Research Article

Development of functional jelly formulated from tunisian dates (*Phoenix dactylifera L.*) and red guava (*Psidium guajava L.): Analysis* of nutritional content and sensory acceptability

Sinta Padillah Munthe[1], Sa'bania Hari Raharjeng[1], Paramitha Viantry[1], Rizki Nurmalya Kardina[1]

[1]Department of Nutrition, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, Surabaya, Indonesia

Correspondence:
Sa'bania Hari Raharjeng
Department of Nutrition, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, Surabaya, Indonesia

Email:
sabaniahr@unusa.ac.id

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Abstract

In the productive age group, iron deficiency anemia among adolescents is caused by various factors, including blood loss due to menstruation, inadequate intake of iron and vitamin C, as well as poor acceptability of iron supplementation tablets, especially due to their unpleasant taste, which affects adherence to consumption. This study aimed to analyze the iron content, vitamin C content, and acceptability of jelly formulated from Tunisian dates (*Phoenix dactylifera* L.) and red guava (*Psidium guajava* L.). This research used an experimental study with a Completely Randomized Design (CRD). The samples included four jelly formulations: F0: 100% beetroot (control); F1: 30% Tunisian dates and 70% red guava; F2: 40% Tunisian dates and 60% red guava; and F3: 50% Tunisian dates and 50% red guava. The acceptability test involved 30 panelists. Iron content was analyzed using UV-Vis spectrophotometry, and vitamin C was measured through iodimetry titration. The data were analyzed using One-Way ANOVA (α <0.05). Acceptability data were analyzed using the Kruskal Wallis test. The results showed that Formulation 3 had the highest average iron and vitamin C contents, amounting to 29.68 mg/100 g and 49.10 mg/100 g, respectively. The One-Way ANOVA analysis yielded a p-value <0,001, indicating significant differences in iron and vitamin C contents among the formulations.

1. INTRODUCTION

Anemia among adolescent girls remains a major public health problem at both global and national levels. Globally, the World Health Organization (WHO) reported that approximately 30.7% of women of reproductive age were affected by anemia in 2023, with the burden remaining particularly high in developing countries. Anemia can lead to fatigue, decreased concentration, impaired growth, reduced productivity, and an increased risk of health complications during future pregnancies. Furthermore, WHO emphasized that the world is still not on track to achieve the global target of reducing anemia prevalence by 50% by 2030. In Indonesia, the prevalence of anemia among adolescent girls remains high and has increased over recent years (World Health Organization, 2025). Data from the Indonesian Riset Kesehatan Dasar (Riskesdas) 2018 showed that the prevalence of anemia among adolescent girls reached 32%, indicating that approximately three to four out of ten adolescent girls experienced anemia. This prevalence increased compared to the 2013 Riskesdas report, which recorded a prevalence of 22.7%, highlighting anemia as a persistent challenge in national health development (Kementerian Kesehatan RI, 2019). This condition represents a significant public health concern that requires serious attention.

Anemia in adolescent girls may cause several immediate symptoms, including dizziness, blurred vision, pale eyelids, skin, palms, lips, and tongue. In the long term, anemia during adolescence may increase the risk of anemia during pregnancy. Adolescent girls will eventually enter reproductive age and experience pregnancy, during which nutritional requirements increase substantially. Essential nutrients needed during pregnancy include iron, vitamin C, folic acid, and calcium. If not properly addressed, anemia may lead to adverse outcomes for both mother and infant (Apriyanti, 2019). Among adolescents, iron deficiency anemia may result from several factors, including blood loss due to menstruation, inadequate intake of iron and vitamin C, and parasitic infections. Consequently, adolescent girls tend to lose twice as much iron as adolescent boys (Yunita et al., 2020).

Government programs and policies aimed at preventing anemia primarily focus on iron supplementation through iron-folic acid tablets among vulnerable groups. The supplements contain 60 mg of elemental iron ($FeSO_4$) and 0.4 mg of folic acid. Iron supplementation has been reported to increase hemoglobin levels (Wahyuni, 2021). Data from Riskesdas 2018 showed that 76.2% of adolescent girls received iron supplementation tablets; however, 98.6% consumed fewer than 52 tablets annually, while only 1.4% adhered to the recommended intake of more than 52 tablets (Kemenkes RI, 2019).This finding demonstrates that compliance with iron supplementation remains low. Several factors contribute to poor adherence, including uncomfortable side effects such as nausea (Juwita, 2018). In addition, the unpleasant taste of iron tablets has been identified as another major factor affecting adherence among adolescents (Irianti & Sahiroh, 2019). Therefore, alternative approaches are needed to fulfill iron and vitamin C requirements for anemia prevention among adolescent girls through the consumption of iron- and vitamin C-rich foods such as dates and red guava.

Dates (*Phoenix dactylifera* L.) contain approximately 1.15 mg of iron per 100 g and are beneficial for increasing hemoglobin levels (Lababan & Rahmawati, 2022). A study conducted by Safitri & Julaecha (2021) reported a significant increase in hemoglobin levels among adolescent girls following date consumption, with median hemoglobin levels increasing from 11.15 g/dL to 12.65 g/dL ($p < 0.05$). The utilization of iron content in dates to improve hemoglobin profiles can be enhanced through combination with vitamin C-rich foods, one of which is red guava, as vitamin C plays an important role in increasing the absorption and bioavailability of non-heme iron in the body. Red guava (*Psidium guajava* L.) is recognized as a rich source of vitamin C, containing approximately 87 mg/100 g of vitamin C (Paramesti et al., 2020). A study by Rusdi et al. (2018) reported that red guava not only increased hemoglobin and serum ferritin levels in patients with iron deficiency anemia, but also improved hemoglobin and ferritin levels in patients with other types of anemia. Therefore, product modification and development are necessary to produce iron- and vitamin C-rich foods that are acceptable to all age groups. One promising alternative is jelly products. Jelly is a fruit-based processed product that is widely favored by consumers due to its sweet taste, unique texture, and ease of preparation with various formulations. Based on this background, the researchers were interested in developing a jelly product formulated from Tunisian dates and red guava as an alternative functional food to increase iron and vitamin C intake for anemia prevention, considering that various age groups highly prefer jelly products and find them practical to consume.

2. MATERIALS AND METHODS

2.1 Materials

The materials used in this study consisted of the main ingredients, Tunisian date fruit and red guava. The Tunisian dates used were selected based on the following criteria: fully ripe, fresh, soft flesh texture, free from physical defects, not dried, free from mold contamination, and in good overall condition. The fruits exhibited a dark brown color, oval shape, moderately thick skin, slightly dry texture, firm yet soft flesh, and a distinctive sweet taste. The red guava used in this study was selected at an adequately ripe stage, characterized by a distinctive aroma, the absence of physical damage and spoilage, a pinkish-red flesh color, a round fruit shape, a smoother skin surface, and a soft flesh texture. Additional ingredients used in the jelly formulation included beetroot (as the control formulation), water, sugar, and calcium lactate. Meanwhile, the tools used to create the jelly formula include a blender, sieve, 0.5 circle jelly mold, bowl, refrigerator, digital scale, stirrer, spoon, knife, and measuring cup. In the acceptability test, the tools and materials used were stationery, an acceptance questionnaire, 3 jelly formulas that had been given label codes, and mineral water. The composition of the jelly formula is presented in Table 1.

Tabel 1. Compotition of Jelly Formula

Mateial	Jelly Formula (Tunisian dates:Red guava)			
	0%:0%	30%:70%	40%:60%	50%:50%
Tunisian date (g)	0	75	100	125
Red guava (g)	0	175	150	125
Beetroot (g)	250	0	0	0
Calcium Alginate (g)	6	6	6	6
Water (mL)	100	100	100	100
Sugar (g)	2	2	2	2
Total (g)	358	358	358 gram	358

2.2 Research Design

This study utilized a true experimental approach, employing a Completely Randomized Design (CRD) to evaluate four treatment formulations of Tunisian dates and red guava: F0 = 0%: 0% (control), F1 = 30%: 70%, F2 = 40%: 60%, and F3 = 50%: 50%. The experimental samples consisted of jelly products made from Tunisian dates (*Phoenix dactylifera* L.) and red guava (*Psidium guajava* L.). The total sample size was determined using the Gomez 1995 repetition formula, resulting in three replications per formulation and a total of 12 samples. Acceptability was assessed by 30 semi-trained panelists, all of whom were female undergraduate nutrition students from the Department of Nutrition at Universitas Nahdlatul Ulama Surabaya. Panelists were selected through purposive sampling, with inclusion criteria comprising willingness to participate, absence of hunger or satiety during testing, prior knowledge of organoleptic evaluation, and no history of allergy to dates or red guava. Students with impaired sensory function due to illness (e.g., flu, sore throat, eye disorders, oral ulcers) or other health conditions were excluded.

2.3 Procedure

The research procedure consisted of three stages: data collection, dietary assessment, and statistical analysis. The data collection process began with the distribution of structured online questionnaires to students at Nahdlatul Ulama University Surabaya through Google Forms shared via WhatsApp groups across study programs. Respondents who met the inclusion criteria and agreed to participate completed the informed consent form before proceeding to the questionnaires. Nutritional knowledge was assessed using a questionnaire adapted from Buxton and Davies, while food attitudes were evaluated using a validated questionnaire adapted from Mulyati. Dietary diversity data were collected using a 24-hour food recall form, which recorded meal times, food items consumed, ingredients, and portion sizes. The collected food intake data were subsequently converted into gram units and analyzed using the Dietary Diversity Score (DDS) based on nine food groups recommended by FAO. All collected data were processed through editing, coding, scoring, cleaning, and tabulation before statistical analysis using Spearman's Rank correlation test. The overall research procedure is presented in Figure 1.

The second procedure was the acceptability test, which was conducted involving 30 panelists. The implementation stage of the acceptability test involved dividing all panelists into two sessions, with 15 panelists participating in Session I and 15 panelists in Session II. In Session I, each panelist was served four jelly formulations labeled with different code numbers. Drinking water was provided to neutralize the taste between samples. The seating arrangement among panelists was spaced approximately ±50 cm. Each panelist was given 20 minutes to evaluate the samples. After the completion of Session I, Session II was conducted using the same procedure. The test was conducted in a closed, quiet, cool room with adequate lighting conditions. Four coded sample formulations were distributed to each panelist, with each sample weighing 10 g, along with an evaluation form, stationery, and water for palate cleansing. A brief explanation regarding the testing procedure and instructions for completing the evaluation form was provided to all panelists. Panelists were then allowed to taste the samples and record their evaluations on the assessment form, and completed evaluation forms were subsequently collected from all panelists.

The third procedure involved analyzing the iron and vitamin C contents. The absorbance of the standard iron solution was measured at a wavelength of 248.3 nm using a UV–Vis spectrophotometer. The analysis of iron content included sample digestion and preparation of the iron (Fe) calibration curve. The iron concentration in the samples was calculated using the regression equation from the calibration curve, expressed as (Y=a+bX). Vitamin C content was determined through the iodimetric titration method. The jelly sample was first homogenized in a mortar, and 5 mL of the sample was measured and diluted with distilled water to a final volume of 100 mL in a volumetric flask, followed by thorough mixing. The solution was filtered using filter paper, and 25 mL of the filtrate was transferred into a 100 mL Erlenmeyer flask. Then, 10 mL of 2 N H_2SO_4 and 10 drops of 1% starch indicator were added. The sample was titrated with 0.01 N iodine (I_2) solution until a stable blue color appeared, signaling the titration endpoint. The volume of iodine solution used was recorded and employed to calculate the vitamin C content, expressed as mg/100 g of sample. The vitamin C content was calculated using the following formula:

$$Vitamin\ C\ content\ (ml/100g) = \frac{(Volumen\ of\ I2\ x\ 0.88\ x\ Fp)\ x\ 100}{Sample\ weight\ (g)} \qquad (1)$$

where:

I2 : volume of iodine solution used in the titration (mL)
0.88 : equivalent factor of vitamin C
Fp : dilution factor
Sample weight : weight of the analyzed sample (g)

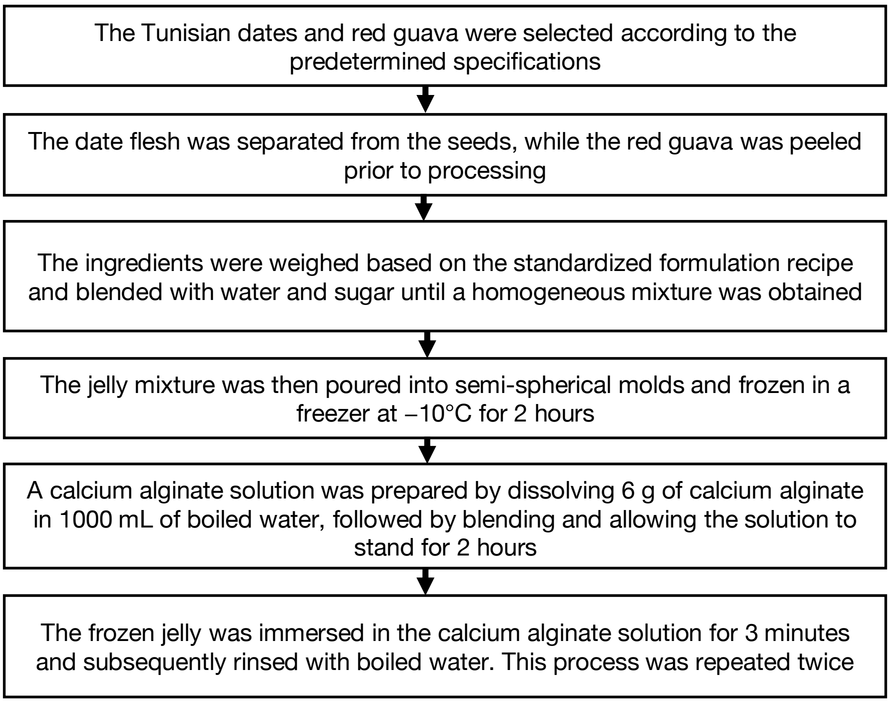


Figure 1. Procedure for Jelly Formulation Preparation

2.4 Analysis Methods

Differences in iron (Fe) and vitamin C contents among formulations were analyzed using the One-Way ANOVA test with a significance level of 95% ($p < 0.05$). Meanwhile, acceptability test data were analyzed using the Kruskal–Wallis test with a significance level of 95% ($p < 0.05$).

3. RESULTS AND DISCUSSION

3.1 Nutrition analysis

Based on the analysis results in Table 2, an increase in iron (Fe) and vitamin C contents was observed across all formulations from F0 to F3. The mean iron content increased gradually from 22.74 ± 0.574 in F0 to 24.58 ± 0.011 in F1, 27.63 ± 0.095 in F2, and reached the highest value in F3 at 29.68 ± 0.015. Statistical analysis showed a p-value < 0.001, indicating a significant difference among the four jelly formulations. A similar trend was observed for vitamin C content. Formulation F0 contained 34.86 ± 0.577 mg/100 g vitamin C, which increased to 41.60 ± 0.529 mg/100 g in F1, 45.06 ± 0.550

mg/100 g in F2, and 49.10 ± 0.100 mg/100 g in F3. Statistical analysis also demonstrated a p-value < 0.001, indicating significant differences in vitamin C content among the formulations.

Table 2. Iron and Vitamin C Analysis

Samples	Iron		Vitamin C	
	Mean ± SD	***p-value***	**Mean ± SD**	***p-value***
F0	22.74 ± 0.574[a]	<0.001	34.86 ± 0.577[a]	<0.001
F1	24.58 ± 0.011[b]		41.60 ± 0.529[b]	
F2	27.63 ± 0.095[c]		45.06 ± 0.550[c]	
F3	29.68 ± 0.015[d]		49.10 ± 0.100[d]	

The increase in iron and vitamin C contents in each formulation may be attributed to the proportion of Tunisian dates and red guava added to the jelly formulations. Tunisian dates contain approximately 7.2 mg iron per 100 g, while red guava contains approximately 87 mg vitamin C per 100 g. In the present study, the 50:50 formulation (F3) produced the highest iron and vitamin C contents. Previous studies have similarly reported that the proportion of iron- and vitamin C-rich ingredients in food product development significantly affects the nutritional composition of the final product. Another research by Dewi et al. (2023) reported that jelly candy formulated with 75% red guava and 25% moringa leaves demonstrated high iron and vitamin C contents, suggesting its potential as an alternative functional snack rich in micronutrients. Likewise, date ice cream formulated with 75% dates and 25% lemon extract showed the highest iron content, reaching 22.56 mg (Putri et al., 2022). Another study demonstrated that a combination of 25% beetroot and 75% red guava juice resulted in the highest iron content of 1.3 mg (Utami & Farida, 2022).

Dates are known to contain quite high levels of iron in the form of non-heme iron. Non-heme iron is known to have lower availability than heme iron, causing it to take longer to be absorbed in the intestine compared to heme iron. The bioavailability of non-heme iron is known to be only 1-10% of the consumed non-heme iron source (Sharp & Srai, 2007). In this condition, Vitamin C plays an important role in enhancing the bioavailability of non-heme iron by reducing ferric iron (Fe^{3+}) to ferrous iron (Fe^{2+}), which is more readily absorbed in the intestine (Pan et al., 2024). Therefore, combining non-heme iron sources with vitamin C-rich foods may provide synergistic benefits for iron absorption.The findings of the present study are also supported by previous studies investigating the relationship between vitamin C intake, iron absorption, and hemoglobin status. Combined supplementation of iron and vitamin C has been shown to produce greater increases in hemoglobin levels compared with iron supplementation alone (Aini & Safitri, 2021). Additionally, adequate vitamin C intake has been linked to enhanced iron absorption efficiency and a reduced risk of iron deficiency anemia (Rieny et al., 2021). Therefore, the combination of Tunisian dates as a non-heme iron source and red guava as a vitamin C source may represent a promising approach to functional foods for supporting iron intake and preventing anemia, particularly among adolescent girls and women of reproductive age.

Besides nutritional enhancement, the development of jelly products may improve consumer acceptability and adherence compared with conventional iron supplementation tablets. Previous studies have reported that direct consumption of dates may cause boredom among consumers, while red guava juice has limited shelf stability. Transforming these ingredients into jelly products provides a more practical, attractive, and palatable alternative. Jelly products are generally favored because of their sweet taste, soft texture, and ease of consumption across various age groups. Therefore, the functional jelly developed in this study has the potential not only to improve iron and vitamin C intake but also to increase consumer acceptance and compliance in anemia prevention programs.

3.2 Sensory Acceptability

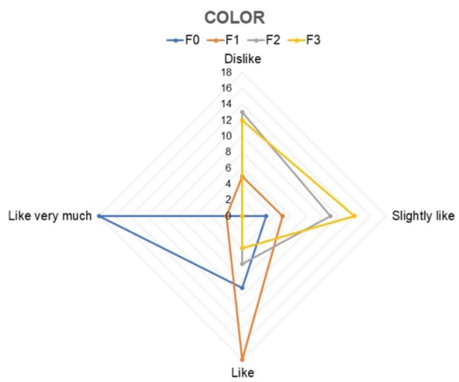
Based on the combined results of the hedonic sensory scores and the distribution of panelists' responses presented in Figure 2 and Table 3, the jelly products formulated with Tunisian dates and red guava demonstrated varying levels of sensory acceptance for color, aroma, taste, and texture attributes. Statistical analysis revealed that color and taste differed significantly among formulations, with p-values of 0.001 and 0.044, respectively ($p < 0.05$), whereas aroma and texture showed no significant differences, with p-values of 0.219 and 0.088, respectively ($p > 0.05$). The radar charts further illustrated the distribution of panelists' preferences across the categories of dislike, slightly like, like, and like very much for each formulation. For the color attribute, formulation F0 showed the highest mean hedonic score (3.50 ± 0.682), while formulation F3 had the lowest score (1.73 ± 0.691). The radar chart in Figure 2(a) demonstrated that F0 received the highest proportion of "like very much" responses, whereas F2 and F3 were more frequently rated within the "slightly like" and "dislike" categories. These findings suggest that increasing the proportion of Tunisian dates and red guava reduced panelists' preference for product color. The formulations containing higher levels of Tunisian dates and red guava produced a paler pink-red color compared with the more intense red color of F0, which contained beetroot only. Color is one of the primary sensory attributes influencing consumer acceptance because it affects visual perception and expectations toward food products (Clydesdale, 1993). Moreover, thermal processing during jelly production may affect the stability of betalain pigments from beetroot and lycopene pigments from red guava, resulting in pigment degradation and non-enzymatic browning reactions that produce duller colors (Azeredo, 2009).

Table 3. Acceptability Statistic Analytic

Samples	Hedonic Sensory Category			
	Color	Aroma	Taste	Textur
F0	3.50 ±0.682^{a}	2.37 ±0.765	2.23 ±0.774^{ab}	3.00 ±0.695
F1	2.37 ±0.858^{b}	2.33 ±0.844	2.77 ±0.858^{bc}	3.20 ±0.551
F2	1.77 ±0.774^{c}	2.23 ±0.971	2.50 ±0.974^{ac}	2.57 ±1.006
F3	1.73 ±0.691^{cd}	1.97 ±0.718	2.17 ±0.791^{ab}	2.57 ±0.817
p-value	0.001	0.219	0.044	0.088

For aroma, the mean hedonic scores ranged from 1.97 ± 0.718 to 2.37 ± 0.765, with no significant differences among formulations. Figure 2(b) also showed relatively similar distributions of panelists' responses, predominantly within the "slightly like" and "like" categories. The absence of significant differences indicates that the aroma characteristics of Tunisian dates and red guava remained acceptable and were not perceived as overly dominant in the jelly products. Aroma acceptance is generally influenced by the balance of volatile compounds and the familiarity of consumers with the aroma profile of food ingredients.

A



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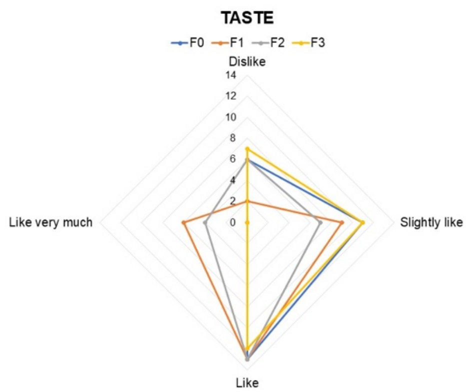

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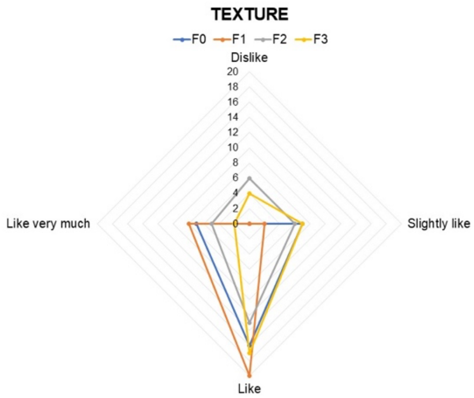

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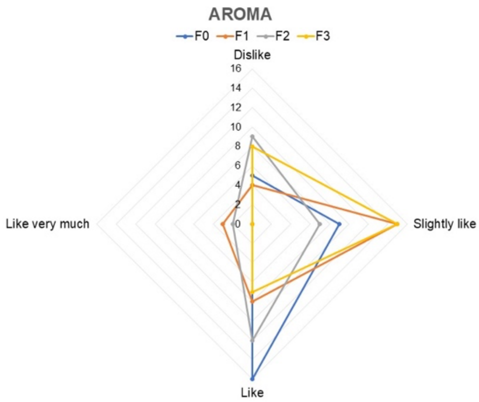

Figure 2. Distribution of panelists' hedonic responses toward jelly formulations based on Tunisian dates and red guava for (a) color, (b) aroma, (c) taste, and (d) texture attributes

Taste evaluation demonstrated significant differences among formulations ($p = 0.044$). Formulation F1 obtained the highest taste score (2.77 ± 0.858), whereas F3 had the lowest score (2.17 ± 0.791). Figure 2(c) showed that F1 received more "like" responses compared with the other formulations, while F3 showed increased responses in the "slightly like" and "dislike" categories. The decreased preference for F3 may be associated with the stronger characteristic flavor produced by the higher proportion of Tunisian dates and red guava. Although dates contributed natural sweetness, the acidic taste and distinct flavor of red guava may have altered the balance between sweetness and acidity, thereby affecting consumer acceptance. Previous studies have reported that flavor balance is an important determinant of sensory acceptability in functional food products (Spence, 2015).

For texture, no significant differences were observed among formulations ($p = 0.088$). Formulation F1 achieved the highest texture score (3.20 ± 0.551), whereas F2 and F3 had lower scores (2.57 ± 1.006 and 2.57 ± 0.817, respectively). Figure 2(d) indicated that most panelists categorized all formulations within the "like" category for texture. These findings suggest that the incorporation of Tunisian dates and red guava did not substantially affect the gel characteristics of the jelly products. However, increased total solids and fiber content from the fruit ingredients may have slightly influenced gel firmness and softness. Formulation F1 demonstrated the best sensory acceptance, particularly in taste and texture attributes, as reflected by both the mean hedonic scores and the distribution of panelists' responses. In contrast, formulation F3 contained the highest nutritional value in terms of iron and vitamin C content but showed lower sensory acceptability due to stronger color and flavor characteristics. These findings indicate that improving nutritional quality through increased fruit incorporation does not necessarily lead to higher consumer acceptance. Therefore, the development of functional jelly products requires an optimal balance between nutritional enhancement and sensory quality to ensure both health benefits and consumer preference.

4. CONCLUSION

The study demonstrated that the addition of Tunisian dates and red guava significantly affected the nutritional and sensory characteristics of jelly products. Formulation F3 showed the highest iron and vitamin C contents, indicating that increasing the proportion of Tunisian dates and red guava enhanced the nutritional value of the product. However, sensory evaluation revealed that formulation F1 achieved the highest overall acceptability, particularly in taste and texture attributes, while higher proportions of the added fruits tended to reduce panelist preference due to changes in color intensity and stronger flavor characteristics. These findings contribute scientifically to the development of functional jelly products by highlighting the synergistic role of Tunisian dates as a source of iron and red guava as a rich source of vitamin C, which may improve the nutritional quality and potential iron bioavailability of the product. The study also emphasizes the importance of balancing nutritional enhancement with sensory acceptability in functional food formulation. Practically, the developed jelly product has the potential to be utilized as an innovative functional snack that may help support iron intake and contribute to anemia prevention efforts, particularly among populations at risk of iron deficiency. Furthermore, formulation F1 may be considered the most suitable formulation for product development due to its better consumer acceptance while still providing improved nutritional value.

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