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The Application of Iron (Fe) from Bay Leaves (*Syzgium Polyanthum*) in Food Flavoring Powder Formula

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ABSTRACT

Anemia caused by iron deficiency is still a nutritional problem in Indonesia. New methods are needed to help increase blood levels of iron by utilizing the habit of people consuming and processing food. Bay leaves (Syzgium polyanthum) offer a potential solution to Indonesia's iron-deficiency anemia issue by utilizing common food consumption habits This research method was a quantitative experiment by finding the best ratio of comparison of the encapsulation leaf extract formula in bay leaves powder and conducted a test of the receipt of the powder formula. The best formula ratio in making powder found in this research was a formula with 4 gr bay leaf extract and seasoning ingredients (10 gr seaweed, 10 gr fried onion, 7 gr white sesame, 5 gr oyster mushrooms, 5 gr sugar, 2 gr salt, 1 gr powder garlic, sesame oil 15 ml, and pepper 0.2 gr. The formula has an iron level (Fe) of 3.2 mg, equivalent to 24.2% RDA.

1. Introduction

Anemia caused by iron deficiency is still a nutritional problem in Indonesia. Data from the Ministry of Health of the Republic of Indonesia (2021) through basic health research shows that anemia proposed in the age group 15-24 years reached 32 %, where the number proportions in women showed 27.2 %higher when compared to men at 20.3 %. Various efforts to prevent anemia in Indonesia have been carried out in multiple ways through supplementation of folate iron tablets containing 60 mg of iron and 0.25 folic acid, distributed free through health facilities such as the Community Health Center and Integrated Health Post. This folate iron tablet supplement program is considered effective in handling iron deficiency but is not prolonged due to a lack of sustainability in consuming supplements. There is a need for a new method that can help increase iron levels through daily food intake by utilizing people's habits of consuming and processing food. People's patterns of consumption are identical, like food with additional toppings on daily food, such as the addition of chili powder, salty flavoring powder, and sweet. Adding topping to this daily staple food is an opportunity to increase iron levels in the blood through daily intake.

Bay leaves (*Syzgium polyanthum*) are one of the natural iron ingredients. According to the Ministry of Health of the Republic of Indonesia (2021), 100 grams of bay leaf powder can contain 44.1 mg of iron. The high iron content in bay leaves has the potential to overcome iron deficiency because bay leaves are very commonly used as an aroma enhancer in various dishes in Indonesia (Hastuti & Lestari, 2021). Masaki et al. (2022) research shows that the best temperature for bay leaf extraction is 50°C. Damayanti and Damayanti (2020) concluded that 1 gram of bay leaf nanoparticles containing 13 mg Fe given to pregnant women significantly affected blood Hb levels. In the In Vivo Test of bay leaf extract (Adyani et al., 2018), a mouse with anemia showed increased hemoglobin levels after being given bay leaf extract for 14 days. It can be concluded that giving bay leaves gives a comparable effect to standard treatment by administering blood-enhancing tablets. Various studies also show that bay leaves influence Hb levels in the blood.

This research aims to optimize the iron (Fe) extraction process from bay leaves by evaluating the most efficient extraction solvent, determining the best polymer compound as an iron-binding agent, and identifying the optimal formula ratio for producing seasoning powder based on bay leaves. Additionally, the iron content in the optimized formula will be analyzed to compare it with the Recommended Dietary Allowance (RDA), ensuring the nutritional adequacy of the resulting product.

2. Methods

2.1. Tools and Materials

Equipment used in this study are tray, digital scales with a precision of 0.01 g, stainless steel spatulas, test tubes 15 ml capacity, blenders, scissors, erlenmeyer flask 500 ml capacity, plastic measuring cups, macerator containers, Whatman filter paper No. 1 (11 cm diameter), filter cloth 100 mesh, sterile plastic bottles, sterile plastic, cups, funnels, electric oven (temperature range 50-200^{o}C), water bath, and spray dryer tool with nozzle size of 0,5 mm). The ingredients used are bay leaves of good quality, dried black tea, table salt fine granules, white sugar, garlic powder, fresh oyster mushrooms (sliced), and ground black pepper.

2.2. Method

This study uses a quantitative method with a complete random design (CRD), three factors, and two replications. Data collection is carried out through chemical analysis and organoleptic tests. Sensory tests carry out the organoleptic test, while chemical analysis is carried out by testing in the laboratory. The first stage in the study was carried out by making bay leaf extract maceration for 48 hours with a ratio of ethanol solvent and aquadest 1:2.

Analysis of iron content uses the method that Andarwulan et al. (2011) used to measure the red color of the feritiocyanate formed with a spectrophotometer with a wavelength of 480 nm.

Then, the extract results were added by polymer compounds with a ratio of 80% sample + 20% maltodextrin with ascorbic acid with a concentration of 1000mg/100gr (100% concentration) to continue the spray drying process. When the temperature reaches 140±5 °C, and the outlet temperature is regulated, the inlet temperature treatment process is in the range of 95±5°C. After the samples that have been microencapsulated have been obtained, iron levels (Fe) are tested. The extract obtained was then added to the charging compound for the microencapsulation process, consisting of 80% of the ingredients plus 20% maltodextrin, which contains vitamin C with a 1000mg/100 grams ratio. The microencapsulation process is carried out using a spray drying tool. Iron levels measure microencapsulation results with absorbance tests using UV-Vis spectroscopy at a wavelength of 580 Nm (Mardiyah et al., 2019).

Bay leaf extract that has gone through the encapsulation stage is then formulated by adding fillers to get powder formulas with three different formulas. In each formula, the filler is added in the form of dried seaweed, fried onions, white sesame, mushrooms, sugar, salt, garlic, sesame oil, and pepper. A hedonic test of the three existing formulas was conducted to get a formulation with the best receipt. The statistical analysis used in this research likely involves comparing means across different groups. Given that the research involves a single classification variant and aims to optimize the formulation of a food flavoring powder using various ingredients, the appropriate statistical test to use would be Analysis of Variance (ANOVA).

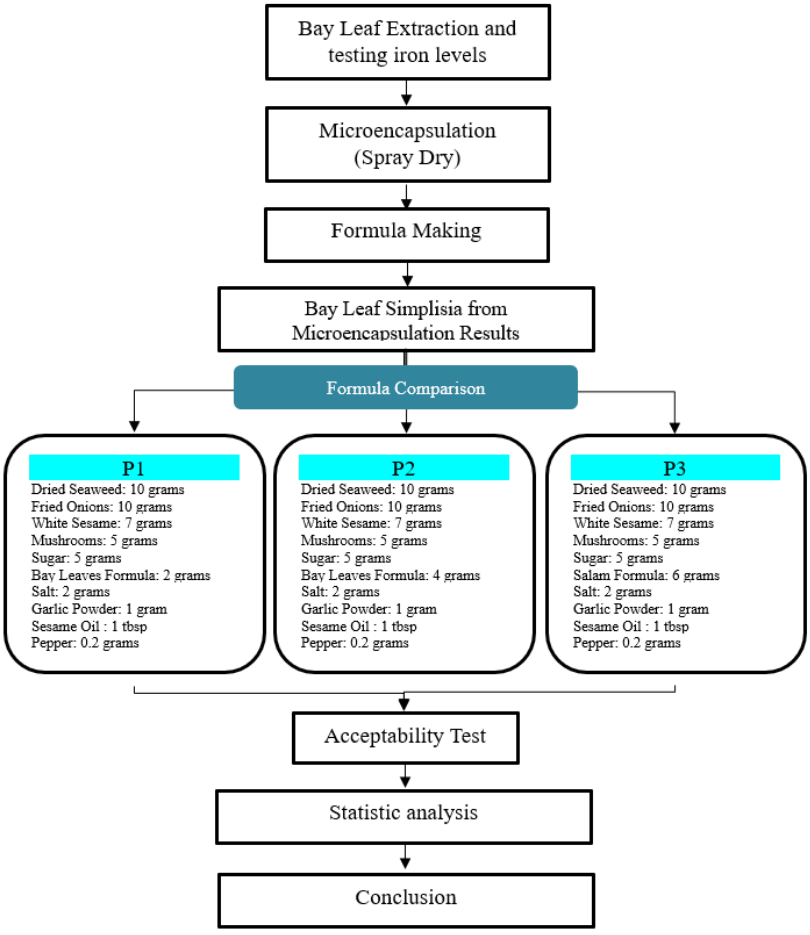

Figure 1 Research Flow Diagram

3. Results and Discussion

3.1. Results

The research began by testing the iron content in bay leaves (Syzygium polyanthum) through a maceration process. The bay leaves were sorted, washed, and dried in an oven at 70°C to maintain quality and reduce moisture content. After drying, the leaves were ground to increase the surface area and shorten the extraction time. Extraction was performed using 96% ethanol and distilled water for 48 hours with three different ratios. The extract obtained was then evaporated at 70°C for 3 hours to purify the active compounds. The final yield was calculated as the weight loss percentage after evaporation, as shown in Table 1**.**

Table 1 Iron (Fe) test results in liquid extracts

Repeat Sample	Fe Result (mg/100gr) (1:2)
Sample 1	16,87
Sample 2	16,49
Sample 3	16,23
Average	**16,53 ± 0,26**

Table 1 shows that liquid extraction results have iron levels. The test results for the sample are presented in Table 2.

Table 2 Iron (Fe) testing after the microencapsulation process

Repetition	Fe results (mg/100gr) Microencapsulation Treatment
Repetition 1	53,18
Repetition 2	50,91
Repetition 3	56,97
Average	**53,69 ± 2,50**

Table 2 shows the results of testing iron levels (Fe) after the microencapsulation process. The average iron content was 53.69 ± 2.50 mg/100gr. After microencapsulation, the sample is added to the formula with three comparisons. Overall, the process of making and comparing the formula is presented in Figure 2 and Figure 3.

Figure 2 Process of adding treatments to the formula

Figure 3 Formula-making process after adding sesame oil

(a) (b) (c)

Figure 4 Formula Appearance (a) Treatment P1; (b) Treatment P2; (c) Treatment P3

3.2. Discussion

The extraction process results are in the form of a dark black liquid extract. Extraction products must be carried out in microencapsulation processes to protect iron from reacting with other compounds and neutralizing colors on extract results. After a spry drying process, the originally dark green material became a dark green color. Another advantage obtained is the texture produced into fine powder. After the taste experiment in the powder of microencapsulation, there is a bitter taste derived from the tannin content in bay leaves and the taste of acid derived from ascorbic acid. Thus, a formulation must be made to balance the innate taste and make it a taste that panelists like. An additional food product layer is needed because the texture produced in the encapsulation process is fine powder. The encapsulation results will be added to the powder formula with a dose of 2 grams, 4 grams, and 6 grams. In this study, the complementary spices consist of 100% formula, seaweed, sesame oil, fried onions, white sesame, mushrooms, salt, sugar, garlic, and pepper.

In Figure 4, it can be seen that adding the treatment of bay leaves results in the encapsulation of the powder formula. The treatment of bay leaves is easily soluble and attached to the formula. Table 2 shows the results of testing iron levels (Fe) after the microencapsulation process. The average iron content was 53.69 ± 2.50 mg/100gr. It can be concluded that the microencapsulation process does not eliminate iron from bay leaf extract.

3.2.1. Hedonic Quality Test (Sensory)

A sensory quality test is carried out to identify critical sensory properties in a product and can provide the level of information or intensity of these characteristics. Sensory quality tests in this study include flavor and aroma parameters.

3.2.2. Taste

Taste is a quality parameter that can be captured by the sense of taste so that the taste is influential in consumer acceptance. The taste can appear to be caused by the food itself or by adding other substances. Taste is a sensation caused by the combination of its constituent materials, so food products are greatly influenced by the composition of the constituent materials (Hamidi et al., 2016). Assessment of Sensory Quality Test Formula Formula powder Third Treatment using a scale of 0-10 cm from the bitter parameter to not bitter, to 25 panelists. The average value of the taste parameter can be seen in Figure 5.

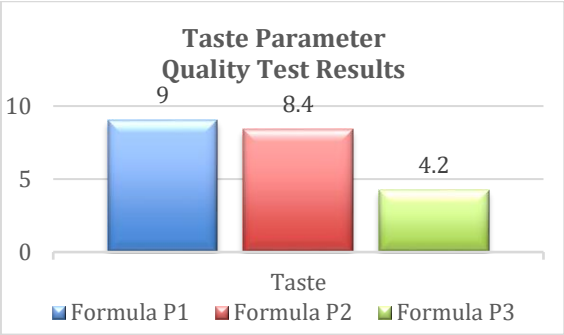

Figure 5 Taste Quality Test Diagram

From Figure 5, the amount of bitterness of the formula is known. In Formula P1, there is a bitterness number 9, which Formula P1 is carried out with the addition of extracts of bay leaf insulation of 2 grams. Then, in formula P2, adding extracts of bay leaf encapsulation of 4 grams gets a bitterness of 8.4. For Formula P3, with the addition of the extract of bay leaves, the most encapsulation (6 grams) gets the lowest bitterness of 4.2. This number shows that the greater the addition of extracts of bay leaves of encapsulation, the more bitter the taste will be in the formula. Adding the extract must be balanced with other seasonings to decrease the bitter taste until tolerated.

Furthermore, statistical testing is carried out. The first test conducted tests data normality. Obtained P value 0,0001 (<0.005) based on the Shapiro-Wilk test. Thus, data is not normally distributed. So, the test conducted for the hypothesis decision is the Kruskal Wallis test, as in Table 4. It can be seen that the results of the quality test for the flavor parameters of the 25 panelists are not trained; it can be concluded that the addition of the extract of bay leaves significantly affects the taste of the bitterness of the powder formula (p-value <0.05). This is because bay leaves have a bitter natural taste, and adding other complementary spices does not follow the addition of bay leaf extract.

Table 3 The Kruskal Wallis test results for taste quality parameters

Formula	N	df	*P value*
Formula P1	25	2	0,0001
Formula P2	25		
Formula P3	25		

In formulas P1, P2, and P3, the aroma formula number is similar in sequences 9.1, 9.2, and 9.1. This number shows that the greater the addition of extracts of bay leaf encapsulation will not cause changes in aroma in the formula. Furthermore, statistical testing is carried out. The first test conducted tests data normality. The P-value results were 0.001 (<0.005) based on the Shapiro-Wilk test. Thus, data is not normally distributed. So, the test was conducted for the hypothesis decision with the Kruskal Wallis test.

From Table 5, it can be seen that the results of the quality test for the aroma parameter of 25 people are not trained; it can be concluded that the addition of bay leaf extract Encapsulation does not significantly affect the aroma of bay leaves on the powder formula (p-value <0.05). The results of the extract encapsulation have an unforgettable aroma because it has been through extraction and drying spray with a charging compound. Then, the composition factor in the formula that uses sesame, sesame oil, and dried seaweed is also a factor, so the dominant aroma of these ingredients.

3.2.3. Hedonic Test

The hedonic test was conducted to identify the panelist's preference level, including taste, color, aroma, and texture parameters. The panelist's favorite test is carried out using five levels of preference: very like (5), like (4), neutral (3), dislike (2), and immensely dislike (1) for the average hedonic test results data presented in Figure 7.

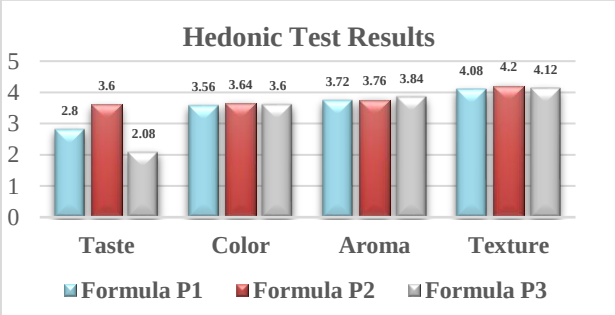

Figure 7 Diagram of hedonic test results

In color parameters, the higher the addition of the bay leaf extract, the more encapsulation does not affect the color parameter; adding iron (Fe) to the formula can negatively affect the color and odor. Bay leaves have an unstable green color and can change color to brown when undergoing processing (Sujianti et al., 2020). One way of processing the use of bay leaves is to encapsulate them; this is done to prevent the emergence of negative interactions in the fee leaf compound.

Table 4 The Result of hedonik Friedman Conover

Parameter	Formula	Mean ± Std Dev	*P value*
Taste	Formula P1	2,80 ± 1,29	0,0001*
	Formula P2	3,60 ± 1,00	
	Formula P3	2,08 ± 0,95	
Aroma	Formula P1	3,72 ± 1,02	0,741
	Formula P2	3,76 ± 1,05	
	Formula P3	3,84 ± 0,80	
Color	Formula P1	3,56 ± 1,16	0,987
	Formula P2	3,64 ± 1,25	
	Formula P3	3,60 ± 1,00	
Texture	Formula P1	4,08 ± 0,91	0,954
	Formula P2	4,20 ± 0,82	
	Formula P3	4,12 ± 0,93	

**Significancy level α 5%.*

As for the aroma and texture parameters, the absence of additional bay leaf extract is caused by the sample being encapsulated with maltodextrin polymer compounds and ascorbic acid. The encapsulation uses spray drying and liquid atomization to form a droplet. Then, the droplet formed is dried using dry air with high temperatures and pressure to have a smooth texture and is attached to the formula (Zaman & Kharisma, 2014). The formula used dried seaweed, white sesame, and fried onions as body formulas. The treatment of bay leaves is attached and merged to the body formula and causes the absence of an effect on the texture parameter; the variation of the complementary spices of the formula can also affect the aroma parameter. In this formula, the aroma of complementary seasoning variations becomes more dominant than the aroma from the encapsulation bay leaf extract.

3.2.4. The Best Formula

After a quality test and hedonic test, it can be concluded that the best formula is the Y formula with the addition of a 4 grams encapsulation bay leaf extract. Furthermore, the iron level test was carried out in Formula P2 to determine the percentage fulfillment of nutritional adequacy (RDA) iron from bay leaves. The results of testing iron levels are listed in Table 5.

Table 5 The Percentage of RDA in formula P2

Tests	Fe Rate (mg)	RDA Fe (mg)	% RDA
Adding of bay leaves into Formula P2	2,6	13,3*	19,6 %
Final product (Fomula P2) *Nett Weight = 50 gram*	3,2		24,2 %

** RDA is determined from the average Iron (Fe) requirements of men and women aged 13-49, according to PMK RI No. 28/2019.*

The final product of Formula P2 has an iron content of 3.2 mg/50 grams compared to RDA. This product can meet 24.2 % of daily needs if consumed daily. When viewed from the source, the primary source of iron in the formula is the extract of bay leaf encapsulation with a level of 2.6 mg. This is followed by another source of iron, which is sourced from white sesame in the formula. Based on data from the Ministry of Health of the Republic of Indonesia (2020), 100 grams of bay leaf powder contains iron, amounting to 44.1 mg. These levels are higher than Moringa leaves (6 mg/100 gr) and spinach leaves (3.5 mg/100 gr). Iron is an essential element in the body that produces energy using oxygen and cell proliferation. Iron can act as a donor or electron acceptor efficiently by interconnecting the forms of Ferri (Fe3+) and Ferro (Fe2+), which are irreplaceable components in oxygen transport (hemoglobin) and oxygen storage (myoglobin) (Brittenham, 2018).

Research conducted by Adyani et al. (2018) showed that hemoglobin levels in the group of mice were given bay leaf extract with various doses proportional to the administration of blood-added tablets. Giving bay leaves gives a comparable effect to standard treatment, namely blood-added tablets. It is more known that bay leaf extract can increase hemoglobin levels compared to groups given anemia standard blood-added tablets. The study used three doses of treatment: 2.2 mg, 4.4 mg, and 6.6 mg, with these different doses obtaining the highest 6.6 mg bay leaf extract in increasing hemoglobin levels between other treatment doses. However, this number is checked through a median test to see the difference in increased hemoglobin levels. In that case, it is concluded that the dose of bay leaf extract does not provide significant hemoglobin levels. So, the three doses of bay leaf extract have the same effect. Regarding rational drugs, the smallest dose of 2.2 mg effectively increases hemoglobin levels.

Furthermore, in her research, other studies conducted by Mirliana (2022) related to the effect of long-term giving for 90 days formula, which contains bay leaf extract, on the hematological profile of white mice. The results of the measurement of the weight of male and female mice and the leading group showed that the additional dose of 1 (400 mg/kg body weight) and dose of 2 (700 mg/kg BW) formula containing bay leaf extract had a weight result with control treatment. One indicator of the toxic effect of a material on animal trials in the toxicity test is a change in body weight, which results in a pattern of animal consumption being disrupted (Silva et al., 2012). The weight gain of the treatment group compared to the control group shows that bay leaf extract does not cause toxicity. So, bay leaf extract can be used more optimally as a source of food, one of which is the addition of bay leaf extract Encapsulation as a source of iron in the powder formula of this research.

4. Conclusion

The most effective solvent variation for isolating Fe content in bay leaves was a mixture of 96% ethanol and distilled water in a 1:2 ratio (p-value 0.001). For the polymer compounds in spray-dried microencapsulation, a mixture of 20% maltodextrin and 1000mg/100gram ascorbic acid yielded the best results in isolating iron from bay leaves, with an iron content of 53.69 mg/100gram (p-value 0.001) and an absorbance level of 0.956 (p-value 0.0001). The optimal formula ratio for making seasoning powder was formula Y, consisting of 4g bay leaf extract and seasoning fillers (seaweed 10g, fried onions 10g, white sesame 7g, oyster mushrooms 5g, sugar 5g, salt 2g, garlic powder 1g, sesame oil 1 tbsp, pepper 0.2g). This formula contained 3.2 mg of iron (Fe), equivalent to 24.2% of the Recommended Daily Allowance (RDA).

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