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# The Effect of Mangrove Crab Shell Powder (*Scylla serrata*) Addition on the Iron Content of Cookies

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**Abstract:** Increased awareness of healthy lifestyles has spurred the growth of functional food trends among communities. Iron deficiency causes anemia, a major nutritional problem in Indonesia. Mangrove crab shells are a local source of iron. In most cases, the edible portion of crabs is limited to the meat, while the shells are discarded, leading to their high potential as a source of waste. The purpose of this study was to determine the effect of adding mangrove crab shell powder on the iron content of cookies. This study employed an experimental design using a Complete Randomized Design (CRD), with treatments of adding different concentrations of mangrove crab shell powder (0%, 3%, 6%, 9%, 12%, 15%). The data were analyzed using ANOVA and Duncan's multiple range test. Findings indicated that adding mangrove crab shell powder significantly affected the iron content of the cookies. The iron content of the modified cookies ranged from 64.13 to 187.54 mg. The higher the concentration of crab shell flour added, the higher the iron content of the cookies. It is recommended that further research be conducted, encompassing organoleptic evaluation, microbiological contamination analysis, and heavy metal contamination assessment, to ensure the product's safety and quality. It is hoped that this research can serve as a reference on the use of crab shell waste as a source of iron that is beneficial to health.

**Keywords:** Cookies; Iron Content; Mangrove Crab Shell Powder.

## Introduction

Public awareness of the importance of healthy living has increased since the COVID-19 pandemic. This phenomenon has led to a shift in food consumption trends among the public. Currently, food is sought after not only for its basic nutritional content and appealing taste, but also for the specific physiological benefits it provides to the body [1]. Food that can provide physiological benefits or additional health benefits to the body, in addition to the basic nutritional functions of the food itself, is also referred to as functional food [2]. According to Amalia et al., functional food is designed to improve health levels and prevent certain disease risks [3].

Anemia is one of the main nutritional problems in Indonesia. According to the Indonesian Health Survey, the prevalence of anemia in Indonesia reached 16.2%. The group at high risk of anemia is women, especially pregnant women. The prevalence of anemia among women in Indonesia is 18%, while the prevalence of anemia among pregnant women reaches 27.7% [4]. One of the causes of anemia is iron deficiency in the body [5]. The anemia prevention program in Indonesia involves the administration of iron supplements accompanied by the provision of supplementary foods. The supplementary foods provided can be in the form of complete meals or snacks [6].

Iron-rich food sources can be obtained from local natural resources, including mangrove crab shells. Mangrove crabs are widely cultivated and farmed in various Asian countries, including Indonesia [7]. Mangrove crabs have high market potential both domestically and internationally [8]. The market potential for mangrove crabs is highly promising, as consumer demand for mangrove crabs tends to increase year by year [9]. The mangrove crab species *Scylla serrata* is the crab with the widest distribution compared to other species [10].

Generally, only the meat of crabs is consumed, while the crab shells are not consumed, making them highly likely to become waste. According to Ningsih and Kurniawan, crab shells are rich in minerals such as calcium, copper, zinc, phosphorus, and iron [11]. According to Ahmed, crab shells contain minerals such as iron (12.08 mg), potassium (6.525 mg), sodium (4.15 mg), calcium (14.375%), and magnesium (150.95 mg) [12]. Based on the research by Widnyani and Putra, the addition of mangrove crab shell flour significantly affects the calcium and magnesium content of cookies [13]. According to research by Annafiz et al., the addition of crab shell flour to edible spoon products has a significant effect on physical and chemical quality (carbohydrates, water, ash, fat, and protein) [14].

Cookies are a popular type of dry cake in Indonesia [15]. According to the Indonesian Food Consumption Statistics report, cookie consumption in 2023 increased by 0.14% from the previous year, reaching 21.215 ounces per capita [16]. Generally, the iron content in cookies is relatively low at 2.98 mg [17]. Research on cookies with ingredients substituted by various types of food sources to increase nutritional value has been widely conducted for application in the Supplementary Feeding Program to address nutritional issues.

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Mangrove crab shells are expected to be used as functional food ingredients in cookies while also addressing the issue of crab shell waste. In this study on cookies with added mangrove crab shell flour, it is necessary to analyze the iron content. Therefore, this study was conducted to determine the effect of mangrove crab shell flour (*Scylla serrata*) concentration on iron content in cookies.

## Research Methods

### Research Location and Time

The research was conducted at the Food Technology Laboratory, Institute of Technology and Health, and the Food Analysis Laboratory, Udayana University. The research was carried out from March to May 2025.

### Tools and Materials

The equipment used in product production includes a digital scale (Idealife), scissors, mortar, pestle, flour mill (Fomac), 80-mesh sieve, stove, mixer (Phillips HR7922), baking tray, oven (Mitochiba MO-888), spatula, scoop, spoon, and gloves. The tools used in iron analysis are a measuring cup, dropper, beaker, Kjedahl flask, filter paper, graduated flask, and Atomic Absorption Spectroscopy (AAS).

The materials used in product production are mangrove crab shells obtained from the Kedonganan area, wheat flour (Segitiga Biru), butter (Royal Palmia), powdered sugar (Rosebrand), salt, palm sugar (Haan), eggs, baking powder (R&W), and vanilla extract. The materials used in the Fe analysis were demineralized water, HClO4, and HNO3.

### Research Design

This study used an experimental approach with a completely randomized design (CRD). This study used one control treatment (100% wheat flour) and five comparison treatments using wheat flour (T) and mangrove crab shell flour (K), namely T1K1 (97% wheat flour, 3% mangrove crab shell flour), T2K2 (94% wheat flour, 6% crab shell flour), T3K3 (91% wheat flour, 9% crab shell flour), T4K4 (88% wheat flour, 12% crab shell flour), and T5K5 (85% wheat flour, 15% crab shell flour). The experiment was repeated three times, resulting in 18 experimental units.

### Product Making

*Production of Crab Shell Flour*

The production of mangrove crab shell flour began with washing the mangrove crabs to remove any dirt, followed by boiling them at 100°C for 30 minutes. The crab meat is then separated from the shells, followed by drying the shells at 65°C for 12 hours. The crab shells are then ground using a mortar and pestle, followed by milling using a flour mill. The flour is then sieved using an 80-mesh sieve [13]

*Modified Cookie Production*

Cookie production begins with the preparation of tools and ingredients. The next step is to mix the butter and powdered sugar and homogenize them using a mixer. One whole egg and one egg yolk are then added to the dough and homogenized again. The next step is to add baking powder, vanilla extract, salt, sugar, and a combination of wheat flour and crab shell flour, as specified in the treatment. The dough is homogenized again using a mixer and then shaped into round cookies. The dough is baked at 100°C for 20 minutes and then cooled on a cooling rack [18].

### Fe Analysis

The testing conducted in this study was the Fe content test using the AOAC standard method. A sample of 1.0–1.2 g was placed in a Kjeldahl flask, and 3 ml of HClO4 and 10 ml of HNO3 were added. The sample was heated for 1.5 hours until clear, then cooled. Ten milliliters of demineralized water were added to the sample, which was then heated for 10 minutes. An additional 30–50 ml of demineralized water was added. The solution was filtered through filter paper into a 100-ml volumetric flask. The sample solution was analyzed using AAS. A standard curve was prepared from standard Fe solutions. Iron content was expressed in mg/L [19].

### Data Analysis

The research data for each parameter was analyzed using the Analysis of Variance (ANOVA) method with the SPSS program at a 95% significance level. If the results showed a significant difference ($p \leq 0.05$), the Duncan test was conducted to determine the differences between treatments.

## Results and Discussion

Based on the results of the ANOVA test, the addition of mangrove crab shell flour had a very significant effect on the Fe content of the modified cookies ($P<0.01$). The Fe content of the modified cookies ranged from 64.13 to 187.54 mg. Based on the results of Duncan's post-hoc test, it can be concluded that all treatments produced cookies with significant differences in the test parameters. The results of the Fe content analysis of cookies with the addition of mangrove crab shell flour are presented in Table 1. The results of the ANOVA and Duncan's test are shown in Tables 2 and 3, respectively.

**Table 1.** Fe Content of Cookies.

| No | Treatment | Fe Content (ppm) |
|---|---|---|
| 1 | Control | $64.13^{f}$ |
| 2 | T1K1 | $69.31^{e}$ |
| 3 | T2K2 | $70.31^{d}$ |
| 4 | T3K3 | $942.8^{c}$ |
| 5 | T4K4 | $153.12^{b}$ |
| 6 | T5K5 | $187.54^{a}$ |

Note: Different notations indicate a significant difference between treatments.

**Table 2**. ANOVA Test Results of Fe Content

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Fe Content | Between Groups | 40134.963 | 5 | 8026.993 | 12022455.35 | .000 |
| | Within Groups | .008 | 12 | .001 | | |
| | Total | 40134.971 | 17 | | | |

**Table 3.** Duncan's Test Results of Fe Content

| Treatment | N | Subset | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Control | 3 | 64.13100 | | | | | |
| T1K1 | 3 | | 69.30733 | | | | |
| T2K2 | 3 | | | 70.30900 | | | |
| T3K3 | 3 | | | | 94.27733 | | |
| T4K4 | 3 | | | | | 153.12100 | |
| T5K5 | 3 | | | | | | 187.53883 |
| Sig. | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

The data in Table 3.1 show that the highest Fe content in modified cookies with the addition of mangrove crab shell flour was obtained in treatment T5K5 (15%), which was 187.54 mg, while the lowest Fe content was obtained in the control treatment (0%), which was 64.13 mg. The data indicate that as the use of mangrove crab shell flour increases, the iron content in the modified cookies also increases. This is because the iron content in mangrove crab shell flour is higher (12.08 mg) than in wheat flour (1.3 mg) [12, 20].

This is also supported by Ahmed's statement that iron content in crabs is more concentrated in the shell (12.08 mg) than in crab meat (1.805 mg) [12]. In line with this, according to the research results of Mamun et al., crab shells have a high Fe content (10.36 mg-31.72 mg), while crab meat has a lower Fe content (4.22 mg-8.34 mg) [21].

In the hedonic taste parameter test, adding 5% crab shell flour to tortilla chips resulted in a score of 3.71 (like very much). The panellists appreciated the savoury taste achieved by the addition of 5% crab shell flour [32]. Fortification of crab shell flour in snack bar products at 3.5% resulted in a sandy, crunchy texture, making the snack bars firmer [33].

According to Nafies' research, cookies substituted with manyung fish flour and green spinach flour showed an increase in iron content with the addition of manyung fish flour and green spinach flour, with the highest iron content reaching 27.8 mg in treatment P3 (30% wheat flour, 25% manyung fish flour, 45% green spinach flour) [22]. A similar study was conducted by Rauf and Mustamin, who found that cookies substituted with jewawut flour and anchovy flour had increased iron content with the addition of flour. The highest iron content was obtained from the 15% treatment with an iron content of 5.04 mg [23].

The high iron content in cookies is also influenced by several factors. The first factor is the testing method used, namely AAS. The AAS instrument is known to have very high sensitivity to metal elements, specifically measuring certain metals, and can measure elements with low concentrations without requiring separation methods [24]. The second factor is the iron content in the raw materials used for the cookies. The wheat flour used is known to be fortified with vitamins and minerals (vitamin B1, B2, folic acid, iron, and zinc). This aligns with SNI 3751-2018 regarding wheat flour, which states that iron fortification in wheat flour must be at least 50 mg/kg [25]. Another possible factor is the presence of exogenous iron from the equipment and water used [26].

Iron is classified as an essential mineral that is crucial for the human body, including its role as a component in the formation of erythrocytes, or red blood cells [27]. Iron deficiency in the body can lead to iron-deficiency anemia. A direct factor that can influence the occurrence of anemia is low intake of iron-rich foods, which causes the body's iron reserves to be insufficient and affects the process of hemoglobin formation [28]. According to Fitria and Prameswari, iron intake from food can help increase blood hemoglobin and prevent anemia in pregnant women [29].

According to the Indonesian Ministry of Health, the recommended daily iron intake for pregnant women is 27 mg [20]. It means that 100g of cookies from all treatments already meet more than 100% of the daily iron requirement. Meeting iron needs can be achieved by consuming cookies in portions adjusted to individual needs. The best treatment yielding cookies with the highest iron content is T5K5 (15%), with an iron content of 187.54 mg/100g. Therefore, according to the RDA, the recommended daily serving size for pregnant women is approximately 14g of cookies per day.

## Conclusion

The conclusion drawn from the study "The Effect of Mangrove Crab Shell Powder (*Scylla serrata*) Addition on the Iron Content of Cookies" is that the concentration of mangrove crab shell flour (*Scylla serrata*) has a very significant effect on the iron content of cookies. The higher the concentration of crab shell flour added, the higher the iron content of the cookies. Mangrove crab shell flour can be applied to other food products, such as supplementary feeding products (PMT), to increase iron content as part of anemia prevention.

**Author's Contribution**

N. K. A. R. Anggraeni: conducted the experimental work, data collection, and initial manuscript drafting. I. A. P. A. Widnyani supervised the research design, data interpretation, and final manuscript revision. I. G. A. Y. Rabani RS & P. R. Sintyadewi: contributed to statistical analysis and validation of iron content measurements. A. A. N. D. A. W. Putra: contributed to literature review, figure preparation, and manuscript editing.

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## References

[1] T. K. Khoerunnisa, "Review: Pengembangan produk pangan fungsional di Indonesia berbasis bahan pangan lokal unggulan," Indonesian Journal of Agricultural and Food Research, pp. 49–59, 2020. Retrived from: https://journal.uniga.ac.id/index.php/IJAFOR/article/view/1149

[2] S. C. E. Setiawan, A. Yuliantara, and P. D. B. Murti, "Pangan fungsional dari bahan pangan tradisional: Tinjauan pustaka," Agrointek, vol. 18, no. 4, pp. 552–560, 2024. doi: https://doi.org/10.21107/agrointek.v18i3.15464

[3] R. N. Amalia, A. Rahmiwati, N. A. Fajar, and N. Sari, "Preferensi pangan fungsional dan implikasinya," SAGO: Gizi dan Kesehatan, vol. 5, no. 2, pp. doi:456–465, 2024.

[4] Kementerian Kesehatan RI, Survey kesehatan Indonesia dalam angka. Jakarta, Indonesia: Kementerian Kesehatan Republik Indonesia, 2023.

[5] I. Kurniati, "Anemia defisiensi zat besi (Fe)," JK Unila, vol. 4, no. 1, pp. 18–33, 2020. doi: 10.23960/jkunila.v4i1.pp18-33

[6] L. C. Friday, M. Hakimi, and B. I. Kandarina, "Pemberian makanan tambahan olahan ikan untuk ibu hamil trimester III sebagai upaya menurunkan volume darah yang hilang selama persalinan di Kota Yogyakarta," Jurnal Ilmu Gizi Indonesia, vol.4, no.1, pp. 59–74,2020. doi:10.35842/ilgi.v4i1.171

[7] M. N. Azra and M. Ikhwanuddin, "A review of maturation diets for mud crab genus *Scylla* broodstock: Present research, problems and future perspective," Saudi Journal of Biological Sciences, vol. 23, no. 2, pp. 257–267, 2016. doi: org/10.1016/j.sjbs.2015.03.011

[8] R. Djamaluddin, Mangrove: Biologi, ekologi, rehabilitasi, dan konservasi. Manado, Indonesia: Unsrat Press, 2018.

[9] Y. Koniyo, Teknologi budidaya kepiting bakau (*Scylla serrata* forsskal) melalui optimalisasi lingkungan dan pakan. Gorontalo, Indonesia: CV. AA Rizky, 2020.

[10] A. Hubatsch, S. Y. Lee, J.-O. Meynecke, K. Diele, I. Nordhaus, and M. Wolff, "Life-history, movement, and habitat use of *Scylla serrata* (*Decapoda, Portunidae*): Current knowledge and future challenges," Hydrobiologia, vol. 763, pp. 5–21, 2016. doi: 10.1007/s10750-015-2393-z

[11] J. R. Ningsih and E. Kurniawan, "Pembuatan karbonat apatit dari bahan dasar cangkang kepiting," Inovasi Teknik Kimia, vol. 8, no. 2, pp. 133–138, 2023. doi: doi.org/10.31942/inteka.v8i2.8125

[12] A. A. Ahmed, "Mineral and amino profile of crab (*Sudanonaonautes aubryi*)," Journal Food Chemistry Advances, vol. 1, 2022, doi: 10.1016/j.focha.2022.100070.

[13] I. A. P. A. Widnyani and A. A. N. D. A. W. Putra, "Formulation, fortification of mangrove crab shell flour (*Scylla serrata*) as a mineral source in functional cookies," Jurnal Pijar MIPA, vol. 19, no. 6, pp. 1037–1040, 2024. doi: 10.29303/jpm.v19i6.7931

[14] M. R. Annafiz, E. N. Dewi, and L. Purnamayati, "The effect of addition swimming crab shells flour (*Portunus pelagicus*) for physical and chemical quality of edible spoon," Indonesian Journal of Fisheries Science and Technology, vol. 16, no. 3, pp. 165–170, 2020. doi: 10.14710/ijfst.16.3.165-170

[15] D. S. Manalu, G. K. Nugrahaini, and N. U. Padoma, "Value added processing mushrooms flour into cookies at CV Assalam Cianjur with Business Model Canvas (BMC) approach," Jurnal Agribisnis, vol. 1, no. 2, pp. 1–13, 2023. doi: 10.33830/Agridev.v1i2.3719.2023

[16] Badan Pusat Statistik Indonesia, Rata-rata konsumsi perkapita seminggu menurut kelompok makanan dan minuman jadi per kabupaten/kota. Jakarta, Indonesia: BPS, 2024.

[17] United States Department of Agriculture [USDA], Cookies, shortbread, commercially prepared, plain. USDA National Nutrient, 2019.

[18] M. T. Hapsoro, E. N. Dewi, and U. Amalia, "Pengaruh penambahan tepung cangkang rajungan (*Portunus pelagicus*) dalam pembuatan cookies kaya kalsium," Jurnal Pengolahan dan Bioteknologi Hasil Perikanan, vol. 6, no. 3, pp. 20–27, 2017. Retrieved from: https://ejournal3.undip.ac.id/index.php/jpbhp/article/view/20293

[19] AOAC, Official methods of analysis of the Association of Analytical Chemist, 18th ed. Washington DC, USA: Association of Official Analytical Chemists, 2005.

[20] Kementerian Kesehatan RI, Tabel komposisi pangan Indonesia (TKPI). Jakarta, Indonesia: Kementerian Kesehatan Republik Indonesia, 2020.

[21] M. Z. Mamun, T. Haque, M. S. Ahmed, M. A. Satter, M. Begum, M. S. Hossen, and M. S. Rana, "Nutritional evaluation of edible swimming crabs *Portunus pelagicus* (Linnaeus, 1758) and *Portunus sanguinolentus* (Herbst, 1783) from coastal area of Bangladesh," Journal of Agriculture and Food

Research, vol. 15, no. 100972, pp. 1–6, 2024. doi: https://doi.org/10.1016/j.jafr.2024.100972
[22] D. A. Nafies, "Analisis kandungan zat besi, protein dan mutu organoleptik cookies substitusi tepung ikan manyung dan tepung bayam hijau sebagai selingan remaja anemia," INSOLOGI: Jurnal Sains dan Teknologi, vol. 3, no. 6, pp. 588–597, 2024. doi: https://doi.org/10.55123/insologi.v3i6.4165
[23] S. Rauf and Mustamin, "Analisis kandungan zat besi cookies substitusi tepung jewawut dan tepung ikan teri dalam mengatasi masalah anemia gizi besi," Media Gizi Pangan, vol. 27, no. 1, pp. 123–130, 2020.
[24] A. Lolo, C. F. Patandean, and E. Ruslan, "Karakterisasi air daerah panas bumi Pencong dengan metode AAS (Atomic Absorption Spectrophotometer) di Kecamatan Biringbulu, Kabupaten Gowa, Provinsi Sulawesi Selatan," Jurnal Geocelebes, vol. 4, no. 2, pp. 102–110, 2020. doi: https://doi.org/10.20956/geocelebes.v4i2.8928
[25] Badan Standarisasi Nasional, Tepung terigu (SNI 3751-2018). Jakarta, Indonesia: BSN, 2018.
[26] Y. Sogen and G. Oematan, "Analisis kandungan zat besi sayur kangkung pada beberapa rantai produksi," Jurnal Pangan, Gizi, dan Kesehatan, vol. 1, no. 2, pp. 39–44, 2009. doi: https://doi.org/10.51556/ejpazih.v1i2.34
[27] M. Aprianto, Buku ajar: Kimia pangan. Yogyakarta, Indonesia: Nuta Media, 2021.
[28] F. Muchtar and D. S. Effendy, "Penilaian asupan zat besi remaja putri di Desa Mekar Kecamatan Soropia Kabupaten Konawe," Jurnal GEMBIRA (Pengabdian Kepada Masyarakat), vol. 1, no. 1, pp. 172–179, 2023.Retrifed from: https://gembirapkm.my.id/index.php/jurnal/article/view/29
[29] S. N. Fitria and G. N. Prameswari, "Analisis kandungan zat gizi dan daya terima cookies tepung lentil (*Lens culinaris*) sebagai PMT ibu hamil," Indonesian Journal of Public Health and Nutrition, vol. 2, no. 1, pp. 122–131, 2022. doi: 10.30867/gikes.v5i1.1309
[30] Kementerian Kesehatan RI, Angka kecukupan gizi yang dianjurkan (Permenkes RI No. 28 Tahun 2019). Jakarta, Indonesia: Kementerian Kesehatan Republik Indonesia, 2019
[31] I. Nafsiah, S. Rizal, D. Koesoemawardani and S. Suharyo, "Karakteristik Senosiru dan Kimia Tortila Chips Dengan Penambahan Tepung Cangkang Rajungan (Portus pelagicus)", Jurnal Agroindustri Berkelanjutan vol 1, no 2. 2022. doi: https://doi.org/10.23960/jab.v1i2.6387
[32] A.N. Latifah, Rochima, I.R. Pratama, and Rostini. "Analisis Tingkat Kesukaam Snack Bar Dengan Penambahan Tepung Cangkang Rajungan", Jurnal Perikanan Unram, vol 15, no 3 pp. 1267-1280. 2025. doi: 10.29303/jp.v15i3.1525