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Formulation, Analysis of Nutrient Content and Power Accept Crackers with Addition of Flour Red Spinach Leaves and Nike Fish Flour as Alternative Snack for School-Age Children

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ABSTRACT
Students need adequate nutrients for their growth and development. Inadequate nutrition can lead to nutritional problems; anaemia is the most common among students. In 2018, the prevalence of anaemia in Central Sulawesi was 0.16%. This study aimed to determine the formulation of crackers, nutritional substances, and acceptability of the additional red spinach flour and Nike fish flour as an alternative snack. The method used for this study was experimental through a Random Design (RAL). The research was conducted from July 2–18, 2023. There were three formulations used with a comparison of red spinach flour and Nike fish flour: F1 (5%:35%), F2 (10%:30%), and F3 (15%:25%). Based on the results of organoleptic tests, it was found that there were significant differences in the colour, aroma, taste, and texture of crackers. The cracker's formula chosen was F3, which contained the following nutrients per 100 grams of water: 5.627%, ash 5.641%, protein 13.193%, fat 15.287%, carbohydrates 60.250%, iron 7.111 mg, and vitamin C 14,766 mg. It was concluded that crackers with the additional red spinach flour and Nike fish flour could achieve the nutritional needs as a contribution of snacks toward students' Recommended Dietary Allowances (RDA) by consuming the crackers in 50 grams of 18 pieces.
Keywords*: Formula, Nutritional substance, Snacks, Students*

ABSTRAK
Anak sekolah membutuhkan nutrisi yang cukup untuk pertumbuhan dan perkembangannya. Tidak tercukupinya kebutuhan gizi anak sekolah dapat menyebabkan masalah gizi. Salah satu masalah gizi yang sering terjadi pada anak usia sekolah adalah anemia. Prevalensi anemia di Sulawesi Tengah pada tahun 2018 sebesar 0,16%. Penelitian ini bertujuan untuk mengetahui formulasi, kandungan gizi dan daya terima kerupuk dengan tepung daun bayam merah dan tepung ikan nila sebagai alternatif jajanan anak sekolah. Metode penelitian eksperimental ini menggunakan Rancangan Acak Lengkap (RAL). Penelitian ini dilaksanakan pada tanggal 2 Juli

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hingga 18 Juli 2023. Terdapat tiga formulasi yang digunakan dengan perbandingan tepung daun bayam merah dan tepung ikan nila yaitu F1 (5%:35%), F2 (10%:30%), dan F3 (15%:25%), berdasarkan hasil uji organoleptik menunjukkan bahwa terdapat perbedaan yang signifikan terhadap warna, aroma, rasa, dan tekstur pada kerupuk. Formula kerupuk yang terpilih adalah F3. Kerupuk mengandung zat gizi per 100 gram yaitu kadar air 5,627%, abu 5,641%, protein 13,193%, lemak 15,287%, karbohidrat 60,250%, zat besi 7,111 mg, dan vitamin C 14,766 mg. Disimpulkan bahwa kerupuk dengan tepung daun bayam merah dan tepung ikan nila dapat memenuhi kebutuhan gizi sebagai sumbangan makanan selingan terhadap AKG anak usia sekolah dengan mengkonsumsi 50 buah kerupuk yang terdiri dari 18 buah.

Kata kunci : Anak sekolah, Formulasi, Makanan jajanan, Zat gizi

INTRODUCTION

In Indonesia, schoolchildren are generally between the ages of 7 and 12. Energy requirements for school-age children are more significant than for other ages, with energy requirements around 80-90 kcal/kgBB/day with 1 gram/kgBB/day protein adequacy. This is because school-age children often do physical activity, requiring greater energy intake. School-aged children are still in the process or stage of growth and development and are quite at risk of experiencing nutritional problems; children who experience nutritional issues can quickly get sick and experience a decline in academic performance, resulting in death (Aulia, 2022). As for dietary problems that usually occur in school-age children, they are underweight and lack protein energy (PEM) and iron deficiency anaemia (Putri, Briawan and Baliwati. 2021).

Iron deficiency anaemia is a nutritional problem caused by a lack of iron (Fe) intake, so the formation of red blood cells and other bodily functions are disrupted (Nurbadriyah, 2021). Iron deficiency anaemia in school-age children is still an unresolved nutritional problem because the prevalence of anaemia in school-age children is more than the national standard, namely ≥20%. (Putri, Briawan and Baliwati. 2021). *World Health Organization* (WHO) Year 2008 in *Worldwide Prevalence of Anemia* reported that the world's entire population suffers from as many as 1.62 billion people, with a prevalence of 25.4% worldwide suffering from anaemia. (Sudarman, et al. 2020) . Based (on the Ministry of Health of the Republic of Indonesia 2018), Basic Health Research Data (Riskesdas) in 2018 reported prevalence incidences of anaemia nutrition iron in Indonesia in children aged 5-12 years as many as 29%. Meanwhile, there were incidences of anaemia in the Province Central Sulawesi year 2018

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group aged 10-14 years as many as 431 people (Ariani et al., 2022).

The high prevalence of iron anaemia in school-aged children is a nutritional problem that must be considered. Therefore, one way to overcome this problem is by consuming food sources containing protein and iron (Utami, Kamil, and Chusna. 2022). One of the efforts that can be made to prevent anaemia in school children is iron, which provides snacks or snacks as additional food for daily consumption (Febriyani, Ekawati and Ina. 2022). Snacks that school children often consume tend to contain little nutritional content (Astuti and Kulsum, 2020). Schoolchildren often consume snack foods such as chips, pastries, and cracker biscuits (Aini, 2019).

The structure of *crackers* comes from flour wheat, and increasing consumption of flour wheat will affect food security and health less because of the glycemic index, which is high in flour wheat. Therefore, one way to increase nutritional value, especially protein content and iron in crackers, is by adding local food ingredients such as flour leaves, red spinach, and nike fish (Jamlean et al., 2020).

Red spinach (Amaranthus tricolor L.) is considered the king of vegetables because it contains nutrients that are good for the body. Spinach contains lots of essential salts and minerals such as vitamin C, calcium, phosphorus and iron (Hartini, Sholihah and Manshur. 2019) while Nike fish (*Awaous Melanocephalus*) is a type of fish found in Gorontalo waters and has nutritional content, namely water content of 79.76%, protein 16.89%, carbohydrates 0.30%, besides that nike fish has a high amino acid content. Complete, both essential and non-essential, the amino acids leucine and lysine have a higher concentration in the essential amino acid group at 1.153% and 0.843% and for non-essential the highest concentration in glutamate and proline content is 1.478% and 0.821% (Azis and Akolo, 2019) This research aims to determine the formulation, nutritional content and acceptability of crackers with the addition of red spinach leaf flour and Nike fish flour as an alternative snack for school-aged children.

METHOD

The research design used is *an experimental trial* with the Completely Randomized Design (CRD) method with three treatments and two repetitions from June 2023 to July 2023. The treatment carried out in the experimental unit was the comparison of red spinach leaf flour and Nike fish meal F1 (5%:35%), F2 (10 %:30%) and F3 (15%:25%). The organoleptic test panellists were semi-

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trained (female students of childbearing age from the Widya Nusantara University nutrition study program). The research sample consisted of 30 students of childbearing age aged 19-29 years.

F formulation used in making *crackers* with the addition of flour, red spinach leaves, and Nike fish meal, namely:

Table 1. The formulation in making crackers

Material	Treatment		
	F1	F2	F3
Wheat flour (g)	150	150	150
Red amaranth flour (g)	7,5	15	22,5
Nike fish meal (g)	52,5	45	37,5
Cornstarch	5	5	5
Salt (g)	4,5	4,5	4,5
Sugar (g)	7,5	7,5	7,5
Margarine (g)	7,5	7,5	7,5
Yeast (g)	3	3	3
Vanilla powder (g)	1	1	1
Baking soda (g)	2	2	2
Water (ml)	7,5	7,5	7,5
Total	248	248	248

RESULTS AND DISCUSSION

Making Red spinach flour and Nike Fish Meal

Red spinach flour is made for two days, where on the first day, the process of separating the spinach leaves from the stalks is carried out, then the blanching process, namely boiling with boiling water for 5 minutes, then drying, which is carried out using a dehydrator at a temperature of 70oC for 4 hours. After drying, the red spinach leaves are ground using a blender and then sifted to produce red spinach leaf flour. At the same time, the Nike fish meal is made within three days, where on the first day, the Nike fish is washed, steamed for 20 minutes, and then drained. After that, the Nike fish is ground using a grinder, and when the Nike fish is smooth, arrange it on an oven tray and bake it at 900C for 6 hours; after that, the fish is blended and then sifted to produce Nike fish flour. Meanwhile, the process of making crackers is through mixing the ingredients until they become a dough, and then the dough is left to rest for 30 minutes; then, the dough is moulded using a pasta machine and baked in the oven at 160ºC for 20 minutes.

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Nutrient-content *crackers* with the addition of red spinach leaf flour and Nike fish meal

The analysis carried out in this research includes analysis of proximate and analysis content substances such as iron and vitamin C in three formulations. Results analysis on *crackers* with the addition of flour leaves, spinach red, and flour fish nike 100 g ram presented in Table 2

Table 2. Mean values and significance analysis proximate, substance iron, and vitamin C *crackers*

Nutrient content	Results of Nutrient Content Analysis			Sig
	F1	**F2**	**F3**	
Water content (%)	8.591 ± 0.463b	10.149 ± 0.335c	5.627 ± 0.491a	0,004
Ash Content (%)	4.591 ± 0.091a	4.816 ± 0.100a	5.641 ± 0.009b	0,002
Protein Content (%)	12.418 ± 0.057a	12.829 ± 0.082ab	13.193 ± 0.232c	0,030
Fat level (%)	13.003 ± 0.092a	14.339 ± 0.261b	15.287 ± 0.313c	0,006
Carbohydrate Content (%)	61.395 ± 0.404b	57.866 ± 0.415a	60,250 ± 1,026b	0,030
Iron (mg)	4.703 ± 0.077a	5.228 ± 0.132a	7.111 ± 0.596b	0,013
Vitamin C (mg)	12.468 ± 0.299a	13.147 ± 0.027b	14,766 ± 0149c	0,003

Source: Data Primary Year 2023

Note: a, b, c = different test results based on the *Duncan* test. Other letters in the same column indicate significant differences ($p<0.05$)

Test results *ANOVA test* which was carried out showed $P<0.05$, so there is a significant influence for each treatment (F1, F2, and F3) on nutritional content (content water, ash, protein, fat, carbohydrates, substances iron, and vitamin C) in *crackers with* addition of flour leaves spinach red and flour fish nike. After that, Duncan's test was used to find out which groups have significant significance in a significant way. Test results *Duncan* found that nutritional content (water, ash, protein, fat, carbohydrates, iron, and vitamin C) in F1, F2, and F3 have a significant influence.

Test organoleptic three formulations.

Organoleptic testing uses the human senses to measure food products' aroma, texture,

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appearance, and taste. Consumer acceptance of a product begins with an assessment of its appearance, taste, and texture, and ultimately, the goal is consumer acceptance of the food product being tested (Permadi, Oktafa, and Agustianto, 2019). The results of the hedonic test in this study are presented in Table 3.

Table 3. Acceptability of crackers with the addition of red spinach leaf flour and Nike fish flour

Organoleptic test parameters	Formulation			Sig
	F1	F2	F3	
Colour	4.80 ± 0.925b	4.60 ± 1.192ab	4.20 ± 1.064a	0,091
Odor	4.37 ± 0.964a	4.60 ± 1.221 a	4.77 ± 1.006 a	0,351
Flavor	3.47 ± 1.042a	4.27 ± 1.363b	4.93 ± 0.980c	0.000
Texture	3.50 ±1.432a	3.90 ± 1.447a	5.17 ± 1.053b	0.000

Source: Primary Data for 2023

Information: a, b and c = different test results from the Duncan test. Other letters in the same column indicate significant differences (P<0.05)

The hedonic test results in Table 4.2 show that the colour and aroma parameters have a significant value of P>0.05, so Ho is accepted, meaning that the variants in the group are homogeneous (same). At the same time, the taste and texture are seen based on a significant value of 0.000 (P<0.05), so Ho is rejected, which means there is a significant difference in *crackers* F1, F2 and F3.

Colour

Test results hedonic average the preference for colour on *crackers* with a combination of flour leaves spinach red and flour fish nike more preferred in F3, namely a combination of flour leaves spinach red as much as 5% grams and flour fish nike 35 % gram has the highest value among the others. The reason for choosing the third formula is because the less the flour leaves spinach red, and the more the addition of flour flourishes Nike, the more it produces colour crackers.

This is in line with research by Santoso, Ronasari and Parwiyanti, 2020 which states that there is an enzymatic browning reaction due to the addition of red spinach leaf flour where red spinach leaves have polyphenol compounds which contain phenolase enzymes at the stage of the process of refining red spinach leaves, cell breakdown occurs which results in The phenolase enzyme comes into contact with oxygen and

the contact between the phenolase enzyme and oxygen creates an enzymatic browning reaction which causes a brown or dark colour to appear. Therefore, the formula with a bit of red spinach leaf flour addition has a brighter colour than other formulas.

Odor

The results of the hedonic test mean the average preference for the aroma of *crackers, which is found in the Ketifa formula with the F3 label, namely a combination of 22.5 grams of red spinach leaf flour and 37.5 grams of Nike fish flour. The aroma of crackers is influenced by the addition of Nike fish flour, which has a slightly fishy smell. The less Nike fish flour added to the crackers mixture, the better the aroma of the crackers*. This aligns with research by Nadimin, Nurjaya, and Lestari (2018), which explains that fish have a distinctive odour that creates a sharp aroma and is difficult to neutralize. The unique aroma of this fish influences the preference for food products.

Flavor

The results of the hedonic test mean the preference value for the taste of *crackers* with a combination of red spinach flour and Nike fish flour in the selected formula, F3, which has a combination of 22.5% red spinach flour and 37.5 gram Nike fish flour. The high score compared to the other two formulas was due to adding less Nike fish meal to F3, so the taste was more acceptable to the panellists.

This is in line with the research of Hemeto, Ahmad, and Mcepate (2019), which states that the results of adding Nike fish meal influence the panellists' level of preference, where the more Nike fish meal is added, the lower the panellists' level of preference for the taste of the product. The presence of amino acids causes the distinctive flavour of fish. Non-essential in fish is amino glutamate.

Texture

The results of the hedonic test on crackers combining red spinach flour and Nike fish flour for the selected formula, which has the highest favorability value among the others, are F3. In F3, the red spinach flour added is 22.5 grams and fish meal Nike is 37.5 grams. The high water content influences the texture of crackers due to the addition of red spinach leaf flour.

This is in line with research by Adi and Tamonob, 2022 which stated that the texture was influenced by adding red spinach leaves, which increased by up to 15% because the percentage of adding spinach 15% still did not change the product's texture. Hence, the panellists liked the resulting texture. The same thing is also

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explained in the research of Loaloka et al ., 2021 where the hardness of a product will decrease with increasing water content in the food ingredient.

Formula *crackers* selected with the addition of flour spinach red and flour fish nike

The analysis carried out in this study included proximate analysis, iron content, and vitamin C in the selected formula (F3). The results of proximate analysis, content, iron, and vitamin C in crackers with the addition of red spinach leaf flour and selected formula Nike fish flour (F3) are presented in Table 4.

Table 4. Nutrient Content of Selected Formulations

Formulas	Parameter	Average Value of Nutrient Content
F3	Water content (%)	5,627
	Ash content (%)	5,641
	Protein content (%)	13,193
	Fat level (%)	15,287
	Carbohydrate content (%)	60,250
	Iron (%)	7,111
	Vitamin C (%)	14,766

Source: Primary Data Year 2023

Based on the results of the selected formulation, F3, the highest nutritional content is found in carbohydrates, with an average value of 60,250 grams. In contrast, the lowest is found in water, with an average value of 5,627 grams.

Contribution of *crackers* with the addition of flour spinach red and flour fish nike to figures adequacy child nutrition school

The nutritional adequacy figure is a value that shows the average need for certain nutrients that must be met every day for almost all people with specific characteristics, including age, gender, level of physical activity and physiological conditions, to live a healthy life. Processed food intended as a snack has a 10-20% nutritional contribution (Kurniawati et al. 2022). The following is the contribution of *crackers*, a combination of red spinach flour and Nike fish flour, to the RDA of school children:

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Table 5. Contribution crackers to the RDA of school children aged 7-9 years

Parameter	Unit	Nutritional content (100 grams)	AKG	%RDA
Energy	kcal	431,355	1650	26,14
Proteins	grams	13,193	40	32,98
Fat	grams	15,287	55	27,79
Carbohydrate	grams	60,250	250	24,1
Iron	milligrams	7,111	10	71,11
Vitamin C	milligrams	14,766	45	32,81

Source: Primary Data 2023

The resulting contribution of *crackers* in the selected formulation exceeds the nutritional requirements as a snack food, namely 10%-20% of the number of servings *crackers* 100 grams/day so that the product *crackers* can be given as much as 50 grams a day to qualify as a snack with an amount of 18 pieces. 18 crackers can be eligible as a snack, with a percentage of 13.07% - 16.49%. K, the water content in crackers with twice repetition of the selected formula is F3 as many as 5.627%, so it can be stated that the water content in crackers still does not meet Standards Indonesian National (SNI) 01-2973-1992, which determines that the water content in crackers is a maximum of 5%. The high water content in product crackers is influenced by adding flour, leaves, spinach, water, wheat, sugar, and margarine.

Water content

The results of the high water content in these crackers are in line with research by Rahmawati, Karimuna, and Hemanto (2020), which states that the water content is influenced by the amount of spinach flour added, where the more red spinach flour added to the product, the higher the water content. The water content of cracker products affects the shelf life and level of crunchiness. The higher the water content of crackers, the shorter the shelf life.

Ash content.

An analysis of the ash levels of the selected formula F3 with results of 5.641% looks very good. It is clear that the ash levels in crackers' combination of flour leaves, spinach red, and flour fish Nike still do not fulfil the quality requirements. Adding flour leaves, spinach, flour fish Nike, and flour wheat influences high ash levels in crackers.

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This is in line with research by Rahmawati, Karimuna and Hemanto 2020 which stated that the more spinach leaf flour added to a product, the greater the ash content because spinach leaf flour can contribute to high ash content. The ash content in the cracker product shows that the cracker combination of red spinach leaf flour and Nike fish flour has mineral content. The presence of minerals in crackers, a combination of red spinach leaf flour and Nike fish flour, can be a healthy snack alternative for school-aged children.

Proteins

The protein analysis results for F3 as the selected formula were 13.193%, while the protein quality requirements *for crackers were by SNI. 01-2973-1992, namely a maximum of 9%. So, it is known that the quality requirements for crackers, a combination of red spinach leaf flour and Nike fish flour, still do not meet them*. Adding spinach leaf flour and wheat flour influences the high protein content in F3.

The high protein content in *crackers* is in line with research, which states that the more spinach leaf flour added to the product, the higher the protein content is because spinach leaf flour has a protein content of 2.16%. Children of school age require a sufficient protein intake to meet daily needs. The high levels of protein in *crackers, the combination of red spinach leaf flour,* and Nike fish meal can be an alternative healthy snack for children school age.

Fat

The results of the analysis of the average fat content of crackers with the addition of red spinach leaf flour and Nike fish meal for F3 were 15.287%, so it is known that the fat content of crackers in this study has met the requirements for fat quality in crackers according to SNI. 01-2973-1992. This product cracker has a high-fat content because the presence of ingredients such as margarine influences it.

This is in line with research by Regina, Soukotta and Gaspersz 2021 where the results of the study state that the fat content in biscuits made by mixing other ingredients, such as margarine, makes the biscuits have a high-fat content, the same thing happens. As explained in research by namely the fat content in cookies is influenced by the contribution of other ingredients such as eggs and margarine, where there are 50% fatty acids in margarine in the form of lipoproteins, which, when added to the dough will cause *cookies* to have high-fat content.

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Carbohydrate

H, the results of the analysis of carbohydrate content in *crackers* F3 were 60.250%. Requirements for the quality of carbohydrates in *cracker* products are not specified in SNI. 01-2973-1992. The high level of carbohydrates in *crackers* is influenced by the addition of spinach leaf flour and wheat flour, which produces high levels of other nutrients, such as where these nutrients affect the calculation of the carbohydrate content.

This is in line with research, which states that carbohydrate levels calculated *by different* methods are influenced by other components such as ash, protein, and fat content. The K carbohydrate content in crackers with red spinach leaf flour and Nike fish meal is one energy source that can be utilised to meet the daily needs of children of school age.

Iron

The ferrous metal analysis was carried out on the *crackers* product with three formulations in two repetitions. Then, the average result of ferrous metal in *crackers* with the selected formula, F3, was 7.111%. The chosen formula has a high iron content due to the significant addition of spinach leaf flour, namely 22.5 grams, more than in the other two formulations.

This is in line with research by Syah et al., 2022 which states that iron levels do not decrease or are not easily damaged by the heating process. The large contribution of red spinach leaf flour is a factor in increasing iron levels in products. Requirements for the quality of iron in crackers are not included in SNI. 01-2973-1992. The iron content in cracker products, with red spinach leaf flour and Nike fish meal, can be an alternative healthy snack to meet the daily iron needs of school-aged children.

Vitamin C

The average results of vitamin C analysis for the three formulations were F1: 12.468%, F2: 13.147% and F3: 14.766%. The large addition of red leaf flour causes the high vitamin C content in F3. Based on the results of the vitamin C analysis, it is known that the highest is found in the third formulation, namely a combination of 22.5% red spinach flour and 37.5% Nike fish flour. This is in line with research by Putra, Lumbessy and Setyowati 2022 which stated that spinach flour has a high vitamin C content, so adding spinach flour to a product can increase the vitamin C content of the product. Vitamin C also plays an important role in the body's absorption of non-heme iron. The vitamin C content in cracker products, with the addition of red spinach leaf flour and Nike fish flour, can be an alternative healthy

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snack to meet the daily vitamin C needs of school-aged children.

CONCLUSION

The formulation for making crackers is done by adding red spinach leaf flour and Nike fish meal in three types of treatment, namely, F1 (5%: 35%), F2 (10%: 30%) and F3 (15%: 25%) and The highest nutritional content is found in the selected formulation, namely F3 with the addition of 22.5 grams of red spinach leaf flour and 37.5 grams of Nike fish meal. 15.287%, carbohydrates 60.250%, iron 7.111 mg, vitamin C 14.766 mg while in the acceptability test of crackers with the addition of red spinach leaf flour and Nike fish meal for the selected formula, namely F3, which was seen as a whole-based on the characteristics of colour, aroma, texture and flavour. F3 (addition of 150 grams of wheat flour, 22.5 grams of red spinach leaf flour, and 37.5 grams of Nike fish flour).

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