AcTion: Aceh Nutrition Journal
October – December, 2025
Original Article
DOI: http://dx.doi.org/10.30867/action.v10i4.2816
Pages: 1157 – 1165
p-issn 2527-3310; e-issn 2548-5741

Effects of moringa leaf powder substitution on organoleptic characteristics, iron, and vitamin C of calamansi orange gummy candy

Pengaruh substitusi bubuk daun kelor terhadap karakteristik organoleptik, zat besi, dan vitamin C pada permen jelly jeruk kalamansi

Nabila Salwa[1], Aripin Ahmad[2*], Eva Fitriyaningsih[3], Rosi Novita[4], Syuja' Rafiqi Arifin[5], Cut Aja Nuraskin[6]

[1] Department of Nutrition, Health Polytechnic of Aceh, Aceh Besar, Indonesia. E-mail: nabiilaslwa@gmail.com
[2] Department of Nutrition, Health Polytechnic of Aceh, Aceh Besar, Indonesia. E-mail: aripinahmad@poltekkesaceh.ac.id
[3] Department of Nutrition, Health Polytechnic of Aceh, Aceh Besar, Indonesia. E-mail: eva.fitriyaningsih@poltekkesaceh.ac.id
[4] Department of Nutrition, Health Polytechnic of Aceh, Aceh Besar, Indonesia. E-mail: rosi.novita@poltekkesaceh.ac.id
[5] Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor, Indonesia. E-mail: syujarafiqi_080701arifin@apps.ipb.ac.id
[6] Department of Dental Health, Health Polytechnic of Aceh, Aceh Besar, Indonesia. E-mail: cutajanuraskin2@gmail.com

***Correspondence Author:**
Department of Nutrition, Health Polytechnic of Aceh, Aceh Besar, Indonesia, Jl. Soekarno–Hatta, Lagang, Darul Imarah, Aceh Besar, Indonesia
Email: aripinahmad@poltekkesaceh.ac.id

Article History:
Received: September 03, 2025; Revised: October 29, 2025; Accepted: December 16, 2025; Published: December 18, 2025.

Publisher:
Politeknik Kesehatan Aceh
Kementerian Kesehatan RI

Abstract

Gummy candy is widely consumed but generally low in micronutrients. Fortification with local ingredients rich in iron and vitamin C may improve its nutritional value. This study aimed to determine the effects of substituting moringa (*Moringa oleifera*) leaf powder solution on the organoleptic characteristics, iron content, and vitamin C levels of calamansi orange gummy candy. This experimental study employed a Completely Randomized Design and was conducted at the Food Laboratory, Department of Nutrition, Poltekkes Kemenkes Aceh, with chemical analyses performed at BSPJI Banda Aceh from November to December 2024. Three formulations with 30%, 40%, and 50% moringa leaf powder solution were prepared in triplicates. The organoleptic acceptance (color, taste, aroma, and texture) was evaluated using a hedonic test by 30 semi-trained panelists. Iron content was analyzed using atomic absorption spectrophotometry, and vitamin C content was determined by titration. Data were analyzed using analysis of variance (ANOVA), followed by Duncan's Multiple Range Test ($\alpha = 0.05$). The results showed that the substitution significantly affected the iron and vitamin C content ($p < 0.001$). Iron levels increased significantly with higher substitution levels (0.16 ± 0.01, 0.21 ± 0.00, and 0.26 ± 0.02 mg per 25 g; Duncan a < b < c). Vitamin C levels also differed significantly, with the 30% formulation showing higher values than the 40% and 50% formulations (3.31 ± 0.00 mg vs. 3.10 ± 0.01 mg and 3.03 ± 0.00 mg per 25 g, respectively; Duncan a > b = b). In conclusion, substitution with moringa leaf powder solution improves the micronutrient content of calamansi gummy candy, with the 50% formulation providing the highest iron content.

Keywords: Ascorbic acid, gummy candy, iron, *Moringa oleifera*, sensory evaluation

Abstrak

Permen jeli banyak dikonsumsi tetapi umumnya rendah mikronutrien. Fortifikasi dengan bahan pangan lokal kaya zat besi dan vitamin C berpotensi meningkatkan nilai gizinya. Penelitian ini bertujuan menganalisis pengaruh substitusi larutan bubuk daun kelor terhadap karakteristik organoleptik, kandungan zat besi, dan kadar vitamin C permen jeli jeruk kalamansi. Metode, penelitian eksperimental dengan Rancangan Acak Lengkap dilakukan di Laboratorium Pangan Jurusan Gizi Poltekkes Kemenkes Aceh, sedangkan analisis kimia dilakukan di BSPJI Banda Aceh pada November–Desember 2024. Tiga formulasi dengan substitusi larutan bubuk daun kelor sebesar 30%, 40%, dan 50% dibuat dalam tiga ulangan. Uji organoleptik (warna, rasa, aroma, tekstur) dilakukan menggunakan uji hedonik oleh 30 panelis semi-terlatih. Kadar zat besi dianalisis menggunakan AAS dan vitamin C dengan titrasi. Data dianalisis menggunakan ANOVA dan dilanjutkan uji Duncan (α=0.05). Hasil, substitusi berpengaruh signifikan terhadap kadar zat besi dan vitamin C (p<0.001).

Kadar zat besi meningkat seiring peningkatan substitusi (0.16±0.01; 0.21±0.00; 0.26±0.02 mg/25 g; Duncan a<b<c). Kadar vitamin C berbeda nyata, dengan formulasi 30% lebih tinggi dibanding 40% dan 50% (3.31±0.00 vs 3.10±0.01 dan 3.03±0.00 mg/25 g; Duncan a>b=b). Kesimpulan, substitusi larutan bubuk daun kelor meningkatkan kandungan mikronutrien permen jeli jeruk kalamansi, dengan formulasi 50% memberikan kandungan zat besi tertinggi.

Kata Kunci: Asam askorbat, Moringa oleifera, permen jeli, uji sensoris, zat besi

Introduction

Gummy candy is a ready-to-eat food product that is easy to distribute, has a relatively long shelf life, and is generally favored by children and adolescents aged 3–18 years old (Rahim et al., 2020). In Indonesia, the per capita consumption of gummy candy ranges from 20 to 30 g. According to the Indonesian National Agency of Drug and Food Control (BPOM, 2018), the daily consumption of gummy candy is higher (9 g/person/day) than that of hard candy (8 g/person/day). Gummy candy is a sugar-based confectionery product containing hydrocolloid components, such as gelatin, which contribute to its characteristic chewy texture. It typically has a clear, transparent appearance and an elastic consistency. The manufacturing process generally requires reversible gelling agents that liquefy upon heating and re-gel upon cooling. Several factors influence the final quality of gummy candy, including fruit selection, type and concentration of gelling agents, and processing methods (Yuwidasari et al., 2019).

Gummy candy is classified as a semi-moist confectionery product. Processing aims to regulate the moisture content and water activity (Aw) to limit microbial growth while maintaining texture and quality. The typical moisture content of gummy candies ranges from approximately 10% to 20%, with water activity values between 0.50 and 0.75, depending on the formulation and processing conditions (Vojvodić Cebin et al., 2024). Under these conditions, gummy candy can generally inhibit microbial activity that may cause food spoilage (Yuwidasari et al., 2019).

Despite its popularity, gummy candy is high in sugar, resulting in a pleasant sweet taste but with low nutritional value. Cane sugar, commonly used in gummy candy, has a higher caloric content than corn sugar (Putri et al., 2015). Therefore, there is a need to develop gummy candies using natural ingredients, such as moringa leaves, to produce a more nutritious and safer product for consumption.

Moringa (*Moringa oleifera*) leaves are recognized as a locally available food source rich in iron and other essential nutrients. Compared with many other plants, moringa leaves have a relatively complete nutritional profile, containing nine essential amino acids and various vitamins and minerals. Previous studies have reported that moringa leaves do not contain compounds harmful to humans (Parti, 2022). Moringa leaves are known to contain iron, protein, vitamin C, vitamin A, potassium, and calcium. With an iron content of up to 28.2 mg, they are considered a potential alternative for preventing anemia in pregnant women. In addition, Moringa leaves contain various antioxidant compounds, making them suitable for use in functional food formulations (Fauziandari, 2019). Dhafir and Laenggeng (2020) reported that 100 g of moringa leaves contain 497.8 mg of calcium and 6.24 mg of iron. Furthermore, Hastuty and Nitia (2022) demonstrated that supplementation with 500 mg of moringa leaf extract twice daily for 14 days effectively increased hemoglobin levels.

Calamansi (*Citrus microcarpa*) is used in gummy candy formulations as a source of vitamin C, which plays an important role in enhancing iron absorption. Calamansi is rich in vitamin C, with levels reaching approximately 30 mg per 100 g of fresh fruit, which is higher than that of many other citrus fruits (TKPI, 2017). It also contains antioxidant compounds, particularly phenolic compounds, at concentrations ranging from 24.50–130.51 μg/g. However, calamansi is rarely consumed directly because of its high acidity, attributed to its citric acid content of up to 5.52%. Despite this, calamansi offers considerable health benefits (Alvita et al., 2021) and is well-known for its distinctive and refreshing aroma (Agustina et al., 2021). Therefore, incorporating calamansi into gummy candy may help mask the undesirable beany odor associated with moringa leaves.

According to the 2023 Indonesian Health Survey, anemia remains a significant public health problem in Indonesia, particularly among pregnant women and their children. The prevalence of anemia affects approximately one in four pregnant women, 23.8% of children aged 0–4 years, and 16.3% of children aged 5–14 years (Kemenkes RI, 2023). Iron deficiency anemia is the primary cause of this condition and may adversely affect fetal growth and maternal health (Obeagu & Obeagu, 2025). Consequently, the development of functional food products represents a potential alternative strategy for preventing and managing anemia in Indonesia.

To date, no studies have reported the combination of calamansi (*Citrus microcarpa*) and moringa leaf powder solution in gummy candy formulations, particularly with respect to their organoleptic properties, iron content, and vitamin C levels. Thus, this study offers novelty by integrating a local vitamin C–rich fruit with an iron-rich plant source into a functional gummy candy product. Based on these considerations, this study aimed to determine the effect of substituting calamansi juice with a Moringa leaf powder solution on the organoleptic properties, iron content, and vitamin C levels of calamansi gummy candy.

Methods

Study Design and Location

This study was an experimental investigation employing a Completely Randomized Design (CRD) with a non-factorial arrangement, consisting of three formulations and three replications (3 × 3 = 9 experimental units). The parameters assessed included organoleptic characteristics evaluated using a hedonic test, including color, taste, aroma, and texture.

Sensory evaluation was conducted at the Food Laboratory of the Department of Nutrition, Health Polytechnic of Aceh, Ministry of Health. Chemical analyses of iron (Fe) and vitamin C contents were performed at the Balai Standarisasi dan Pelayanan Jasa Industri (BSPJI), Banda Aceh. Statistical analysis of the data was performed using analysis of variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) when significant differences were observed. The study was conducted between November and December 2024.

Materials

The materials used in this study included high-quality ingredients, including moringa leaves, calamansi (*Citrus microcarpa*), bovine gelatin, and corn sugar. Moringa leaf powder was obtained from Dari Bumi, a halal-certified producer in Indonesia. Fresh calamansi fruits were purchased from Suzuya Mall, Banda Aceh, and selected based on freshness, green color, and weight range of 15–20 g. The gelatin used was halal-certified bovine gelatin powder produced by Hays Food & Co. The corn sugar used in this study was from the Tropicana Slim brand.

Preparation of Moringa Leaf Powder Solution and Calamansi Juice

Moringa leaf powder (10 g) was weighed and placed in a container. Mineral water was then added to obtain a final volume of 100 mL. The mixture was stirred until a homogeneous solution was obtained.

Fresh calamansi fruits were washed under running water and cut in half. The juice was extracted by squeezing the fruit through a strainer to remove any seeds. The collected juice was placed in a container and used immediately for further analyses.

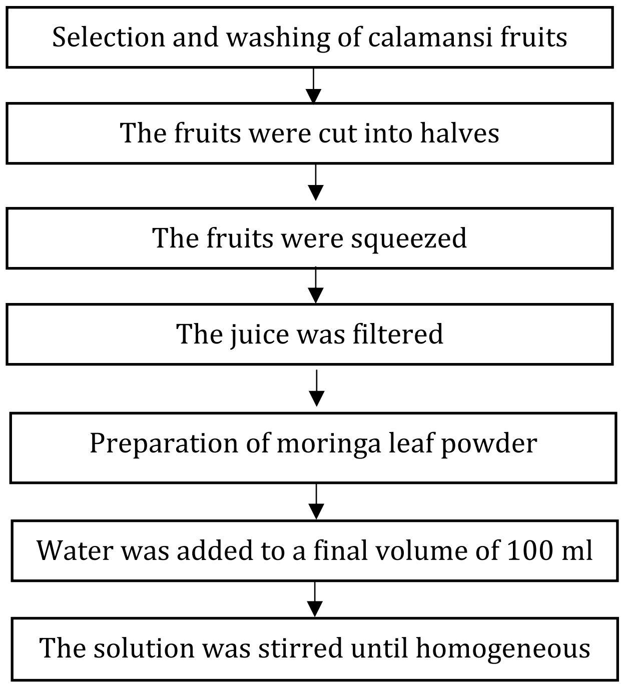

Figure 1. Flow diagram of moringa leaf powder solution and calamansi juice preparation

Preparation of Gummy Candy

Calamansi gummy candy was prepared with moringa leaf powder solution using three formulations: Formulation A (30% substitution), Formulation B (40% substitution), and Formulation C (50% substitution). The ingredient compositions are listed in Table 1.

Table 1. Ingredients for gummy candy preparation

Ingredients	F-A (30%)	F-B (40%)	F-C (50%)
Moringa leaf powder solution	30 mL	40 mL	50 mL
Calamansi juice	70 mL	60 mL	50 mL
Gelatin	20 g	20 g	20 g
Corn sugar	10 g	10 g	10 g

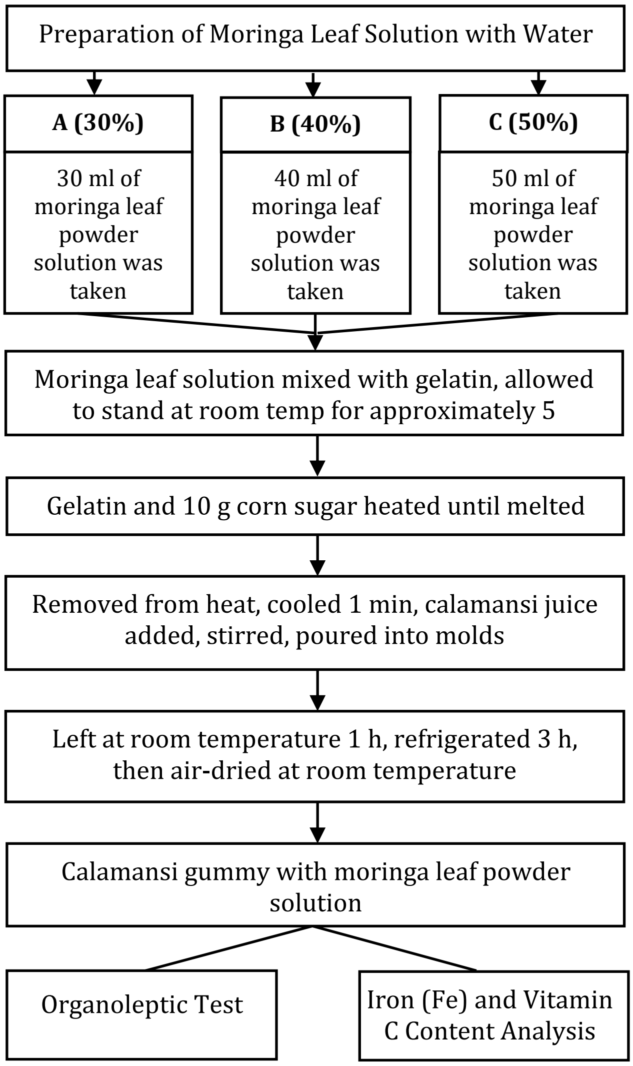

Figure 2. Flow diagram of gummy candy production.

The gummy candy preparation process involved weighing all the ingredients according to the formulation. The moringa leaf powder solution was mixed with gelatin and allowed to stand for approximately 5 min. Gelatin and corn sugar were heated in a saucepan over low heat until completely dissolved. The mixture was removed from the heat and allowed to cool for approximately 1 min before adding calamansi juice, followed by stirring until homogeneous. The mixture was poured into silicone molds and left at room temperature for approximately 1 h, followed by refrigeration for approximately 3 h until fully set. The gummies were then removed from the molds and air-dried at room temperature until their outer surfaces became firm. The overall production process is shown in Figure 2.

Organoleptic Test

Organoleptic evaluation was conducted using a hedonic test to assess the panelists' preferences for the color, taste, aroma, and texture of the calamansi gummy candy substituted with moringa leaf powder solution. The panelists consisted of 30 semi-trained individuals, namely students from the Department of Nutrition, Poltekkes Kemenkes Aceh, who had completed the Food Technology course. A five-point hedonic scale was used, ranging from 5 (extremely like) to 1 (extremely dislike).

Analysis of Iron (Fe) and Vitamin C Content

The iron content was determined using atomic absorption spectrophotometry (AAS) in accordance with iron (Fe) testing standards issued by the National Standardization Agency (2004) at the Industrial Standardization and Service Center, Banda Aceh. Vitamin C content was analyzed using a titration method at the Food and Agricultural Product Analysis Laboratory of Syiah Kuala University.

Ethical Considerations

This study was approved by the Health Research Ethics Committee of Poltekkes Kemenkes Aceh (approval code: DP.04.03/12.7/269/2024).

Result and Discussion

Gummy candy is a popular snack consumed by individuals of all ages, from children to adults (Fadia et al., 2024). It is classified as a semi-moist, chewy confectionery product, commonly made from gelatin and carrageenan (Rashati et al., 2019). The formulation of gummy candy typically includes gelling agents, water, sugar, sweeteners, and flavoring agents (Mierza et al., 2023).

Commercially available gummy candies generally contain high amounts of sugar and provide limited nutritional values. Therefore, substituting them with nutrient-rich food ingredients is necessary to improve their nutritional profiles. Local food sources, such as moringa leaves and calamansi, are potential candidates for this purpose. Parameswari et al. (2025) reported that moringa leaves are rich in iron and vitamin C, whereas other studies have demonstrated that calamansi contains high levels of vitamin C (Anggreani & Yeni, 2020). Gummy candy is typically prepared by mixing the gummy base, followed by heating and the addition of other ingredients at approximately 80 °C. Ingredients must be incorporated while the mixture is hot to achieve desirable final characteristics such as chewiness and ease of mastication (Rani et al., 2022).

In this study, an organoleptic evaluation was conducted to assess the acceptability of calamansi gummy candy substituted with moringa leaf powder solution in terms of color, taste, aroma, and texture. Chemical analyses were performed to determine the iron and vitamin C contents.

Organoleptic Test

The organoleptic evaluation of calamansi gummy candy substituted with moringa leaf powder solution was conducted using a hedonic test to determine the panelists' preferences for color, taste, aroma, and texture. A descriptive summary of each formulation is provided in Table 2.

Table 2. Description of gummy candy products

Formulation A (30%)	Formulation A (40%)	Formulation A (50%)
		
Color: Transparent greenish-yellow Taste: Sour calamansi Aroma: Characteristic calamansi aroma Texture: Chewy Iron: 0.16 mg/serving (25 g) Vitamin C: 3.31 mg/serving (25 g)	Color: Yellowish green Taste: Sour orange–calamansi Aroma: Characteristic calamansi aroma Texture: Slightly fibrous and chewy Iron: 0.21 mg/serving (25 g) Vitamin C: 3.10 mg/serving (25 g)	Color: Dark greenish-yellow Taste: Slightly sour orange–calamansi Aroma: Characteristic calamansi aroma Texture: Chewy and fibrous Iron: 0.26 mg/serving (25 g) Vitamin C: 3.03 mg/serving (25 g)

The colors of the gummy candies were generally similar across all formulations. Substitutions with 30%, 40%, and 50% moringa leaf powder solutions resulted in a yellowish-green appearance, with higher substitution levels producing a more intense green color. The highest mean color preference score was observed for the 30% formulation. This trend may be attributed to the increasing concentration of moringa leaf pigments, which intensify the green color but may reduce the visual appeal when present in higher amounts. These findings are consistent with those of Rahmawati & Adi (2017), who reported that excessive addition of moringa leaf powder can negatively affect product appearance.

Taste acceptability was also similar among the formulations. All formulations exhibited a sour taste with slight bitterness; however, higher concentrations of Moringa oleifera leaf powder produced a more pronounced Moringa flavor. The highest taste preference score was observed for the 50% formulation, as the acidity of calamansi effectively masked the bitterness of Moringa leaves, resulting in a more balanced flavor.

Conversely, the 30% formulation was the least preferred due to excessive sourness, which created an unbalanced taste profile. The bitter and astringent taste of Moringa leaves is associated with phytochemical compounds such as alkaloids, tannins, and phenols. The addition of acidic ingredients, such as calamansi juice, can help mask bitterness and improve sensory acceptability (Dwika et al., 2016).

Aroma evaluation revealed no significant differences among the formulations. All samples exhibited a fresh calamansi aroma with a slight moringa leaf aroma. However, higher moringa concentrations resulted in a stronger odor. The highest aroma preference score was observed for the 30% formulation, as higher concentrations of moringa leaf powder produced a more pungent aroma. The characteristic unpleasant odor of moringa leaves has been linked to lipoxygenase enzymes and essential oil compounds (Paramita et al., 2024). Nevertheless, the addition of calamansi juice effectively masked this odor, consistent with the findings of Rahmawati & Adi (2017), who reported that citrus flavoring improved the acceptability of moringa-based jelly candy.

Texture evaluation showed that all formulations had a chewy consistency, although the 50% formulation was slightly chewier than the others. The highest texture preference score was observed for the 50% formulation. This may be attributed to the higher fiber content associated with increased moringa leaf concentrations. Fresh moringa leaves contain approximately 0.9 g of fiber per 100 g (Gopalakrishnan et al., 2016), and an increased fiber content contributes to greater chewiness. These results are consistent with those of Syahifah (2020), who reported enhanced chewiness in jelly candy with higher moringa leaf content.

Analysis of Iron Content

As shown in Table 3, the mean iron content of calamansi gummy candy substituted with moringa leaf powder solution was 0.16 mg/25 g for the 30% formulation, 0.21 mg/25 g for the 40% formulation, and 0.26 mg/25 g for the 50% formulation. The highest iron content was observed in the 50% formulation.

Table 3. Iron content of gummy candy per 25 g

Formulations	Mean	p-value	Subset for alpha = 0.05		
			1 (a)	2 (b)	3 (c)
30% Moringa Leaf Powder Solution	0.16 [a]		0.1633		
40% Moringa Leaf Powder Solution	0.21 [b]	0.000		0.2100	
50% Moringa Leaf Powder Solution	0.26 [c]				0.2600

ANOVA results indicated that substitution with 30%, 40%, and 50% moringa leaf powder solutions significantly affected the iron content ($p < 0.001$). Duncan's Multiple Range Test revealed significant differences among all formulations, with iron content increasing proportionally with moringa concentration. This finding aligns with Maharani (2020), who reported that increased moringa leaf addition resulted in a higher iron content in food products. Based on the Recommended Dietary Allowance (RDA) for adolescent girls, the consumption of 25 g of calamansi gummy candy contributes approximately 1.0%, 1.4%, and 1.7% of the daily iron requirements for the 30%, 40%, and 50% formulations, respectively. Thus, the 50% formulation provided the highest contribution to dietary Fe intake.

Compared with conventional gummy candies, which typically contain high sugar levels and minimal micronutrients (Fatsecret, 2022), calamansi gummy candy substituted with moringa leaf powder solution offers improved nutritional value, particularly in terms of iron content. Adequate iron intake is essential for red blood cell formation, and sufficient iron levels are associated with increased hemoglobin concentration (Nurhasanah, 2023). Therefore, this product has the potential to be an alternative snack for adolescent girls, especially those at risk of anemia.

Analysis of Vitamin C Content

Vitamin C content analysis (Table 4) showed mean values of 3.31 mg/25 g for the 30% formulation, 3.10 mg/25 g for the 40% formulation, and 3.03 mg/25 g for the 50% formulation, respectively.

The highest vitamin C content was observed in the 30% formulation of the product.

Table 4. Vitamin C content of gummy candy per 25 g

Formulations	Mean	p-value	Subset for alpha = 0,05	
			1 (a)	2 (b)
30% Moringa Leaf Powder Solution	3.31 [a]		3.3100	
40% Moringa Leaf Powder Solution	3.10 [b]	0.000		3.1033
50% Moringa Leaf Powder Solution	3.03 [b]			3.0300

ANOVA results demonstrated that the substitution level significantly affected the vitamin C content ($p < 0.001$). Duncan's test indicated that the 30% formulation differed significantly from the 40% and 50% formulations, while no significant difference was observed between the latter two. Based on the RDA for adolescent girls, the consumption of 25 g of gummy candy contributes approximately 4.7%, 4.4%, and 4.3% of the daily vitamin C requirements for the 30%, 40%, and 50% formulations, respectively.

Vitamin C is highly sensitive to environmental factors such as heat, light, enzymes, and alkaline conditions, which may lead to its degradation during processing (Hariadi, 2020). This explains the lower vitamin C content in gummy candy compared to fresh calamansi fruit (Karo, 2021). To minimize vitamin C loss, calamansi juice was added at the final stage of processing after heating was discontinued and the mixture was allowed to cool briefly.

Vitamin C enhances iron absorption by reducing ferric iron to the more absorbable ferrous form in the small intestine. It can increase iron absorption by up to fourfold and counteract the inhibitory effects of compounds such as phytates and tannins (Krisnanda, 2019). Therefore, the combination of iron-rich moringa leaves and vitamin C–rich calamansi in this gummy candy formulation may optimize iron bioavailability, making it a suitable alternative snack for adolescent girls, particularly those affected by anemia.

Conclusion

The substitution of moringa leaf powder solution at concentrations of 30%, 40%, and 50% significantly affected the sensory properties, iron content, and vitamin C levels of calamansi orange gummy candy. Increasing substitution levels enhanced the iron content and chewiness, whereas higher concentrations slightly reduced the vitamin C levels owing to processing sensitivity. Among the formulations, the 50% moringa leaf powder solution provided the highest iron content and achieved the best overall sensory acceptance, particularly in terms of taste and texture.

These findings indicate that calamansi gummy candy fortified with 50% moringa leaf powder solution has the potential to be a functional snack to improve iron intake, especially in adolescent girls at risk of anemia. Further intervention-based studies are recommended to evaluate the effectiveness of these products in improving hemoglobin status under real consumption conditions.

Acknowledgments

The authors express their sincere gratitude to the Director of Poltekkes Kemenkes Aceh for the institutional support and encouragement. We also appreciate the Head of the Department of Nutrition for academic guidance and facilitation throughout the study. In addition, the authors thank all panelists and individuals involved who generously contributed their time, expertise, and support, which were essential to the successful completion of this study.

References

Agustina, F. N. U. R., Wahyudi, A., Jumiyati, J., Meriwati, M., & Nurhayati, N. (2021). *Pemanfaatan Pangan Lokal Sari Jeruk Kalamansi (Citrofortunella Microcarpa) dengan Penambahan Sari Pepaya (Carica Papaya l) sebagai Minuman Peningkat Imunitas Tubuh* (Doctoral dissertation), Poltekkes Kemenkes Bengkulu.

Alvita, L. R., Elsyana, V., & Kining, E. (2021). Formulasi permen jelly jeruk kalamansi dengan substitusi glukomanan konjak. *Jurnal Gizi dan Kuliner (Journal of Nutrition and Culinary)*, *1*(2), 11. https://doi.org/10.24114/jnc.v1i2.26863

Anggreani, N. & Yeni, R. F. (2020). Analisis kadar vitamin C pada jeruk lokal di Provinsi Bengkulu. *2507*, 1–9. https://doi.org/10.52161/jiphar.v7i2.193

Badan Pengawas Obat dan Makanan. (2018). *Peraturan Badan Pengawas Obat dan Makanan Nomor 30 Tahun 2018 tentang angka konsumsi pangan*. Badan Pengawas Obat dan Makanan.

Daniela, C., & Maria, P. (2022). Pengaruh penambahan sari buah jeruk dan sari andaliman serta konsentrasi sukrosa terhadap uji organoleptik, kadar vitamin C, dan kadar air permen (hard candy). *Jurnal Riset Teknologi Pangan dan Hasil Pertanian (RETIPA)*, *3*, 44–50. https://doi.org/10.54367/retipa.v3i1.2244

Dhafir, F., & Laenggeng, H. (2020). Kandungan kalsium (Ca) dan zat besi (Fe) daun kelor (*Moringa oleifera*). *Jurnal Kreatif Online*, *8*(1), 153–158.

Dwika, W., Putra, P., Agung, A., Dharmayudha, G. O., & Sudimartini, L. M. (2016). Identifikasi senyawa kimia ekstrak etanol daun kelor (*Moringa oleifera* L.) di Bali. *Indonesia Medicus Veterinus*, *5*(5), 464–473.

Fadia, M., Saragih, B., & Anjang, R. (2024). Studi pembuatan permen jelly kombinasi kulit buah naga (*Hylocereus polyrhizus*) dan kelakai (*Stenochlaena palustris*) terhadap kadar antioksidan, total padatan terlarut, tekanan darah, dan saturasi. *Jurnal Teknologi Pangan dan Gizi*, *23*, 153–159. https://doi.org/10.33508/jtpg.v23i2.5015

Fauziandari, E. N. (2019). Efektivitas ekstrak daun kelor terhadap peningkatan kadar hemoglobin pada remaja putri. *Jurnal Kesehatan Karya Husada*, *7*(2), 24–29. https://doi.org/10.36577/jkkh.v7i2.230

Gopalakrishnan, L., Kruthi, D., & Santhosh, K. D. (2016). *Moringa oleifera*: Nutritive importance and its medicinal application as a review. *Food Science and Human Wellness*, *5*, 49–56. https://doi.org/10.21608/ejchem.2021.78212.3823

Hariadi, H. (2020). The influence of carambola starfruit (*Averrhoa bilimbi*) and papaya (*Carica papaya*) on organoleptic properties, vitamin C content, and fiber in jelly candies. *IOP Conference Series: Earth and Environmental Science*, *443*(1), 1–7. https://doi.org/10.1088/1755-1315/443/1/012017/

Hastuty, Y. D., & Nitia, S. (2022). Moringa leaf extract and its effect on hemoglobin levels in young girls. *Jurnal Kesehatan Poltekkes Palembang*, *17*(1), 2654–3427.

Karo, F. Y. E. B. (2021). The use of konjac flour as gelatin substitution in making panna cotta. *IOP Conference Series: Earth and Environmental Science*, *782*(3), 1–7. https://doi.org/10.1088/1755-1315/782/3/032106

Kementerian Kesehatan Republik Indonesia. (2023). *Survei kesehatan Indonesia (SKI)*. Badan Kebijakan Pembangunan Kesehatan, Kementerian Kesehatan RI.

Krisnanda, R. (2019). Vitamin C helps in the absorption of iron in iron deficiency anemia. *Jurnal Penelitian Perawat Profesional*, *2*(3), 279–286. https://doi.org/10.37287/jppp.v2i3.137

Maharani. (2020). Pengaruh penambahan sari daun kelor terhadap kadar zat besi, vitamin C, dan daya terima kue dadar gulung. *Jurnal Nutrisia*, *23*(2), 1–120. https://doi.org/10.29238/jnutri.v23i2.223

Mierza, V., Dwiyanti, S. P., Mulidini, M., Nibullah, S. G., & Abbas, Z. A. (2023). Pengembangan formulasi sediaan gummy candy dengan variasi konsentrasi gelatin sebagai gelling agent. *Journal of Pharmaceutical and Sciences*, *6*(2), 649–654. https://doi.org/10.36490/journal-jps.com.v6i2.102

Nurhasanah, I. (2023). Analisis kadar zat besi (Fe) pada tepung kulit kentang. *Jurnal Ners*, *7*(2), 1005–1008. https://doi.org/10.31004/jn.v7i2.16783

Obeagu, G. U., & Obeagu, E. I. (2025). Complications of anemia in pregnancy. *Medicine*, *104*, 35. https://doi.org/10.1097/MD.0000000000044246

Parameswari, G. V., Hapsari, M. W., & Novianingrum, M. P. (2025). Potential iron and vitamin C from moringa leaves as a food product to overcome anemia: A systematic review. *Science Technology and*

Management Journal, *5*(1), 67–71. https://doi.org/10.53416/stmj.v5i1.343

Paramita, I. S., Rahayu, D., Erowati, D., & Atasasih, H. (2024). The influence of *Moringa oleifera* leaf flour addition on white chocolate as an alternative snack for anemia prevention in adolescent girls. *Al Gizzai: Public Health Nutrition Journal, 4*(2), 142–152. https://doi.org/10.24252/algizzai.v4i2.48306

Parti, W. E. (2022). Konsumsi kapsul tepung daun kelor dan sari jeruk manis terhadap peningkatan kadar hemoglobin remaja putri post menstruasi. *Jurnal Kesehatan Delima Pelamonia*, *6*(2), 107–113. https://doi.org/10.37337/jkdp.v0i0.283

Putri, R. M. S., Ninsix, R., & Sari, A. G. (2015). Pengaruh jenis gula terhadap mutu permen jelly rumput laut (*Eucheuma cottonii*). *Jurnal Teknologi Pertanian Andalas*, *19*(1), 51–58. https://doi.org/10.25077/jtpa.19.1.51-58.2015

Rahim, E. M., Fadhilla, R., Ronitawati, P., Swamilaksita, P. D., & Harna, H. (2020). Penambahan ekstrak serai (*Cymbopogon citratus*) dan ekstrak tomat (*Solanum lycopersicum*) terhadap nilai gizi, kandungan Fe, dan vitamin C permen jelly. *Jurnal Nutrisia*, *21*(2), 75–82. https://doi.org/10.29238/jnutri.v21i2.145

Rahmawati, P. S., & Adi, A. C. (2017). Daya terima dan zat gizi permen jeli dengan penambahan bubuk daun kelor (*Moringa oleifera*). *Media Gizi Indonesia*, *11*(1), 86–93. https://doi.org/10.20473/mgi.v11i1.86-93

Rani, K. C., Ningrat, K. W. C., Melinda, S., & Jayani, N. I. E. (2022). Formulasi chewable gummy daun kelor (*Moringa oleifera*) dengan gelling agent konjak glukomanan dan kappa karagenan. *Media Pharmaceutica Indonesiana*, *4*(1), 1–12. https://doi.org/10.24123/mpi.v4i1.5032

Rashati, D., Eryani, M. C., & Akademi Farmasi Jember. (2019). Formulasi dan uji stabilitas gummy candies buah naga (*Hylocereus polyrhizus*) dengan variasi konsentrasi gelatin dan karagenan. *Jurnal Informasi Kesehatan Indonesia*, *5*(2), 58–64. https://doi.org/10.31290/jiki.v5i2.1434

Syahifah, H. (2020). *Konsentrasi daun kelor (Moringa oleifera) terhadap sifat fisikokimia dan organoleptik permen jelly sari daun kelor.* Skripsi. Universitas Semarang.

Tim Komposisi Pangan Indonesia. (2017). *Tabel komposisi pangan Indonesia*.

Vojvodić Cebin, A., Bunić, M., Mandura Jarić, A., Šeremet, D., & Komes, D. (2024). Physicochemical and sensory stability evaluation of gummy candies fortified with mountain germander extract and prebiotics. *Polymers*, *16*(2), 259. https://doi.org/10.3390/polym16020259

Yuwidasari, E. A., Yudiono, K., & Susilowati, S. (2019). Kualitas permen jelly dari pektin kulit buah naga (*Hylocereus polyrhizus*). *Bistek Pertanian*, *6*(1), 28-41.