

EVALUATE THE STABILITY OF IRON AND COLOR IN RED GUAVA JUICE DURING STORAGE BY VARIOUS PACKAGING METHODS

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ABSTRACT

Anemia is a condition caused by iron deficiency, which can be prevented through the consumption of iron-rich foods. One food with potential in anemia prevention is red guava. This study aimed to evaluate the stability of color and iron content in red guava juice under different storage durations and packaging types. Four treatments were applied: F0 (no storage), F1 (stored in plastic bottles for 3 days), F2 (glass bottles for 3 days), and F3 (aluminum foil for 3 days). The color of the juice was analyzed using UV-Vis spectrophotometry, while iron content was measured using Atomic Absorption Spectrophotometry (AAS). The results showed an increase in color absorbance in all samples after storage: F0 (0.1391), F1 (0.5412), F2 (0.5231), and F3 (0.6682). The highest iron content was observed in F0 and F2 (0.00145 mg/L), while the lowest was in F1 and F3 (0.0013 mg/L). These findings indicate that storage affects the quality of red guava juice, and glass bottles are the most effective packaging in maintaining both iron content and color stability

Keywords: anaemia; iron; red guava; storage; packaging

INTRODUCTION

Anemia is a disease that occurs as a result of a lack of healthy erythrocyte cells, which generally occurs because the body lacks iron. (Febriani, 2021). Anemia due to iron deficiency occurs when the body does not have enough iron reserves, so that hemoglobin production decreases during the process of red blood cell formation (erythropoiesis) (Utami & Farida, 2022). The incidence rate of anemia in Indonesia is still relatively high, especially in pregnant women with a prevalence of 27.7%. Meanwhile, the incidence of anemia that occurs in adolescents with an age range of 15-25 years is 15.5%. Adolescent girls have a greater prevalence of anemia than adolescent male adolescents at 18%, while adolescent boys are 14.4% (Kementrian Kesehatan Republik Indonesia, 2023). Efforts to prevent anemia can be done with a pharmacological approach through Fe tablet supplementation, but anemia control can also be done through non-pharmacological approaches, namely by improving the diet and consumption of foods containing iron. The type of food that has the potential to control and prevent anemia is red guava fruit (Utami & Farida, 2022).

Guava is one of the fruits that is quite in demand because it has a thick flesh with a soft texture, sweet taste, and quite large fruits. As a fruit that comes from tropical and subtropical regions, red guava is easily accessible to the public because of its high availability and economical price (Fitriani & Zahrulianingdyah, 2022). There are 2 types of guava fruits, namely guava with white and red flesh. In addition to the color difference, red guava contains comprehensive nutrients and contains more iron (Hadi, 2023). Iron is a micronutrient that belongs to the group of minerals that have an important function for the body. Iron is a component in red blood cells that functions to transport oxygen throughout the body so that it plays a crucial role in the formation of hemoglobin (Putri et al., 2024). Based on the Indonesian Food Composition Table (Moeloek, 2020), In 100 g of red guava contains 1.1 mg iron. Iron contributes to the formation of hemoglobin which can play a role in preventing anemia. Antioxidants in iron have a role in the process of forming lymphocytes which function to fight infection and are related to the activity of superoxide dismutase enzymes, cellular respiration

and enzyme cofactors which help inhibit the formation of free radicals (Utami & Farida, 2022). Red guava is not only consumed directly, but can also be consumed by making processed drinks such as juice.

Processed guava juice can accelerate iron absorption and make it easier to consume (Utami & Farida, 2022). People have a habit of producing processed juices in large quantities for reasons of busyness or practicality and then storing them in the refrigerator. This is commonly done to save time, as mentioned in the article (Tiofani & Aisyah, 2022), That storing juice in the refrigerator is a common practice that is believed to be safe to consume within a few days. In guava juice stored for a long time, it can affect the stability of iron and discoloration of guava juice, this is caused by several factors such as high temperature and exposure to sunlight. To reduce the possibility of a decrease in iron content and a decrease in color quality in guava juice can be done by reducing oxidation reactions through quality packaging media (Permadi et al., 2024).

Packaging is a tool used to prevent or minimize the possibility of damage in products. Packaging is also a tool to protect products to be consumed by considering temperature, and storage time. There are several types of packaging such as PET plastic bottles, glass bottles, and aluminum foil (Astuti et al., 2023) . Based on this, this study aims to find out the best packaging method to maintain iron stability and color stability in red guava juice during storage.

METHODS

The research design used was experimental with a quantitative approach and a 3 x 1 Factorial Group Random Design (RAK) design. There are two main factors in this study, namely the packaging factor consisting of three levels, namely glass bottles, plastic bottles, and aluminum foil, and the storage temperature factor consisting of one level, namely cold temperature (6.6-10oC) which is stored for 3 days. This treatment results in a total of 4 treatment combinations and each treatment will be repeated 2 times. The combination of treatments consists of: F0 : No packaging and 0 days storage. F1 : Plastic bottle packaging and 3-day storage. F2 : Glass bottle packaging and 3-day storage. F3 : Aluminum foil packaging and 3-day storage.

Ingredients used in making juice include: 100 grams of red guava, and cold water. Tools used in making juice include: blender, funnel, measuring cup, scale, plastic bottle, glass bottle, and aluminum foil. The materials used in the test include: ntric acid (HNO₃), Fe standard solution, blank solution, buffer, aquades, Hcl 0.1N, and filter paper. The tools used in this study include: *Atomic Absorption Spectrophotometry* (AAS), *UV-vis spectrophotometer*, measuring flask, pipette, beaker, erlenmeyer, hot plate, analytical scale, funnel, test tube, glass cuvette.

This research was carried out in two places, namely in the Natural Materials Processing Laboratory, Institut Teknologi Sumatra. As well as in the Food Engineering laboratory, Politeknik Negeri Lampung. The iron data collection technique is carried out based on SNI 6989-84-2019 using the *Atomic Absorption Spectrophotometry* (AAS) method. A sample of 100 ml is added to 5 ml of HNO₃ concentrate, then heated until clear and diluted to a volume of 100 ml. The resulting destruction solution was measured using AAS at a wavelength of 248.3 nm. The Fe level is determined from the calibration curve obtained from the standard Fe solution. Color absorbance measurements were performed using uv-vis spectrophotometry at a wavelength of 520 nm. The filtered guava juice sample is put into a cuvette, then the absorbance value is recorded after calibration using aquades

blanks. Measurements were taken on day 0 and day 3. Data from the results of the research will be processed with the aim of obtaining an average score. To determine the influence of packaging type, storage duration, and interaction of both on iron content and color, data was analyzed using one-way ANOVA using a significance level of 5% ($\alpha = 0.05$), if there was a significant difference, it would be tested with a post hoc test.

RESULTS AND DISSCUSION

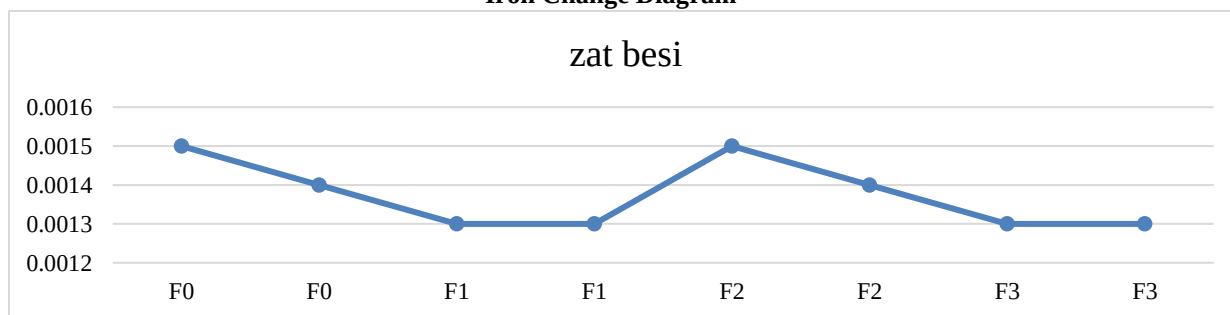
Testing of the value of iron content in red guava juice was carried out by the *Atomic Absorption Spectrophotometry* (AAS) method using a wavelength of 248.3 nm. The results of the iron test are shown in table 1.

Table 1
Iron Test Results

Treatment	Iron	Mean Iron
Unpackaged 0 day (F0)	0,0015	0,00145
Unpacked 0 days (F0)	0,0014	
3-day plastic bottle (F1)	0,0013	0,0013
3-day plastic bottle (F1)	0,0013	
3-day glass bottle (F2)	0,0015	0,00145
3-day glass bottle (F2)	0,0014	
Aluminum foil 3 days (F3)	0,0013	0,0013
Aluminum foil 3 days (F3)	0,0013	

Based on the data from table 1, it can be seen that there is a difference in the value of iron content before storage and after storage. The samples without storage and packaging had an average value of 0.00145, while after 3 days of storage it had a value of 0.0013. This difference in iron content value is visualized in figure 1

Figure 1
Iron Change Diagram



Based on Figure 1, it can be seen that there was a decrease in the value of iron content in the F1 and F3 samples with a value of 0.0013, while the F2 sample showed no change in value after 3 days of storage at cold temperatures. The image shows changes in the value of iron in the sample before and after being treated with storage and packaging. To find out if there is a significant difference from the iron test data, it will be done statistically using the one way anova test. The results of the statistical test are shown in table 2.

Table 2
Results of Iron Statistical Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0,000	3	0,000	6,000	0,058
Within Groups	0,000	4	0,000		
Total	0,000	7			

Based on the results of the statistical iron test using a one-way anova in table 4.2, it was shown that there was no significant difference between the treatment groups for changes in iron values and niai sig. (p-value) = 0.058.

Testing of color absorbance values in red guava juice was carried out by *the uv-vis Spectrophotometry* method using a wavelength of 520 nm. The results of the color absorbance value test are shown in table.3.

Table 3
Color Absorbance Test Results

Treatment	Color Absorbance	Mean color
No packaging 0 days (F0)	0,1380	0,1391
No packaging 0 days (F0)	0,1403	
3-day plastic bottle (F1)	0,5385	0,54125
3-day plastic bottle (F1)	0,5440	
3-day glass bottle (F2)	0,5220	0,5231
3-day glass bottle (F2)	0,5242	
Aluminum foil 3 days (F3)	0,6718	0,6682
Aluminum foil 3 days (F3)	0,6646	

Based on the data from table 3, the difference in color absorption value before storage and after storage is shown. The largest change in color absorbance value was found in the F3 sample with a 3-day cold storage treatment using aluminum foil packaging. This change in absorbance value is visualized in Figure 2.

Figure 2
Color Absorbance Change Diagram

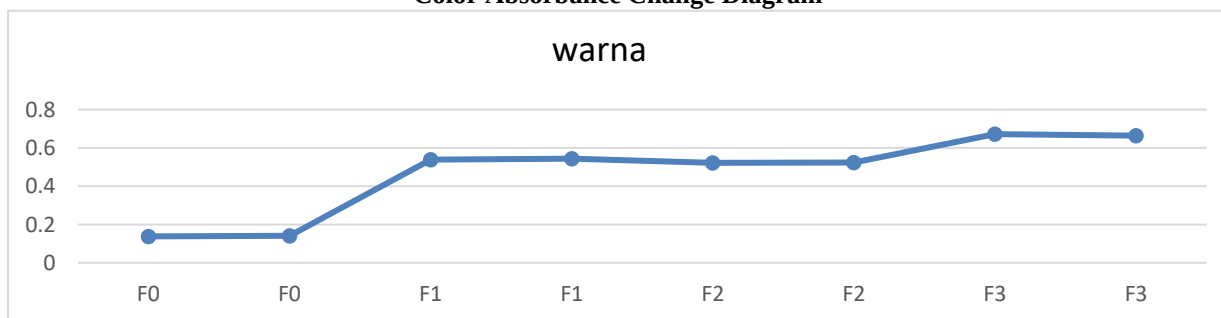


Figure 2 shows that the value of color absorbance changes after being given different storage and packaging treatments. The highest change was found in the F3 sample with a value of 0.6682, while the lowest change was found in the F2 sample with a value of 0.5231. To find out if there is a

significant difference in the color absorbance test data, it will be carried out statistically using a one-way anova test. The results of the statistical test are shown in table 4.

Table 4
Results of Color Absorbance Statistical Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0,313	3	0,104	9057,987	<0,001
Within Groups	0,000	4	0,000		
Total	0,313	7			

Based on the results of the color absorbance statistical test using one way anova, in table 4 it is shown that there is a significant difference between the treatment groups on the change in color absorbance value and the value of the color absorbance sig. <0,001. After the one-way analysis of anova showed that there was a significant difference, then a post hoc test was carried out. The results of the post hoc test are shown in table 5.

Table 5
Color Hoc Post Test Results

Sample	Significant Value
Unpacked and storage (F0)	3-day plastic bottle (F1) 0,002
	Botol kaca 3 hari (F2) 0,000
	Aluminum foil 3 days (F3) 0,003
3-day plastic bottle (F1)	Unpacked and storage (F0) 0,002
	3-day glass bottle (F2) 0,129
	Aluminum foil 3 days (F3) 0,004
3-day glass bottle (F2)	Unpacked and storage (F0) 0,000
	3-day plastic bottle (F1) 0,129
	3-day aluminum foil (F2) 0,017
Aluminum foil 3 days (F3)	Unpacked and storage (F0) 0,003
	3-day plastic bottle (F1) 0,004
	3-day glass bottle (F2) 0,017

The results of the Post Hoc Test showed that there was a significant difference between the F0, F1, F2, F3 samples, with a significance value of 0.002, 0.000, 0.003. In the F2 and F3 samples, it was shown that no real difference was found between the treatments with a significance value of 0.129. While other samples show that there is a noticeable difference.

Based on data from table 1, iron results were obtained with an average of samples. It can be seen that the largest change in iron value was found in the F3 sample, namely by storage using aluminum foil

packaging stored in the refrigerator for 3 days with an iron value of 0.0013 and an F1 sample stored for 3 days in the refrigerator using plastic bottle packaging that got an iron value of 0.0013, while the F0 sample data that was not treated without storage and packaging obtained a result of 0.00145.

In a study conducted by (Beyene, 2012) showed that iron levels did not change significantly during 4.5 days of storage with a fairly high temperature of 40oC and a humidity of 70-100%. on day 0 the iron level obtained was 51.72 mg/L, while on day 4.5 it showed the result of iron levels of 51.66 mg/L. Even according to (Iftikhar et al., 2022) shows that iron content remains stable during storage for up to 26 weeks. The retention value of iron is 91.3% at a temperature of 43oC. Based on data from the journal, this stability supports this study which shows a non-significant decrease after 3 days of storage.

According to (Demasta et al., 2020) The discoloration that occurs in the fruit is one of the signs that can be used in identifying damage to the fruit. Signs that the fruit has been damaged usually the color of the fruit changes from bright to dark, especially in fruits such as (apples, bananas, red guava, pears, and salak). The process of changing the color of the fruit to brown is called the browning process. Enzymatic browning that occurs in fruits can result in decreased taste quality and damage to fruits. Based on the data from table 3, the results of color absorbance with the sampling average can be seen that the largest change in color absorbance value is found in the F3 sample, namely by storage using aluminum foil packaging stored in the refrigerator for 3 days, an absorbance value of 0.6682 is obtained, while the sample data without storage and packaging obtains a result of 0.1391. Increased color absorbance values after being treated with storage indicate changes or degradation in the color components in the sample. The increase in absorbance value can be caused by oxidation reactions that occur during storage, especially if the packaging is not able to block the entry of light and oxygen properly.

This change in color absorbance value does not necessarily reflect an increase in the pigment content in the juice. According to (Azman et al., 2022) In his research on the stability of anthocyanins from blackcurrant pulp, it was explained that the copigmentation effect can cause an increase in color intensity (*hyperchromic effect*) due to the formation of anthocyanin pigment complexes and other compounds such as chlorogenic acid or rosmarinic acid. This effect increases the value of color absorbance visually and spectrophotometrically. However, the anthocyanin content continues to decrease over time due to chemical degradation due to the influence of temperature, and oxidation. In addition to a decrease in anthocyanins, an increase in absorbance values can indicate a change in color characteristics that can affect the attractiveness of the juice.

Packaging is a process of covering products that has the goal of minimizing damage to the product. Packaging also has a function as a container for a product that is useful for storing products for a certain time (Sulaiman, 2021). According to (Sulaiman, 2021) The packaging used in this study is included in modern packaging. Modern packaging, which is packaging that is created with various forms and materials so that it is expected to help or facilitate humans in using it. Examples of modern packaging include paper, plastic bottles, metal, fiber, aluminum foil, and glass bottles. Packaging can affect the quality of food through changes in physical and chemical properties, which occur due to the migration of chemical substances from packaging materials, such as plastic monomers, white lead, or due to corrosion in packaging that has passed its useful life. In addition, changes in the aroma or taste, as well as the texture of food can also occur due to changes in water vapor and oxygen levels,

both in the product and the surrounding environment. This condition can cause serious damage during the storage process

The packaging used to store the samples is intended to see the best quality packaging that can retain iron and color absorbance. Packaging that is able to maintain the best color quality and iron in defending the sample from oxidation reactions that can affect the decrease in iron value and the increase in color absorbance by looking at how much light can be absorbed or the intensity of light in the sample. The high value is obtained from the less light read by the uv vis spectrophotometry on the sample. Based on the results of the research conducted and shown in table 1, the best packaging in retaining iron and color is a glass bottle with a nutrient value of 0.00145 and a color absorbance of 0.5231. Meanwhile, plastic bottles have better quality in maintaining color with a value of 0.5412 while aluminum foil with a value of 0.6682. The results obtained in the glass bottle packaging method which has better quality in this study have similarities with the research according to (Pranatami, 2020), A study on the comparison of the number of bacteria in breast milk with different containers showed that the highest bacterial colonies were found in breast milk stored in plastic bags ($5,4 \times 10^3$ CFU/ml), then on plastic bottles ($4,4 \times 10^3$ CFU/ml), dan hasil terendah terdapat pada botol kaca ($4,3 \times 10^3$ CFU/ml). The results obtained in the aluminum foil packaging method in this study are packaging that is not good in product maintenance compared to glass bottles and plastic bottles, this has a difference in the results obtained due to the difference in the packaging method used. Meanwhile, the packaging used in the previous study was aluminum foil and plastic bags. According to (Novita et al., 2021) A study conducted on the estimation of the shelf life of Arabica coffee powder, showed that coffee grounds packaged using aluminum foil have a slow rate of quality decline compared to plastic packaging.

According to (Permadi et al., 2024) Exposure to light and air can cause oxidation reactions in natural pigments resulting in dark-colored derivative compounds and absorbing more light at certain wavelengths. The increase in color absorbance value indicates a decrease in the quality of the guava juice product because the more light is absorbed by the sample, the quality of the product has decreased.

Based on table 2, no significant differences were found between treatment groups on changes in iron values that produced sig.(p-value) = 0,058, This shows that the packaging method of plastic bottles, glass bottles, and aluminum foil does not have a significant average difference. The post hoc test is carried out if the results of the anova test show significant results, but in the anova test to see the effect of the packaging method on the stability of iron and color shows that there is no significant effect, then the post hoc test is not carried out.

Based on table 4, it was found that there was a real difference between treatment groups against changes in color absorbance values ($F(3,4)=9057.987$, $p<0,001$). This shows that there are at least two groups that have significant average differences.

Based on table 5, significant differences were found between the unpackaged group and all the 3-day storage groups ($p<0.05$). Aluminum foil packaging shows significant differences compared to glass bottles ($p=0,017$), shows the effect of packaging during storage on color change. In addition, the difference between glass bottle packaging and plastic bottles with a significant value ($p=0,129$),

shows that there is no noticeable difference between the packaging during storage against color change.

CONCLUSIONS

This study shows that storage and packaging have a significant effect on color stability, especially due to the oxidation process. However, neither showed a significant effect on iron stability. From the test results, glass bottle packaging is most effective in maintaining iron and color stability. Plastic bottles are better than aluminum foil packaging at maintaining color absorbance, although both have equal effectiveness in maintaining iron content.

RECOMMENDATION

This study has limitations in the amount of data produced, namely only eight data from four treatment groups. To obtain more representative results and reduce the risk of insignificance due to small sample sizes, it is recommended that further studies use larger sample sizes, increase storage frequency, or explore a wider variety of packaging methods. In addition, the study has not tested microbial growth in the samples, so to determine its feasibility and safety aspects thoroughly, microbiological testing needs to be added in the follow-up study. In addition, in the process of making guava juice, the addition of water should not be excessive because it can affect the accuracy of iron level measurements

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