from the standard calibration curve, fp: Dilution factor; V : Volume end of test solution (mL); Wspl : Test portion weighing weight (g); Vspl : Test portion pipetting volume (mL).

The antioxidant activity content test using the 1,1 diphenyl-2-picrylhydrazyl (DPPH) method (15). Lumi-lumi fresh noodle samples of as much as 1 g were prepared in a blank solution consisting of a mixture of 0.2 mL ethanol and 3.8 mL DPPH, then vortexed and incubated for 30 minutes. Measurement of antioxidant activity using a 515 nm wavelength UV-VIS spectrophotometer. The results of the Lumi-lumi fresh noodle antioxidant activity test will be calculated using the following formula: % Antioxidant activity = Absorbance of the stamp – Absorbance of the sample/Stamp absorbance x 100%.

Data Analysis

The research data was analyzed using SPPS version 20. Physical quality data were analyzed using analysis of variance (ANOVA) with a significance value (P<0.05), if there is a significant difference, the Tukey test continues. Sensory data were analyzed using the Kruskal Wallis test with a significance value (P<0.05); if there is a significant difference, the Mann-Whitney test continued to see significant differences in sensory parameters of each treatment. The nutritional content, Fe mineral, and antioxidant activity data results were analyzed using the Independent Sample T-test with a significance value (P<0.05) to identify the best formulation.

RESULTS AND DISCUSSIONS
Physical quality of Lumi-lumi fresh noodles

The results of the analysis of the rehydration power of noodles and fresh cooking time of various natural flavours between treatments were not significantly different (P>0.05) presented in **Table 1**

Table 1. Physical quality analysis of fresh noodles Lumi-lumi fortification of various natural flavours

Parameter	Treatment				P value
	F1	F2	F3	F4	
Rehydration Power (%)	68.96±3.07ᵃ	73.50±2.38ᵃ	67.20±7.00ᵃ	65.20±7.47ᵃ	0.353
Cooking Time (minutes)	2.06±0.04ᵃ	2.07±0.05ᵃ	2.12±0.04ᵃ	2.11±0.03ᵃ	0.293

*The data presented consists of mean ± standard deviation. Different letter notations in the same row show a noticeable difference (P<0.05).

Rehydration power is the ability of noodles to absorb water after a gelatinization event (16). The highest average result of fresh noodle rehydration power was carrot extract treatment with an average of 73.50%, followed by yellow pumpkin extract treatment with an average of 68.96%, broccoli extract with an average of 67.20%, and the lowest in beet extract treatment with an average of 65.20%. The high rehydration power of fresh noodles Lumi-lumi fortification of various flavours is caused by the use of high-protein wheat flour and protein content in Lumi-lumi fish, the protein content in the constituent ingredients of noodles affects the ability of noodle dough to bind water during the boiling process. This is reinforced

by the statement by previous researchers (7) that the higher protein content in noodles causes the formation of a complex bond between protein and starch, which affects the water absorption process. Cooking time is needed for noodles to be fully cooked by removing the white dot in the middle of the noodle strands during the cooking process (16). The shorter the cooking time, the less solids are lost in the water during cooking. Conversely, the longer the cooking time, the more water content contained in the noodles; this affects the texture and taste, and the resulting noodles are easily damaged (17).

The results of the identification of cooking time showed that the cooking time was shorter,

namely in the treatment of yellow pumpkin extract for 126 seconds, followed by carrot extract for 127 seconds, beet extract for 131 seconds, and broccoli pull for 132 seconds. However, statistically, it shows no real difference. This is thought to be due to the composition of flour, fish, and eggs that are added equally between treatments. The gluten content present in wheat germ, as well as protein in the raw materials for making noodles contribute to the ripening time.

This is reinforced by the statement by previous researchers (16) that the content of gluten and protein in food has a real effect on the length of noodle cooking; the higher the protein content, the longer the noodle cooking process. Fresh noodles with various natural flavours before and after cooking can be seen in **Figure 1**; raw noodles are shown in Figure (a), and cooked noodles are shown in Figure (b).
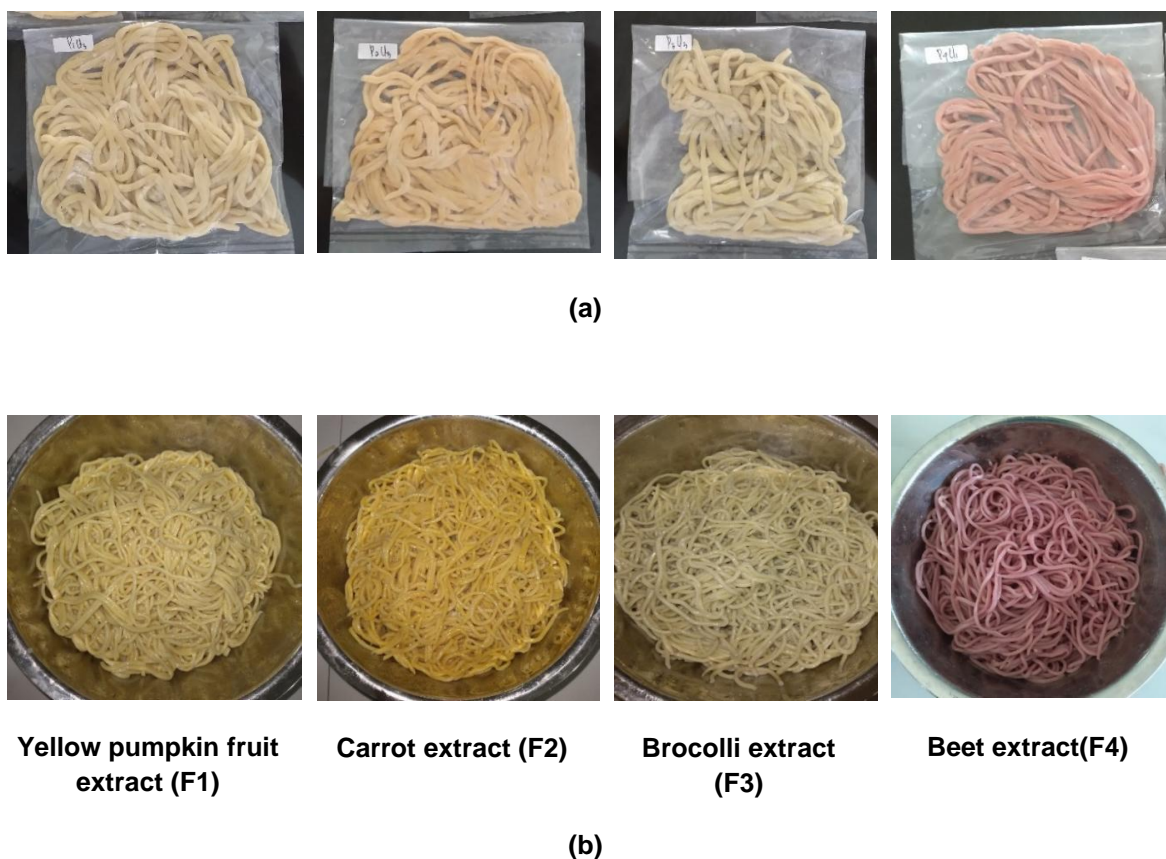

(a)

| **Yellow pumpkin fruit extract (F1)** | **Carrot extract (F2)** | **Brocolli extract (F3)** | **Beet extract(F4)** |

(b)

Figure 1. Lumi-lumi fresh noodles before cooking (a) and after cooking (b)

Acceptability (sensory)

The results of the analysis of the acceptability of Lumi-lumi fresh noodles fortified with various natural flavours are presented in **Table 2**. In terms of appearance parameters, significant differences were obtained between treatments (p<0.05). The appearance of the formulation most preferred by panelists was found in the carrot extract fortification treatment with an average value of 4.21 with the criteria of liking, followed by beet extract with an average value of 3.71 (like),

broccoli extract with an average value of 3.51 (somewhat like) and yellow pumpkin extract with an average value of 3.43 (somewhat like). Overall, fresh noodles with various fortified flavours have a normal appearance like fresh noodles in general, without any significant difference compared to fresh noodles, so panelists can accept it when choosing their preferred formulation. In the color parameter, significant differences were obtained between treatments (p<0.05). The color aspect assessment of the panelists gave the highest

score on carrot extract fortification treatment with an average value of 4.31 with like criteria, followed by beet extract with an average value of 3.71 (like), broccoli extract with an average value of

3.50 (somewhat like) and yellow pumpkin extract with an average value of 3.38 (somewhat like). The color of the noodles favored by the panelists was light orange (not thick and not pale).

Table 2. Sensory analysis of fresh noodles Lumi-lumi fortification of various natural flavours

Parameter	Treatment				P value
	F1	**F2**	**F3**	**F4**	
Appearance	3.43±0.93[a]	4.21±0.88[b]	3.51±1.17[a]	3.71±1.18[a]	
Color	3.38±1.02[a]	4.31±0.77[b]	3.50±1.04[a]	3.71±1.19[a]	
Aroma	3.68±1.03[a]	4.15±0.65[c]	3.13±1.34[b]	3.68±1.17[a]	0.000
Taste	2.85±1.07[a]	3.50±1.15[c]	3.05±1.17[b]	3.45±1.18[b]	
Texture	3.23±1.11[a]	4.00±0.92[b]	3.95±1.12[b]	3.95±1.04[b]	
Overall	3.15±0.95[a]	3.93±0.97[b]	3.73±1.17[b]	3.68±1.06[b]	

[*]The data presented consists of mean ± standard deviation. Different letter notations in the same row show a noticeable difference (P<0.05).

So, the fresh noodles of carrot extract are preferred by panelists compared to the fresh noodles of yellow pumpkin extract; this is due to the color in the formulation of fresh noodles Lumi-lumi fortification of pale yellow pumpkin extract. This is in line with the research of the hedonic test of fresh noodles, the addition of mackerel fish meal and carrot juice that was most liked by panelists, the more the addition of carrot juice, the increasing panelists' preference for noodles (18).

In the aroma parameter, significant differences were obtained between treatments (p<0.05).

The aroma aspect assessment from the panelists gave the highest score on carrot extract fortification treatment with an average value of 4.15 with like criteria, followed by beet extract with an average value of 3.68 (likes), yellow pumpkin extract with an average value of 3.68 (likes), and broccoli extract with an average value of 3.13 (somewhat likes). The aroma of fresh noodles with the fortification of various flavours that the panelists least liked was the fresh noodles of broccoli extract; this was caused by the distinctive aroma of broccoli and unpleasant so that it masked the distinctive Aroma of fish that the panelists tended to dislike. This result is in line with the research of the distinctive smell of broccoli can dominate the Aroma of cat tongue cake and beat the Aroma of fat from flour; the more substitution of broccoli powder, the stronger the Aroma of broccoli cookie dough (19). In the Taste parameters, significant differences were obtained between treatments (p<0.05). The assessment of taste aspects from the panelists gave the highest

score on the carrot extract fortification treatment with an average value of 3.50 with the criteria of liking, followed by beet extract with an average value of 3.45 (somewhat like), broccoli extract with an average value of 3.05 (somewhat like) and yellow pumpkin extract with an average value of 2.85 (somewhat like). Lumi-lumi fresh noodles have a taste like fresh noodles in general, carrot extract is preferred by panelists because of the sweet taste produced by sugar in carrots (12).

In the Texture parameters, significant differences were obtained between treatments (p<0.05). The assessment of texture aspects from panelists gave the highest score on carrot extract fortification treatment with an average value of 4.00 with the criteria of likes, followed by beet extract with an average value of 3.95 (likes), broccoli extract with an average value of 3.95 (likes) and yellow pumpkin extract with an average value of 3.23 (somewhat likes). In the overall acceptance parameters, significant differences were obtained between treatments (p<0.05). The assessment of the overall aspect from the panelist gave the highest score on the carrot extract fortification treatment with an average value of 3.93 with the criteria of likes, followed by broccoli extract with an average value of 3.73 (likes), beet extract with an average of 3.68 (likes), and yellow pumpkin extract with an average value of 3.15 (somewhat likes).

Scoring test

Determination of the best product of Lumi-lumi fresh noodles fortified with various flavours

based on the best results from physical and organoleptic quality parameters presented in **Table 3**. The determination is carried out by the scoring method. The score starts from numbers 1 to 4, with the highest score value of 4, which shows the parameter value better.

Table 3. Selection of the best formulation based on the results of the hedonic test of fresh noodles Lumi-lumi fortification of various flavours

Organoleptic	Treatment			
	F1	F2	F3	F4
Appearance	1	4	2	3
Color	1	4	2	3
Aroma	2	4	1	3
Taste	1	4	2	3
Texture	1	4	2	3
Overall	1	4	3	2
Total	**7**	**24**	**12**	**17**

*Remarks: (F1) yellow pumpkin extract, (F2) carrot extract, (F3) broccoli extract and (F4) beet extract. Numbers 1-4 mean that the higher the number, the higher the value of fresh noodles Lumi-lumi based on predetermined parameters.

Based on the results of the **Table 3** scoring test, the best products were obtained, namely the treatment of fresh noodles Lumi-lumi carrot extract (F2) and fresh noodles Lumi-lumi beet extract (F4), with a total score of 24 and 17, respectively. Next, the identification of nutritional value, Fe mineral, and antioxidant activity was carried out.

Nutrition content

The results of the nutritional content analysis of Lumi-lumi fresh noodles fortified with various natural flavours are presented in **Table 4.** The results of the statistical test of the moisture content of fresh noodles are a significant difference ($P<0.05$). The average water content in the best formulations of F2 and F4 is 45.46% and 54.29% which meet the requirements for maximum moisture content in cooked fresh noodles according to SNI 2987 of 2015, which is a maximum of 65%.

The results of statistical tests showed a significant difference in ash content ($P<0.05$), the average ash content in the best formulations of F2 and F4 was 0.68% and 0.46%. The ash content test is the total ash content of Lumi-lumi fresh noodle products.

Table 4. Analysis of the nutritional content of fresh noodles in the best formulations

Parameter	F2	F4	*P value*
Water content (%db)	45.46±1.07[a]	54.29±0.39[b]	0.003
Ash content (%db)	0.68±0.02[b]	0.46±0.00[a]	0.001
Fat content (%db)	5.60±0.47[a]	8.43±0.21[b]	0.006
Protein content (%db)	11.81±0.75[a]	14.77±0.03[b]	0.003
Crude fiber content (%db)	8.65±0.77[a]	16.04±0.46[b]	0.001
Carbohydrate content (%db)	27.79±1.73[b]	6.02±0.67[a]	0.000

Information:
The data presentation in the table is the average of 3x repetitions ± standard deviations
Different letter notations in the same column and row show a noticeable difference ($P<0.05$).

Furthermore, the results of statistical tests showed a significant difference in fat content ($P<0.05$), the average fat content in the best formulations of F2 and F4 was 5.60% and 8.43%. According to SNI 01-2987-1992, the maximum fat content requirement for fresh noodles is around 7%. Based on this, the fat content in Lumi-lumi beet extract fresh noodles (F4) exceeds the

requirements of the existing fat content. This is in line with previous researchers with the results of research on high-fat content in control formulation fresh noodles (F0), which is 9.55% (20). The high-fat content in Lumi-lumi fresh noodles occurs because of the fat content in eggs and fish in the noodle dough-making process and the cooking oil in fresh noodles after boiling so that the noodles do not clump or stick when served.

The results of statistical tests showed a significant difference in protein levels (P<0.05), the average protein levels in the best formulations of F2 and F4 were 11.81% and 14.77%. According to SNI 2987 of 2015, the minimum protein content contained in cooked noodles is 6.0%, so the results of the protein content test in Lumi-lumi fresh noodles meet the requirements for protein levels in fresh noodles. The protein content in fresh noodles is influenced by the ingredients used, especially high-protein flour (21). In addition, Lumi-lumi fresh noodles also use animal protein in the form of chicken eggs and Lumi-lumi fish meat, which are rich in macro and micronutrients (minerals). Using high-protein ingredients (fish meat) can improve the nutritional quality of fresh noodles in terms of their protein content (22).

Protein plays a vital role in the human body, namely in the growth and maintenance of cells and tissues, as the main source of energy after carbohydrates and fats, and as a building agent and regulator. In addition, protein also plays an essential role in regulating enzymes in the body's metabolic processes and body hormones from the dangers of toxic substances (23). In children, protein plays a role in physical activity; the more active, the higher the need for protein. Protein intake is the most impactful factor on children's activities in elementary school; less protein intake in high-risk children is 2,623 times as low physical activity compared to adequate protein intake (24). Protein also increases hemoglobin levels; the higher the protein intake, the higher the hemoglobin levels, thus preventing anemia in adolescent girls (25). The study's results by previous researchers stated a significant relationship between protein intake and the incidence of KEK in brides-to-be; this is illustrated by the size of a person's LiLA (26). Protein intake is also closely related to stunting in Baduta; infants with a history of nutrient intake (protein) that is less than needed have a 20 times greater risk of stunting (27). The fiber and carbohydrate content analysis showed a significant difference (P<0.05) between the treatment of F2 and F4 formulations, respectively, 8.65% and 16.04% of crude fiber values. Then, by 27.79% and 6.02% carbohydrate value

.

Fe Mineral

Analysis of iron (Fe) mineral content was carried out on formulations F2 (Lumi-lumi fresh noodles carrot extract) and F4 (Lumi-lumi fresh noodles beetroot extract) presented in the graph below
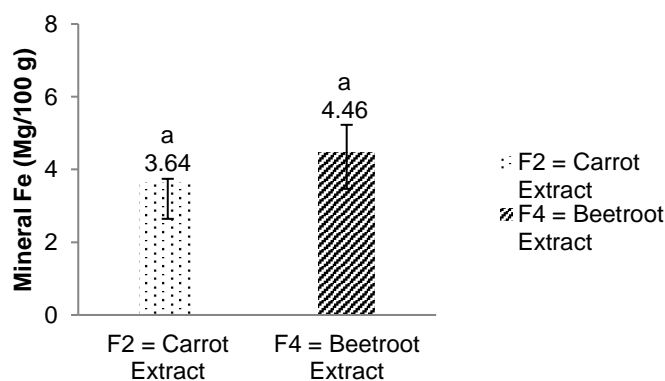

Figure 2. Graph the average iron (Fe) mineral content in the best-formulated Lumi-lumi fresh noodles.

The results of the Fe mineral analysis between F2 and F4 treatments showed no significant difference (P>0.05), as presented in Figure 2. The average iron (Fe) levels of F2 and F4 were 3.64% and 4.46%.

Iron in the body has essential functions for the nervous system, including myelination, neurotransmitters, dendrithogenesis, and nerve metabolism. Iron deficiency in infants affects growth, cognitive function, and behavior. In adolescents, iron becomes a source of energy for muscles that impact physical endurance and ability to work. Iron deficiency during pregnancy can increase the risk of perinatal and infant mortality (28).

Antioxidant activity

Antioxidant activity content was analyzed on formulations F2 (Lumi-lumi fresh noodles carrot extract) and F4 (Lumi-lumi fresh noodles beetroot extract), presented in the graph below.
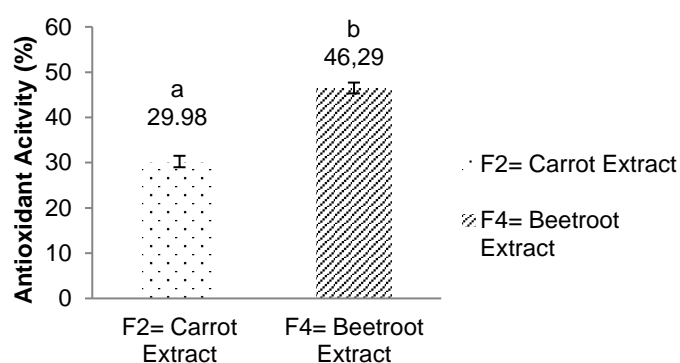

Figure 3. Graph the average antioxidant activity content in the best-formulated Lumi-lumi fresh noodles.

In the results of antioxidant activity (Figure 3), there was a significant difference (P<0.05) between treatments with F2 and F4 respectively, namely 29.98% and 42.90%. High levels of antioxidant activity in F4 (beet extract) are thought to contain many bioactive components that act as antioxidants. Beets contain flavonoids 360-2760 mg/kg, betacyanin 840-900 mg/kg, betanin 300-600 mg/kg, ascorbic acid 50-868 mg/kg, and carotenoids 0.44 mg/kg (29). Such compounds act as antioxidants.

Antioxidant compounds are reported to be effective in inhibiting the development of colon cancer cells (30) and hypertension in the elderly (31), and the flavonoid content in beets is known to prevent cognitive disorders and neurodegenerative diseases (32).

CONCLUSIONS AND RECOMMENDATIONS

The results of the physical and sensory quality tests of selected products are on fresh noodles fortified with carrot and beet extract. Then the results of identifying protein content, crude fiber, Fe mineral, and the highest antioxidant activity were obtained in the fortification treatment of beet extract, covering 14.47%, 16.04%, 4.46 mg / 100 g, and 42.90%.

Thus, Lumi-lumi fresh beetroot noodles are recommended as functional local food products because they contain Fe mineral and high antioxidant activity.

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Comparison of temulawak (*Curcuma xanthorrhiza Roxb.*) and turmeric (*Curcuma longa*) powder drinks against adolescent diet and body weight

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ABSTRAK

Latar Belakang: *Salah satu permasalahan gizi yang sering terjadi pada remaja adalah kurang energi kronis. Temulawak dan kunyit secara turun-temurun telah digunakan untuk terapi menaikkan berat badan dengan cara meningkatkan nafsu makan. Melalui kandungan karminativum dari minyak atsiri yang ada dalam rimpang temulawak dan kunyit.*

Tujuan: *Penelitian ini bertujuan untuk menganalisis pengaruh konsumsi minuman serbuk temulawak dan kunyit terhadap pola makan dan berat badan pada usia remaja.*

Metode: *Penelitian ini menggunakan desain quasi eksperimental. Sampel penelitian adalah santriwati Pondok Pesantren Miftahul Jannah Malang, sebanyak 45 responden yang terbagi menjadi 3 kelompok yaitu P0 (kontrol/tidak diberikan apapun), P1 (20 gr bubuk temulawak), dan P2 (5 gr bubuk kunyit). Teknik sampling yang digunakan adalah purposive sampling. Bubuk temulawak dan kunyit dilarutkan dalam 125cc air dan diberikan selama 14 hari. Pola makan dan berat badan responden setelah perlakuan diukur menggunakan metode Semi Quantitative - Food Frequency Questionnaire dan pengukuran langsung dengan timbangan digital. Data hasil pengukuran dilanjutkan dengan analisis statistika menggunakan uji wilcoxon signed ranks test Untuk melihat perbedaan pola makan sebelum dan sesudah perlakuan. Serta uji paired t test untuk melihat perbedaan berat badan antara sebelum dan sesudah perlakuan.*

Hasil: *Dari hasil Uji Wilcoxon didapatkan bahwa pada kelompok kontrol dan kunyit tidak ada perbedaan nyata skor pola makan sebelum dan sesudah diberikan perlakuan (p>0,05), sedangkan pada kelompok temulawak terdapat perbedaan nyata (p<0,05). Hasil Uji t test paired pada kelompok temulawak menunjukkan perbedaan berat badan yang bermakna antara sebelum dan sesudah perlakuan sedangkan pada kelompok kunyit dan kontrol tidak ada perbedaan (p>0,05).*

Kesimpulan: *Pemberian minuman serbuk temulawak efektif dalam memperbaiki pola makan dan meningkatkan berat badan pada usia remaja..*

KATA KUNCI*: berat badan; kunyit; nafsu makan; temulawak*

ABSTRACT

Background: *One of the nutritional problems that often occurs in teenagers is a chronic lack of energy. Temulawak and turmeric have been used for generations as a therapy to gain weight by increasing appetite, through the karminativum content of essential oils in the rhizomes.*

Objectives: *This study aims to analyze the effect of temulawak and turmeric powder drink consumption on adolescents' dietary patterns and weight.*

Methods: *This research design uses quasi-experimental. The population and sample of this study were female students of Miftahul Jannah Islamic Boarding School Malang, as many as 45 respondents were divided into 3 groups P0 (control), P1 (20 grams of ginger), and P2 (5 grams of turmeric). The sampling technique used is non-purposive sampling. The research instrument used the semi Quantitative – Food Frequency Questionnaire method and measured body weight using digital scales. The measurement data was followed by statistical analysis using the Wilcoxon Signed Ranks Test to see differences in eating patterns before and after treatment. As well as the Paired T-Test to see the difference in body weight between before and after treatment.*

Results: *From the results of the Wilcoxon test, it was found that in the control and turmeric groups, there was no significant difference in dietary pattern score (frequency and variation) before and after being given treatment (p>0.05), while in the temulawak group, there was a difference (p<0.05). Results of the paired t-test the temulawak group had a significant difference in body weight between before and after treatment, while the turmeric and control groups had no difference (p> 0.05).*

Conclusions: *Giving temulawak powder drinks is effective in increasing dietary patterns and body weight in adolescents.*

KEYWORD*: appetite; temulawak; turmeric; weight*

INTRODUCTION

The adolescent period is a transition phase between childhood and adulthood, starting from the age of 10-13 and concluding at 18-22 (1). Chronic energy deficiency (malnutrition) during this phase is caused by insufficient food intake, due to a lack of appetite or self-consciousness about body shape, leading to dieting. This is reflected in the 2018 Riskesdas (Riset Kesehatan Dasar) data, indicating that the prevalence of adolescent girls suffering from Chronic Energy Deficiency (CED) reached 13.88% in East Java and 31.8% nationally. In the age group of 15-19, the prevalence is 37.73%, while early (12-15) and late (15-21) adolescent subgroups show rates of 22.53% (2).

Traditional medicine offers a potential avenue for addressing underweight conditions. This treatment consists of remedies made from natural ingredients or combinations of substances derived from plants, animals, or minerals in an unrefined state (3). In Indonesia, traditional medicine is classified into 3 categories, namely "jamu," Standardized Herbal Medicine (OHT), and phytopharmaceuticals. Furthermore, certain herbs such as turmeric and temulawak (*Curcuma xanthorrhiza Roxb.*) have been traditionally used to promote body weight gain by enhancing appetite. Turmeric, in both preclinical and clinical studies, has been shown to improve appetite due to the carminative properties of essential oil in the rhizome (4). This plant contains curcumin, proven to address various digestive issues, including enhancing food absorption in the intestines, managing stomach ulcers, acting as a hepatoprotector, increasing appetite, and antioxidant activity (5-8).

Turmeric is a substitute for synthetic antibiotics, as it contains active compounds or bioactive substances, particularly 3–5% curcumin and 2.5–6% (9). Curcumin in turmeric serves as

both an antibacterial and antioxidant agent. It has properties capable of increasing appetite and facilitating bile secretion, thereby enhancing digestive system activity (10).

Temulawak (*Curcuma xanthorrhiza Roxb.*) has been known since ancient times and exists in shaded places in the majority of rural areas, specifically those in the middle and highlands. This plant is native to Indonesia and belongs to the *Zingiberaceae* family (11). Temulawak is utilized to increase appetite due to its ability to enhance stomach emptying, leading to a feeling of hunger and an increase in appetite (12). Temulawak is one of the traditional medicines capable of enhancing and improving appetite in children, as it contains essential oil with carminative properties. The carminative action stimulates the digestive system, thereby eliciting appetite (4). The effect of the essential oil of temulawak is possible due to its choleretic properties, enhancing bile secretion. Bile, containing bile acids and conjugates, plays a crucial in the absorption of dietary fats and the catabolism of cholesterol (13). This study aims to develop a powdered drink from temulawak and turmeric for improving the dietary patterns and weight of adolescents.

MATERIALS AND METHODS
Study Design, Place, and Time
This study adopted a quasi-experimental design and was conducted at Miftahul Jannah Islamic Boarding School, Malang, between February to May 2023.

Study Sample
The sample comprised adolescent female students (santriwati) from Miftahul Jannah Islamic Boarding School. Furthermore, the total number of respondents was 45, divided into 3 groups based on certain criteria, namely P0 (control/not given anything), P1 (20 grams of temulawak), and P2 (5 grams of turmeric). The weight of each treatment material is different based on each effective dose in our preliminary study and also the previous study (14). The inclusion criteria were willingness to participate, age 15-24 years, residency at the boarding school, each group staying in a different block of rooms, non-pregnant or breastfeeding, and non-smoker status. Meanwhile, the exclusion criteria were students who were ill, had false

consciousness about body shape, and did not participate until the observation was concluded.

Temulawak and Turmeric Drinks
Adolescents typically have a preference for snacks or refreshing beverages consumed between daily activities. Therefore, temulawak and turmeric drinks were developed as suitable options. These drinks were prepared based on the procedures outlined by the previous study (14). The materials and equipment used were a scale, stove, and measuring glass. The required ingredients are temulawak, turmeric, boiled water, and sugar. Subsequently, the preparation process comprised the addition of one tablespoon of sugar to 20 grams of temulawak and 5 grams of turmeric each, grating and extracting the juice, and mixing with half a glass of water or 125 cc. The resultant mixture, blended with sugar, yielded a distinctively flavored beverage when steeped in hot water (14). The doses of ginger and turmeric used in this study were based on the effective doses of the two ingredients in our preliminary study and also the previous study (14). Each of the drinks was given to respondents once daily for 2 weeks (14 days), either in the morning or evening before eating (14).

Measuring Dietary Patterns and Body Weight
Dietary patterns were evaluated using the Food Frequency Questionnaire (FFQ) method, a tool designed to capture data on the frequency of consuming various food items or finished meals during a specific period, such as days, weeks, months, or years. The questionnaire contains a list of foods and the frequency of consumption over a designated period. The items listed in the questionnaire are those consumed frequently by respondents (15). Each food item consumed was assigned a score based on frequency, namely never (score 0), 2 times/month (score 5), 1-2 times/week (score 10), 3-6 times/week (score 15), 1 time/day (score 25), and >3 times/day (score 50). The diversity of food consumption is directly proportional to the frequency and the score (16). Additionally, body weight was measured using an Omron brand digital scale.

Data Analysis
Bivariate data analysis was conducted to assess the differences in pre-post test data using

Wilcoxon and Paired t-tests. The analysis was performed using the SPSS 22 application with a significance level of 95%. A p-value < 0.05 indicated a relationship between the independent and dependent variables. However, a value ≥ 0.05 implies no significant relationship. All respondents willingly provided voluntary consent to participate in this study by completing the informed consent form. The entire procedure received ethical approval from the Research Ethics Commission of the Health Polytechnic of the Ministry of Health in Malang, with Registration Number: 211/KEPK-POLKESMA/2022..

RESULTS AND DISCUSSIONS
The effect of temulawak and turmeric powder drinks on diet
Control Group

Dietary patterns of female students (santriwati) at Miftahul Jannah Islamic Boarding School were categorized into two groups, namely poor and good. If the dietary pattern score is the same or above the median of the population, it is classified as good. Meanwhile, if the diet score is below the population median, it is classified as poor.

Table 1. Frequency distribution of respondents' dietary patterns in the control group

Dietary Pattern	Before	After	*p-value*
Poor	47%	53%	1.00
Good	53%	47%	
Median	650	730	

According to **Table 1**, 15 respondents (47%) fell into poor dietary category, while 17 (53%) were classified under good dietary. Statistical analysis using the Wilcoxon test through SPSS yielded a significant degree of p = 1.00. Therefore, it can be concluded that there is no significant difference between dietary patterns before and after treatment.

In the control group, there was no change in dietary patterns before and after because no intervention was provided. This result was supported by the Wilcoxon statistical test, where no significant difference was observed in the average dietary patterns before and after the treatment.

Based on **Table 2**, 15 respondents had poor temulawak dietary patterns (47%), while 17 fell into the good category (53%). Statistical analysis using the Wilcoxon test through SPSS showed a significant p-value of 0.025. Therefore, it was inferred that there were differences in dietary patterns before and after treatment.

Table 2. Frequency distribution of respondents' dietary patterns before and after being given temulawak

Dietary Pattern	Before	After	*p-value*
Poor	47%	13%	0.025
Good	53%	87%	
Median	750	900	

Following the administration of temulawak, changes in dietary patterns were observed before and after treatment. The active ingredients in the rhizome of the plant include xanthorrhizol, curcuminoids containing yellow substances (curcumin), demethoxycurcumin, essential oil, protein, fats, cellulose, and minerals. Among these ingredients, curcumin and xanthorrhizol have medicinal properties and are widely recognized and used.

According to the data, the observed improvement in dietary patterns of 15 respondents can be attributed to the essential oil of temulawak, particularly xanthorrhizol, which acts as a potent appetite stimulant. A previous study by Utami et al, 2019, found that a dose of ginger 10 g/day did not affect weight loss and food intake (17), while a study by Linawati et al 2021, a dose of ginger 20 g/day affected food intake and body weight (14).

The essential oil can enhance appetite due to its choleretic properties, enhancing stomach emptying, digestion, and fat absorption in the intestines. It also stimulates the secretion of various hormones that regulate increased appetite. In addition to administering temulawak, providing supplements for children and introducing varied and preferred dishes are contributing factors. This is in line with the study of Marni et al. (2015), that temulawak can enhance dietary patterns in adolescents (18).

Turmeric Group

Based on **Table 3**, 15 respondents had poor turmeric dietary patterns (47%), while 17 had good dietary patterns (53%). Statistical analysis using the Wilcoxon test through SPSS showed a non-significant p-value of 0.564. Therefore, it was concluded that there was no difference in dietary patterns before and after treatment. The results showed that turmeric had

no difference in dietary patterns. According to a theoretical study conducted by Afrina et al. (2022), curcumin shows suboptimal bioavailability when administered orally due to rapid degradation and poor absorption in the digestive tract. This leads to low plasma concentration and distribution in tissues (19). This is because the smaller dose of turmeric so that causing less absorption which does not happen with temulawak with higher doses. Curcumin in the body is transformed into dihydrocurcumin (DHC), tetrahydrocurcumin (THC), hexahydrocurcumin (HHC), and octahydrocurcumin through reductase activity, followed by further brokendown into glucuronide derivatives. The different formulations need to be tested to maximize the effects. While oral administration is the conventional route, the impact of subcutaneous administration of curcumin also needs to be investigated.

Table 3. Frequency distribution of respondents' dietary patterns before and after being given turmeric.

Dietary Pattern	Before	After	*p-value*
Poor	47%	53%	0.564
Good	53%	47%	
Median	710	705	

Effect of temulawak and turmeric powder drinks on body weight

Table 4 shows the before and after body weight of female students at Miftahul Jannah Islamic Boarding School. In the control group, no change in body weight was observed before and after treatment, as no intervention was provided. This result is supported by the statistical analysis of the Paired t-test, indicating no significant difference in the average body

weight. Following the administration of temulawak, changes in body weight were observed before and after treatment. Furthermore, weight gain is influenced by food consumption, which may be enhanced through the use of traditional remedies such as temulawak honey. Temulawak contains chemical compounds such as curcuminoids and essential oils (xanthorrhizol, germacrone, and others) capable of increasing appetite.

Table 4. Effect of body weight on the control group, temulawak, and turmeric

Intervention	Body weight		
	Before	**After**	*p-value*
Control Group	48	47.67	0.143
Temulawak Group	45.93	46.6	0.00
Turmeric Group	48.27	48.87	0.24

These compounds play a role in enhancing the digestive organs, stimulating the gallbladder,

releasing bile, and stimulating the release of pancreatic juice containing amylase, lipase, and

protease enzymes, thereby improving the digestion of carbohydrates, fats, and proteins (20). The effects lead to an increase in food consumption due to the increased absorption of nutrients. After the absorption, the requirements for proteins, carbohydrates, and other substances for the development of body cells and the formation of enzymes and hormones are met (21). Following the administration of turmeric, there was no change in body weight before and after the treatment. This is due to a lack of change in dietary patterns which is a factor influencing body weight. Dietary patterns refer to how an individual or a group of people select and consume food in response to physiological, psychological, cultural, and social influences, and these include dietary habits, food habits, or dietary patterns (22).

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, no difference in dietary patterns and body weight was observed in the control and turmeric groups before and after treatment. However, a better dietary pattern and body weight following the administration of temulawak. It is recommended to investigate the effects of turmeric on dietary patterns and body weight using higher doses.

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Effect of antioxidant dietary behaviour in smokers with chronic obstructive pulmonary disease risk during COVID-19 pandemic

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ABSTRAK

Latar Belakang: *Perokok berisiko mengalami Penyakit Paru Obstruktif Kronis(PPOK)yang mempunyai risiko penurunan kualitas hidup akibat penurunan fungsi paru. Penurunan fungsi paru akibat peningkatan radikal bebas. Asupan makanan yang mengandung antioksidan dapat membantu mengurangi radikal bebas.*

Tujuan: *Penelitian ini bertujuan untuk mengetahui pengaruh asupan antioksidan (vitamin A, C, dan E) terhadap perkembangan risiko PPOK pada perokok aktif.*

Metode: *Penelitian ini dilakukan pada bulan Mei-Juli 2023 di Surabaya. Penelitian ini menggunakan desain cross sectional, dengan metode purposive sampling dan snowball sampling. Subjek penelitian adalah perokok aktif dewasa. Asupan antioksidan terdiri dari asupan yang dikonsumsi subyek sehari-hari yang mengandung vitamin A, vitamin C, dan vitamin E dengan menggunakan metode Food Frekuensi Questionnaire (FFQ) untuk menggambarkan asupan gizi dalam periode tertentu. Penilaian risiko PPOK diukur menggunakan tes fungsi paru dengan spirometri, dengan penilaian rasio nilai volume ekspirasi paksa dalam satu detik (FEV1)/kapasitas vital paksa (FVC) di bawah 0,70 didefinisikan sebagai keterbatasan aliran udara. Data diuji dengan uji Spearman untuk melihat hubungan antara asupan antioksidan dari makanan dengan fungsi paru.*

Hasil: *Penelitian ini melibatkan 49 perokok aktif penderita PPOK. Sebagian besar subyek mengalami kekurangan asupan vitamin A (77,55%), vitamin C (87,76%), dan seluruh subyek mengalami kekurangan vitamin E. Makanan mengandung vitamin A yang paling banyak dikonsumsi adalah minyak sawit. Makanan mengandung vitamin C yang paling banyak dikonsumsi adalah pepaya, dan makanan mengandung vitamin E yang paling banyak dikonsumsi adalah daging ayam. Tidak terdapat hubungan antara vitamin A dengan perkembangan risiko PPOK (Sig.=0.187;r=-0.192), namun terdapat hubungan bermakna (negatif lemah) antara vitamin C dengan risiko perkembangan PPOK (Sig.=0.031;r=-0.309). Semua subjek mengalami defisiensi vitamin E.*

Kesimpulan: *Semakin rendah asupan vitamin C maka semakin besar risiko terjadinya PPOK yang ditandai dengan menurunnya fungsi paru.*

KATA KUNCI*: asupan makanan antioksidan; rasioFEV1/FVC; kuesioner frekuensi makanan; PPOK; perokok*

ABSTRACT

Background: *Smokers are at risk of Chronic obstructive pulmonary disease (COPD)which has a risk of decreasing in quality of life because of lung function decline and smoking habits. Decreased lung function due to an increase in free radicals. Intake of foods that contain antioxidants can help reduce free radicals.*

Objectives: *The research aimed to determine the effect of antioxidant intake (vitamins A, C, and E) on the development of COPD risk in active smokers.*

Methods: *This study was conducted in May-July 2023 in Surabaya. This study used a cross-sectional design, with purposive sampling and snowball sampling methods. The subjects were adult active smokers. Antioxidant intake consisted of the intake consumed by subjects daily containing vitamins A, vitamin C, and vitamin E using the Food Frequency Questionnaire (FFQ) method to describe nutritional intake in a certain period. COPD risk assessment was measured using a pulmonary function test with spirometry, with an assessment of the ratio of forced expiratory volume in one second (FEV1) / forced vital capacity (FVC) below 0.70 defined as airflow limitation. The data were tested using the Spearman test to see the relationship between antioxidant intake from food and lung function.*

Results: *This study involved 49 active smokers with COPD. Most subjects experienced deficiencies in vitamin A (77.55%), and vitamin C (87.76%), and all subjects experienced vitamin E deficiencies. The most consumed food containing vitamin A was palm oil, the most consumed food containing vitamin C was papaya, and the most consumed food containing vitamin E was chicken. There was no relationship between vitamin A and the development of COPD risk (Sig.=0.187; r=-0.192), but there was a significant relationship (weak negative) between vitamin C and the risk of developing COPD (Sig.=0.031; r=-0.309). All subjects had a deficiency of vitamin E.*

Conclusions: *The lower the intake of vitamin C, the greater the risk of COPD which is characterized by decreased lung function.*

KEYWORD: *antioxidant dietary intake; FEV1/FVC ratio; food frequency questionnaire; COPD risk; smoker*

INTRODUCTION

Respiratory problems can also come from smoking behavior because cigarette smoke has a lot of free radicals and triggers a decrease in antioxidant capacity even in plasma. Free radicals that continue to increase will cause oxidative stress and can cause systemic inflammation (1,2). Smoking behavior is very difficult to separate from society (3). A person who smokes means that the smoker will inhale the 4000 chemicals contained in cigarettes, especially nicotine. Cigarette nicotine is transported into the lungs by inhaled tar particles where a broad alveolar surface region facilitates accelerated incorporation into the circulation of the pulmonary system (4). Cigarette smoke contains various dangerous chemicals that have the potential to harm health. Cigarette smoke is also a major risk factor for the occurrence of several diseases such as chronic obstructive pulmonary disease (COPD) because it contains around 1015-1017 oxidants or free radicals (5). Chemicals that are produced from cigarette smoke when they enter the airways contain many types of free radicals. The human body has free radicals called endogenous free radicals which are the product of normal cellular metabolism but are caused by smoking, air pollution, and vehicle fumes. Free radicals at high concentrations will produce harmful modifications to cell components such as lipids, proteins, and DNA (deoxyribonucleic acid). If there is an increase in the number of free radicals continuously in the body it will trigger oxidative stress and stimulate peroxidation in cells and ultimately can cause death in body cells (6). Oxidative stress causes an

increase in the rate of cell damage due to oxygen induction, oxidative stress can have an impact on the development of chronic and degenerative diseases such as cancer, ischemia, etc (7).

The body can neutralize free radicals if the number of free radicals is not excessive with endogenous antioxidant defense mechanisms (6), endogenous antioxidants, or enzymatic antioxidants, namely Superoxide Dismutase (SOD), catalase, and glutathione peroxidase. These antioxidants include conjugate proteins so their activity is highly dependent on metal ions (8). Antioxidants work by giving electrons to free radicals so they can stop the process of cell destruction. Antioxidants will neutralize free radicals so that they cannot take electrons from DNA cells. Therefore, the body needs antioxidants that can help protect itself from the dangers caused by free radicals and radical compounds (6,8,9). Antioxidants are needed to prevent oxidative stress. Antioxidants are very easily oxidized, so free radicals will oxidize antioxidants and protect other molecules in cells from damage caused by oxidation by free radicals or reactive oxygen (10,11).

When the body cannot neutralize free radicals because of an imbalance in the number of endogenous antioxidants and free radicals in the body endogenous antioxidants are insufficient. The body needs antioxidants from the outside (6). By intake of exogenous antioxidants such as supplements of vitamin E, vitamin C, vitamin A, and others. Other body defense systems that can be used to fight free radicals can be affected by nutrients from food, by consuming food ingredients containing antioxidants and non-antioxidants so that endogenous antioxidants in the body can be maintained high (12,13). The Food Frequency Questionnaire (FFQ) is a method or way to be able to describe certain nutritional intake in a certain period. Several studies in Indonesia have examined the description of nutritional intake from their research using the FFQ such as Pratiwi et al. (9), Suryadinata and Lorensia (14). The aim of the research waseffect of antioxidant intake (vitamins A, C, and E) in food using the FFQ against respiratory disorders, on chronic obstructive pulmonary disease (COPD) risk development in smokers. The FFQ method was used to provide information about the food

consumed and for the assessment of nutrients that have been consumed within a certain period (15).

MATERIALS AND METHODS
Research Design

This study was an observational study using a retrospective study design to measure the intake of antioxidants (vitamins A, C, and E) using the FFQ questionnaire. Data collection was carried out from May to July 2023 in South Surabaya area by filling out the questionnaires. The ethics committee of the University of Surabaya approved the study protocols (No. 127/KE/V/2023). The independent variable of this study was active smokers, in Rungkut District, Surabaya. The dependent variable of this research was levels of antioxidants (vitamins A, C, and E) from food intake and COPD risk development with lung function measurement. Smoking status was several questions that were asked to the subject about smoking and were categorized as active smokers, no longer smoked, and never smoked. Active smokers are individuals who have smoked ≥100 cigarettes in their life until now they still smoke >1 cigarette per day (16).

The Brinkman index is calculated by multiplying the number of cigarettes smoked per day by the number of years of smoking. If the number of years spent smoking was less than 1, the Brinkman index was calculated using 0.5 as the number of years of smoking. The value of the Brinkman Index (IB) is mild (0-199), moderate (200-599), and severe (>600) (17,18). Assessment COPD risk progression is measured using pulmonary function tests with a spirometer Cortec Sp10W. A forced expiratory volume in one second (FEV1)/forced vital capacity (FVC) value below 0.70 was defined as airflow limitation(19).

Antioxidant intake was the intake consumed by subjects daily containing vitamin A, vitamin C, and vitamin E using the FFQ which was a method for seeing or assessing the frequency of eating certain foods over a certain period. Vitamin A intake was the total amount of vitamin A content from food sources of vitamin A which was consumed on average per day by subjects, expressed in units of μg, the adequacy rate of vitamin A for ages 19-64 years was 600 μg/day (20). Antioxidant intake data were obtained by interview using the FFQ to examine antioxidant

intake. This method is a semi-qualitative method providing information about the food ingredients consumed only in the form of names and quantities that are not explicitly stated. This method also only requires information from a research subject about which foods are frequently or not frequently sampled without needing to be further broken down into the size and portion consumed by the subject. Another advantage of using this FFQ is that form recording can be done systematically, does not require a food scale instrument, can be done at low literacy, and of course can be done anywhere, and also does not force subjects to remember actual daily consumption (21,22). However, the FFQ method does not represent the actual daily consumption but only becomes the dietary pattern of each individual. Because at the time of conducting interviews using the FFQ, several obstacles depended on the honesty and memory of the research subject which was overcome by providing an overview of what foods had been eaten and how often the consumption research subject was helped to mention so that it could help the research subject to remember again (22,23,24).

The research subject was selected at the age of 18-45 years because 18 years of age was the highest prevalence in Indonesia (25). The maximum age taken was 45 years because it was the final age limit, if you entered the age of the elderly, they were susceptible to malnutrition (26). Age is related to the aging process where the older a person is, the greater the decrease in lung function capacity and also be influenced by environmental factors (27,28). The results of cross-tabulation also between age and the adequacy of antioxidant nutrition, namely vitamin A, vitamin C, and vitamin E, showed that there was a relationship between increasing age and will decrease in the intake of vitamins A, C, and E due to changes in diet or susceptibility to malnutrition (29).

Setting and Samples

The population used for this research were smokers. The subject used in this study was part of the population that met the following criteria: The inclusion criteria were (1) males aged >18 years; (2) active smokers, this type of cigarette used filter; (3) Willing to participate in research by signing informed consent; (4) Work on regular weekdays (min ±7 hours/day); (5) Didn't have eating disorders and gastrointestinal diseases such as gastroesophageal reflux disease (GERD), gastritis and dyspepsia; and (6) Didn't vegetarian or on a certain diet. The sampling technique used purposive sampling and snowball sampling. The sample size calculation uses the Lameshow formula, $n=[Z\alpha2.p.q]/[d2]$, $Z\alpha2$ is the critical value of the Normal distribution at $\alpha/2$ (for a confidence level of 95%, α is 0.05, and the critical value is 1.96); p is the estimated population proportion (0.5); q is 1-p; and d2 is the error tolerance (10%). So the minimum sample size is 49 research subjects.

The questionnaire was distributed in the South Surabaya area (Rungkut sub-district, Surabaya), then the smokers were facilitated to gather in a place for clinical examination by clinicians and filling in the database, then pulmonary function testing. The total number of smokers who were present became the total population. The total population in the Rungkut area was 65 people and those who did not meet the requirements: were 5 people who were not willing to be interviewed, 5 people who could not be contacted again, and 6 people who did not smoke. So the number of research subjects was 49 people.

Measurement and Data Collection

FFQ Data Preparation. Preparation for making a questionnaire by listing a list of foods containing vitamins A, C, and E based on foods that were often consumed. The food data was carried out by a preliminary study of 20 smokers in other regions. Food ingredients that were consumed less than 10% because they had never been consumed or were not usually consumed are excluded from the food list. Collecting data on the research subject was carried out using telephone interviews using the FFQ. The data collected in the form of household sizes would be processed to obtain data in the form of calorie intake using the Nutrisurvey program. Nutrisurvey is a powerful software for analyzing food nutrients from a menu or consumption survey. For example, to find the antioxidant intake obtained when consuming chicken meat, namely by opening the Nutrisurvey

software, enter the word "chicken meat" then enter the amount in grams that were asked during the interview, then the data on antioxidant intake in the form of vitamins A, C, and E will appear.

Data Analysis

The final nutritional survey result will show an analysis of the total food consumed at a certain time. The desired data such as vitamin A, vitamin C, and vitamin E showed the results in the form of numbers in units of each, namely vitamin A in units of µg, vitamin C, and vitamin E in units of mg. Then it was matched with the value of the Nutritional Adequacy Rate recommended for the Indonesian (20) (cut off).

The data collected in the form of household sizes would be processed to obtain data in the form of calorie intake using the program Nutrisurvey. Nutrisurvey is a powerful software for analyzing food nutrients from a menu or consumption survey. After the data on antioxidant intake were collected, the data were inputted into the SPSS version 24 program, then statistical analysis was carried out. The ordinal scale data was tested using the chi-square test and the ratio scale data with the Kolmogorov-Smirnov normality test which was then followed by an independent t-test to see differences in antioxidant intake from food in COPD risk development, which is divided into two, namely risk of clinically significant COPD (FEV1/FVC ratio <0.70) and no risk of clinically significant COPD (FEV1/FVC ratio ≥0.70). The chi-square test was said to be significantly different if the P value was <0.05. The data were also tested with the Spearman test to see the relationship between antioxidant intake from food and lung function.

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RESULTS AND DISCUSSIONS

Subjects in this study were grouped according to age and smoking severity (**Table 1**). The most research subjects found in early adulthood and late adulthood were 19 of 49 (38.76%) and late adults were 22 of 49 (44.90%). Most of the subjects were moderate smokers (26 of 49) and the most smoking duration was <20 years (**Table 1**).

Profile of Vitamin A Intake

The initial form of vitamin A can be found in chicken meat, chicken eggs, palm oil, spinach, apples, and papaya. Vitamin C intake was the total amount of vitamin C content from food sources of vitamin C consumed by subjects on average per day, expressed in mg units. The vitamin adequacy rate for ages 19-64 years was 75 mg/day (20). In all subjects, the average consumption of food intake that contained the highest vitamin A content in the research subject was palm oil at 109.00 µg/day followed by chicken eggs at 127.10 µg/day.

Table 1. Frequency distribution of characteristics

Characteristics	Frequency (n=49)	Percentage (%)
Age (years)		
Late adolescence (17-25)	8	16.33
Early adulthood (26-36)	19	38.76
Late adulthood (36-45)	22	44.90
Smoking severity (cigarettes per day) by Index Brinkman		
Light Smoker (8-10)	12	24.49
Moderate Smoker (11-12)	26	53.06
Heavy smokers (21-30)	11	22.45
Duration of smoking (years)		
<20	36	73.47
20-29	12	24.49
≥30	1	2.04
Lung function value (FEV1/FVC ratio) (%)		
Risk of clinically significant COPD (<0.70)	31	63.27
No risk of clinically significant COPD (≥0.70)	18	36.73

The results of the study of the frequency of foods most frequently consumed by the research subject containing vitamin A were chicken meat, chicken eggs, meatballs, tempeh, and bananas. In the sufficient level group, the average consumption of food intake that contained the highest vitamin A content in the research subject was palm oil at 181.12 μg/day followed by chicken eggs at 171.74 μg/day. The results of the study of the frequency of foods most frequently consumed by the research subject containing vitamin A were chicken meat, chicken eggs, meatballs, spinach, and bananas. In the deficit level group, the average consumption of food intake that contained the highest vitamin A content in the research subject was palm oil at 73.68 μg/day followed by chicken eggs at 124.61 μg/day. The results of the study of the frequency of foods that were most frequently consumed by the research subject containing sufficient vitamin A were chicken meat, chicken eggs, meatballs, tempeh, spinach, papaya, and banana (**Table 2**).

Table 2. Profile of Consumption Patterns of Vitamin A

Type of Food	Number of Subjects			Average (gram)	Standard Deviation	CI	Min (μg)	Max (μg)
	Total subjects (n=49)	Sufficient Category (n=11)	Deficit Category (n-=38)					
Corn	30	6	24	9.00	10.92	3.91	4.10	50.00
Chicken meat	48	11	34	48.21	46.77	13.23	6.67	240.00
Chicken eggs	46	9	37	66.92	66.07	19.09	4.28	240.00
Quail eggs	9	9	0	0.51	1.42	0.93	0.83	7.14
Mackarel tuna	12	11	0	4.91	17.97	10.17	3.33	120.00
Salted fish	17	6	11	6.58	18.58	8.83	2.50	120.00
Mackerel	5	5	0	1.23	5.82	5.11	1.25	40.00
Milkfish	18	5	13	3.70	7.64	3.53	3.33	40.00
Tilapia fish	18	8	10	7.80	18.81	8.69	3.33	120.00
Palm oil	21	9	12	2.18	2.55	1.09	5.00	6.67
Catfish	28	11	17	11.53	24.65	9.13	3.33	120.00
Meatballs	42	8	34	55.27	61.81	18.69	8.00	240.00
Tempe	45	11	34	75.45	62.36	18.22	14.28	150.00
Green beans	20	7	13	16.47	45.55	19.96	1.67	300.00
Long beans	28	7	21	8.20	14.55	5.39	3.33	60.00
Spinach	39	8	31	13.47	14.45	4.54	3.33	40.00
Cassava leaves	25	9	16	9.35	19.51	7.65	3.33	120.00
Gambas	2	2	0	1.07	5.97	8.27	11.43	40.00
Bean	19	7	12	3.03	5.11	2.30	3.33	20.00
Basil leave	25	7	18	3.28	6.65	2.56	0.83	42.85
Apple	19	6	13	6.30	17.99	8.09	3.33	120.00
Papaya	39	8	31	10.14	14.89	4.68	1.66	60.00
Banana	41	11	30	19.98	25.14	7.70	3.33	120.00
Mango	29	9	20	4.88	6.10	2.22	1.57	20.00
Orange	36	10	26	8.99	10.93	3.57	3.33	40.00
Guava	18	7	11	2.43	4.51	2.08	1.67	14.28

The types of food containing vitamin A that were most consumed by research subjects were chicken meat (average=48.21g±46.77) and chicken eggs (average=66.92g±66.07), which were widely consumed by both subjects in the sufficient category (100% and 81, 82%) and deficit (89.47% and 97.37%) (Table 2). Previous research by Fekete et al. (29), conducted a literature review between 2018 and 2023. No human RCTs or clinical trials on the association between COPD and vitamin A supplementation were found in the PubMed database in the past five years. For vitamin A, although serum antioxidant vitamin levels were significantly higher among those who took vitamin A supplements than in those who did not, there was no clear statistical evidence that vitamin A supplementation was necessary for the beneficial

effects of vitamin A on the lungs. Meanwhile, another study by Lorensia et al. (31), which looked at the relationship between vitamin A as antioxidant intake on lung function in construction workers, had a value of p=0.05, which means associated with lung function but is a very weak correlation (correlation coefficient value - 0.036).

Profile of Vitamin C Intake

Sources of vitamin C come from food, especially vegetables and fruits, that taste sour, such as oranges, pineapples, or papaya. In vegetables, the content of vitamin C is mostly found in spinach, cassava leaves, and basil leaves. In all subjects, the average consumption of food intake that contained the highest vitamin C content in the research subject was papaya at 6.30 mg/day followed by orange at 4.80 mg/day. The results of the study of the frequency of foods most frequently consumed by the research subject containing vitamin C were corn, spinach, papaya, orange, and bananas. In the sufficient level group, the average consumption of food intake that contained the highest vitamin C content in the research subject was papaya at 22.48 mg/day followed by potato at 17.03 mg/day.

The results of the study of the frequency of foods most frequently consumed by the research subject containing vitamin C were potato, cassava leaves, spinach, mango, banana, and orange. In the deficit level group, the average consumption of food intake that contained the highest vitamin C content in the research subject was papaya at 4.17 µg/day followed by orange at 4.32 µg/day. The results of the study of the frequency of foods that were most frequently consumed by the research subject containing sufficient vitamin C were spinach, papaya, banana, and orange (**Table 3**).

Table 3. Profile of consumption patterns of Vitamin C

Type of Food	Number of Subjects			Average (gram)	Standard Deviation	CI	Min (mg)	Max (mg)
	Total subjects (n=49)	Sufficient Category (n-=6)	Deficit Category (n-=43)					
Corn	30	3	27	9.00	10.92	3.91	4.10	50.00
Potato	25	5	20	27.71	61.84	24.24	3.33	300
Salted fish	17	2	15	6.58	0.10	8.83	2.50	120.00
Tilapia fish	18	0	18	7.80	0.10	8.69	3.33	120.00
Catfish	28	0	28	11.53	24.65	9.13	3.33	120.00
Long beans	28	4	24	8.20	14.55	5.39	3.33	60.00
Spinach	39	4	35	13.47	14.45	4.54	3.33	40.00
Cassava leaves	25	5	20	9.35	19.51	7.65	3.33	120.00
Gambas	2	2	0	1.07	5.97	8.27	11.43	40.00
Bean	19	0	19	3.03	5.11	2.30	3.33	0
Basil leave	25	4	21	3.28	6.65	2.56	0.83	42.85
Apple	19	3	16	6.30	17.99	8.09	3.33	120.00
Papaya	39	6	33	10.14	14.89	4.68	1.66	60.00
Pineapple	18	3	15	2.12	5.74	2.65	1.66	28.57
Banana	41	6	35	19.98	25.14	7.70	3.33	120.00
Mango	29	5	24	4.88	6.10	2.22	1.57	20.00
Orange	36	5	31	8.99	10.93	3.57	3.33	40.00
Guava	18	2	16	2.43	4.51	2.08	1.67	14.28

The types of food containing vitamin C that were most consumed by research subjects were bananas (average=19.98g±25.14) and papaya (average=10.14g±14.89), which were widely consumed by both subjects in the sufficient (100% and 100%) categories. deficit (81.40% and 76.74%) (Table 3). In previous research by Fekete et al. (30), conducted a literature review between 2018 and 2023, based on an estimate of total vitamin C consumption, it was found that patients with chronic respiratory disease consumed significantly less vitamin C than healthy controls. Effect of intravenous vitamin C on exercise-induced redox balance, inflammation, exertional

dyspnea, neuromuscular fatigue, and exercise tolerance in patients with COPD. Serum concentrations of antioxidants have been shown to correlate positively with FEV1 in patients with COPD, and supplementation with antioxidants such as vitamin C improves the symptoms of the disease. Another study by Lorensia et al. (31), which looked at the relationship between antioxidant (vitamin C) intake on lung function in construction workers, had a value of p=0.00 and r=0.63, which means there are differences in vitamin C with lung function of a smoker and non-smoker. The relationship between vitamins C got a correlation value of 0.000, meaning that the intake of vitamin C had no relationship or correlation. The most consumed food containing vitamin C was lodeh and sambal.

Profile of Vitamin E Intake

Vitamin E intake was the total amount of vitamin E content from food sources of vitamin E consumed by subjects on average per day, expressed in mg units. The adequacy rate of vitamins for ages 19-64 years was 15 mg/day (20). Vitamin E is widely found in food, especially in plant oils such as oil, spinach, fish, and eggs. Based on the results, none of the research subjects from the subjects in the research subject met the adequate intake of vitamin E, namely ≥15 mg/day. Based on **Table 4** shows that the largest average was 1.43 mg/day, namely chicken eggs,

although the highest but does not meet the adequacy rate of vitamin E. and chicken eggs. The average consumption of food intake that contained the highest vitamin E content in the research subject was chicken eggs at 1.43 mg/day although the highest did not meet the adequacy rate of vitamin E. The frequency of foods most frequently consumed by research subjects containing vitamin E were tempeh and chicken eggs (**Table 4**).

The type of food containing vitamin E that was most consumed by research subjects was tempeh (average=0.79g±0.62) (**Table 4**). Previous research by Liu et al. (32), used data from NHANES (National Health and Nutrition Examination Survey) from 2013–2018, showing that vitamin E intake among U.S. adults was well below the recommended levels and that higher vitamin E intake was negatively associated with COPD incidence. Meanwhile, in another study by Lorensia et al. (31), which looked at the relationship between antioxidant (vitamin E) intake on lung function in construction workers, there was no relationship or correlation between the intake of vitamin E (P-value=1,000) in food with lung function in the respiratory distress group and without interference. The most consumed food containing vitamin E is fried egg/omelet and spinach.

Table 4. Profile of consumption patterns of Vitamin E

Type of Food	Total subjects (n=49)	Average (gram)	Standard Deviation	CI	Min (mg)	Max (mg)
Chicken eggs	48	1.43	1.29	0.36	0.10	4.80
Mackarel tuna	7	0.05	0.18	0.14	0.10	0.30
Salted fish	14	0.13	0.38	0.20	0.10	0.70
Milkfish	18	0.08	0.16	0.07	0.10	0.60
Tilapia fish	17	0.09	0.21	0.10	0.10	1.20
Palm oil	21	0.08	0.10	0.04	0.10	0.20
Catfish	26	0.21	0.49	0.19	0.10	2.40
Tempeh	47	0.79	0.62	0.18	0.10	1.50
Peanut shell	15	1.0	2.91	1.47	0.10	18.90
Spinach	29	0.15	0.24	0.09	0.10	0.40
Basil	9	0.03	0.07	0.05	0.10	0.40
Apple	13	0.14	0.61	0.32	0.10	4.10
Papaya	25	0.11	0.17	0.07	0.10	0.60
Mango	15	0.03	0.05	0.02	0.10	0.10
Guava	7	0.01	0.04	0.03	0.10	0.10

The relationship between vitamin A and C intake with COPD Risk

Table 5 showed that as many as 77.55% of the total research subjects were in vitamin A deficiency. The assessment of vitamin A intake from the research subject was assessed using the FFQ method and analyzed using the Nutrisurvey 2007. The table showed that as many as 87.76% of the total research subjects were in deficit of vitamin C. From the calculation results in **Table 5**, it is known that the Spearman Significance value between COPD risk and vitamin A intake was -309 with Sig. (2-tailed) of 0.187.

Because the Sig.=0.187>0.05, it can be concluded that there was no relationship between vitamin A and COPD risk development. While in the test between COPD risk and vitamin C intake, the Spearman's rho r Significance value was 0.031. Because the Sig.=0.031>0.05, it can be concluded that there was a significant relationship (weak negative) between vitamin C and COPD risk development. This is different from previous research by Wong et al. (33), who examined the

relationship between dietary antioxidant intakes and CRDs using data from the 2001–2018 National Health and Nutrition Examination Survey (NHANES), and found that the association between composite dietary antioxidant index and prevalence of Chronic respiratory diseases was consistent across all subgroups, suggest that it was not influenced by these demographic factors. Higher dietary antioxidant intakes were associated with a lower prevalence of CRDs (particularly emphysema and chronic bronchitis) in general adults.

Other research by Lorensia et al. (31), showed no significant difference between antioxidant intake in the group of interference and without interference. Intake of vitamin A on lung function has a value of p=0.05, which means associated with lung function but has a very weak correlation (correlation coefficient value -0.036) while vitamins C and E have a value of p=1.00, which means there is a relationship, and is a very weak correlation (correlation coefficient value of -0.036).

Table 5. Distribution frequencies based on Vitamin A and C Intake

Antioxidant Intake	COPD risk		Frequency intake	Percentage intake (%)	Mean±SD Intake (µg)	Spearman test (r)
	risk of clinically significant COPD	No risk of clinically significant COPD				
Vitamin A intake						
Sufficient (≥600 µg/day)	3	8	11	22.45	630.98±21.07	-0.192
Deficit (≤600 µg/day)	28	10	38	77.55	370.00±146.02	
Total	31	18	49	100	1.000.98±168.81	
Vitamin C intake						
Sufficient (≥75 mg/day)	5	10	6	12.24	79.62±6.05	-0.309*
Deficit (≤75 mg /day)	26	8	43	87.76	21.56±16.70	
Total	31	18	49	100	98.18±23.84	

*Correlation is significant at the 0.05 level (2-tailed)

The types of food that are mostly consumed by subjects were:

Chicken Eggs were among the most consumed by the research subject. When the eggs were still raw they contained vitamin A of 160µg/100g, vitamin E 1050µg/100g. If the egg yolk was only taken and was still raw, the vitamin A content was 371 µg/100g, vitamin E was 2580 µg/100g. Meanwhile, if the egg white was only then there is no vitamin A and vitamin E content back (34). Different conditions of eggs that have undergone a cooking process or are processed into food such as boiling or frying. The research

that has been done, has shown that several groups of eggs that are still raw materials, half-cooked eggs, and eggs that have been cooked until cooked have each group contains different vitamin A and vitamin E content. Raw whole eggs contain vitamin A of 182, 160 µg/100g, and vitamin E 1.43; 1.05 mg/100g. Soft-boiled eggs contain vitamin A 132; 160 µg/100g and vitamin E 2.17; 1.04 mg/100g. The last group of eggs that were cooked until cooked contained vitamin A 61.5; 149 µg/100g and vitamin E containing 1.03; 1.03 mg/100g (34). The nutritional quality of eggs produced by native chickens is superior to those

produced from farms. However, research that has been conducted in the United States states that the levels of vitamin A and vitamin E in eggs are not influenced by the type of residence of the birds in this study (35). The results of this study were that chicken eggs were the most consumed by the research subject but had limitations from the survey, which could not be known how the chicken eggs were processedChicken eggs were among the most consumed. According to research when whole eggs are still raw they contain vitamin A of 160μg/100g and vitamin E of 1050μg/100g. If the egg yolk was only taken and was still raw, the vitamin A content is 371 μg/100g, vitamin E was 2580 μg/100g.

Meanwhile, if the egg white was only then there was no vitamin A and vitamin E content back. Different conditions if eggs that had undergone a cooking process or were processed into food such as boiling or frying. In the research that had been done, it had shown that several groups of eggs that are still raw materials, half-cooked eggs, and eggs that have been cooked until cooked have each group contains different vitamin A and vitamin E content. Raw whole eggs contain vitamin A of 182, 160 μg/100g, and vitamin E 1.43; 1.05 mg/100g. Soft-boiled eggs contain vitamin A 132; 160 μg/100g and vitamin E 2.17; 1.04 mg/100g. The last group of eggs that were cooked until cooked contained vitamin A 61.5; 149 μg/100g and vitamin E containing 1.03; 1.03 mg/100g (29). The nutritional quality of eggs produced by native chickens was superior to those produced from farms. However, research that had been conducted in the United States states that the levels of vitamin A and vitamin E in eggs were not influenced by the type of residence of the birds in this study (34). Chicken eggs also contain omega-3 which can play a role in reducing oxidative stress by increasing antioxidant capacity (35,36).

Corn contains dietary fiber that the body needs (with a relatively low glycemic index compared to rice so corn rice was recommended for people with metabolic diseases such as diabetes. Vitamin A and vitamin E were found in yellow corn as micronutrients, vitamins also act as natural antioxidants. Which could increase the body's immunity and inhibit degenerative cell damage. Vitamin A has activities to slow down aging, anticipates cancer, heart disease, stroke, and cataracts, and can catch free radical attacks that are considered to cause disease (37,38). The nutritional composition of the research that has been carried out, which is found in sweet corn in units/100g of the material contains 400 SI of vitamin A, whereas ordinary corn contains 117.0 SI. Jangung also contains vitamin C in units/100g of ingredients for sweet corn as much as 12.0 Mg and ordinary corn as much as 9.0 Mg (37,38).

Vegetable Spinach is one of the most important and nutritious vegetables eaten raw or cooked. Spinach provides excellent amounts of vitamin B6, riboflavin, folate, niacin, soluble dietary fiber, omega-3 fatty acids, and minerals. Spinach was also rich in iron (39). According to research on spinach extract that had been researched, spinach contains vitamin A (26.85 ± 0.154μg) and vitamin C (19.66 ± 0.21 μg) and besides that, the antioxidant activity and antidiabetic effect of spinach are comparable to IC50 of 3.03 μg/mL, 6.03 μg/mL, and 3.046 μg/mL respectively (40). The results of the study used spinach which has been processed into clear spinach soup.

Papaya is a fruit that is commonly consumed by many people with high nutritional value available at an affordable price. Low-calorie content (32 Kcal/100g ripe fruit) made this fruit a favorite fruit for someone who is losing weight. Papaya was low in carotene which helps prevent free radical damage compared to other fruits, but all the other nutrients are present. Papaya fruit contains many enzymes such as papain which is in a good amount in raw fruit which is very good for digestion, helping protein in food in acidic, alkaline, and neutral medium. All parts of this papaya from the leaves, seeds, and papaya juice show anti-free radical and antioxidant activity (41). The content of vitamin A contained in papaya according to research that has been done is 47μg/100g of papaya, the content of vitamin C in papaya is 60.9 mg/100g of papaya, while the content of vitamin E in papaya is 0.3 mg/100g of papaya (41).

Bananas were considered a source of some of the vitamins that are in their fruit. However, the results of the fruit morphological characteristics indicated that each banana cultivar had characteristics related to its genome group.

According to research conducted by using four cultivars of Indonesian bananas, namely the Berlin banana, green ambon banana, Bandung plantain, and Cardaba banana in a 100g meal portion containing high carbohydrates, total sugar, potassium, and vitamin C, moderate protein, low fat, and high calories due to its high nutritional value. Bananas are a nutritious food that is recommended for all in general (42).

Implication and limitations

Another method was the 24-hour recall method, which remembers the food consumed during the last 24 hours from midnight to midnight again. This method used household measurement tools in each household to determine the proportion of food consumed, such as food models, pictures, or photos of food. This method had limitations or shortcomings, namely, it is very dependent on the subject's memory, the need for skilled personnel, and the flat slope syndrome. So that with all the considerations, this study took the FFQ method because this method did not require repeated data collection after all during a pandemic like this it did not make it easier to meet directly and can lead to differences in perceptions between researchers and the research subject and also did not force the subject of researchers to remember for 24 hours they've consumed everything (43,44).

CONCLUSIONS AND RECOMMENDATIONS

Most of the subjects had a deficiency of vitamin A (77.55%), a deficiency of vitamin C (87.76%), and all subjects had a deficiency of vitamin E. There was no relationship between vitamin A and COPD risk development, but there was a significant relationship (weak negative) between vitamin C and COPD risk development, so the lower the intake of vitamin C, the greater the risk of developing COPD, which is indicated by a decrease in lung function from the FEV1/FVC ratio.

AUTHOR CONTRIBUTIONS

All authors equally contributed to this paper with the conception and design of the study, literature review and analysis, drafting and critical revision and editing, and final approval of the final version.

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Early marriage is a risk factor for stunting in children in Gunungkidul Regency

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ABSTRAK

Latar Belakang: *Prevalensi stunting pada tahun 2022 di Indonesia masih tinggi, yaitu 21,6%. Stunting pada anak balita dapat disebabkan karena adanya masalah gizi selama periode 8000 Hari Pertama Kehidupan. Faktor usia ibu saat menikah juga dapat menyebabkan stunting pada anak balita. Masih ada kejadian pernikahan usia dini (menikah pada usia<19 tahun) di Kabupaten Gunungkidul. Ada 312 kasus pernikahan dini (menikah pada usia<19 tahun) di Kabupaten Gunungkidul pada periode tahun 2017 - 2022.*
Tujuan: *Untuk menganalisis hubungan antara pernikahan usia dini dengan kejadian stunting pada anak usia 0-59 bulan di Kabupaten Gunungkidul..*
Metode: *Penelitian menggunakan desain kohort retrospektif dengan kelompok sampel terpapar dan tidak terpapar sebesar masing-masing 65 orang. Teknik pengambilan sampel menggunakan simple random sampling. Data usia pernikahan dini diperoleh dari catatan yang ada di Kantor Urusan Agama Kabupaten Gunungkidul. Pengumpulan data karaktersitik sampel, usia ibu saat menikah, status pemberian ASI, dan penyakit infeksi anak dilakukan dengan teknik wawancara menggunakan kuesioner. Kejadian stunting dinilai dengan melakukan pengukuran panjang badan atau tinggi badan.*
Hasil: *Hasil analisis bivariat menunjukkan bahwa ada hubungan yang signifikan antara usia ibu menikah (RR=25,4; IK=5,72-112,62; p=0,000), jenis kelamin anak (RR=2,37; IK=1,02-5,4; p=0.040), riwayat penyakit infeksi saluran pernafasan akut (RR=4,80; IK=2,03-11,34; p=0,000), dan riwayat penyakit diare (RR=5,1; IK=2,16-12,08; p=0,000) dengan kejadian stunting pada anak usia 0-59 bulan. Analisis multivariat menunjukkan bahwa usia ibu menikah, (OR=36,5; IK=6.82-195.52; p=0,000), riwayat penyakit infeksi saluran pernafasan akut (OR=3,32; IK=1,09-1,.09; p=0,035), dan riwayat penyakit diare (OR=6,9; IK=2,19-22,15; p=0,001)berpengaruh terhadap kejadian stunting.*
Kesimpulan: *Pernikahan usia dini, riwayat penyakit infeksi saluran akut, dan riwayat penyakit diare merupakan faktor risiko kejadian stunting pada anak balita usia 0-59 bulan di Kabupaten Gunungkidul.*

KATA KUNCI: *stunting; pernikahan, usia dini; anak balita; gunungkidul*

ABSTRACT

Background: *The prevalence of stunting in 2022 in Indonesia is still high, namely 21.6%. Stunting in children under five can be caused by nutritional problems during the first 8000 days of life. The mother's age at marriage can also cause stunting in children under five. There are 312 incidents of early marriage (married at <19 years of age) in Gunungkidul Regency in the period 2017-2022.*

Objectives: *to analyze the relationship between early marriage and the incidence of stunting in children aged 0-59 months in Gunungkidul Regency.*

Methods: *The study used a retrospective cohort design with exposed and unexposed sample groups of 65 people each. The sampling technique uses simple random sampling. Data on the age of early marriage was obtained from records at the Gunungkidul Regency Religious Affairs Office. Data were collected on sample characteristics, breastfeeding status, and child infectious diseases using interview techniques using a questionnaire. The incidence of stunting is assessed by measuring body length or height.*

Results: *Result of the bivariate analysis showed that there was a significant relationship between the mother's age at marriage (RR=25.4; CI=5.72-112.62; p=0.000), gender of the child (RR=2.37; CI=1 .02-5.4; p=0.040), history of acute respiratory infections (RR=4.80; CI=2.03-11.34; p=0.000), and history of diarrhea (RR=5.1; CI=2.16-12.08; p=0.000) with the incidence of stunting in children aged 0-59 months. Multivariate analysis showed that maternal age at marriage, (OR=36.5; CI=6.82-195.52; p=0.000), history of acute respiratory infections (OR=3.32; CI=1.09-1.09; p=0.035), and a history of diarrhea (OR=6.9; CI=2.19-22.15; p=0.001) influence the incidence of stunting.*

Conclusions: *Early marriage, history of acute tract infections, and history of diarrhea are risk factors for stunting in children aged 0-59 months in Gunungkidul Regency..*

KEYWORD*: stunting; marriage; early age; children under five; gunungkidul*

INTRODUCTION

Stunting is a condition of chronic malnutrition that is characterized by a child's length or height being less than minus two standard deviations (<-2SD) (1). The condition of stunting in children has an impact on disrupting brain development and intelligence, impaired physical growth, metabolic disorders in the body (2), decreased immune system, and high risk of developing degenerative diseases in old age such as diabetes, obesity, and cancer, as well as decreased productivity and work capacity, causing low economic productivity (3).

The prevalence of stunting in Indonesia in 2022 is still high, namely 21.6%. The provinces with the highest prevalence of stunting are East Nusa Tenggara, namely 35.3%, West Sulawesi at 35.0%, Papua at 34.6%, and the Special Region of Yogyakarta at 16.4%. In the Special Region of Yogyakarta, the highest prevalence of stunting is in Gunungkidul Regency at 23.5% (4). The

Indonesian government targets reducing the stunting rate by 14% in 2024 (5).

Adequate nutrition during the first 1,000 days of life, pregnancy, and the early years of life is critical to a child's future health (6). A newborn's healthy development and longevity depend on optimal nutrition over the first 1000 days (from conception to the child's second birthday). Physiological changes, elevated energy demands, and shifting dietary requirements—all essential for the best possible growth and development—come with pregnancy and the postpartum phase (7). However, previous research states that intervention is needed for the first 8,000 days of life starting from the time of conception until the child is 19 years old. Intervention at the first 1,000 days of life is a priority but is not sufficient so intervention is still needed for the next 7000 days. The two most important packages identified during the first 7,000 days of life development

intervention period were paying attention to needs in childhood and adolescence and interventions focused on ages 15-19 years by involving the community, media, and health systems (8).

Two factors cause stunting, namely direct causes and indirect causes. Direct causal factors include lack of nutritional intake and infectious diseases. Indirect causal factors include poor food security, sanitation, and environmental health (9). The mother's age at marriage can also cause stunting in children due to the mother's psychological factors such as not being ready for her pregnancy and not knowing how to maintain and care for her pregnancy (10). This is closely related to the mother's low education so knowledge about stunting and the nutritional needs of her child is also low(11).

The Indonesian government has regulations regarding the age limit for women and men who are permitted to marry, namely if both have reached the age of 19 years(12). However, there are still many cases of marriage of children under the age of 19, or what is called early marriage. Early marriage is defined as a marriage that takes place between a couple under the age of 19 with or without consent (13). Early marriage is not only seen in terms of age but also a person's physical, and psychological maturity and responsibility. Children born to couples who marry at an early age can experience poor physical health and nutrition as well as high infant mortality rates due to the mother's poor skills in caring for children and problems with reproductive health (14,15).

In general, economic factors, educational factors, and knowledge of teenagers and their parents influence the incidence of early marriage (16). When the pandemic occurred in 2020, economic factors and public health levels decreased (17). Low economic factors cause families to be unable to pay education costs and tend to see their daughters as a burden on the family's economy so they tend to marry off their children as early as possible (18). This causes the number of early marriages to increase every year during the COVID-19 pandemic, as happened in Gunungkidul Regency (19). In this study, data on mother's marriages collected were marriages in the 2017 - 2022 period.

The prevalence of women in Indonesia who married before the age of 18 in 2018 reached 1.2 million with a percentage of 11.2% and placed Indonesia in the 10 countries with the highest absolute number of child marriages in the world (20). The percentage of early marriages in the Special Region of Yogyakarta Province in 2020 was 6.2% with the highest cases of applications for marriage dispensation being in Gunungkidul Regency with 218 cases (21). In Gunungkidul Regency, there are 4 sub-districts where the incidence of early marriage increased every year from 2017 to 2022, namely Gedangsari District (75 incidents), Saptosari District (67 incidents), Karangmojo District (115 incidents), and Wonosari District (55 incidents) (22).

Several previous studies have shown that there is a relationship between the mother's age at marriage and the incidence of stunting in children under five (23). On the other hand, there is also previous research that shows that there was no relationship between early marriage age and the incidence of stunting in children under five. However, in this research, there is a trend that showed that the earlier the age at which mothers marry, the higher the percentage of stunted and malnourished children (24,25). Previous research used a cross-sectional design to analyze the relationship between early marriage and the incidence of stunting (23,26), while this study used a retrospective cohort design which can examine the causal relationship between the mother's early marriage age and the incidence of stunting in children under five aged 0-59 months. The research was conducted in four sub-districts that have a high prevalence of stunting, namely Karangmojo District (37.04%), Gedangsari District (30.23%), Wonosari District (22.23%), and Saptosari District (18.26%).

MATERIALS AND METHODS

This research was an observational study using a retrospective cohort research design. This research was conducted using maternal marriage age records obtained from the Office of Religious Affairs (Kantor Urusan Agama) Gunungkidul Regency. From these records, an exposed group was formed, namely mothers who married at an early age (<19 years), and a non-exposed group, namely mothers who did not marry at an early age (≥19 years). Each group of mothers assessed the nutritional status of their children to determine the

incidence of stunting in children. The research was carried out in four sub-districts in Gunungkidul Regency which have a high prevalence of stunting, namely, Karangmojo District, Gedangsari District, Wonosari District, and Saptosari District. The research was conducted in March-July 2023. The variables in this research consist of independent variables, dependent variables, intermediate variables, and confounding variables. The independent variable in this study was the mother's age at marriage. The dependent variable was the incidence of stunting. Intermediate variables were breastfeeding status and childhood infectious diseases. Confounding variables were maternal education and maternal employment.

The research population was women who were married between 2017-2022 in Karangmojo District, Gedangsari District, Wonosari District, and Saptosari District according to data from the Office of Religious Affairs (Kantor Urusan Agama) Gunungkidul Regency. The number of women who married at the age of <19 years in the 2017-2022 period was 312 cases. The research sample consisted of an exposed group (mothers who married at the age of <19 years) and an unexposed group (mothers who married at the age of ≥19 years) in the period 2017-2022 in Karangmojo District, Gedangsari District, Wonosari District, and Saptosari District who met the study inclusion criteria. Research inclusion criteria included mothers who had children aged 0-5 years and still living at the research site at the time of data collection. For mothers who had more than one child under five, the children selected as research subjects are older.

The sample size used the Lemeshow formula for retrospective cohort studies and was calculated using the sample size application as follows:

$$n = \frac{(Z1-\alpha\sqrt{2P(1-P)}+Z1-\beta\sqrt{P1(1-P1)+P2(1-P2)^2})^2}{(P1+P2)^2}$$

$$n = \frac{1.96\sqrt{2.0,43(1-0,43)}+0,842\sqrt{0,467(1-0,467)+0,533(1-0,533)^2}}{(0,467-0,533)^2} \quad (1)$$

$$n = 58$$

Where n is minimum sample size, $]Z_{1\ \alpha/2}$ (1,96) value on a standard normal distribution that is equal to the level of significance α (for α 5% is 1,96), $Z_{1-\beta}$ value on the standard normal distribution which is equal to the (power) (for β = 20% is 0,842), P1 is proportion of exposure in the exposed group 46,7% (Zulhakim et.al., 2022) and P2 proportion of exposure in the unexposed group 53,3%. Based on the results of the sample size calculation, the minimum sample size was 58 people. To anticipate incomplete data, the sample size was increased by 10%, so the sample size was 63.8 rounded up to 65. The sample size for this study was 130 people, consisting of 65 people in the exposed group and 65 people in the unexposed group. The sampling technique used simple random sampling. The sample was selected proportionally based on the total cases in each sub-district. The number of samples selected from each sub-district is based on the following calculations:

$$ni = \frac{Ni}{N} \times n \quad (2)$$

Where ni is opulation size by stratum, N total population, Ni is number of samples by stratum and n total sample size. The number of samples in the exposed group and the non-exposed group in each sub-district was taken proportionally. No samples were lost to follow up or drop out from the study. Early marriage was categorized into mothers who married at an early age (<19 years) and mothers who did not marry at an early age (≥19 years). The mother's age at marriage was obtained from records at the Office of Religious Affairs (Kantor Urusan Agama) Gunungkidul Regency.

The incidence of stunting was assessed using indicators of length-for-age or height-for-age. The infantometer was used to collect body length data for children aged 12-23 months, while the microtoise was used to collect height data for children aged 24-59 months. For children aged <2 years whose body length was measured using a microtoise, the measurement result was added by 0.7 cm, whereas for children aged >2 years whose height was measured using an infantometer, the measurement result was reduced by 0.7 cm. Measurement of body length and height according to body length/height measurements (27). The incidence of stunting was categorized into not stunting (z-score length-for-age or height for age ≥ -2 SD) and stunting (z-score length-for-age or height for age <-2 SD) (1). The incidence of stunting is assessed by measuring the child's

length or height. Data on children's body length or height was obtained from integrated health post (Posyandu) activities carried out during the research period. For a child's body length or height obtained during a period outside the research period, the child's body length or height was measured directly using a body length measuring instrument (infantometer) or a height measuring instrument (microtoise). Data collection was

carried out by the researcher dan 4 enumerators. Enumerators had received training from the researcher to measure body length/height and perception similarities using research questionnaires. The length/height data collected at the Posyandu were based on the distribution of maternal marriage data so that the children involved in this study were not taken from all Posyandu at the research location.
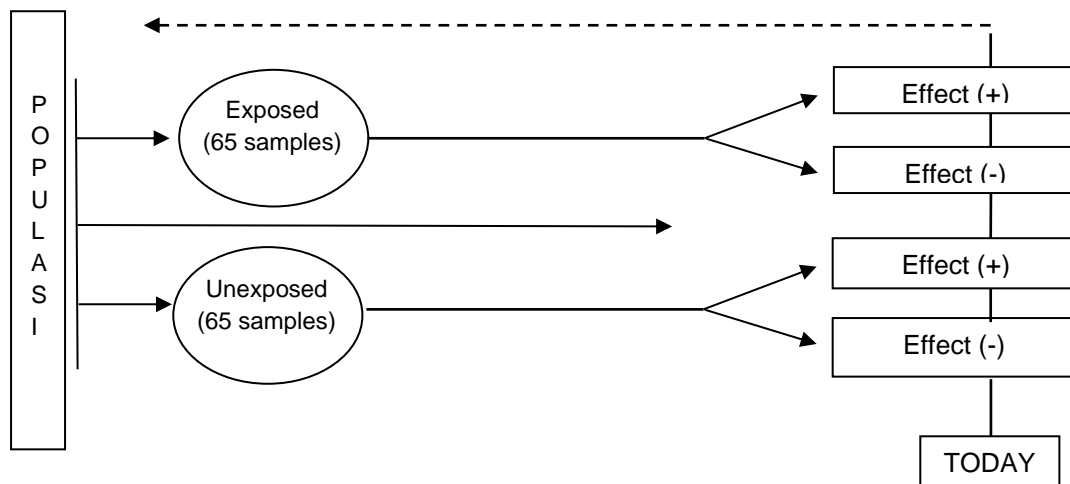

Figure 1. Diagram of cohort retrospective study

Infectious diseases were infectious diseases that have been suffered by children under five within one year of data collection. Children were categorized as having an infectious disease if they had experienced one or more infectious diseases such as Acute Respiratory Infection (ARI), pneumonia, and/or diarrhea (28). Children were categorized as not having an infectious disease if they did not suffer from one of the infectious diseases such as ARI, pneumonia, and/or diarrhea. Acute Respiratory Infection (ARI) was characterized by fever, cough for less than 2 weeks, runny nose/stuffy nose, and sore throat. Pneumonia is characterized by high fever, cough, and difficulty breathing. Diarrhea was characterized by defecating 3-6 times a day, defecating > 6 times a day, and soft or liquid faeces (28).

Continued breastfeeding status(yes/no) was the status of a child who is or is not being breastfed from birth to 24 months(29), adjusted to the child's age. If the age of the child was ≤ 24 months, then the continued breastfeeding status was

determined according to the conditions at the time of collection. If the age of the child is> 24 months, then the continued breastfeeding status is determined from the child's birth to 24 months of age.

Maternal age was categorized into <20 years old, 21-24 years old, 25-29 years old, 30-34 years old, and ≥35 years old(30). The mother's education level was the last formal education completed by the mother until she received a graduation certificate which was assessed from the time of marriage until the time of data collection. The mother's education level was categorized into low/medium education level (not completed elementary school, completed elementary school/middle school/high school/equivalent) and high education level (graduated college/equivalent)(31). Maternal employment was the mother's last job since marriage until the time of data collection. It was categorized into unemployed and employed(32).

Data collection was carried out using interview techniques and direct measurement.

Interviews using a structured questionnaire were conducted to collect data on maternal characteristics mother's age at marriage, mother's age (mother's age at the time of interview), mother's education, and mother's employment, child's characteristics (age, gender), breastfeeding status, and child infectious diseases. Questions about childhood infectious diseases were used in the list of questions in the Basic Health Research (2018) questionnaire (28). This research received an ethical letter from the Health Research Ethics Committee Universitas 'Aisyiyah Yogyakarta (Number. 2973/KEP-UNISA/VI/2023). Each research subject was explained in the research. Research subjects who were willing to be involved in the research were asked to sign an informed consent form.

Data analysis was carried out in three stages. In the first stage, univariate analysis was carried out to describe the research variables in mean value (standard deviation), frequencies, and percentages. Bivariate analysis was carried out to analyze the relationship between independent variables, intermediate variables, and confounding variables with the dependent variable. Bivariate analysis used the Chi-Square Test. Multivariate analysis was carried out to analyze the relationship between independent variables, intermediate variables, and confounding variables with dependent variables that had a p-value <0.25 in bivariate analysis. Multivariate analysis used a logistic regression test. This study uses a 95% confidence interval, a significance level (α) of 5%, and a two-way hypothesis test. Data analysis used the SPSS version 25.

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RESULTS AND DISCUSSIONS

In this study, the exposed and unexposed groups each consisted of 65 people. The total sample involved in this research was 130 mothers and 130 children. The presentation of univariate analysis is differentiated according to the scale of the variable data. Univariate analysis presents the variables of mother's age at marriage, age of children under five, age of mother, and z-score length/height-for-age with a numerical data scale in the form of mean value (± standard deviation), minimum value and maximum value.

Variables with a categorical data scale, namely mother's education level, mother's employment level, child's gender, child's breast milk status, ARI, pneumonia, and diarrhea are presented in frequency and percentage values. Normality test showed that data of mother's age at marriage, age of mother, and z-score length/height-for-age of children under five. Based on **Table 1**,

Table 1. Description of the characteristics of subjects

Characteristics	Mean (±SD)	n	%
Sex of children			
Girl		67	51.5
Boy		63	48.5
Age of children (mo)	28.89 (13.480)		
24 – 59		85	65.4
0 – 23		45	34.6
Age of mother (yo)	24.52		
<20		33	25.3
20 – 24		47	36.2
25 – 29		23	17.7
30 – 34		21	16.2
≥ 35		6	4.6
Education level of mother			
Low		127	97.7
High		3	2.3
Employment status of mother			
Unemployed		102	78.5
Employed		28	21.5

the majority of children were girls (51.5%) with the large stage categories in the 24-59 month age group (65.4%). Most of the mothers were 20-24 years old (63.8%), had a low level of education (97.7%), and did not work (78.5%). Based on **Table 2**, the average age at which mothers marry was 19.2 years. The average length-for-age/height-for-age z-score was -1.11. The majority of children did not experience stunting (76.2%), were not breastfed (60.0%), did not experience Acute Respiratory Infection (71.5%), did not experience pneumonia (99.2%), and did not experience diarrhea (64.6%).

Children who have experienced diarrhea are 6.9 times more likely to experience stunting compared to children who have never experienced diarrhea. In the multivariate analysis, the results of the analysis showed that the variables that influenced the incidence of stunting in children under five were the mother's age at marriage, history of acute respiratory infections, and diarrhea. The strength of the relationship from the largest to the smallest is the mother's age at marriage (OR=32.69), diarrhea (OR=5.58), and acute respiratory tract infections (OR=3.49).

Table 2. Description of maternal age at marriage, z score length-for-age/height-for-age, breastfeeding status, and infectious disease

Variables	Mean (SD)	n	%
Mother'sage at marriage (yo)	19.22 (2.8)		
<19 tahun		65	50.0
≥ 19 tahun		65	50.0
Z-Scorelength-for-age / height-for age	-1.11 (0.8)		
Stunted		31	23.8
Non stunted		99	76.2
Continued breast feeding			
No		78	60.0
Yes		52	40.0
Acute Respiratory Infection			
Yes		37	28.5
No		93	71.5
Pneumonia			
Yes		1	0.8
No		129	99.2
Diarrhea			
Yes		46	35.4
No		84	64.6
Total		130	100.0

This study found that there was a relationship between the mother's age at marriage and the incidence of stunting in children under five. The results of this study support previous research which stated that there is a relationship between the age of the mother at marriage and the incidence of stunting in children under five (33). However, the results of this study are not in line with previous research which stated that there was no relationship between the mother's age at marriage and the incidence of stunting in children under five (34). The younger a woman gets married, the higher the risk of her child experiencing stunting because she is not ready to give birth to a child. The mother's age at marriage affects early pregnancy which can cause health problems, especially reproductive health, namely the risk of developing uterine cancer is greater because cervical cells are immature (35). Early pregnancy can also result in energy and protein deficiencies because in general teenagers need maximum nutrition until the age of 21 years.

Table 3. Results of bivariate and multivariate analysis

Variable	Stunting				Analysis of Bivariate		Analysis of Multivariate	
	Stunted (n=31)		Non-stunted (n=99)		RR (CI95%)	P-value	OR (CI 95%)	P-value
	f	%	f	%				
Sex of children								
Boy	20	31.7	43	68.3	2.37	0.040		
Girl	11	16.4	56	83.6	(1.02-5.46)			
Age of children (mo)								
24 – 59	22	25.9	63	74.1	1.39	0.454		
0 – 23	9	20.0	36	80.0	(0.58-3.36)			
Mother'sageatmarriage (years)								
<19 years	29	44.6	36	55.4	25.4	0.000*	36.50	0.000*
≥19 years	2	3.1	63	96.9	(5.72-112.62)		(6.82-195.52)	
Education level of the mother								
Low	31	24.4	96	75.6	0.76	0.327		
High	0	0.0	3	100.0	(0.69-0.83)			
Employment status of the mother								
Unemployed	22	21.6	80	78.4	0,58	0.245		
Employed	9	32.1	19	67.9	(0.23-1.46)			
Continuedbreastfeeding								
No	20	25.6	58	74.4	1.29	0.556		
Yes	11	21.2	41	78.8	(0.56-2.97)			
AcuteRespiratoryInfection								
Yes	17	45.9	20	54.1	4.80	0.000*	3.32	0.035
No	14	15.1	79	84.9	(2.03-11.34)		(1.09-10.09)	
Pneumonia								
Yes	1	100.0	0	0.0	4.30	0.238		
No	30	23.3	99	76.7	(3.14-5.88)			
Diarrhea								
Yes	20	43.5	26	56.5	5.11	0.000*	6.97	0.001*
No	11	13.1	73	86.9	(2.16-12.08)		(2.19-22.15)	

Mothers who are pregnant at the age of <20 years experience a concurrency of nutrients with their fetus because the mother is still in the period of growth and development. Therefore, if the mother's nutrition during pregnancy is inadequate, the risk of the child's growth and development is hampered (36). Mothers who marry at an early age are also at risk of increasing infant and maternal mortality rates, and the risk of complications in pregnancy, childbirth, and postpartum (37). Mothers who marry at an early age have poor parenting patterns for their children which are influenced by economic factors, education, and local environmental factors. Mothers' parenting patterns related to food intake in the first 1000 days of life influence nutritional intake and have a direct impact on the incidence of stunting in their children (38). In addition, parenting patterns related to maternal hygiene and sanitation can also influence the incidence of stunting(39). The frequency of stunting in children was impacted by mothers' hand-washing habits. During the cooking process, cross-contamination of food could occur due to dirty hands. Eating food that has been produced using unhygienic methods may result in food poisoning, which manifests as diarrhea, vomiting, and decreased appetite. The symptoms may cause the kids to eat less, which would leave their nutritional needs unmet and result in growth disorders (40). Children under five who live in homes with adequate sanitation facilities are less likely to suffer from stunting than children in homes with inadequate sanitation (41). Fecal waste disposal into a water stream is considered an unimproved sanitation facility since it has the potential to contaminate the environment. Children under five love to engage in exploratory play outside, using their hands to

touch the ground, water, and nearby animals. The children's mouthing activity during play may be a direct source of helminth and microbial transfer (42).

This study found that there was a relationship between the sex of children and the incidence of stunting in children under five. Boys are more likely than girls to be severely stunted. The results of this study support previous research (43). However, multivariate analysis in this study showed that there was no significant relationship between the child's sex and the incidence of stunting. The reason for the disparity in nutritional status between the sexes during infancy is that boys are introduced to complementary food earlier than girls, and they are also given more of them. Boys may therefore be more susceptible to growth retardation than girls since they are more likely to be exposed to complementary foods at an early age and/or maybe more vulnerable to this early introduction because of their lower prior nutritional status. Boys typically don't grow as fast as girls. In contrast to infancy, there are more sex-based disparities in height status during the second and third years of life (44).

This study found that there is a relationship between a history of Acute Respiratory Infection and the incidence of stunting in children under five. The results of this study support previous research which stated that there is a relationship between a history of Acute Respiratory Infection and the incidence of stunting in children under five(45,46). However, the results of this study are not in line with previous research which stated that there was no relationship between a history of Acute Respiratory Infection and the incidence of stunting in children under five (47).

Infectious diseases in children cause disturbances in the body's metabolism and immune system due to inflammation. Acute respiratory infections cause a child's immune system to decrease and stress the antibody system which affects the child's reduced appetite, resulting in inadequate nutritional intake. This situation affects children's growth (45,46). Children who suffer from acute respiratory infections usually experience symptoms of coughs and colds accompanied by an increase in body temperature, so the need for nutrients also increases. If this is not balanced with adequate nutritional intake, it can cause malnutrition in children (48).

Generally, Acute Respiratory Infection is caused by 3 factors, namely environmental factors, child factors, and mother behavioral factors. Environmental factors include air pollution such as cigarette smoke, vehicle fumes, smoke from the kitchen due to cooking using firewood, or smoke from mosquito coils. Individual child factors include the child's immunization status, child's vitamin A status, child's nutritional status, child's age, and birth weight. Behavioural factors include the behaviour of mothers and other family members in efforts to prevent Acute Respiratory Infection (49). Therefore, paying attention to food intake that is appropriate to children's needs, maintaining the quality of a clean living environment and healthy behaviour as well as fulfilling immunizations for children can help improve nutrition and prevent Acute Respiratory Infection (50).

This study found that there was a relationship between the history of diarrhea and the incidence of stunting in children under five. The results of this study support previous research which states that there is a relationship between a history of diarrhea and the incidence of stunting in children under five (45,48). However, the results of this study are not in line with previous research which stated that there was no relationship between a history of diarrheal disease and the incidence of stunting in children under five (47,51). Children under five experience diarrhea more often because their intestines are more sensitive to substances that enter their food. Diarrhea is an infectious disease characterized by a change in the shape of the stool to become soft, the frequency of defecation increases, and is accompanied by vomiting (52). Infectious diseases accompanied by diarrhea and vomiting can cause children to lose fluids or what is usually called dehydration (53).

A child who has diarrhea experiences malabsorption of nutrients which is caused by an imbalance in the intake of food coming in and going out (54). If diarrhea occurs repeatedly over a long period, it can disrupt the height growth of children under five, because children under five generally need adequate nutritional intake for their growth and development (55). One of the factors

causing diarrhea is poor hygiene and sanitation practices of parents, especially mothers (56,57). Poor maternal sanitation practices such as not washing hands properly with soap, especially after defecating and after disposing of baby faeces, using refillable drinking water that is no longer boiled for daily consumption, and indirect waste management burning or throwing away in rubbish dumps (58,59)

This research has advantages in terms of research design, namely a retrospective cohort which can study the cause-and-effect relationship of the independent variable (mother's early marriage) with the dependent variable (stunting). However, the weakness of the retrospective cohort research design is that there is recall bias to remember the child's history of infectious diseases in the last year.

CONCLUSIONS AND RECOMMENDATIONS

There is a significant relationship between the mother's age at marriage, history of ARI, and history of diarrhea with the incidence of stunting in children under five aged 0-59 months in Gunungkidul Regency. The mother's age at marriage, history of ARI, and history of diarrhea were risk factors for stunting in children under five. The results of this research can be used as a basis for consideration in formulating efforts to prevent early marriage and infectious diseases because they have an impact on the incidence of stunting in children aged 0-59 months. The public needs to receive health education regarding the negative impacts of early marriage on mothers and children.

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Single-session nutritionist-led counseling improves health self-efficacy among teachers

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ABSTRAK

Latar Belakang: Peningkatan prevalensi obesitas dan sindrom metabolik (MetS) di kalangan guru membutuhkan intervensi yang terarah untuk mencapai hasil yang diinginkan. Konseling yang dengan nutrisionis dapat meningkatkan efikasi diri terkait kesehatan pada kelompok sasaran dengan memberikan pengetahuan, keterampilan, dan kepercayaan diri untuk menjalani gaya hidup yang lebih sehat.

Tujuan: Penelitian ini bertujuan untuk mengevaluasi apakah intervensi konseling tatap muka satu kali dapat secara signifikan meningkatkan efikasi diri pada kalangan guru.

Metode: Studi eksperimental ini menggunakan desain pre-dan-post-test yang melibatkan 23 guru SMK (14 perempuan dan 9 laki-laki) yang berpartisipasi dalam sesi konseling selama tiga jam yang dilakukan dalam satu hari oleh nutrisionis terlatih. Sebelum intervensi, peserta menjalani pengukuran antropometri dan skrining risiko MetS. Efikasi diri dinilai menggunakan kuesioner tervalidasi sebelum dan sesudah konseling. Analisis statistik dilakukan menggunakan uji t-berpasangan serta uji chi-square atau Fisher's Exact.

Hasil: Temuan menunjukkan peningkatan signifikan pada skor efikasi diri dari rata-rata awal 26±2 menjadi 28±2 setelah intervensi (p<0,001). Proporsi guru yang dengan peningkatan kepercayaan diri dalam memilih makanan yang tepat berbeda secara signifikan sebelum dan sesudah intervensi (p=0,02). Prevalensi obesitas di kalangan peserta tinggi, dengan 57% dikategorikan obesitas berdasarkan Indeks Massa Tubuh (IMT).

Kesimpulan: Konseling gizi terarah dapat secara efektif meningkatkan efikasi diri pada kalangan guru, yang berpotensi meningkatkan kepercayaan diri dalam menjalani gaya hidup sehat dan mengurangi risiko MetS. Studi ini menekankan pentingnya mengintegrasikan intervensi konseling gizi oleh nutrisionis di lingkungan pendidikan untuk mempromosikan kesehatan di kalangan guru, yang berperan sebagai role model bagi siswa.

KATA KUNCI: efikasi diri; guru; konseling gizi; obesitas; promosi kesehatan; sindrom metabolik (SMet).

ABSTRACT

Background: *The increasing prevalence of obesity and metabolic syndrome (MetS) among teachers necessitates targeted interventions to enhance health outcomes. Nutritionist-led counseling can enhance health self-efficacy by equipping individuals with knowledge, skill, and confidence to have healthier lifestyles.*

Objectives: *The study aims to assess whether a single face-to-face counseling intervention can significantly improve self-efficacy among teachers.*

Methods: *This experimental study employed a pre-and-post-test design involving 23 high-school vocational teachers (14 females and 9 males) who participated in a one-day, three-hour counseling session by trained nutritionists. Participants underwent anthropometric measurements and MetS risk screening before the intervention. Self-efficacy was assessed using a validated questionnaire before and after counseling. Statistical analyses were conducted using paired t-tests and chi-square or Fisher's Exact tests.*

Results: *The findings indicated a significant increase in self-efficacy scores from a baseline mean of 26±2 to 28±2 after the intervention (p<0.001). Notably, the proportion of teachers who reported confidence in selecting appropriate foods significantly improved (p=0.02). The prevalence of obesity among participants was high, with 57% categorized as obese based on BMI.*

Conclusions: *Targeted nutrition counseling can effectively enhance self-efficacy among teachers, potentially leading to healthier lifestyle confidence and reduced MetS risk. This study underscores the importance of incorporating nutritionist-led interventions in educational settings to promote health among teachers, who serve as role models for students.*

KEYWORD*: Nutrition counseling; self-efficacy; metabolic syndrome (MetS); obesity; health promotion; teachers.*

INTRODUCTION

Metabolic syndrome (MetS) is a condition of metabolic abnormalities that significantly increase the risk of developing cardiovascular diseases, type 2 diabetes mellitus, and other chronic diseases. It has emerged as a critical public health concern due to its association with substantial morbidity and mortality (1). It was estimated that MetS prevalence in Indonesia was approximately 21.66%, which was significantly higher than other Southeast Asian countries such as the Philippines (11.9%) (2). Limited study in Indonesia focusing on the prevalence of MetS among teachers. Two studies indicated that the prevalence of MetS among teachers in Jakarta was 24.6% while in Sulawesi was 39.5%(3,4). Several determinant factors have been known to increase the MetS among teachers, such as having a BMI>25 kg/m2, being less active, central obesity, sitting more than 4 hours/day, age, and dietary pattern (3, 4, 5).

Nutrition plays a significant role in managing and preventing MetS. Effective dietary interventions can significantly improve health outcomes by targeting the underlying metabolic disturbances (6). Nutritionist-led counseling programs have shown promise in various settings by providing personalized dietary guidance and support, which can enhance individuals' self-efficacy (7). Self-efficacy the belief in one's ability to execute behaviors necessary to manage their health. Self-efficacy is a key determinant of health behavior change. Individuals with high self-efficacy are more likely to engage in health-promoting behaviors, adhere to dietary recommendations, and ultimately manage their metabolic risk factors more effectively (8). In educational settings, where stress and sedentary behavior are prevalent, enhancing self-efficacy through tailored nutritional counseling could be particularly beneficial.

This study aims to evaluate the impact of a nutritionist-led counseling program on self-efficacy among teachers at SMK Roudlotun Nasyiin in

Mojokerto. By focusing on this specific population and intervention, the research seeks to contribute to the understanding of how targeted nutritional support can influence self-efficacy and, consequently, metabolic syndrome risk. The findings may provide valuable insights for developing more effective health promotion strategies within educational institutions and beyond.

MATERIALS AND METHODS

This is an experiment research (with pre and post-test) examining the effect of nutritional counseling on self-efficacy towards health among high-school vocational teachers in SMK Roudlotun Nasyiin. This vocational school is located in Mojokerto, East Java Province, Indonesia. Of 35 total teachers, twenty-three volunteered to participate in one day of counseling (3 hours duration), given by trained nutritionists after receiving an assessment including anthropometric measurement and MetS screening risk. The number of participants was regarded as sufficient to achieve significance with $\alpha=0.05$ and a side effect of 3.27 according to a prior study (9).

The anthropometry measurements included Body Mass Index (BMI) and visceral and total body fat percentage using microtoice and Bioelectrical Impedance Analysis (BIA) portable scale version HBF-375 (Omron Dalian Co., Ltd, Kyoto, Japan). Total body fat of more than 25% in males is considered obese while for females is more than 32% (10). The MetS risk data was collected from an interview conducted by a trained nutritionist using a questionnaire (11). The questionnaire consists of eight questions with each question scores ranging from either 0-3, 0-4, or 0-1 (depending on the option of the question), contributing to a maximum total score of 13 points. If the respondent has scored$\geq$7 points, then they are categorized as a person with a high risk of MetS.

The anthropometry and MetS risk screening were used as data to conduct a counseling session. The session of counseling lasts for 1-2 hours and aims to improve the self-efficacy of the client to set a healthier lifestyle and dietary patterns. A pocketbook related to MetS prevention and management was developed by the research team and used as media to help clients understand the counseling topic (**Figure 1**). Clients were requested to self-administer a Hypertension self-efficacy questionnaire (12) before and after counseling. The questionnaire consists of ten questions with three scale options, incapable (scored 1), limited capability (scored 2), and capable (scored 3). Thus, in total the questionnaire scores 10-30 points. Anthropometry and MetS data were presented descriptively as Mean±SD.

RESULTS AND DISCUSSIONS

A total of 23 volunteers, consisting of 14 females and 9 males participated in this present study. The mean age of participants was 37±13 years old. Respondents' characteristics can be seen in Table 1 below of 23 respondents, only 10 people had a BMI less than 25 kg/m2 and thus this subsample of teachers was eligible for MetS risk screening using a questionnaire developed previously by Je, et al. (2017) aimed at non-obese adults (11). Our result showed that among those 10 eligible participants, the score of MetS was 4.73 on average. Two participants were regarded with high risk for developing MetS.

According to BMI for the Asia-Pacific population, 57% of our respondents were categorized as obese while the rest of 39% was non-obese. When the obesity category was defined using the percentage of total body fat, the prevalence of obese respondents was 61% whereas non-obese respondents were 39%. Mostly, our respondents were categorized as obese, both when assessed using BMI for the Asia-Pacific population (13) and total body fat percentage cut-offs. The prevalence of obesity among the teachers in this population was considered as high. Our finding is in accordance with a study conducted among a sample of teachers in Jakarta indicating that the prevalence of obesity was about 64.5%.(4).

Another study which was also carried out in Jakarta, suggested a similar result, suggesting a prevalence of 63.1% concerning obese teachers (14). In other countries such as India, it has been suggested that the obesity prevalence among teachers, especially among female teachers, was 70.2% (5).
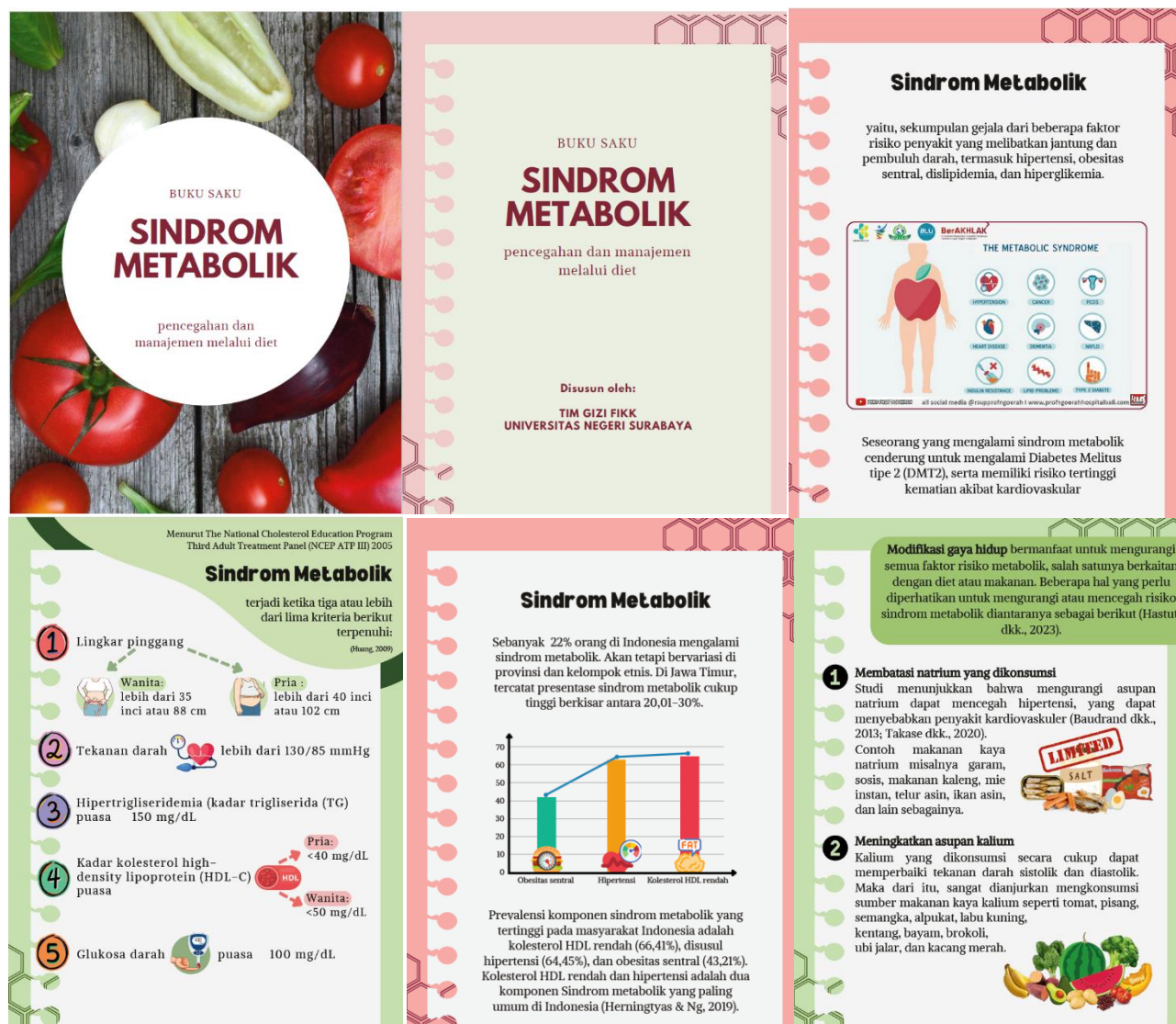
Figure 1. The pocketbook is used as the media for counseling in this present study. This book consists of several chapters, namely 1) what is metabolic syndrome; 2) what are the signs and symptoms of metabolic syndrome; 3) metabolic syndrome evidence in Indonesia; and 4) how diet can prevent and manage metabolic syndrome

Obesity, especially abdominal obesity is strongly linked with MetS (3). In our study, the MetS risk was assessed using a questionnaire screening aimed for non-obese adults. This method is in contrast with the characteristics of our respondents which more than half (57%) teachers were categorized as obese. Other criteria for MetS using International Diabetes Federation (IDF) or WHO, which require additional diagnostic assessments such as prediabetes or diabetes, elevated non-HDL cholesterol, and blood pressure (1) might be burdensome for some of the respondents and demand a higher compliance. As the MetS prevalence is increasing in the global world, including in Indonesia, there is a need to prevent and manage this condition (2).

In this study, we involved teachers as the targeted population. School teachers can be considered as the best role models, especially for healthy behavior among their students (15). For instance, a study conducted in preschoolers demonstrated that students were more active if taught by teachers whose higher physical activity (16).

Table 1. The Characteristics of Participants in This Study

Characteristics	n (%)
Gender	
Male	9 (39%)
Female	14 (61%)
BMI category	
Obese (BMI≥25 kg/m^2)	13 (57%)
Non-obese (BMI<25 kg/m^2)	10 (43%)
Total Body Fat	
Obese	14 (61%)
Non-Obese	9 (39%)
Metabolic Syndrome Risk[1]	
At risk	8 (80%)
Lower Risk	2 (20%)

The respondents that were eligible for MetS risk screening were only 10 out of 23 according to Je et al (2017) questionnaire

We analyzed respondents' self-efficacy statements for each questionnaire item. Generally, in baseline state, most of the teachers stated that they were capable to maintain blood pressure, weight, stress, caffeine intake, refraining from smoking, and medication prescribed by their doctor (as depicted in **Table 2**). Notably, all respondents reported that they were able to avoid consuming alcohol. Conversely, the items that garnered the most responses indicating limited capability or inability to perform were selecting appropriate foods, engaging in physical activity, and avoiding exposure to secondhand smoke. A significant difference was observed in one item, specifically statement number 3, between the pre- and post-counseling intervention periods (X2 = 5.8, p-value < 0.05). Notably, there was no change in the proportion of teachers reporting the capability to avoid consuming alcohol or refrain from smoking between the pre-and post-intervention periods. There was a similar proportion of teachers reporting capable of avoiding alcoholic drinks and refraining from smoking before vs. after counseling.

Table 2. Respondent Percentage Answering the Self-Efficacy Statement into three Levels Before and After Counselling Session

Statement Items	Baseline			After Receiving a counselling			X^2	P-value
	I	L	C	I	L	C		
I am able to visit a health officer to monitor my blood pressure	5%	18%	77%	5%	5%	91%	0.7	0.4
I am capable of maintaining my body weight to avoid becoming overweight.	0%	50%	50%	0%	32%	68%	0.8	0.4
I am capable of selecting appropriate foods for hypertension patients, such as low-sodium, low-fat foods, fruits, and vegetables.	9%	55%	36%	5%	23%	73%	5.8	0.02
I am able to engage in physical exercise for at least 30 minutes each day or as recommended by a healthcare professional.	18%	50%	32%	5%	45%	50%	0.8	0.4
I am capable of avoiding the consumption of alcoholic beverages.	0%	0%	100%	0%	0%	100%	0.09	0.4
I am able to reduce my caffeine intake, such as from coffee.	5%	23%	73%	0%	9%	91%	1.7	0.2
I am capable of managing stress when facing challenges.	0%	32%	68%	0%	14%	86%	1.2	0.3
I am able to refrain from smoking.	5%	14%	82%	5%	14%	82%	0.0	1.0

Statement Items	Baseline			After Receiving a counselling			X^2	P-value
	I	L	C	I	L	C		
I am capable of avoiding exposure to others who are smoking.	9%	45%	45%	0%	36%	64%	1.3	0.2
I am capable of using medication according to the instructions when prescribed by a healthcare professional	0%	14%	86%	0%	18%	82%	0.0	1.0

I = incapable, L = limited capability, and C=capable

Furthermore, we analyzed the overall self-efficacy scores, which were calculated from the aggregate of 10 statements. At the outset, the baseline mean score was 26±2 points. Following the counseling session, the mean score exhibited a statistically significant increase of 2 points, resulting in a post-counseling score of 28±2 points (as depicted in **Figure 2**). A paired t-test revealed a p-value of <0.001, indicating a significant difference between the self-efficacy scores obtained before and after the counseling intervention. This finding suggests that the counseling event had a notable impact on participants' self-efficacy.
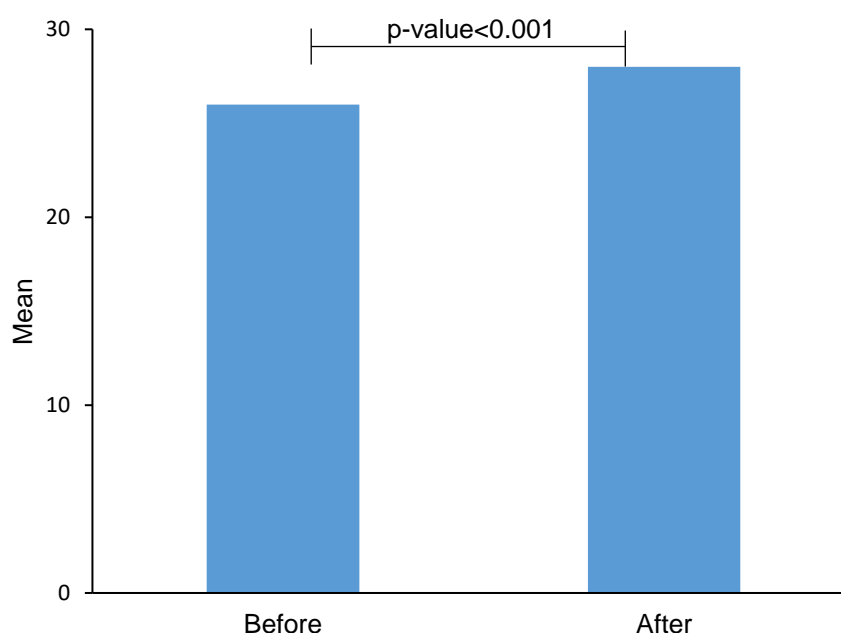

Figure 2. Self-Efficacy Mean Score After (Right Bar) vs. Before (Left Bar) Given a One-Day Counselling Intervention. The mean score of the self-efficacy after and before intervention was 28±2 and 26±2 (p<0.05 based on an independent t-test).

Our finding shows that there was a moderate enhancement in teachers' self-efficacy after giving a single face-to-face counseling. However, the effect size was considered significant. Another important result was derived from the self-efficacy items analyses. It is also clearly seen that the intervention increased the proportion of teachers who were confident about eating a nutritious diet, hence those who reported a higher self-efficacy score. It has been reported that nutrition intervention conducted in workplace sites was more favorable among overweight and obese people, especially among the male population. A systematic review indicates that the overweight and obese men population is difficult to recruit in the healthcare setting. Therefore, place setting

consideration is very important for health promotion, especially among the male population (21). In this present study, men and female teachers with obese and non-obese profiles were included. Unfortunately, the small sample size did not allow us to further analyze whether the counseling intervention has a different effect with regard to gender and BMI categories. Since this aspect is very interesting to explore, a trial including a large sample is warranted to investigate whether gender and BMI have any effects on counseling effectiveness.

Self-efficacy is defined as how confident an individual is to be able to perform a particular behavior (17). Previously, many trials have suggested that counseling intervention significantly improves self-efficacy in various objectives, including breastfeeding continuation among lactating women (9), self-management among tuberculosis outpatients (18), and decreasing cardiovascular risk among the elderly (19).

The significant contribution of our study is that we demonstrated a face-to-face counseling even when conducted in a single session, could enhance teachers' self-efficacy. In this study, the counselors consisted of experienced nutritionists and a dietitian. It is known that a counselor's performance is an important factor that can increase self-efficacy in counseling (20). This finding might suggest that counseling if performed by experienced counsellors could bring beneficial impact to improve self-efficacy among targeted people who are busier and have a limited availability to conduct an extensive intervention health program.

It was notable that face-to-face counseling became the most common delivery method in nutrition intervention rather than indirect methods. Other delivery methods including telephone follow-up and home visits accompanying face-to-face intervention could enhance the effectiveness of the intervention (21). In addition, we also used a pocketbook as the media in the counseling process. This pocketbook was developed by the researcher team and it provides information about several aspects including MetS introduction, MetS condition in Indonesia, and how diet and lifestyle can be implemented to prevent and manage the condition of MetS. These materials are very important as the information to increase the self-efficacy of our respondents.

In this study, we used the hypertension self-efficacy questionnaire to assess the effect of the counseling because currently, the questionnaire directed for MetS is not available yet in the literature. The questionnaire to measure self-efficacy among people with hypertension however is relevant to the content of our counseling themes. Nevertheless, it has been known that hypertension is the part or element of MetS and both these conditions are strongly connected. Dietary Approaches to Stop Hypertension (DASH) diet that is originally designated to control and prevent hypertension also has a positive benefit for people with MetS (22,23).

The disadvantage of this present research is due to the absence of a control group to compare the outcomes. Therefore, future research is warranted to conduct a quasi-experimental design, incorporating two arms (control vs. intervention groups) to better study the effect of counseling on client's self-efficacy. Additionally, this research only focuses on self-efficacy improvement that was self-reported by the targeted population rather than observed behaviors. Although a study indicated that multiple nutrition counseling given in a week could improve diet among people with T2DM (24), the greatest effect of dietary behavior change could be observed 6 to 12 months after the intervention (21). Thus, a long-term and intensive health promotion program in the future might be employed when addressing behavioral change. This present study examines the importance of a client-centered counseling intervention on general health self-efficacy.

CONCLUSIONS AND RECOMMENDATIONS

Our finding suggests that a single face-to-face counseling intervention has a significant beneficial effect on self-efficacy toward health among a group of teachers. As the obesity prevalence is high among the teacher population and at the same time the metabolic syndrome is increasing as well, a nutritionist-led counseling program might be implemented targeting the teacher population. Based on our discussion, future trials including a large sample size are warranted to study whether nutrition counseling

has a different effect on health self-efficacy across different gender or BMI conditions. In addition, a long-term effect such as observed behavior is warranted to be incorporated in future studies.

ACKNOWLEDGEMENT

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Effect of unripe berline banana flour on synbiotics yogurt of physicochemical and microbiological properties

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ABSTRAK

Latar Belakang: *Yoghurt sinbiotik tergolong dalam produk susu fermentasi yang mengkombinasikan antara bakteri probiotik dengan bahan yang mengandung komponen prebiotik. Tepung pisang berlin mentah memiliki kandungan pati resisten yang dapat berperan sebagai prebiotik..*

Tujuan: *Penelitian bertujuan untuk mengetahui pengaruh penambahan tepung pisang berlin mentah pada yogurt sinbiotik terhadap properties fisikokimia dan mikrobiologi.*

Metode: *Penelitian ini merupakan penelitian True Experimental dengan rancangan acak lengkap. Kelompok perlakuan terdiri atas 4 kelompok yakni P0 (inulin 2%), P1 (UBF 1%), P2 (UBF 2%), dan P3 (UBF 3%). Proses pembuatan yoghurt sinbiotik tepung pisang berlin mentah yaitu diawali dengan membuat tepung pisang berlin, starter yogurt, dan yogurt sinbiotik. Uji yang dilakukan yakni uji fisikokimia dan mikrobiologi. Data uji fisikokimia dianalisis secara deskripitif dan uji mikrobiologi dianalisis menggunakan kruskall walls dengan taraf 95% menggunakan SPSS.*

Hasil: *Pada uji fisikokimia diketahui bahwa pada kelompok dengan penambahan UBF (P1, P2, P3) memiliki kadar abu, energi, pati resisten, dan viskositas yang lebih tinggi dibandingkan kelompok inulin (P0). Pada uji mikrobiologi diketahui bahwa terdapat perbedaan signifikan total BAL antar kelompok perlakuan (P=0.002), tidak terdapat perbedaan terkait parameter koliform antar kelompok (P=0,707), dan salmonella teridentifikasi negative pada semua kelompok.*

Kesimpulan: *Penambahan tepung pisang berlin mentah dapat mempengaruhi kandungan BAL dalam yogurt dan berpotensi sebagai produk pangan fungsional yang bermanfaat bagi kesehatan.*

KATA KUNCI*: fisikokimia; mikrobiologi; pati resisten; UBF; yogurt sinbiotik*

ABSTRACT

Background: *Synbiotic yogurt is a fermented milk product that combines probiotic bacteria with ingredients that contain prebiotic components. Unripe berlin banana flour contains resistant starch that can act as a prebiotic.*

Objectives: *This study aimed to determine the effect of the addition of unripe banana flour to synbiotic yogurt on physicochemical and microbiological properties.*

Methods: *This research is true experimental with a completely randomized design. The treatment group consisted of 4 groups, namely P0 (2% inulin), P1 (1% UBF), P2 (2% UBF), and P3 (3% UBF). The process of making unripe berlin banana flour synbiotic yogurt begins with making berlin banana flour, yogurt starter, and synbiotic yogurt. The tests conducted were physicochemical and microbiological. Physicochemical test data was analyzed descriptively and microbiological tests were used the Kruskall walls test, with 95% level confidence using SPSS.*

Results: *In the physicochemical test, it was found that the group with the addition of UBF (P1, P2, P3) had higher ash content, energy, resistant starch, and viscosity than the inulin group (P0). In the microbiological test, it was found that there were significant differences BAL total between treatment groups (P=0.002), there were no differences related to coliform parameters between groups (P=0.707), and salmonella was identified as negative in all groups.*

Conclusions: *The addition of unripe berlin banana flour can affect the LAB content of yoghurt and has the potential to be a functional food product with health benefits.*

KEYWORD*: physicochemistry; microbiology; resistant starch; UBF; synbiotic yogurt*

INTRODUCTION

Synbiotic yogurt is classified as a fermented milk product that combines probiotic bacteria with ingredients that contain prebiotic components. Synbiotic yogurts have the potential to improve health outcomes and the ability to prevent and control chronic diseases via a synergistic effect between probiotic bacteria and prebiotic compounds (1). The current development of yogurt is used as an alternative functional food to meet the needs of people who want to have a healthy life easily. Functional food is processed food that contains one or more functional components, which based on scientific studies, have certain physiological functions, proven not harmful and safe for health. Synbiotics aim to stimulate the growth or activity of Bifidobacteria and Lactobacilli by using carbohydrates with several probiotic starches. The advantage of this combination is that it increases the survival of probiotic bacteria because specific substrates are available for fermentation so that the body benefits more fully from the combination (2). The production of synbiotic yogurt is generally done by

using lactic acid bacteria that function as probiotics, such as Bifidobacterium bifidum, Lactobacillus casei, or Lactobacillus acidophilus with the objective of improving the quality and added value of yogurt as a health drink (3). Prebiotics are indigestible food components that support beneficial bacteria (4). Resistant starch (RS) has a high prebiotic capacity because it is an indigestible carbohydrate, but it has a favorable influence on the probiotic microflora environment in the gut, thus providing health effects for humans (5).

Unripe banana flour is a food ingredient that contains prebiotics. Unripe banana flour supports the growth of probiotic bacteria that are resistant to α-amylase and trypsin hydrolysis (6). The resistant starch (RS) content in unripe banana flour is a natural source that contributes to the development of prebiotics (7). RS is a plant prebiotic classified as a type of dietary fiber that can modulate gut health in humans and has clinically beneficial effects on colon health (8,9). Dietary fiber is a source of energy for microbiota

activity that plays a role in maintaining colon health (10). The analysis of unripe berlin banana flour contained 40.01% RS from 100 g of flour, while ripe berlin banana flour contained 39.76% (11). RS as a soluble fiber has potential as a prebiotic due to its ability to resist digestion pass through the colon and positively stimulate fermentation of the gut microbiota. RS also stimulates hormones that play a role in appetite control, preventing fat accumulation and thus aiding in weight management (12). Synbiotic yogurt with the addition of unripe berlin banana flour which has RS content is beneficial as a prebiotic that is beneficial to health. The purpose of this study is to analyze the effect of the addition of unripe Berlin banana flour on total lactic acid bacteria (LAB), RS content, and acceptability of synbiotic yogurt with the addition of unripe berlin banana flour.

MATERIALS AND METHODS

This research was conducted at the Dietetics Laboratory, Clinical Nutrition Study Programme, Jember State Polytechnic. In addition, the research was also conducted in the Analysis Laboratory at the Food Industry Technology Study Programme, Jember State Polytechnic and Microbiology Laboratory, FMIPA, University of Jember. The research was conducted in July-August 2023. The type of banana used in this study is the Berlin banana. The main ingredients used in this study were unripe banana flour (UBF), skimmed milk, sugar, and inulin, and the starter used was Maltodextrin and active bacterial cultures (Bifidobacterium longum, Lactobacillus rhamnosus, Lactobacillus casei, Lactobacillus helveticus, Lactobacillus bulgaricus, Lactobacillus acidophilus, Streptococcus thermophilus).

This research is True Experimental research with a completely randomized design. The treatment groups consisted of P0 (synbiotic yogurt with the addition of inulin), P1 (synbiotic yogurt with the addition of UBF 1%), P2 (synbiotic yogurt with the addition of UBF 2%), and P3 (synbiotic yogurt with the addition of UBF 3%). The process of making unripe berlin banana flour synbiotic yogurt begins with making berlin banana flour with the manufacturing process, according to Putri Damayati et al., 2020 (13). Furthermore, make a yogurt starter by dissolving 125 grams of powdered skim milk into 1 L of warm water at

45oC. A dry yogurt starter of as much as 3 grams was put into a warm sterile milk solution, which was then incubated for 24 hours in a closed container. The next stage is the preparation of unripe Berlin banana flour synbiotic yogurt by preparing unripe Berlin banana flour first with the following percentages: P0 = 2% Inulin, P1 = 1% unripe banana flour, P2 = 2% unripe banana flour, and P3 = 3% unripe berlin banana flour. Prepare 13 grams of skimmed milk and 2.5 grams of sugar, then mix and dissolve with water up to 100 mL and heat to a temperature of 80°C, after cooling to 45°C, inoculate with yogurt starter as much as 3 mL for each treatment. Each treatment was then incubated at 42°C for 12 hours.

Analysis of ash, fat, protein, carbohydrate, and resistant starch using standardized analysis methods in SNI 01-2891-1992. Total energy analysis refers to SOP number 13/PL17.3.03/SOP/2021, viscosity SOP number 4/PL17.3.2.03/SOP/2021, Total acid, pH analysis refers to SNI 2973-2011. The lactic acid bacteria analysis test uses the spread plate method, the coliform test uses the 3-tube APM method, while the salmonella test uses the salmonella selective media test.Physicochemical test data were analyzed descriptively and microbiological tests were analyzed using Kruskall walls and continued with the Whitney test with a 95% confidence level.

RESULTS AND DISCUSSIONS

The ash content of P0, P1, P2, and P3 were 0.97%, 1.05%, 1.14%, and 1.21%, respectively. The mineral content present in food products can also affect the assessment of the ash content of the product. The most mineral content found in bananas is potassium (14).

The fat content in all treatment groups is in accordance with the product standards yogurt, the fat content of min 3%. Group P3 has lower fat content than other groups. In unripe bananas, the fat content is known to be 0.18% (15). The results of the analysis of fat content in unripe berlin banana flour were 1.07% (16). Functional foods that utilize the presence of prebiotics effect to improving the fatty acid profile (17).

The protein content in the table above shows that all treatment groups are in accordance with the protein content standards set by SNI 2891: 2009, which is a minimum of 2.7%. The P1 group

had higher protein levels compared to the P2 and P3 groups. The carbohydrate content of P2 is at a higher level than the other groups. The carbohydrate source in the sugar content is inulin in P0 and unripe banana flour in P1, P2, and P3. All yogurt formulations use 2.5 g/100 ml of sugar, which fulfills the claim of low-sugar yogurt products (18).

Inulin is a type of carbohydrate that acts as a prebiotic (19). The carbohydrate content of unripe berlin banana flour is 82.6% per 100 g flour (16). The total energy of the yogurt was below the calorie requirement of yogurt per serving, which is less than 120 kcal/ serving (20).

Total acid in all groups had values around 0.78%-0.93%, and these values were in accordance with the SNI quality requirements with a range of values of 0.5%-2% (21). LAB activity ferments the presence of fiber in unripe banana flour as an energy source, which will produce lactic acid. The fermentation activity carried out by LAB during yogurt making causes the accumulation of lactic acid products produced so that the value of total acid titration can increase (22).

Table 1. Physicochemical properties of unripe berlin banana flour symbiotic yogurt

Paramaters	Groups (Mean ± SD)				Quality Reqirements SNI
	P0	P1	P2	P3	
Ash (%)	0.97±0.03	1.05±0.03	1.14±0.04	1.21±0.04	Max 1.0%
Fat (%)	3.33±0.04	3.30±0.00	3.25±0.00	3.23±0.04	Min 3.0%
Proteins (%)	3.81±0.08	3.75±0.06	3.64±0.06	3.23±0.04	Min 2.7%
Carbohydrate (%)	5.47±0.37	5.74±0.01	5.93±0.14	3.59±0.03	-
Energy (kcal/100g)	67.03±1.52	67.14±0.57	67.53±0.34	68.51±0.71	-
Total Acid (%)	0.93±0.03	0.88±0.01	0.82±0.03	0.78±0.04	0.5%-2%
Resistant Starch (%)	2.47±0.05	2.59±0.03	2.61±0.09	2.77±0.03	-
Viscosity (mm/s)	0.25±0.00	1.03±0.04	0.73±0.04	0.50±0.00	-
pH	3.93±0.01	3.96±0.01	2.61±0.09	4.02±0.01	3.80-4.50

Figure 1. The pocketbook is used as the media for counseling in this present study. This book consists of several chapters, namely 1) what is metabolic syndrome; 2) what are the signs and symptoms of metabolic syndrome; 3) metabolic syndrome evidence in Indonesia; and 4) how diet can prevent and manage metabolic syndrome

The most resistant starch was found in the P3 group. The greater the addition of unripe banana flour, the greater the resistant starch content. Resistant starch (RS) in unripe bananas has the potential to act as a prebiotic due to its ability to resist digestion and pass through the colon, positively stimulating gut microbiota fermentation (12). The lowest viscosity was found in the P0 compared P1, P2, and P3 groups. Banana flour contains pectin, which can increase the viscosity of yogurt (23). Pectin is a hydrocolloid that can bind water strongly, with this strong water-binding ability, it will reduce syneresis in yogurt (24).

The highest pH value of yogurt was obtained in P3 with a value of 4.02, while the lowest pH value was in P2 with a pH value of 2.61 According to SNI 2009, good yogurt quality requirements have a pH value ranging from 3.80-4.50. In the results, it is known that the P0, P1, and P3 groups meet the quality requirements of yogurt.

Table 2. Microbiology properties of unripe berlin flour symbiotic yogurt

Paramaters	Groups (Mean ± SD)				P Value	Quality Requirements SNI
	P0	P1	P2	P3		
BAL Total (10^{7}CFU/ml)	1.25[a]	8.6[b]	4.65[ab]	0.70[a]	0.002	Min 10^7
Coliform (APM index/ml)	19[a]	7[a]	23[a]	32[a]	0.707	Max 10
Salmonella	negative	negative	negative	negative	negative	Negative/25g

Notes: The different superscripts within the same row showedsignificant difference (P<0.05)

Based on the analysis of the number of lactic acid bacteria (LAB) in unripe banana flour synbiotic yogurt, it is known that there are differences between treatment groups p=0.002. Group P1 had a greater number of LAB compared to the other groups. The higher the addition of unripe berlin banana flour in the synbiotic yogurt product, the less the amount of LAB. The results of coliform testing on yogurt products showed no significant difference p=0.707. Group P1 is known to have a coliform result of 7 and is in accordance with the quality requirements of yogurt in SNI 2891: 2009, which is a maximum of 10. Salmonella test showed negative results in all treatment groups. This condition is in accordance with the quality requirements of yogurt in SNI 2891: 2009, which is negative. Salmonella bacteria are inhibited through the process of making synbiotic yogurt by pasteurization with a temperature of about 80oC. In addition, the presence of Lactobacillus acidophilus bacteria is known to have a role in inhibiting the growth of pathogens such as Salmonella (25).

CONCLUSIONS AND RECOMMENDATIONS

The addition of unripe berlin banana flour can affect the LAB (p<0.05) and has the potential to be a functional food product with health benefits.

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Nutrient content, antioxidant activity, and organoleptic quality of coriander seeds (Coriandrum sativum L.) and white ginger (Zingiber officinale Rosc.) tea bags as functional drinks for hypertension

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ABSTRAK

Latar Belakang: Prevalensi tekanan darah tinggi di Indonesia meningkat hingga tahun 2018 sebanyak 34,1%. Tekanan darah yang tinggi dapat disebabkan oleh diet yang kurang sehat seperti konsumsi natrium berlebih sehingga diperlukan konsumsi kalium dan antioksidan yang dapat menurunkan tekanan darah.

Tujuan: Menganalisis mutu gizi (kadar air, kadar abu, kadar kalium, dan aktivitas antioksidan) dan mutu organoleptik (warna, aroma, dan rasa) pada teh celup biji ketumbar dan jahe putih sebagai minuman fungsional bagi penderita hipertensi.

Metode: Penelitian menggunakan eksperimental dengan jenis penelitian Rancangan Acak Lengkap (RAL) 3 taraf perlakuan dan 3 kali pengulangan dengan proporsi biji ketumbar dan jahe putih: P1 (55:45), P2 (50:50), dan P3 (45:55). Menentukan mutu organoleptik dengan metode hedonik dan deskriptif, kadar air dengan metode oven, kadar abu dengan metode pengabuan, kadar kalium dengan calculated value, dan aktivitas antioksidan dengan metode DPPH.

Hasil: Kadar air, kadar abu, dan kadar kalium masing-masing formulasi teh celup biji ketumbar dan jahe putih telah memenuhi standar. Nilai IC50 pada masing-masing formulasi teh celup biji ketumbar dan jahe putih menunjukkan sifat antioksidan yang sangat kuat. Hasil mutu organoleptik warna menunjukkan bahwa P2 (50:50) memiliki nilai tertinggi dan berbeda nyata dengan P1 (55:45) dan P3 (45:55) (p value < 0,05), sedangkan pada aroma dan rasa P2 (50:50) memiliki nilai tertinggi namun tidak terdapat perbedaan yang nyata (p value > 0,05).

Kesimpulan: Formulasi terbaik teh celup biji ketumbar dan jahe putih sebagai minuman fungsional bagi penderita hipertensi yaitu P2 (50:50).

KATA KUNCI: biji ketumbar; hipertensi; jahe putih; teh celup

ABSTRACT

Background: High blood pressure prevalence in Indonesia increased to 34.1% in 2018. High blood pressure can be caused by an unhealthy diet, including high sodium intake. Therefore, potassium and antioxidant intake are needed to lower blood pressure.

Objectives: Analyzing the nutritional quality (moisture content, ash content, potassium content, and antioxidant activity) and organoleptic quality (colour, aroma, and taste) of coriander seeds and white ginger tea bags as functional drinks for hypertension.

Methods: The study used experimental research with Completely Randomized Design (CRD) using three treatment levels and three repetitions with ratio of coriander seeds and white ginger used in this study is P1 (55:45), P2 (50:50), and P3 (45:55). Determinating organoleptic quality using hedonic and descriptive, water content using oven method, ash content using incineration method, potassium content using calculated value, and antioxidant activity using DPPH method.

Results: Moisture content, ash content, and potassium content of each coriander seed and white ginger tea bag formulation have met the standards. The IC50 values in each coriander seed and white ginger tea bag indicate very strong antioxidant properties. Organoleptic quality results for colour indicate that P2 (50:50) has the highest value and significantly differs from P1 (55:45) and P3 (45:55) (p-value < 0.05), while for aroma and taste, P2 (50:50) has the highest value but no significant difference was observed (p-value>0.0.

Conclusions: The best formulation of coriander seeds and white ginger tea bags as a functional drink for hypertension is P2 (50:50).

KEYWORD: coriander seed; hypertension; tea bags; white ginger

INTRODUCTION

Basic Health Research in 2018 reported that the prevalence of hypertension in the population aged > 18 years increased from 25.8% in 2007 to 34.1% in 2018 (1). The prevalence of hypertension in 2018 in East Java was relatively higher than in Indonesia. Furthermore, the prevalence of hypertension in 2021 remained relatively unchanged, at 36.2% (2).

Fitri et al. (2018) research showed that 82.4% of hypertensive elderly respondents consumed sodium (3). The research results by Rohatin and Prayuda (2020) showed that among 34 elderly respondents with low potassium intake, 28 elderly respondents had hypertension (4). According to Kurniadi and Nurrahmani (2017), sodium consumption should be balanced with potassium consumption. An increased concentration of potassium in the intracellular fluid will lower blood pressure (5).

Afifah's (2019) research showed that there was a decrease in blood pressure from 170/100 mmHg to 145/80 mmHg after being given a decoction of coriander seeds 1.5% in 100 mL for 3 days (6). With the same amount of decoction, the research results by Rahmah (2021) also showed a significant decrease in blood pressure from 156/94 mmHg to 124/82 mmHg (7). The Indonesian Nutritionist Association (2018) states that 100 g of coriander seeds contains 1787 mg of kalium, which can lower blood pressure (8). Widiasari (2018) explained that flavonoid content in coriander seeds also has an antihypertensive effect that lowers oxidative stress levels, inhibiting angiotensin-converting enzyme (ACE), which acts as a regulator of artery blood pressure and electrolyte and promotes endothelial relaxation (9).

Tamrin et al. (2015) research showed that 52.8% of respondents experienced a decrease in blood pressure after being given 4% white ginger extract for five consecutive days (10). Kristiani and Ningrum (2020) explain that gingerol compounds in white ginger are capable of lowering blood pressure by blocking calcium channel voltage in blood vessel cells, resulting in vasodilation (11). Andini et al. (2023) research

showed that the addition of ginger powder up to 40% resulted in colour and aroma with the highest level of panelist's favorability, namely 3.65 (like) and 4.20 (like) (12).

Each coriander seed and white ginger are great ingredients in herbal tea, but both are only processed by boiling the ingredients. Therefore, this process caused the tea to not last long. Research by Septiwi et al. (2019) showed that drying by the roasting method reduced the moisture content in bay leaves and red ginger rhizomes by 3% and 5%, respectively (13). Based on these facts, a study needs to be conducted on formulating coriander seeds and white ginger tea bags to prolong their shelf life without reducing or altering the nutrient component in both ingredients, which can be utilized in tea as functional drinks. Functional drinks or foods should help to prevent a disease occurrence; they should do more than just provide basic nutrition and can be consumed as a normal diet (14).

MATERIALS AND METHODS

The study uses experimental research with a Completely Randomized Design (CRD) design using three treatment levels and three repetitions. The treatment levels are determined based on the lack of potassium consumption by 1056.2 mg. The treatment levels using ratio of coriander seeds and white ginger used in this study is P1 (55:45), P2 (50:50), and P3 (45:55). The research was conducted from January to June 2023 at 1) the Food Material Science Laboratory, 2) the Ministry of Health Malang Health Polytechnic for the processing of coriander seed and white ginger tea ingredients, 3) the Faculty of Public Health Laboratory, Airlangga University for testing water content, ash content, and antioxidant activity, and 4) the Organoleptic Laboratory, Ministry of Health Malang Health Polytechnic for organoleptic quality testing.

The formulation of coriander seed and white ginger tea bags uses coriander seeds, white ginger tea bags, and mineral water. Coriander seeds are processed by roasting for 1 hour and then blended after cooling. White ginger is processed by blanching in boiling water at 100 °C for 1 minute and then cut crosswise. Additionally, white ginger is dried in an oven at 60 °C for 6 hours, and then it is blended. Afterward, coriander seed powder and white ginger powder are mixed and weighed according to treatment levels. Finally, the mixture of coriander seed powder and white ginger powder is placed in tea bags at 2 g each and sealed with a string.

Nutrient content analysis using provisions in accordance with the Indonesian National Standards Number 01-2891-1992. Water content is measured using the oven method, and ash content is measured using the ashing method; meanwhile, potassium content is measured using the calculated value method. Analyzing potassium content using calculated value by determining retention factor first based on the Food and Agriculture Organization (FAO) (2002) according to the type of material and its processing method, and then estimating potassium content using the formula potassium content raw material multiplied by its retention factor then divided by yield factor. Antioxidant activity is measured using the DPPH method based on research by Dinanti (2016) (15). Organoleptic quality preference testing uses a hedonic test with 30 untrained panelists from the Nutrition Department, Malang Ministry of Health Polytechnic. The hedonic test scale ranges: 1 = strongly dislike, 2 = dislike, 3 = like, and 4 = strongly like. Descriptive testing uses a descriptive test with 10 trained panelists from the Nutrition Department, Malang Ministry of Health Polytechnic, where panelists assess the sensory evaluation strength of the product using a scale ranging from: 1 = very weak, 2 = weak, 3 = moderately strong, 4 = strong, and 5 = very strong. Test results data are processed using SPSS 20. Water content, ash content, and antioxidant activity data are analyzed using One Way Anova and the post-hoc Duncan Multiple Range Test. Preference test data is analyzed using Kruskal-Wallis analysis and post-hoc Mann Whitney test.

RESULTS AND DISCUSSIONS
Water Content

One Way Anova test shows that there are significant differences in the variables of water content. Duncan's post-hoc tests on water content showed marked differences between P1 and P2 with P3. The water content of coriander seed and white ginger tea bag formulations ranges from 2.47 – 4.12%. The results showed that the higher

the proportion of white ginger, the higher the water content in coriander seed tea bags and white ginger.

The water content at each treatment level has met the requirements based on the Indonesian National Standard (SNI) 3836-2013, where the maximum water content is 8%. This is in line with the results of research by Andini et al. (2023), which show that the higher the proportion of ginger addition, the higher the water content in tea (12). The Indonesian Nutritionist Association (2018) states that fresh white ginger contains 55% water content, so the addition of ginger to tea will increase water content (8).

Ash Content

Duncan's post-hoc test on ash content showed that the P1 treatment level was significantly different from P2 and P3, the P2

treatment level was significantly different from P1 and P3, and the P3 treatment level was significantly different from P1 and P2. The ash content of coriander seed and white ginger tea bag formulations ranges from 1.34 – 1.96%. The lower the proportion of coriander seeds, the higher the ash content in coriander seed tea bags and white ginger.

The ash content at each treatment level has met Indonesian National Standard (SNI) 3836-2013 requirements with a maximum ash content of 8%. The results showed that the ash content at each treatment level of coriander seed tea bags and white ginger was below the specified requirements. In line with the results of research, Siagian et al. (2020) showed that the processing of herbal tea with the same drying time and temperature of 8 hours and a temperature of 50 °C resulted in an ash content of 1.04 – 1.20% (16).

Table 1. Average nutrient levels and IC50 value of coriander seed and white ginger tea bags

Treatment levels (%) *	Water content (%) **	Ash content (%) **	Potassium content (mg)	IC50 value (ppm) **
P$_1$ (55:45)	2.47 ± 0.26^a	1.34 ± 0.09^a	1151.47	48.71 ± 0.49^a
P$_2$ (50:50)	3.02 ± 0.30^a	1.67 ± 0.10^b	1027.43	37.24 ± 7.78^a
P$_3$ (45:55)	4.12 ± 0.67^b	1.96 ± 0.16^c	903.39	31.35 ± 0.24^b

*) Proportion of coriander seeds and white ginger
**) Values followed by the same letter indicate non-significant difference

The ash content describes the minerals and contaminants contained in tea. The higher the ash content, the higher the contaminants in tea. This is due to the presence of soil or sand residues on the surface of the material. Low ash content in tea indicates good tea quality, but the lower the ash content, the lower the mineral content in the tea (17).

Antioxidant Activity

Duncan's post-hoc test results at IC50 values showed that the level of P3 treatment was significantly different from P1 and P2. The IC50 values of coriander seed and white ginger tea bag formulations range from 31.35 to 48.71 ppm. The lower the proportion of coriander seeds, the lower the IC50 value in the formulation of coriander seed tea bags and white ginger.

Martinez et al. (2020) explain that the lower the IC50 value, the stronger the antioxidant properties in the material. IC50 values below 50

ppm fall into the category of very strong antioxidant properties (21). Its powerful antioxidant abilities can affect blood pressure drops. Antioxidants such as flavonoids have antihypertensive effects that can reduce oxidative stress and inhibit ACE. Gingerol compounds in white ginger are able to prevent blood clots so that blood vessels dilate and blood pressure decreases (9).

Potassium Content

The higher the proportion of coriander seeds, the higher the potassium levels in coriander seed tea bags and white ginger. The highest potassium levels were produced at the P1 treatment level with a proportion of coriander seeds and white ginger of 50:50, which was 1151.47 per 100 g. The Tea Council of Canada (2023) states that a good serving dose of tea bags for high potassium consumption is as much as three tea bags with a weight per bag of 2 g (18). The results of a study

by de Abreu et al. (2023) showed that root vegetables and herbs, after soaking for 5 minutes in deionized water heated to boiling point, can reduce potassium content by up to 15% (19). Therefore, coriander seed tea bags and white ginger can meet the lack of potassium consumption by 1 – 2%, which is 15 – 19 mg per serving.

A food product can be said to be a source of potassium if it has met 15% of the needs based on the Recommended Dietary Allowance per 100 g of ingredients (20). The results showed that in 100 g of coriander seed and white ginger tea bags ingredients, they met the standard for P1 formulation with a proportion of coriander seeds and white ginger 55:45 by 24.5%; P2 formulation with a proportion of coriander seeds and white

ginger 50:50 by 21,9%; and P3 formulation with a proportion of coriander seeds and white ginger 45:55 by 19,2% from potassium intake based on Recommended Dietary Allowance.

Organoleptic Preference

Organoleptic characteristics of coriander seeds and white ginger tea bags in **Figure 1** showed that the bitterness was strongest at the P1 treatment level of 2.6 (moderately strong). The strongest spiciness was felt at the P3 treatment level of 3.7 (strong). Coriander aroma is strongest at the P1 treatment level of 3.4 (rather strong). The distinctive ginger aroma is the strongest at the P3 treatment level of 4.4 (strong). The yellowness at the P1 treatment level has the highest yellow color level of 4.0 (strong).
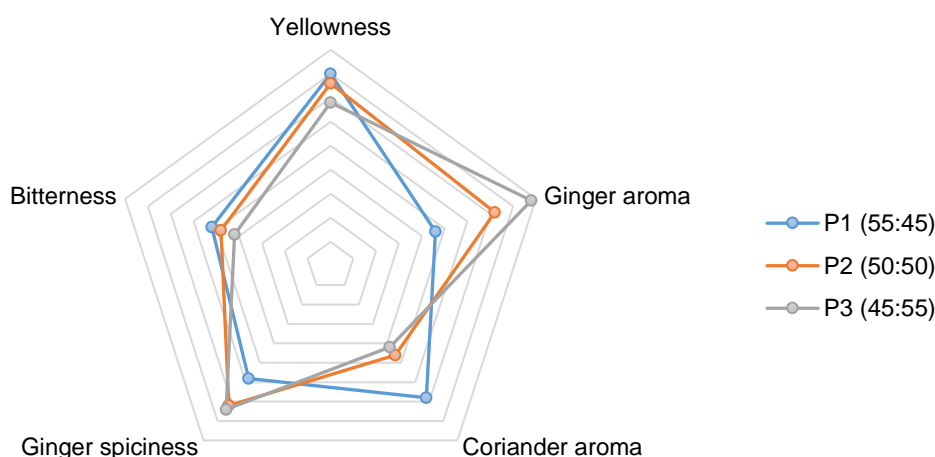

Figure 1. Organoleptic characteristics of coriander seeds and white ginger tea bags

The results of the Kruskal-Wallis test showed that there was a significant difference in the color preference between the formulation of coriander seed and white ginger tea bags, while there was no significant difference in aroma and taste preferences. The color preference was significantly different in P2 treatment with P1 and P3. The P2 treatment level with a proportion of coriander seeds and white ginger of 50:50 resulted in the panelist preference level for the highest color, aroma, and taste quality, with values of 3.43 for color, 3.33 for aroma, and 2.97 for taste.

Panelist's preference level for formulations of coriander seed and white ginger tea bags was highest when the proportion of white ginger was up to 50%. However, at the P3 treatment level, which had the highest proportion of white ginger at 55%, the panelist favorability decreased. A proportion of white ginger more than 50% resulted in an herbal tea with a stronger aroma that was less preferred by panelists. The level of taste preference in coriander seed and white ginger tea bags increased in the proportion of coriander seeds up to 50%. However, when the proportion

of coriander seeds exceeded 50%, panelist favorability decreased.

The results of the research showed that P2 treatment levels with the proportion of coriander seeds and white ginger 50:50 have the highest color, aroma, and taste preference levels. Research by Andini et al. (2023) showed that adding white ginger up to 40% resulted in higher panellist likeliness by 3,65 (like) (12). Pebiningrum et al. (2017) explained that white ginger contains oleoresin, which is dark brown. This substance includes phenolic compounds that

are easily oxidized, causing the formation of quinones (ketone compounds) that are brown (22). The coriander aroma is produced from the essential oil content of coriander seeds, which ranges from 0.4 to 1.1%. Coriander seed essential oil has compounds that function as aromatic compounds so that they can cause aromas that overlap with other aromas in food (23). White ginger contains gingerol, shogaol, and zingerone, which are the components that produce a pungent, distinctive taste and aroma in ginger (24).

Table 2. Panelist level of preference for organoleptic quality of coriander and white ginger tea bags

Treatment levels (%) *	Strongly dislike		Dislike		Like		Strongly like		Average ± SD **
	n	%	n	%	n	%	n	%	
Color									
P_1 (55:45)	0	0	6	20	21	70	3	10	2.90 ± 0.55^a
P_2 (50:50)	0	0	3	10	11	36.7	16	53.3	3.43 ± 0.68^b
P_3 (45:55)	0	0	9	30	14	46.7	7	23.3	2.93 ± 0.74^a
Aroma									
P_1 (55:45)	0	0	7	23,3	13	43.3	10	33.3	3.1 ± 0.76^a
P_2 (50:50)	0	0	3	10	14	46.7	13	43.3	3.33 ± 0.66^a
P_3 (45:55)	0	0	6	20	17	56.7	7	23.3	3.03 ± 0.67^a
Taste									
P_1 (55:45)	2	6.7	9	30	17	56.7	2	6.7	2.63 ± 0.72^a
P_2 (50:50)	0	0	7	23.3	17	56.7	6	20	2.97 ± 0.67^a
P_3 (45:55)	2	6.7	7	23.3	15	50	6	20	2.83 ± 0.83^a

*) Proportion of coriander seeds and white ginger

**) Values followed by the same letter indicate non-significant difference

Coriander seeds have an earthy bitter flavor or bitter taste with earthy or typical plant nuances. Khetrapal (2021) explained that coriander seeds have a distinctive bitter taste caused by the content of linalool compounds in essential oils. Linalool compounds cause citrus and soapy flavor effects in coriander seeds (23). The distinctive spiciness taste of ginger is produced from the oleoresin compound content of white ginger. The content of oleoresin compounds includes gingerol, zingiberen, shagaol, essential oils, and resins. Gingerol compounds, together with zingeron and shogaol compounds, cause ginger to have a spicy taste (24).

The P2 treatment rate with the formulation of coriander seed tea bags and white ginger 50:50 can be consumed as a daily drink. The formulation of coriander seed tea bags and white ginger with a weight per bag of 2 g can be

consumed by brewing with 200 ml of mineral water at 100 °C for 5 minutes (25). Coriander seed and white ginger tea bags can be served without or with sweeteners.

CONCLUSIONS AND RECOMMENDATIONS

Coriander and white ginger tea bags in the P2 formulation with a proportion of coriander seeds and white ginger of 50:50 is the best treatment level with a moisture content of 3.02%, ash content of 1.67%, potassium content of 21.9% RDA per 100 g of material, and an IC50 value of 37.24. The best treatment level of P2 has a yellow-orange gold color with a panelist favorability level of 3.43 (likes), a slightly concentrated ginger aroma with a panelist favorability level of 3.33 (likes), and a deep spicy taste with a panelist favorability level of 2.97 (likes).

Coriander seed tea bags and white ginger at the P2 treatment level can be recommended as functional drinks for people with hypertension with high potassium and antioxidant content. Steeping the formulation of coriander seed tea bags and white ginger produces a precipitate that causes a darker steeping color. This can be caused by tea powder that is too fine. It is necessary to study the length of the destruction of ingredients to produce coarse tea powder.

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