Pharmacoscript
Hidayat et al./*Pharmacoscript, Volume 9, No, 1, Februari 2026, 98-114*
P-ISSN : 2622-4941 | E-ISSN : 2685-1121

FORMULATION OF GUMMY CANDY PREPARATIONS CONTAINING CHIA SEED OIL (*Salvia hispanica* L.)

Taufik Hidayat*, Alna Salsabila, Firman Gustaman, Alika Rahma Kalimatillah
Departement of Pharmaceutics, Faculty of Pharmacy, Universitas Bakti Tunas Husada, Tasikmalaya, Indonesia
*Email: taufikhidayat@universitas-bth.ac.id
Received: 30/08/2025 Revised: 15/01/2026 Accepted: 28/01/2026 Published: 28/02/2026

ABSTRACT

Gummy candy is a type of soft ceonfection that utilizes gelatin as a gelling agent, resulting in a characteristic chewy texture. Chia seed oil (*Salvia hispanica* L.) was used as the active ingredient due to its high alpha-linolenic acid content. This study aims to determine the formula and characteristics of good gummy candy with varying concentrations of chia seed oil and gelatin and to determine the level of preference among children. The prepared gummy candies were evaluated for organoleptic properties, pH, weight uniformity, moisture content, and texture profile analysis. The results showed that all formulations produced bear-shaped gummy candies with a sweet taste and varying colors. The pH values ranged from 4.51 to 4.88, and all formulations met the weight uniformity requirements. Texture profile analysis showed that increasing gelatin concentration resulted in higher hardness and chewiness. Hedonic testing revealed no significant differences ($p > 0.05$) among the three formulations in terms of color, aroma, and taste, indicating that all formulations were equally acceptable to the panelists. In conclusion, chia seed oil can be successfully formulated into gummy candy preparations, and variations in gelatin concentration influence the physical texture characteristics without significantly affecting consumer preference.
Keywords: *Gummy Candy, Chia Seed Oil, Gelatin*

INTRODUCTION

Currently, advancements in healthcare are progressing rapidly, leading to increased public awareness of healthy lifestyles, particularly with regard to nutritional intake in children. According to a 2022 report from the Indonesian Ministry of Health (BKPK Kemenkes, 2022), the prevalence of stunting among toddlers decreased to 21.6%, while the prevalence of wasting increased to 7.7%. Undernutrition and malnutrition in children can result in impaired physical growth, delayed brain development, reduced immunity, and an increased risk of disease later in life. Furthermore, children experiencing malnutrition have a mortality risk up to 12 times higher than that of well-nourished children (UNICEF, 2023). Therefore, meeting the recommended dietary allowance (RDA) is essential to support optimal growth and development in children.

Alpha-linolenic acid (ALA), an omega-3 fatty acid, is an essential nutrient that plays a crucial role in child growth and development. ALA contributes to brain development, reduces oxidative stress, and exerts anti-inflammatory effects without significant side effects (Huffman et al., 2011; Kousparou et al., 2023). As an essential fatty acid, ALA cannot be synthesized by the human body and must be obtained from dietary sources (Barceló-Coblijn & Murphy, 2009). According to the Indonesian Ministry of Health regulation (Permenkes No. 28 of 2019), the recommended intake of omega-3 fatty acids is 0.7 g/day for children aged 1-3 years and 0.9 g/day for children aged 4-9 years.

Chia seed oil (Salvia hispanica L.) is a natural source rich in alpha-linolenic acid. The term “chia” originates from the Spanish words chian or chien, meaning “oily,” with reflects its high lipid content. Historically, chia seeds have been consumed as a staple food since approximately 3500 BC in Central Mexico (Muñoz et al., 2013). Previous studies have reported that chia seed oil obtained through cold-press extraction contains up to 68.6% alpha-linolenic acid, hilghlighting its potensial as a functional ingridient (Dominguez-Candela et al., 2022). Chia seed oil has been incorporated into various food products, such as yogurt, to enhance their nutritional value due to its high omega-3 fatty acid content (Derewiaka et al., 2019). In addition, chia seed oil has also been formulated into cosmetic and pharmaceutical preparations, including hair emulsion formulations, owing to its antioxidant properties and beneficial effects on hair and skin health (Rahmayanti et al., 2024).

Despite its nutritional benefits, chia seed oil has certain limitations when administered directly, particularly in pediatric populations. Omega-3-rich oils generally possess a distinctive odor and taste which may reduce palatability and compliance in children. Therefore, an appropriate dosage form is required to improve acceptability and ease of consumption. Gummy candy was selected in this study because it has a pleasant taste, chewy texture, attractive shape, and appealing color, which are generally well accepted by children. Additionally, gummy candy can effectively mask the characteristic taste and odor of chia seed oil, thereby increasing compliance and supporting regular nutritional intake.

Variation in gelatin concentration is an important factor in gummy candy formulation, as it directly influences the texture (firmness and elasticity), moisture content, and overall sensory properties of the final product. Studies on hydrocolloid-based gummies have demonstrated that increasing the concentration of gelling agents such gelatin generally enhances gel strength and textural hardness, whereas lower concentrations result in softer gels, these variations may affect consumer as well as the release profile of incorporated actives compounds. For example, previous research on gummy formulations with different gelling agent levels has shown that higher gelatin content is associated with increased chewiness and firmness, which may be preferred in certain applications or populations (Jiamjariyatam, 2018).

Based on these considerations, this study aimed to formulate chia seed oil into a gummy candy preparation and evaluate its physical characteristics, texture profile, and consumer acceptance. Variations in gelatin and chia seed oil concentrations were applied to assess their effects on the quality and acceptability of the gummy candy formulation.

(A) **(B)** **(C)**

Figure 1. (A) *Salvia hispanica* L. Plant, (B) chia seed as the oil source, (C) chia seed oil (Source: Wikimedia commons)

METHODS

Materials

The materials required were chia seed oil (Salvia hispanica L.) (Happy Green®), gelatin (Green valley®), sucrose (ROFA®), sorbitol (Ambudja®), citric acid (weifang®), glucose syrup, potassium sorbate, food flavor (GKC®), and distilled water.

The instruments used in this study included an analytical balance (Mettler Toledo®), oven (Memmert ®), desiccator, pH meter (Ohaus ®), texture analyzer (Brookfield ®), crucibles with lids. Crucible tongs, trays, electric stove, spatula, beaker glass (Pyrex ®) and gummy candy molds.

Research Path

1. Chia Seed Oil Analysis

The chia seed oil used in this study was purchased from a local supplier. Chia seed oil analysis begins with sample preparation first by putting 10 µL of sample into a vial, then adding 400 µL of dichloromethane solvent and adding 10 µL of bis(trimethylsilyl)trifluoroacetamide(derivatizing agent), after that close the vial tightly, and oven at 60-70˚C for 30 minutes, after heating 1,080 µL DCM was added to obtain a final volume of 1,500 µL. The vial wa then tightly closed, and the sample was ready for GC-MS injection.

2. Gummy Candy Preparation

Gummy candy preparation was initiated by weighing all required ingridients. After that, put the gelatin into some hot distilled water and let stand for ± 10 minutes until the gelatin expands (mixture 1). Heating sucrose, sorbitol, glucose syrup, citric acid, and potassium sorbate on an electric stove until homogeneous (mixture 2). Mixing mixture 1 into mixture 2 until homogeneous, once homogeneous remove the mixture from the stove. After that, add chia seed oil and flavor, then homogenize using a magnetic stirrer at 300 rpm for 10 minutes. Then the mixture was poured into gummy molds and stored for 24 hours at room temperature to form a good gummy candy preparation.

Table 1. Formula gummy candy chia seed oil

Bahan	Formula I (%)	Formula II (%)	Formula III (%)	Function
Chia seed oil	2	3,5	5	Active substance
Glucose syrup	25	25	25	Binder and sweetener
Sucrose	20	20	20	Sweetener
Gelatin	6	8	10	Gelling
Sorbitol	6	6	6	*Plasticizer*
Citric acid	0,17	0,17	0,17	Acidifier and flavor enhancer
Flavour and color	0,4	0,4	0,4	Flavouring and coloring
Potassium sorbate	0,1	0,1	0,1	Preservative
Water	Ad 100	Ad 100	Ad 100	Solvent

3. Evaluation of Gummy Candy

3.1 Organoleptic Test

Gummy candy preparations that have been made are observed visually including shape, color, aroma, taste, and texture (Andarifera et al., 2025).

3.2 Weight Uniformity Test

The weight uniformity test was carried out by weighing 20 gummy candies one by one, then calculating the average tablet and calculating the deviation from the average weight of the gummy candy with the formula (United States Pharmacopeia, 2012).

Deviation =

$$\frac{(weight\ of\ each - average\ weight)}{average\ tablet\ weight} \times 100\%$$

3.3 pH Test

The pH test is carried out using a pH meter that has been previously calibrated, then dipped into the gummy candy preparation that has not been poured into the mold.

3.4 Water Content Test

The principle of moisture content determination is the weight loss of the sample during oven heating at 100˚C ± 2˚C, which is calculated using a gravimetric method (National Standardization Agency, 2008). The water content test was carried out by first heating the cup and lid in an oven at 100˚C ± 2˚C for approximately one hour and cooling it in a desiccator for 20-30 minutes then weighing the cup and lid on an analytical balance (W_0). Second, put 5 grams of gummy candy preparation into the cup and lid and then weigh it (W_1). Third, heat the cup containing the gummy candy preparation in an oven at 100˚C ± 2˚C for three hours (3 hours after the oven temperature is 100˚C), with the cup lid placed on the side of the cup. Fourth, cool the cup containing the gummy candy preparation in desiccant for 20-30 minutes and then weigh it. Fifth, reheat for one hour and repeat until the weights between one hour heating have interval ≤ 2 mg (W_2). Finally, calculate moisture content. Perform the water content test in duplicate (National Standardization Agency, 2008).

Water content formula (National Standardization Agency, 2008):

$$\text{Water Content} = \frac{W_1 - W_2}{W_1 - W_0} \times 100\%$$

W_0 = Weight of empty cup and lid, (gram)

W_1 = weigth of cup, lid, and gummy preparation candy, (gram)

W_2= weight of cup, lid, and gummy preparation after drying, (grams)

3.5 Texture Profil Analysis

Texture Profile Analysis (TPA) was performed using a TA-TX Plus Texture Analyzer (Stable Micro System, UK). Gummy candy samples were placed at the center of the platform and analyzed using a alumunium probe (P/36R, 36 mm diameter). The instrument was set with a trigger force of 5 g, a pre test speed of 1mm/s, a test speed of 1mm/s, and a post test speed pf 1 mm/s. A double compression test with a strain of 50% of the sample height was applied to simulate the chewing process.

The texture parameters obtained included hardness, adhesiveness, springiness, cohesiveness, gumminess, and chewiness. Adhesiveness represents the work requaried ti overcome the attractive forces between the sample surface and the probe, whereas cohesiveness describes the strength of the internal bonds within the gummy candy matrix. These parameters were evaluated to characterize the mechanical properties and chewing behavior of the gummy candy.

3.6 Hedonic Test

Hedonic testing was carried out on 30 panelists aged 5-6 years old to expressed their preference for color, taste, aroma, and texture. Hedonic test assessment with a level of preference of 1-4, 1 namely = very dislike; 2 = dislike; 3 = like; 4 = very like. This study was conducted in accordance with ethical standards and was approved by the Ethics Commitee of Universitas Bakti Tunas Husada Tasikmalaya, with ethical approval number No.076-01/E.01/KEPK-BTH/V/2024.

4. Data Analysis

Hedonic test data (color, aroma, taste, and texture) were analyzed using a non-parametic statistical approach. Descriptive analysis was conducted to obtain the mean scores for each formualation. Due to the ordinal nature of hedonic data and the use same panelists to evaluate all formulations, differences in consumer preference among formulations were statistically analyzed using the Friedman test. When significant differences were observed ($p<0.05$), pairwise comparisons were further performed using the Wilcoxon signed-rank test.

RESULTS AND DISCUSSION

1. Chia Seed Oil Analysis

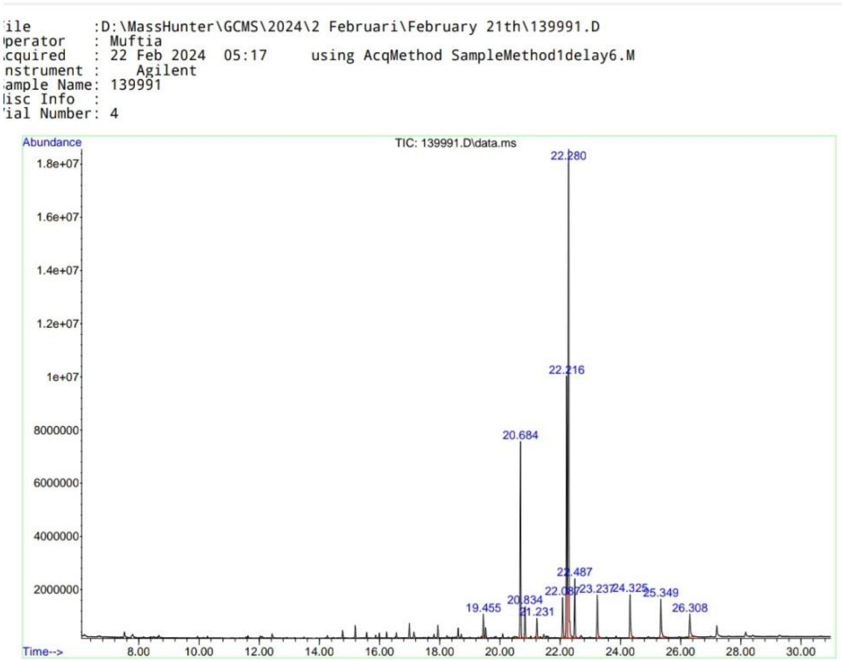

Figure 2. GC-MS chromatogram chia seed oil

Table 2. Fatty acid composition of chia seed oil determined by GC-MS

No	Retention Time	Are %	Compound	Quality
1	19.459	1.56	Cyclodecasiloxane	83
2	20.681	12.32	Palmitic Acid	99
3	20.833	2.18	Cyclooctasiloxane	72
4	21.236	1.51	11-Octadecenois acid	99
5	22.093	2.88	Cyclononasiloxane	71
6	22.219	18.78	9,12-)catadecadienois acid	99
7	22.282	43.47	Alpha Linolenic acid	99
8	22.484	3.86	Stearic acid	99
9	23.240	3.55	Hexasiloxane	58
10	24.324	3.97	Hexasiloxane	58
11	25.345	3.49	Hexasiloxane	58

The GC-MS chromatogram of chia seed oil is presented in Figure 2. The chromatogram revealed a dominant peak at a retention time of 22.280 min. Compound identification based on mass spectral matching indicated that this peak corresponded to alpha-linolenic acid. Quantitative analysis of the chromatogram data Table 2 showed that alpha-linolenic acid accounted for 43.47% of the total fatty acid composition.

Minor siloxane-related peaks observed in the chromatogram are commonly associated within analytical artefacts in GC-MS analysis, including those originating from the analytical system or derivatization reagents, and were therefore exluded from the fatty acid composition of chia seed oil.

The presence of Alpha-linolenic acid (ALA) at 43.47% in the chia seed oil indicates that the raw material possesses high functional potential as a plant-based source of omega-3. Although some literature suggests that ALA content in chia oil can reach 60-68% (Kulczy´nski et al., 2019), this variation may be attributed to geographical factors of the plant's growth, extraction methods, and oil storage conditions (Zettel & Hitzmann, 2018). The dominance of ALA is crucial as it is an essential fatty acid that cannot be synthesized by the human body and plays a vital role in pediatric brain development as well as possessing anti-inflammatory effects (Timilsena et al., 2016).

2. Organoleptic Test

Gummy candy formulations were composed of chia seed oil as the active compound and gelatin as the gelling agent, along with sweeteners, flavoring agents, and coloring agents. Chia seed oil was incorporated as a functional ingredient due to its high omega-3 fatty acid (Derewiaka et al., 2019), while gelatin was used to provide the characteristics chewy texture of gummy candy (Jiamjariyatam, 2018). Organoleptic observations confirmed that gelatin functions effectively as a gelling agent to maintain product shape retention, where higher gelatin concentrations yield a more robust matrix and clearer (more transparent) appearance. Clarity is a significant factor influencing consumer perception of gummy candy quality (Gunes et al., 2022).

Based on the results of the organoleptic test, it is known that the three formulas have a similar shape, namely the shape of a bear. There are also differences in each formula in terms of texture, color, aroma, and taste. The different textures in the three formulas are influenced by different gelatin concentrations. The difference in taste in each formula is due to the different concentration of chia seed oil. The different colors and aromas in each formula are influenced by the different flavors added. The organoleptic test results can be seen in

Table 3, while the physical appearance of the products is presented in Figure 3.

Table 3. Organoleptic test result gummy candy chia seed oil

No	Inspection Organoleptic	Result		
		Formula 1	**Formula 2**	**Formula3**
1.	Shape	Bear	Bear	Bear
2.	Texture	Soft chewy	Chewy	chewy
3.	Color	Orange	Yellow clear	Green
4.	Fragrance	Mango	Lychee	Melon
5.	Flavour	Sweet	Sweet	Slightly sweet with characteristic chia oil taste

(A) (B) (C)

Figure 3. Physical appearance of gummy candy formulations: (A) Formula 1, (B) Formula 2, and (C) Formula 3

3. Weight Uniformity Test

The weight produced in formula 1 is 1.262 grams, formula 2 is 1.263 grams, and formula 3 is 1.267 grams. All formulas meet the requirement that the average weight of tablets are more than 324 mg or 0.324 grams, there are no more than 2 tablets that have weights deviating from 5% and no 1 tablet whose weight deviates from 10% (United States Pharmacopeia, 2012). The good weight uniformity across all formulations indicates that the manual molding process possesses high reproducibility and that the mixture maintained a homogenous viscosity during pouring (Ergun et al., 2018). The CV (coefficient of variation) values obtained from the calculations show that none exceed 5%, thus meeting the weight uniformity requirements (Aulia et al., 2023).

Table 4. Weight uniformity test result

Formula	Mean ± SD	%KV
1	1,262 ± 0,023	1,787
2	1,263 ± 0,017	1,346
3	1,267 ± 0,013	0,990

4. pH Test

The pH values of formula 1, formula 2, and formula 3 were 4.51, 4.66, and 4.81, respectively. The pH measurement was conducted as a single measurement for each formulation. According to Lees and Jackson, all formulas met the optimal pH range for gel preparation pH 4.5 – 6.0 (Gunes et al., 2022). pH below 4.0 can induce excessive hydrolysis of gelatin during heating, which would decrease bloom strength and cause the candy to become mushy or suffer from syneresis (Hartel, 2018). Changes in the pH of gummy candy are caused by the addition of citric acid to the preparation and differences in gelatin. Additionally, the acidic environment created by citric acid acts as a natural preservative that inhibits the growth of pathogenic microbes, considering that gummy candies possess a relatively high moisture content (Isa et al., 2024).

5. Water Content Test

The results of the water content test can be seen in Table 5.

Table 5. Water content test result

Formula	Water content (%)	RSD (%)
1	19,85 ± 0,827	4,17
2	16,495 ± 0,459	2,79
3	7,195 ± 0,066	0,92

The results of the water content test are presented in Table 5. All formulations showed moisture content values below 20%, meeting the Indonesian National Standard requirement for soft gummy candy. However, Formula 1 showed a relative standard deviation (RSD) value of 4.17%, which was slightly higher than the recommended limit of 4%.

A higher gelatin concentration can reduce the moisture content because gelatin has the ability and retain water within the gel matrix (Gaglio et al., 2020). In moisture content determination, the parameter measured is free water present in the product. During the heating and cooking process, free water evaporatres, including a portion of water that is weakly bound within the gelatin gel structure. When a higher amount of gelatin is used with a relatively lowet water content, gelatin hydration becomes less optimal, resulting in a greater amount of unbound water. This free water is more prone to evaporation, leading to a lower moisture content in the final product (Mukhaimin et al., 2022).

Although the RSD value slightly exceeded the limit, the deviation was minimal and the moisture content value remained within the acceptable standard for soft gummy candy quality (National Standardization Agency, 2008).

6. Texture Profil Analysis

Texture profile analysis showed difference in gelatin content affects on the texture parameters of gummy candy. The results of the texture profile analysis can be seen in Table 6.

Table 6. Texture analysis result

Formula	Hardness g	Adhesiveness g.sec	Springiness	Cohesiveness	Gumminess	Chewiness
F1	571,906±291,251	-3,177±3,107	3,277±0,309	0.886±0,015	558,571±211,045	1797,829±518,954
F2	714,897±104,901	-1,791±0,692	3,433±0,142	0.992±0,027	708,589±95,175	2425,989±225,760
F3	831,016±119,911	-5,805±2,928	2.801±0,144	1,003±0,045	823,343±106,463	2297,832±178,675

6.1 Hardness

Measures the maximum force needed to press or deform the gummy candy the first compression, reflecting the pressure needed to deform the product. As shown in Table 6, hardness values increased proportionally with higher gelatin concentrations. F3 (10% gelatin) exhibited the highest hardness (831,016 g) compared to F1 (571,906 g). This happens because gelatin works as a gelling agent that builds a strong internal frame. A higher concentration creates a tighter network, resulting in a firmer texture. A higher gelatin concentration results in a denser protein network and increased water-binding capacity, reducing the free water and creating a firmer, more rigid texture (Jiamjariyatam, 2018).

6.2 Springiness

Measures the ability of the sample to recover its original shape after the deforming force is removed. F2 showed the highest springiness (3.433), while F3 exhibited the lowest (2.801). While gelatin generally provides elasticity, an excessive concentration (10% in F3) creates a matrix that is too dense and rigid, which can actually decrease the material's flexibility and ability to "spring back" compared to the more optimal network found in F2 (Toker et al., 2025) .

6.3 Adhesiveness

Is defined as the work required to overcome the attractive forces between the surface of the food and the surface of the probe. The results show that higher gelatin content led to higher (more negative) adhesiveness values, with F3 reaching -5,805 g.sec. This suggests that the increased density of the gelatin-sorbitol matrix in F3 enhances the interfacial bonding with the probe. Higher adhesiveness indicates a stickier mouthfeel, which is a critical quality parameter for consumer preference (Wang & Hartel, 2021).

6.4 Cohesiveness

Represents the strength of internal bonds within the gummy candy matrix. The value increased from 0.886 (F1) to 1.003 (F3), indicating that F3 has a more compact and integrated internal structure. The greater concentration of gelatin facilitates more extensive protein-protein interactions, making the gummy more durable and less likely to fall apart or lose its shape when chewed.

6.5 Gumminess and Chewiness

Of the candies are closely tied to their hardness. Gumminess (Hardness × Cohesiveness) and Chewiness (Gumminess × Springiness) both peaked in F3 at 823,343 and 2297,832, respectively. These high values indicate that F3 requires more energy to be broken down before swallowing. While higher gelatin provides a desirable "chewy" characteristic, excessively high values in F3 may result in a product that is too tough, whereas F1 offers a softer, more easily masticated texture.

7. Hedonic Test

The sensory evaluation was conducted to assess consumer acceptance of the chia seed oil gummy candies. A total of 30 panelists evaluated the samples based on color, aroma, taste, and texture using a 4-point hedonic scale. The results of the hedonic evaluation, analyzed using the Friedman test, are presented in Table 7.

Table 7. Friedman test result of hedonic evaluation

Parameter	Mean Rank F1	Mean Rank F2	Mean Rank F3	Sig (p-value)
Warna	1.97	1.77	2.27	0.084
Aroma	2.20	2.02	1.78	0.188
Rasa	2.03	2.23	1.73	0.093
Texture	1.83	2.50	1.67	<0.001

Table 8. Wilcoxon signed rank test for texture parameter

Pairwise Comparison	Formula 2 – Formula 1	Formula 3 – Formula 2	Formula 3 – Formula 1
Z-value	-3.133	-3.246	-1.075
Sig (p-value)	0.002	0.002	0.283

The results of the hedonic evaluation indicated that there were no significant differences ($p > 0.05$) among the three formulations in terms of color, aroma, and taste. This suggests that variations in chia seed oil concentration (2–5%) and gelatin concentration (6–10%) did not markedly influence these sensory attributes. The similar acceptance scores for color, aroma, and taste may be attributed to the use of the same type and concentration of sweeteners and flavoring agents in all formulations, which provided a comparable sensory profile. This is a positive finding for pediatric product development, as palatability is a primary determinant of pediatric compliance in supplement consumption (Otegbayo et al., 2024).

In contrast, a significant difference ($p < 0.05$) was observed for the texture attribute. This finding indicates that differences in gelatin concentration affected the perceived texture of the gummy candies. Gelatin functions as a gelling agent that forms a three-dimensional network within the gummy matrix; therefore, increasing its concentration results in a firmer and more elastic texture that can be distinguished by panelists during mastication (Jiamjariyatam, 2018). This result is consistent with the instrumental texture profile analysis, which showed increased hardness and chewiness with higher gelatin concentrations.

Further pairwise comparison using the Wilcoxon signed-rank test revealed that the texture of Formula 2 differed significantly from Formula 1, while no significant difference was observed between Formula 2 and Formula 3. Although a statistical difference in texture was detected, all formulations were still acceptable to the panelists. Based on the balance between sensory acceptance and instrumental texture characteristics, Formula 2 (8% gelatin) was considered the most optimal formulation. Formula 2 (8% gelatin) provided the best balance, consistent with psychophysical studies stating that consumers prefer gummy candies that offer sufficient bite resistance (chewiness) yet break down easily in the mouth (Cebin et al., 2024).

CONCLUSIONS

The development of palatable dosage form is essential to improve children's compliance with functional nutritional products. This study demonstrated that chia seed oil (Salvia hispanica L.) can be successfully formulated into gummy candy with acceptable physical and sensory characteristics.

Gummy cany with good characteristics were defined as having a stable shape, acceptable organoleptic properties, pH within the optimal range for gelatin-based confections (4.5-6.0), moisture content below 20%, and a chewy but not excessively hard texture. Texture profile analysis showed an increasing trend in hardness and shewiness with gelatin concentrations.

Hedonic evaluation revealed significant differences int exture perception among formulaions, while no significant differences (p>0.05) were observed for color, aroma, and taste, indicating that all formualtions were equally acceptable to panelist. Overall, these findings support the potential application of chia seed oil gummy candies as a child-friendly functional food to improve omega-3 intake.

REFERENCES

Andarifera, A. Z., Zaini, E., Yosmar, R., & Fitriani, L. (2025). Formulation and Physical Characterization of Chewable Gummy from Galangal Rhizome Extract (*Kaempferia galanga* L.) as a Nutraceutical Product. *Jurnal Sains Farmasi & Klinis*, *12*(2), 145–155. https://doi.org/10.25077/jsfk.12.2.145-155.2025

Aulia, G., Fadhilah, H., Ismaya, N. A., & Indah, F. P. S. (2023). Formulation and Evaluation of Gummy Candy from the Extract of Jathropa Leaf (*Jatropha curcas* L.). *Jurnal Kefarmasian Indonesia*, *13*(2), 103–112. https://doi.org/https://doi.org/10.22435/jki.v13i2.6429

Barceló-Coblijn, G., & Murphy, E. J. (2009). Alpha-linolenic acid and its conversion to longer chain n− 3 fatty acids: Benefits for human health and a role in maintaining tissue n− 3 fatty acid levels. *Progress in Lipid Research*, *48*(6), 355–374.

BKPK Kemenkes. (2022). Pocket Guide to the Results of the Indonesian Nutrition Status Survey (SSGI) Year 2022 - Health Policy Agency Health Development Agency. In *BKPK Ministry of Health*. https://doi.org/https://www.badankebijakan.kemkes.go.id/pocket-book-results-survey-nutrition-status-indonesia-ssgi-year-2022/

Cebin, A. V., Buni´, M., Jari´, A. M., Šeremet, D., & Komes, D. (2024). Physicochemical and Sensory Stability Evaluation of Gummy Candies Fortified with Mountain Germander Extract. *MDPI Polymers*, *16*(259), 1–25. https://doi.org/https://doi.org/10.3390/polym16020259

Chang, I., Im, J., & Cho, G.-C. (2016). Introduction of microbial biopolymers in soil treatment for future environmentally-friendly and sustainable geotechnical engineering. *Sustainability*, 8(3), 251.

Derewiaka, D., Stepnowska, N., Bry, J., Ziarno, M., Ciecierska, M., & Kowalska, J. (2019). Chia seed oil as an additive to yogurt. *Grasas Y Aceites*, *70*(2), 1–12.

Dominguez-Candela, I., Lerma-Canto, A., Cardona, S. C., Lora, J., & Fombuena, V. (2022). Physicochemical characterization of novel Epoxidized vegetable oil from chia seed oil. *Materials*, *15*(9), 3250.

Ergun, R., R Lietha, & R.W Hartel. (2018). Moisture and Shelf Life in Sugar Confections Moisture and Shelf Life in Sugar. *Critical Reviews in Food Science and Nutrition*, 162–169. https://doi.org/10.1080/10408390802248833

Gaglio, R., Franciosi, E., Todaro, A., Guarcello, R., Alfeo, V., Randazzo, C. L., Settanni, L., & Todaro, M. (2020). Addition of selected starter / non-starter lactic acid bacterial inoculums to stabilise PDO Pecorino Siciliano cheese production. *Food Research International*. https://doi.org/10.1016/j.foodres.2020.109335

Gunes, R., Palabiyik, I., Konar, N., & Toker, O. S. (2022). Soft confectionery products: Quality parameters, interactions with processing and ingredients. *Food Chemistry*. https://doi.org/https://doi.org/10.1016/j.foodchem.2022.132735

Hartel, R. W. (2018). Fats, Oils and Emulsifiers 4. *Confectionery Science and Technology*, 85–124. https://doi.org/10.1007/978-3-319-61742-8

Huffman, S. L., Harika, R. K., Eilander, A., & Osendarp, S. J. M. (2011). Essential fats: how do they affect growth and development of infants and young children in developing countries? A literature review. *Maternal & Child Nutrition*, *7*, 44–65.

Indonesian Ministry of Health. (2020). Indonesian Pharmacopoeia VI Edition (VI). *Department of the Ministry of Health of the Republic of Indonesia*.

Isa, N. S. M., Cheok, H. Y., Mohsin, A. Z., & Mohdmaidin, N. M. (2024). Tropical Journal of Natural Product Research The Effect of Different Citric Acid Concentrations on Physicochemical and Antioxidant Properties of Red Pitaya Peel Gummy Candies. *Tropical Journal of Natural Product Research*, *8*(12), 9654–9663. https://doi.org/https://doi.org/10.26538/tjnpr/v8i12.45

Jiamjariyatam, R. (2018). Influence of gelatin and isomaltulose on gummy jelly properties. *International Food Research Journal*, *25*(2), 776–783.

Kousparou, C., Fyrilla, M., Stephanou, A., & Patrikios, I. (2023). DHA/EPA (Omega-3) and LA/GLA (Omega-6) as bioactive molecules in neurodegenerative diseases. *International Journal of Molecular Sciences*, *24*(13), 10717.

Kulczy´nski, B., Kobus-Cisowska, J., Taczanowski, M., Kmiecik, D., & AnnaGramza-Michałowska. (2019). The Chemical Composition and Nutritional Value of Chia Seeds — Current State of Knowledge. *Nutrients MDPI*, 1–16. https://doi.org/10.3390/nu11061242

Maringka, C. T., Putra, A. B. N., & Lo, D. (2024). Development of gummy candy with polydextrose, isomalto-oligosaccharides, fructo-oligosaccharides, and xylitol as sugar replacers. *International Journal of Gastronomy and Food Science, 35*, 100881.

Mukhaimin, I., Nurwany, H. M., & Prasetyati, S. B. (2022). The Effect of Gelatin Concentration In Patin Fish Bones (*Pangasius pangasius*) on The Quality Characteristics of Jelly Candy. *Fisheries Product Technology Media*, *10*(2), 68–75. https://doi.org/https://doi.org/10.35800/mthp.10.2.2022.38772

Muñoz, L. A., Cobos, A., Diaz, O., & Aguilera, J. M. (2013). Chia seed (*Salvia hispanica*): an ancient grain and a new functional food. *Food Reviews International*, *29*(4), 394–408.

National Standardization Agency. (2008). Confectionery-Part 2: Soft SNI 3547.2.2008. *In Badan Standarisasi National Standardization Agency (p. 1)*.

Otegbayo, B. O., Tanimola, A. R., Ricci, J., & Gibert, O. (2024). Thermal Properties and Dynamic Rheological Characterization of Dioscorea Starch Gels. *MDPI*, *10*(51), 1–18. https://doi.org/https:// doi.org/10.3390/gels10010051

Permenkes. (2019). Recommended Nutrient Intake for the People of Indonesia. In *Regulation of the Minister of Health of the Republic of Indonesia Number 28 Year 2019 P*.

Rahmayanti, M., Oktavia, R. P., Amalina, F., Fadila, S. A. N., Nastiti, G. P., & Syarifuddin, S. (2024). Optimization of nanoemulsion hair serum from chia seed oil using the Simplex Lattice Design method. *Pharmaciana*, *14*(3), 370–381. https://doi.org/10.12928/pharmaciana.v14i3.27936

Song, X., Chiou, B., Xia, Y., Chen, M., Liu, F., & Zhong, F. (2022). The improvement of texture properties and storage stability for kappa carrageenan in developing vegan gummy candies. *Journal of the Science of Food and Agriculture*, 102(9), 3693–3702.

Timilsena, Y. P., Adhikari, R., Colin, J. B., & Adhikari, B. (2016). Microencapsulation of chia seed oil using chia seed protein isolate-chia seed gum complex coacervates. *International Journal of Biological Macromolecules*. https://doi.org/10.1016/j.ijbiomac.2016.05.058

Toker, O. S., Atalar, I., Kurt, A., & Palabiyik, I. (2025). Red Beet Extract Powder , Gelatin and Sucrose Interactions in Gummy Candies. *Foods*.

UNICEF. (2023). *Wasting (Undernutrition and Malnutrition) and its Impact on Children*. United Nations Children's Fund Indonesia. https://www.unicef.org/indonesia/id/gizi/artikel/dampak-wasting-pada-anak

United States Pharmacopeia. (2012). (2091) Weight Variation Of Dietary Supplements. *In United States Pharmacopeia (p. 1117)*.

Wang, R., & Hartel, R. W. (2021). Confectionery gels : Gelling behavior and gel properties of gelatin in concentrated sugar solutions. *Elsevier*, 1–42.

Zettel, V., & Hitzmann, B. (2018). Applications of chia (*Salvia hispanica* L.) in food products. *Trends in Food Science & Technology*. https://doi.org/10.1016/j.tifs.2018.07.011