Duta Pharma Journal e-ISSN : 2829-811X, p-ISSN : 2830-7054
Volume 6 Issue 1 June 2026, page 31-45

Characteristics and Hedonic Evaluation of "Microgum" Chewable Gummy containing *Moringa oleifera* and *Cucurbita moschata* as a Potential Micronutrient Supplement

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Submitted : May 16, 2026 ***Accepted : May 30, 2026*** ***Published : June 29. 2026***

Background: Malnutrition and micronutrient deficiencies remain major public health problems, the the low acception of conventional supplements is one of contributing factor. Natural ingredients such as *Moringa oleifera* leaves and pumpkin seeds (*Cucurbita moschata*) contain bioactive compounds that may support the development of functional supplement products. **Objective:** This study aimed to formulate and evaluate chewable gummies (microgummy) containing *Moringa oleifera* leaf extract and *Cucurbita moschata* seed extract through physical, hedonic, and stability evaluations. **Methods** This quantitative experimental study used three formulations containing different concentrations of *Moringa oleifera* leaf extract (5%, 10%, and 15%). Extraction was performed by maceration using distilled water as the solvent. Evaluations included phytochemical screening, pH, swelling ratio, syneresis, dispersion time, weight uniformity, accelerated stability, and hedonic testing involving 15 panelists. Data were analyzed using One-Way ANOVA followed by Duncan's post hoc test. **Results:** showed that *Moringa oleifera* leaf extract contained flavonoids, tannins, and saponins, while pumpkin seed extract showed positive results for alkaloids. All formulations had a pH value of 5. Swelling ratio values for F1, F2, and F3 were 2.00%, 2.02%, and 2.90%, while syneresis values were 3.125%, 2.752%, and 12.12%, respectively. Dispersion times were 16.59, 13.37, and 2.55 minutes. Only F1 met the weight uniformity requirement and dispersion standard (15-30 minutes). Accelerated stability testing at 40°C caused visible melting and deformation in all formulations. Hedonic evaluation showed that only aroma differed significantly among formulations ($p<0.05$). Formula F3 obtained the highest hedonic scores for color (4.20±0.41), taste (4.20±0.51), and texture (4.13±0.51). **Conclusion:** each formulation demonstrated different physicochemical characteristics which can vary because of the moringa leaves and pumpkin seed composition. The hedonic test shows that F3 achieved higher hedonic preference scores.

Keywords: chewable gummy, moringa leaves, pumpkin seeds, stability

INTRODUCTION

Malnutrition remains a critical issue in many developing countries including Indonesia. According to RISKESDAS 2018, the prevalence of anemia among adolescent girl reached 32% with micronutrient deficiencies such as iron, vitamin A and zinc remain high especially among school-age children (Berger et al., 2022). Another case of malnutrition in children is stunting, the low acception of conventional supplements such as capsules or drinks is one of contributing factor due to their unpleasant taste and difficulties experienced when consuming capsules. Research shows that children tend to prefer products with attractive shapes, pleasant flavors, bright colors, and practical features (Rashati et al., 2019). Therefore, it's necessary to develop a dosage form that fulfills these criteria such as chewable gumm formulation.

Chewable gummy is a confectionery product made from water or fruit juices combined with gelling agent, resulting a chewy texture with attractive appearance (Widana, 2025). Chewable gummy are practical, candy-like, and easily accepted by various age groups because of their form and easily to use which can be form in many variant of colour and taste.

Indonesia had a wide variety of plants with significant health benefits, one of which includes moringa leaves *(Moringa oleifera*) and pumpkin seeds (*Cucurbita moschata*). Moringa plants are esay to cultivate and widely distributed making them readily available (Putri et al., 2024). Moringa leaves possess high antioxidant activity, are rich in nutrients and various bioactive compound such as flavonoids, phenolics, triterpenoids/steroids and tannins (Saputra et al., 2020, (Rani et al., 2022)). Another potential plant is pumpkin seeds, a waste from pumpkin but rich of bioactive compound such as steroids, alkaloids, flavonoids and tannins (Sunnah, 2024). High level of Phenolic compound lead to potential antioxidants activity by donating hydrogen atoms to free radical and neutralizing their oxidative activity (Ananda, 2022). Furthermore, pumpkin seeds are rich in nutrients such as protein, carbohydrates, vitamins A and B, and minerals such as iron, phosphorus, calcium, and fiber (Saadah & Silvia, 2022). With these benefits, the utilization of developing a combination of moringa leaves and pumpkin seeds into an appealing product such as chewable gummy.

A study on the development of gummy formulations containing pumpkin seeds has been conducted by Sunnah (2024), while Winda (2025) carried out the formulation and evaluation of moringa leaf gummies. Both studies demonstrated that these materials can be successfully formulated into gummy dosage forms. However, no previous study has combined both ingredients into a single gummy product. This study aims provide not only integrating local biodiversity into a nutritious and marketable product, but also to provide an alternative utilization of both ingredients in addressing malnutrition. Furthermore, this research focuses on the formulation development, product evaluation such as physichochemical characteristic and hedonic testing of gummies containing moringa leaves and pumpkin seeds.

MATERIALS AND METHOD

Materials

The plant materials used in this study were Moringa oleifera leaves and pumpkin seeds (Cucurbita moschata) from farmers' harvests in Semarang Regency. In addition, additional materials used included gelatin (food grade), glycerin (food grade), sucrose (food grade), citric acid (food grade), sodium benzoate (food grade), and distilled water. The tools used in this study included an OHAUS Pioneer analytical balance, a Maspion Hot Plate Stirrer, an IKA® C-Mag HS 7 magnetic stirrer, a PYREX glass beaker (volume 50-500 mL), a silicone chewable gummy mold, a pipette, a stirring rod, a Herb Grinder 06B (capacity 300 g), a black cloth, a thermometer, a pH indicator, a glass jar, a mixing pan.

Methods

This study used a quantitative experimental approach to develop and evaluate the stability of chewable gummy products based on Moringa oleifera leaves and pumpkin seeds (*Cucurbita moschata*). The materials used, namely Moringa leaves and pumpkin seeds, were first subjected to a determination test to ensure the correctness of the plant species, after which the materials went through a sorting process, then extracted by maceration for five hours using distilled water as a solvent. The resulting thick extract was then tested for quality including determination of yield, content, and qualitative phytochemical screening. Determination of yield was carried out by calculating the ratio between the weight of the thick extract obtained and the weight of the initial simplex using the following formula:

Formula : Yield (%) = $\frac{M1}{M2}\ X\ 100\%$

Explanation :
M1 : extract mass (g)
M2 : simplisia mass (g)

The production of chewable gummy begins with an extraction process using the maceration method by weighing fine moringa leaf powder and fine pumpkin seed powder. After that, each fine powder is wetted using distilled water. The wetted fine powder is then macerated for 5 hours at room temperature (25–30°C) using distilled water as a solvent with a material to solvent ratio of 1:4. Aquadest was chosen because it is safe for use in functional food preparations and is able to extract polar compounds. After the extraction process is complete, filtration is carried out to separate the extract and residue. The extract used in the formulation is a liquid extract from the filtered results.

The next stage is the production of chewable gummy by first developing gelatin using a ratio of 1:5 for 10 minutes. Sucrose is dissolved using distilled water and then heated at a temperature of 70–80°C. Next, glycerin is added to the sucrose solution while stirring and heating. The expanded gelatin is then added to the mixture while continuing to stir. Sodium benzoate and citric acid were each dissolved in 5 mL of distilled water, then added to the mixture and stirred until homogeneous. After the mixture was homogeneous at room temperature, moringa leaf extract and pumpkin seed extract were added to the mixture while stirring. Next, the flavor was added little by little until homogeneous. The homogeneous mixture was then poured into silicone molds and allowed to set until the chewable gummy structure became more solid. The chewable gummy was then slowly released from the mold and packaged in plastic packaging.

The extracts were then formulated into 3 gummy preparations with the following composition:

Table 1. Formulation of Moringa Leaf Extract and Pumpkin Seed Extract Gummy

Ingredient	F1 (%)	F2 (%)	F3 (%)
Pumpkin seed extract	5	5	5
Moringa leaf extract	5	10	15
Gelatin	40	40	40
Gliserin	10	10	10
Sukrosa	10	10	10
Asam Sitrat	0,6	0,6	0,6
Na Benzoat	0,5	0,5	0,5
Aquadest ad	100 mL	100 mL	100 mL

The formed chewable gummy was then evaluated for its physical characteristics through several tests, including:

a. Organoleptis test

This study, organoleptic tests were conducted with the observed parameters including taste, color, odor and shape of chewable gummy (Rani et al., 2022)

b. pH test

pH test was conducted using a pH indicator. Three melted chewable gummies were prepared. The pH of each chewable gummy was then measured using pH indicator (Wijiani et al., 2024).

c. Uji swelling ratio

The swelling ratio test was conducted by weighing the initial weight of the chewable gummy, then soaking it in 100 mL of distilled water for 10 seconds at room temperature (25-30 C). Then the chewable gummy was removed and the surface was cleaned with filter paper to remove water. After that, the chewable gummy was weighed again and the weight before and after soaking was calculated:

Formula : *Swelling ratio test* = $\frac{Ws\text{-}Wd}{Wd}\ X\ 100\%$

Explanation:
Ws : Weight of gummy after soaking
Wd : Weight of gummy before soaking

d. Dispersion Test

The Dispersion Test was carried out by inserting the Chewable gummy into a beaker glass containing distilled water at a temperature of 37°C. Then stir constantly with a magnetic stirrer until all the Chewable gummy is dispersed, and turn on the stopwatch to see the time required for all the Chewable gummy to be homogeneously dispersed in distilled water and recorded as the dispersion time (Rani et al., 2022).

e. Syneresis Test

Weigh the initial weight of the chewable gummy at room temperature (25 ± 5 °C) by attaching filter paper to the entire surface. After that, weigh the final weight of the chewable gummy preparation, then compare it with the initial weight and calculate the percentage of syneresis(Rani et al., 2022).

$$\textbf{Formula :} \text{ Sineresis test} = \frac{A\text{-}B}{A} X\ 100\%$$

Explanation :
A : initial weight
B : final weight

f. Weight Uniformity Test

The weight uniformity test was conducted by randomly selecting 20 chewable gummy units, weighing them individually, and recording them. The average weight of the chewable gummy was then calculated. The weight uniformity was deemed to meet the requirements if no single preparation deviated by more than 7.5% from the average weight of the chewable gummy. If any tablet deviated outside the range, the test was repeated with an additional 20 chewable gummy tablets. The chewable gummy was deemed to meet the requirements if no single unit deviated by more than 10% from the average weight of the chewable gummy. The data obtained were then analyzed using the One-Way ANOVA method using the SPSS version 25 application (Herawati et al., 2024).

g. Stabilitas test

Stability testing was conducted by storing chewable gummies of each formulation in a climatic chamber for 2 weeks at cool or cold temperatures (8-15°C), room temperature (15-30°C), and warm temperatures (30-40°C). The stability of the preparation was then assessed by observing changes in shape, color, odor, and texture Stability evaluation included organoleptic observations such as changes in color, aroma, texture, and shape. The chewable gummies were observed for melting and stickiness during storage (Wijiani et al., 2024).

h. Hedonic test

The hedonic test was conducted using the five human senses as parameters for assessing the organoleptic quality of the product. The senses used included taste, sight, smell, and touch. The test involved 15 panelists aged 10-20 years, consisting of both males and females. Inclusion criteria included children aged 10-20 years, healthy individuals willing to participate in the study, and able to assess sensory characteristics. Exclusion criteria included allergies to product ingredients, impaired sense of taste or smell, and illness during the test. The hedonic assessment scale can be seen in Table 2.

Table 2. Skala Likert

Category	Scor
Extremely unlikely	1
unlike	2
Neutral	3
Likely	4
Extremely likely	5

Before conducting the hedonic test, the study first obtained ethical approval from the research ethics committee, and all panelists were provided with informed consent as a form of agreement to participate in the study. The observational data were analyzed using Normality and Homogeneity tests. The requirement for using One-Way ANOVA is that the data must be normally distributed and homogeneous. The results of the normality and homogeneity tests showed that the data were normally distributed and homogeneous with a significance value > 0.05. Furthermore, one-way analysis of variance (One-Way ANOVA) was conducted to identify significant differences among the three formulations in terms of aroma, color, adhesiveness, homogeneity, and panelist preference. Subsequently, Duncan's multiple range test was performed to examine the significant differences in more detail (Sukmawati et al., 2025). Further analysis using Duncan's test was conducted to identify treatments with similar or different effects and to determine the smallest to the greatest effects among the treatments (Herawati et al., 2024).

RESULT AND DISCUSSION

RESULT

Extraction Process

The extraction of *Moringa oleifera* leaves produced a greenish-brown liquid extract, while the extraction of *Cucurbita moschata* seeds yielded a yellowish-cream liquid extract.

Table 3. Extraction Yield Results

Sample	Initial Weight (g)	Extract Weight (g)	Yield (%)
Moringa Leaf Extract	100 g	52,025 g	52,025 %
Pumpkin Seed Extract	100 g	13,033 g	13,033 %

Phytochemical Screening

The phytochemical screening results of *Moringa oleifera* leaf extract revealed the presence of flavonoids, tannins, and saponins, while alkaloids and steroids/terpenoids were not detected.

Table 4. Phytochemical Screening Results of Moringa Leaf Extract

Secondary Metabolites	Reagents	Observation Results	Interpretation
Flavonoid	Mg powder + amyl alcohol + HCl	Color formation in the upper layer	+
Alkaloid	Maeyer, Dragendroff, Bouchardart	No precipitate is formed	-
Tanin	FeCl3	Greenish-black color	+
Steroid	N Heksan (salkosky) + Liberman Bouchardart	Steroid: no green color is formed Terpenoid: no purple color is formed	-
Saponin	Aquadest	Foam formation	+

The phytochemical screening results of *Cucurbita moschata* seed extract showed the presence of alkaloids, whereas flavonoids, tannins, and steroids were not detected.

Table 5. Phytochemical Screening Results of Pumpkin Seed Extract

Secondary Metabolites	Reagents	Observation Results	Interpretation
Flavonoid	2 Mg + Hcl	No yellow color is formed	-
Alkaloid	Maeyer, Drandendroft, Bounchardat	Formation of precipitate	+
Tanin	FeCl3 1%	No brown color is formed	-
Steroid	Chloroform +H2SO4	No brown ring is formed	-

Organoleptic testing

Table 6. Organoleptic Evaluation

Indicator	F 1	F2	F3
Taste	Sweet	Sweet	Sweet
Color	Yellow	Red	Green
Aroma	Orange aroma	Raspberry aroma	Melon aroma
Texture	Chewy	Chewy	Very Chewy

The organoleptic evaluation demonstrated differences among the three formulations in terms of color, aroma, and texture. All formulations exhibited a sweet taste.

Figure 1. Organoleptic Evaluation

Phytochemical Evaluation

Table 7. Physicochemical Evaluation Results of Microgummy Formulations

Formulation	pH	Swelling Index	Sineresis
F1	5	2.00%	3.125%
F2	5	2.02%	2.752%
F3	5	2.90%	12.12%

All formulations exhibited a pH value of 5. The highest swelling ratio was observed in F3 (2.90%), whereas the lowest syneresis value was recorded in F2 (2.752%).

Dispersion Time Test

Table 8. Dispersion Time Test Results

Formulation	Dispersion Time (min)
F1	16.59
F2	13.37
F3	02.55

Formula F1 met the standard dispersion time requirement for gummy products (15–30 minutes), while F2 and F3 exhibited dispersion times below the acceptable range.

Weight Uniformity Test

Table 9. Weight Uniformity Test Results

Formulation	Average Weight (g)	Column A (5%)	Column B (10%)	Description
F1	1,326	1,259-1,392	1,193-1,458	Complies
F2	1,344	1,276-1,411	1,209-1,478	Non-compliant
F3	1,311	1,245-1,376	1,179-1,442	Non-compliant

Only Formula F1 complied with the weight uniformity requirements.

Accelerated Stability Test

Following storage at 40°C, all formulations exhibited physical changes, including softening and deformation. In contrast, all formulations maintained their physical characteristics during storage at room temperature (25°C).

Figure 2. Microgum Preparations Before and After Accelerated Stability Testing

Hedonic Evaluation

Table 10. Mean value of sample hedonic test

Parameter	F1	F2	F3
Color	3.93±0.70	3.73±0.96	4.20±0.41
Smell	3.53±1.06	2.93±0.96	3.87±0.91
Taste	4.00±0.84	3.40±1.05	4.20±0.51
Texture	3.87±0.74	3.80±0.86	4.13±0.51

The highest hedonic scores for color, taste, and texture were observed in Formula F3.

Table 11. ANOVA Results Hedonic Test

		Sum of Squares	**Df**	***Mean Square***	**F**	**Sig.**
Color	Between Groups	1.644	2	0.822	1.551	0.224
	Within Groups	22.267	42	0.530		
	Total	23.911	44			
Smell	Between Groups	6.711	2	3.356	3.488	0.040
	Within Groups	40.400	42	0.962		
	Total	47.111				
Taste	Between Groups	5.200	2	2.600	3.640	0.035
	Within Groups	30.000	42	0.714		
	Total	35.200	44			
Texture	Between Groups	0.933	2	0.467	0.896	0.416
	Within Groups	21.867	42	0.521		
	Total	22.800	44			

The ANOVA analysis demonstrated significant differences among formulations for aroma (p = 0.040) and taste (p = 0.035). However, no significant differences were observed for color (p = 0.224) and texture (p = 0.416).

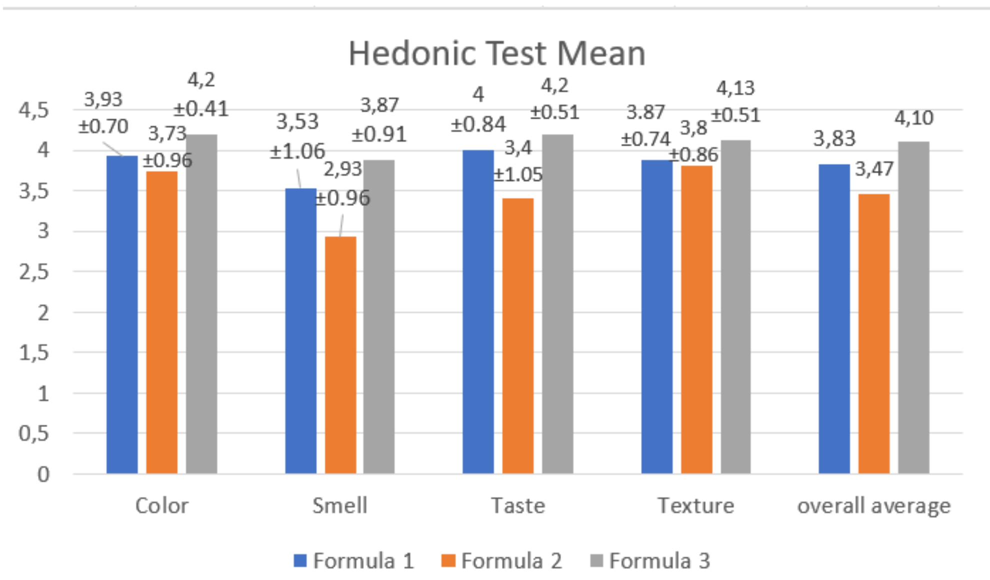

Figure 4. Average hedonic test of Mikrogum preparation Warna

The Duncan post hoc analysis revealed that Formula F3 achieved significantly higher aroma and taste scores than Formula F2.

Tabel 12. Duncan test for hedonic test

Homogenous Subsets of Aroma

Sampel	N	Subset 1	Subset 2
Formula 2	15	2.93	
Formula 1	15		3.53
Formula 3	15		3.87
Sig.		1.000	2.46

Homogenous Subsets of Rasa

Sampel	N	Subset 1	Subset 2
Formula 2	15	3.40	
Formula 1	15		4.00
Formula 3	15		4.20
Sig.		1.000	3.70

DISCUSSION

Extraction Process

The extraction of *Moringa oleifera* leaves used plant material collected from Ngampin Village, Semarang Regency. The taxonomic identification (determination) of the plant was conducted to ensure the authenticity and uniformity of the plant material. The extraction process produced a greenish-brown liquid extract from *Moringa oleifera* leaves and a yellowish-cream liquid extract from *Cucurbita moschata* seeds. The difference in extract color indicates variations in the composition of soluble compounds extracted from each plant material. This finding suggests that the water-soluble bioactive compounds present in *Cucurbita moschata* seeds may be present in lower concentrations or may exhibit different solubility characteristics compared with those in *Moringa oleifera* leaves (Suria et al., 2024).

The material solvent ratio 1:4 produce extracts without sediment that indicates the volume of solvent used was sufficiently optimal to dissolve active compounds, the appropriate ratio also significantly influences extraction efficiency and quality of the extract (Elinaningtyas, 2024). The extraction yield of *Moringa oleifera* leaf extract and *Cucurbita moschata* seed extract can be shown in Table 3. The extraction yield of *Moringa oleifera* leaf extract was 52.025%, while the yield of *Cucurbita moschata* seed extract was 13.033%. These findings suggest that the extraction process was carried out optimally, as both yields exceeded 10%. The efficiency of the extraction process can be evaluated, among other parameters, by the magnitude of the yield obtained (Dewatisari et al., 2018).

Phytochemical Screening

Phytochemical screening results support the use of *Moringa oleifera* leaf extract and *Cucurbita moschata* seed extract, presented in Tables 4 and 5. Based on the test results, *Moringa oleifera* leaf extract showed positive results for flavonoids, tannins, and saponins, while alkaloids and terpenoids/steroids were not detected. The presence of flavonoids and tannins in *Moringa oleifera* leaf extract indicates high potential antioxidant activity, which is relevant in supporting immune function and preventing micronutrient-based malnutrition (Saeful Amin & Lidiasari, 2025). In addition, the presence of saponins can increase the bioavailability of active compounds in the digestive system (Irwani & Candra, 2020).

Cucurbita moschata seed extract showed positive results for alkaloids but no other compounds were detected. Phenolic such as flavonoid, tannin and steroid is not detected from the extract. It is important to analyze the micronutrient content in the extract to support the objectives of this study. however, such analysis has not yet been conducted due to limitations in the availability of equipment and reagents.

Organoleptic testing

Organoleptic testing was conducted to evaluate the physical characteristics of the chewable gummy preparation both visually and sensorially, including color, aroma, taste, and texture. This evaluation utilizes the human senses to assess both visual and sensory parameters of a preparation (Rizal et al., 2024). The result presented in table 6.

Formula 1 exhibited an orange color, Formula 2 appeared red, and Formula 3 appeared green, as presented in Figure 1. In Formula F1 (5% *Moringa oleifera* leaf extract), the characteristic odor of moringa was relatively masked by the addition of orange essence, which imparted a fresh aroma and increased its overall acceptability (Isfianti, 2018). The texture was chewy and elastic, with a predominantly sweet taste, making this formulation the most balanced in terms of sensory attributes. In Formula F2 (10% *Moringa oleifera* leaf extract), the color of the preparation appeared more intense compared to F1. The taste remained sweet; however, the characteristic aroma of moringa became more pronounced. The addition of raspberry essence was not fully effective in masking the typical moringa odor. The texture remained chewy but was softer than F1, indicating a decrease in gel matrix elasticity with increasing extract concentration. In contrast, Formula F3 (15% *Moringa oleifera* leaf extract) exhibited a green color with a melon aroma and a sweet taste; however, the characteristic moringa odor remained quite dominant despite the addition of flavoring agents. The texture of this formulation tended to be excessively chewy and less elastic compared to the other formulations.

Stability Test

The pH test was conducted to determine the acidity level of the chewable gummy preparation containing *Moringa oleifera* leaf extract and *Cucurbita moschata* seed extract. The pH parameter is important in oral preparations as it affects the stability of active compounds and consumer comfort during administration (Winda et al., 2025). The results of the pH test are presented in Table 7.

The pH test was conducted to determine the acidity level of the chewable gummy preparation Based on the findings, all formulations (F1, F2, and F3) exhibited a pH value of 5, which is classified as acidic (Siregar et al., 2022). This pH value remains within a safe range for oral preparations and is consistent with the general characteristics of gummy products (Wijiani et al., 2024). A mildly acidic condition may also contribute to improved microbiological stability, as the growth of most pathogenic bacteria tends to be optimal at neutral pH (Atasoy et al., 2024). The similar pH values indicate that variations in extract concentration did not significantly affect the acidity of the preparation. However, since the pH measurement was conducted using pH indicator paper, the results are considered approximate and less accurate than measurements obtained using a digital pH meter.

Swelling Ratio Test

The swelling ratio test was conducted to determine the ability of the gummy preparation to absorb water and expand (Rani et al., 2022). The results presented in table 7. From the result it can be show that increasing the concentration of *Moringa oleifera* leaf extract tended to increase the swelling ratio value. Formula F3, containing the highest extract concentration (15%), exhibited the highest swelling ratio compared to the other formulations. This may be attributed to the increased extract concentration affecting the gel matrix structure, making the preparation more capable of absorbing water and undergoing expansion. In addition, the higher content of dissolved compounds and water in the formulation may result in a less compact gel structure, allowing faster water penetration into the gummy matrix (Ganea et al., 2025).

Syneresis Test

The syneresis test was performed to evaluate the physical stability of the chewable gummy preparation during storage, particularly in terms of its ability to retain water within the gel matrix. Syneresis is expressed as the percentage of water loss over a specified storage period (Nakhil et al., 2018) A lower syneresis value indicates better gel stability in maintaining moisture and structural integrity (Nugraha et al., 2022). Based on the results, increasing the concentration of *Moringa oleifera* leaf extract showed a tendency to increase the percentage of syneresis in the gummy preparation. This is likely due to the higher content of dissolved compounds, such as polyphenols and tannins, which can interact with gelatin and affect the compactness and stability of the gel matrix (Rizalianti, 2025). these interactions may disrupt the three-dimensional structure of the gel network and reduce its ability to retain water. Additionally, increases in water content and total solids may disturb the stability of water distribution within the gel matrix, resulting in suboptimal water binding and greater water release during storage (Putri et al., 2024).

Dispersion Time Test

The dispersion time test was conducted to determine the time required for the gummy preparation to disperse or disintegrate in an aqueous medium, simulating conditions in the oral cavity or gastrointestinal tract (Sunnah, 2024). This parameter is important to ensure that the release of active compounds can occur optimally. The results of the dispersion time test are presented in Table 8.

In the formulation, extract concentration influences the dispersion time of the gummy preparation. The standard dispersion time for gummy products ranges from 15–30 minutes (Sunnah, 2024). Based on Table 8, the dispersion times of formulations F1, F2, and F3 were 16.59 minutes, 13.37 minutes, and 2.55 minutes, respectively. Formula F1, containing the lowest extract concentration (5%), met the required dispersion time standard, which was likely due to the formation of a stronger gel matrix that slowed water penetration (Rani et al., 2022). Meanwhile, Formulas F2 and F3 exhibited dispersion times below the acceptable standard range. In Formula F3, which contained the highest extract concentration (15%), the very rapid dispersion time was likely caused by increased water content and dissolved compounds that weakened the gel matrix structure (Heliana et al., 2023).

Weight Uniformity Test

The weight uniformity test of the gummy preparation was conducted based on the requirements of the Indonesian Pharmacopoeia (FI) (Ditjen POM, 2014). Third Edition and referred to the gummy candy testing study by (Ginting et al., 2022). Based on the results of the weight uniformity test presented in Table 9

Formula F1 containing 5% *Moringa oleifera* leaf extract met the requirements because no more than two units deviated in Column A and no units deviated in Column B (Hendraputra H et al., 2024). In contrast, Formulas F2 (10%) and F3 (15%) did not meet the requirements because the number of deviating units exceeded the acceptable limits in both Column A and Column B. In general, increasing extract concentration tended to reduce the weight uniformity of the gummy preparation. This may be attributed to the increased amount of extract, which affected the viscosity of the solution, the homogeneity of the mixture, and the molding process. Excessively high viscosity may hinder the uniform distribution of mass into the molds (Mahardika & Tivani, 2023). Therefore, formulations with lower extract concentrations demonstrated better weight stability and consistency compared to formulations with higher extract concentrations.

Stability testing

The accelerated stability testing which has to be done in 2 different temperature, 40°C and 5°C. The result of chewable gummy before and after accelerated stability test can be seen in figure 2. Based on the results, the chewable gummy show observable physical changes in shape and texture when it is tested in 40°C, become incomplete a cycle. This condition may be caused by high temperatures weakening hydrogen bonds within the gel matrix, thereby disrupting the three-dimensional structure responsible for maintaining water retention and product form (Joy et al., 2024). These changes indicate that elevated temperatures may affect the integrity of the gel matrix and reduce the ability of the preparation to maintain its physical form. When the gummy storage at at 25°C (room temperature), the preparations maintained their shape, texture, and overall physical appearance properly throughout the observation period, this became an ideal temperature storage for gummy.

Hedonic test

Based on statistical analysis of all observation parameters based on the level of consumer preference for Mikrogum (Micronutrient Chewable Gummy) products. Product development is based on differences in the concentration of Moringa leaf extract to assess the parameters of color, aroma, taste, and chewiness. Based on the results of the one-way ANOVA (ANOVA) analysis, it shows that only the aroma parameter has a significant effect. While the color, taste, and chewiness parameters do not have an effect. This is based on a significant value if ($p < 0.05$) indicates a significant difference.

While (p>0.05) indicates no significant difference that affects. In the aroma parameter, a significance value of 0.04 (p <0.05) was obtained, indicating a significant difference. Then, parameters that have significant differences were further tested using the Duncan method to determine the real difference value. Furthermore, the average results of the hedonic assessment from the panelists on the parameters of color, taste, aroma, and chewiness are presented in Figure 4.

Color

Color is a visual aspect of a product that can be observed directly. Color is one of the important factors influencing consumer decisions in accepting or rejecting a product (Setiawan et al., 2022). The results of the color parameter analysis showed an F-value of 1.551 with a significance level of 0.224 (p>0.05), which means that statistically there is no significant difference in the product's color attributes. Based on the hedonic assessment presented in Figure 3, the average of the three formulations is in the category of quite like to like. The formulation with the highest average value in the color attribute is F3, with a value of 4.2. The composition of F3 uses moringa leaf extract (105% w/v), producing a transparent green color and not pale. The green color comes from the moringa leaf extract. The addition of natural coloring extracts is absorbed by the candy matrix, especially in jelly or gummy candies (Winda, 2024).

Smell

Smell is one of the main parameters for assessing the quality of food products, especially gummy preparations. Aroma can be perceived through the sense of smell to determine whether a product is acceptable or not (Uday et al., 2022). The results of the aroma attribute analysis showed an F count of 3.488 with a significance value of 0.04 (p <0.05), which means that the aroma attribute showed a significantly different effect. Based on the results of these differences, further tests were conducted using the Duncan method. Based on the Duncan test, it showed that the aroma in F2 with a value of 2.93 and F3 with a value of 3.87 had a significant difference or a significant difference. Meanwhile, in formula 2 compared to formula 1, there was no significant difference. Thus, the essence used was not able to optimally mask the distinctive odor of moringa leaves and gelatin (Salwa et al., 2025).

Taste

Taste influences the sensory perception of a product, determining whether it is acceptable to consumers. Consumers often consider taste over other quality attributes when selecting a product (Setiawan et al., 2022). The results of the taste parameter analysis showed an F-value of 3,640 with a significance value of 0.035 (p>0.05), thus concluding that there was significant difference in taste attributes. Based on the hedonic test presented in Figure 3, the average value of the three formulations was in the category of quite liking to liking, with formulation F3 having the highest value of 4.2. Taste preferences can be subjective due to individual differences in preferences. What makes F3 superior compared to other Fs is the composition used with a composition of moringa leaf extract (15% w/v) providing a balanced taste to the product. The added extract has the potential to improve organoleptic values (such as taste and color) and provide additional nutrition to the product (Sujana et al., 2021).

Texture

Chewyness is an organoleptic parameter related to texture and is one of the important factors after taste in influencing the acceptance of a product (Krawan et al., 2019). Chewyness influences consumer perception when chewing, thus playing a role in determining the comfort and appeal of the product. Consumers tend to prefer gummy products with an appropriate level of chewiness, neither too hard nor too soft (Amalia et al., 2025). The results of the chewiness parameter analysis showed that the F count was 0.896 with a significance value of 0.416 (p> 0.05), so it can be concluded that there is no real or insignificant difference in the chewiness parameter between formulations. Based on the hedonic test presented in Figure 3, the average value of the three formulations is in the category of quite like to like, with formulation F3 having the highest value of 4.13.

Based on the results of the ANOVA test, there were significant differences (meaningful), so a further test (Post Hoc Test) was conducted to determine which groups were different. The further test (Post Hoc Test) was conducted using the Duncan test. From Table 11, it shows that in the sample there were significant differences or significant differences between aroma and taste in the entire formulation.

In the sample, the significance value for the aroma parameter was 0.009 ($p < 0.05$) indicating a significant difference between groups. While in taste, it had a significance value of 0.0003 ($p < 0.05$) indicating a significant difference between groups.

Based on the results of Homogenous Subsets in the aroma of Formula 2 is in subsets 1 and in the aroma of Formula 3 in subsets 2 so that in terms of aroma it has the potential to be significantly different. In Formula 2 is in subset 1 with a value of 2.93 while in formula 3 in subset 2 with a value of 3.87. This indicates that formula 2 and formula 3 in terms of aroma have a significant/real difference. While in formula 1 compared to formula 3 there is no significant difference. Based on the results of Homogenous Subsets in the taste of Formula 2 is in subsets 1 and in the aroma of Formula 3 in subsets 2, so in terms of taste it has the potential to be significantly different. In Formula 2 is in subset 1 with a value of 3.40 while in formula 3 in subset 2 with a value of 4.20. This indicates that formula 2 and formula 3 in terms of taste have a significant/real difference. While in formula 1 compared to formula 3 there is no difference. Therefore, Formula 3 showed the highest level of panelist preference in organoleptic assessment, especially in taste and aroma.

CONCLUSION

Based on the research findings, microgummy formulations based on *Moringa oleifera* leaf extract and *Cucurbita moschata* seed extract demonstrated different physical characteristics, stability profiles, and organoleptic acceptability across each formulation. Formula F1 showed the best performance in terms of weight uniformity and dispersion time according to the applied standards. Formula F2 exhibited the lowest syneresis value, while Formula F3 was preferred for several hedonic attributes, however, it requires improvement in gel structure due to its excessively rapid dispersion time and poor stability at high temperatures. The results indicated that no single formulation was optimal for all evaluated parameters, therefore, the best overall formulation could not yet be determined comprehensively. In addition, all formulations still require further optimization to improve product stability. This study also has limitations because it did not include analyses of nutritional content, safety, bioavailability, or effectiveness in the target population. Therefore, further studies related to formulation standardization, nutritional evaluation, and more comprehensive stability testing are needed for future development.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to all parties who have provided support, assistance, and contributions in the preparation and completion of this research, enabling its publication in journal form. Special appreciation is extended to the Institute for Research and Community Service (LPPM Universitas Ngudi Waluyo) for the financial support provided through the research grant program, which made this study possible through to the publication stage. The authors also acknowledge all individuals and parties who have contributed, either directly or indirectly, including fellow researchers, respondents, and others who cannot be mentioned individually, for their assistance, support, and cooperation throughout the research process. It is hoped that the results of this study will contribute to the advancement of knowledge and practice in the related field.

REFERENCES

Amalia, R. R., Lestari, E., Kasih, A. N., & Nurhalisa. (2025). PENGARUH KONSENTRASI SARI BAYAM HIJAU (Amarathus tricolor L .) TERHADAP KARAKTERISTIK. *Jurnal Humaniora Dan Teknologi*, *11*(2), 92–104.

Ananda, D. R. (2022). *KOMPOSISI BIJI LABU KUNING DALAM SNACK BAR DITINJAU DARI SIFAT FISIK, ORGANOLEPTIK DAN AKTIVITAS ANTIOKSIDAN*. 439–446.

Atasoy, M., Álvarez Ordóñez, A., Cenian, A., Djukić-Vuković, A., Lund, P. A., Ozogul, F., Trček, J., Ziv, C., & De Biase, D. (2024). Exploitation of microbial activities at low pH to enhance planetary health. *FEMS Microbiology Reviews*, *48*(1). https://doi.org/10.1093/femsre/fuad062

Berger, M. M., Shenkin, A., Schweinlin, A., Amrein, K., Augsburger, M., Biesalski, H., Bischoff, S. C., Casaer, M. P., Man, M. E. De, Muscogiuri, G., Rezzi, S., Cuerda, C., Pietka, M., & Pironi, L. (2022). *ESPEN Guideline ESPEN micronutrient guideline*. *41*.

https://doi.org/10.1016/j.clnu.2022.02.015

Dewatisari, W. F., Rumiyanti, L., & Rakhmawati, I. (2018). Rendemen dan Skrining Fitokimia pada Ekstrak Daun Sanseviera sp . Rendemen and Phytochemical Screening using Leaf extract of Sansevieria Sp . *Jurnal Penelitian Pertanian Terapan*, *17 (3)*(January), 197–202.

Ditjen POM. (2014). Farmakope Indonesia Edisi V. In *Jakarta: Departemen Kesehatan Republik Indonesia*.

Elinaningtyas. (2024). Pengaruh Jenis Pelarut Dan Jumlah Pelarut Pada. *Distilat*, *10*(9), 296–302.

Ganea, M., Georgiana Ioana, P. C., Ghitea, T. C., Ștefan, L., Groza, F., Frent, O. D., Nagy, C., Iova, C. S., Schwarz-Madar, A. F., Ciavoi, G., Vicas, L. G., Constanta, P. D., & Moisa, C. (2025). Development and Evaluation of Gelatin-Based Gummy Jellies Enriched with Oregano Oil: Impact on Functional Properties and Controlled Release. *Foods*, *14*(3). https://doi.org/10.3390/foods14030479

Ginting, M., Marbun, N. R., Sinaga, M., Fitri, K., & Leny, L. (2022). Formulasi dan Evaluasi Sediaan Gummy Candies dari Sari Ganggang Hydrilla (Hydrilla Verticillata L.) yang Tumbuh di Perairan Danau Toba. *Majalah Farmasetika*, *8*(1), 13. https://doi.org/10.24198/mfarmasetika.v8i1.36649

Heliana, M., Sanny, P., Widyowanti, R. A., & Adisetya, E. (2023). *Pengaruh Penambahan Ekstrak Bunga Telang (Clitoria Ternatea) terhadap Karakteristik Selai Kolang-Kaling (Argena Pinnata)*. *1*(September), 1911–1919.

Hendraputra H, H., Sari Lubis, M., Indrayani Dalimunthe, G., & Yuniarti, R. (2024). FORMULASI TABLET HISAP BUAH RIMBANG (Solanum torvum Sw.) MENGGUNAKAN METODE KEMPA LANGSUNG DENGAN VARIASI BAHAN PEMANIS FORMULATION OF RIMBANG FRUIT (Solanum torvum Sw.) SUCTION TABLETS USING DIRECT COMPRESSION METHOD WITH VARIATIONS OF SWEETENER INGREDIE. *FARMASAINKES: Jurnal Farmasi, Sains, Dan Kesehatan*, *3*(2), 145–160.

Herawati, I. E., Tristiyanti, D., & Kartikawati, E. (2024). PERBANDINGAN AKTIVITAS ANTIBAKTERI DAUN TEMPUH WIYANG (Emilia sonchifolia L.) DAN DAUN SITUDUH LANGIT (Erigeron sumatrensis Retz.) TERHADAP BAKTERI Propionibacterium acnes ATTC 1223. *Journal of Pharmacopolium*, *6*(3), 18–27. https://doi.org/10.36465/jop.v6i3.1202

Irwani, N., & Candra, A. A. (2020). Aplikasi Ekstrak Daun Binahong (Anredera cordifilia) terhadap Kondisi Fisiologis Saluran Pencernaan dan Organ Viceral pada Broiler. *PETERPAN (Jurnal Peternakan Terapan)*, *2*(1), 22–29. https://doi.org/10.25181/peterpan.v2i1.1716

Isfianti, D. E. (2018). Pemanfaatan Limbah Kulit Buah Jeruk Nipis (Citrus aurantifolia) Dan Daun Kelor (Moringa oleifera Lamk) Untuk Pembuatan Lulur Tradisional Sebagai Alternatif "Green Cosmetics." *Jurnal Tata Rias*, *07*(2), 74–86.

Joy, J. M., Padmaprakashan, A., Pradeep, A., Paul, P. T., Mannuthy, R. J., & Mathew, S. (2024). A Review on Fish Skin-Derived Gelatin: Elucidating the Gelatin Peptides—Preparation, Bioactivity, Mechanistic Insights, and Strategies for Stability Improvement. *Foods*, *13*(17). https://doi.org/10.3390/foods13172793

Krawan, Y. ., Hervelly, H. ., & Pirmansyah, W. (2019). Korelasi Konsentrasi Black Tea Powder (Camelia sinensis) terhadap Muiu Sensori Produk Dark Chocolate. Pasundan Food Technology Journal (PFTJ), 6(2),. *Pasundan Food Technology Journal*, *6*(2), 105–115.

Mahardika, M. P., & Tivani, I. (2023). FORMULASI GUMMY CANDY DARI EKSTRAK ETANOL KULIT NANAS MADU(Ananas comosus L. Merr) TERHADAP BAKTERI Streptococcus mutans. *Parapemikir : Jurnal Ilmiah Farmasi*, *12*(2), 257. https://doi.org/10.30591/pjif.v12i2.5201

Nakhil, U., Kaltsum, U., Purwojati, N., & Latifah, E. (2018). Uji Stabilitas dan Penentuan Formula Optimum pada Gel Madam "Gel Ekstrak Daun Adam Hawa (Rheo Discolor) sebagai Gel Antiinflamasi" untuk Penelitian Lanjutan. *Prosiding APC (Annual Pharmacy Conference)*, *3*, 14–24.

Nugraha, W., Koesoemawardani, D., Nurainy, F., & Rizal, S. (2022). Pengaruh Penambahan Karagenan Terhadap Sifat. *Media Teknologi Hasil ...*, *1*(2), 253–261.

Putri, R. J., Halid, N. H. A., Himaniarwati, H., Baco, J., Mutma'innah, P., Indriani, F., Sari, S., Ningsih, R., & Mutiara, M. (2024). Literasi Gizi Melalui Pemanfaatan Dalam Pengolahan Daun Kelor

Untuk Pencegahan Stunting Pada Anak Di Desa Pangan Jaya Kecamatan Lainea Kabupaten Konawe Selatan. *Jurnal Mandala Pengabdian Masyarakat*, *5*(1), 123–127. https://doi.org/10.35311/jmpm.v5i1.362

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. *MPI (Media Pharmaceutica Indonesiana)*, *4*(1), 1–12. https://doi.org/10.24123/mpi.v4i1.5032

Rashati, D., Christiningtyas Eryani, M., & Farmasi Jember, A. (2019). Formulasi Dan Uji Stabilitas Gummy Candies Buah Naga (Hylocereus Polyrhizus) Dengan Variasi Konsentrasi Gelatin Dan Karagenan Sebagai Gelling Agent Formulation And Stability Test Of Gummy Candies Fruit Dragon (Hylocereus Polyrhizus) With Variation Of Gela. *Jurnal Informasi Kesehatan Indonesia*, *5*(2), 58–64.

Rizal, R., Shandy, V. R., Rusdi, M. S., & Afriyeni, H. (2024). Analisi Mutu organoleptik Sirup Kayu Manis Dengan Modifikasi Perbandingan Kosentrasi Gula Aren dan Gula Pasir. *Jurnal Penelitian Dan Pengkajian Ilmiah Eksakta*, *3*(2), 58–67.

Rizalianti, N. R. (2025). *Pemanfaatan Berbagai Jenis Buah dalam Pembuatan Permen Jeli terhadap*. *03*(02), 36–45. https://doi.org/10.31316/jitap.v3i2.9092

Saadah, R. W., & Silvia, S. (2022). *Modifikasi Labu Kuning (Curcubita moschata) pada Permen Gummy Jelly sebagai Camilan Tinggi Protein dan Vitamin A untuk Anak Stunting Modified Pumpkin (Curcubita moschata) in Gummy Jelly Candy as a High Vitamin A Snack for Stunting Children*. *6*(1). https://doi.org/10.20473/amnt.v6i1SP.2022.266-274

Saeful Amin, & Lidiasari, A. L. (2025). Analisis Senyawa Bioaktif Daun Kelor (Moringa Oleifera L.) Sebagai Agen Hipokolesterolemik Potensial. *Journal of Public Health Science*, *2*(2), 166–171. https://doi.org/10.70248/jophs.v2i2.2210

Salwa, N., Ahmad, A., Fitriyaningsih, E., Novita, R., Arifin, S. R., & Nuraskin, C. A. (2025). Effects of moringa leaf powder substitution on organoleptic characteristics, iron, and vitamin C of calamansi orange gummy candy. *AcTion: Aceh Nutrition Journal*, *10*(4), 1157. https://doi.org/10.30867/action.v10i4.2816

Saputra, A., Arfi, F., & Yulian, M. (2020). *LITERATURE REVIEW : ANALISIS FITOKIMIA DAN MANFAAT EKSTRAK DAUN KELOR (Moringa oleifera)*. *2*(3), 114–119.

Setiawan, A., Nurlaela, S., & Puspitojati, E. (2022). Evaluasi Organoleptik Produk Kristal Jahe Emprit (Zingiber Officinale) di Daerah Istimewa Yogyakarta. *Food Scientia : Journal of Food Science and Technology*, *2*(2), 189–198. https://doi.org/10.33830/fsj.v2i2.3609.2022

Siregar, M. Z., Adam, M., Azis, A., & Al-azhar, U. (2022). *Pengenalan Sifat Asam Basa Bahan Makanan Dengan Menggunakan pH Indikator dan kertas Lakmus di Yayasan Layar Dakwah*. *2*(4), 1241–1248.

Siti, M. A. F., Hutami, S. R., Ike, C. A., Kesehatan, F. I., & Muhammadiyah, U. (2025). *SKRINING FITOKIMIA DAN UJI KUALITATIF AKTIVITAS ANTIOKSIDAN EKSTRAK ETANOL DAUN KELOR (Moringa oleifera Lam) DENGAN METODE KROMATOGRAFI LAPIS TIPIS (KLT) PHYTOCHEMICAL SCREENING AND QUALITATIVE TEST OF ANTIOXIDANT ACTIVITY OF ETHANOL EXTRACT FROM MORINGA LEAVES (Moringa oleifera Lam) USING THIN LAYER CHROMATOGRAPHY (TLC) METHOD*. *9*(1), 114–124.

Sujana, D., Hasyim, D. M., Ramdani, H. T., Fadilah, S. N., Yuliasari, S., & Arismawati, M. (2021). EFEK ANTIPIRETIK DARI PERASAN, INFUSA, DAN DEKOKTA KUNYIT (Curcuma domestica Val.) PADA MENCIT YANG DIINDUKSI LARUTAN PEPTON. *Pharma Xplore Jurnal Ilmiah Farmasi*, *6*(2), 27–35. https://doi.org/10.36805/farmasi.v6i2.1939

Sukmawati, A. P., Wilujeng, B. Y., Pritasari, O. K., & Fernandas, M. A. H. F. (2025). *PENGARUH PROPORSI PINANG DAN EKSTRAK TEH HIJAU TERHADAP HASIL JADI BODY LOTION Adhitya Putri Sukmawati*. *14*(Desember), 336–343.

Sunnah. (2024). Pengembangan Gummy Ekstrak Biji Labu Kuning (Cucurbita Moschata D.) Sebagai Sumber Antioksidan. *Media Informasi Penelitian Kabupaten Semarang*, *6*(1), 27–39. https://doi.org/10.55606/sinov.v6i1.798

Sunnah, I., Josika, E., Batukh, Y. E., Apoteker, P., Ngudi, U., Jl, A., No, D., Tim, K. U., Semarang, K., & Tengah, J. (2024). *Pengembangan Gummy Ekstrak Biji Labu Kuning (Cucurbita Moschata D*

.) Sebagai Sumber Antioksidan Tujuan Penelitian supaya dapat dimanfaatkan sebagai suplemen untuk penghambatan radikal bebas . *6*(1), 27–39.

Suria, Y., Ali, N. F. M., & Masrida, W. ode. (2024). Karakterisasi Senyawa Antibakteri Dari Ekstrak Biji Labu Kuning (Cucurbita Moschata Duch). *Jurnal Penelitian Sains Dan Kesehatan Avicenna*, *3*(3), 214–226.

Uday, S., Antuli, Z., & Une, S. (2022). PENGARUH LAMA BLANCHING DAN TINGKAT KEMATANGAN DAUN TERHADAP AKTIVITAS ANTIOKSIDAN DAN KARAKTERISTIK ORGANOLEPTIK TEH CELUP DAUN SEMBUNG (Blumea balsamifera) THE EFFECT OF BLANCHING TIME AND MATURITY LEVEL ON ANTIOXIDANT ACTIVITY AND ORGANOLEPTIC CHARACTE. *Jambura Journal of Food Technology (JJFT)*, *4*, 78–88.

Wicaksana, A. H., Rakhmad, W. N., & Lestari, S. B. (2023). Hambatan Komunikasi dalam Organisasi Ikatan Mahasiswa Berprestasi Wonogiri. *Interaksi Online*, *11*(4), 73–83.

Widana, A. R. (2025). *Sustainable Development Goals : Analisis Kebijakan Diversifikasi Pangan untuk Mewujudkan Nol Kelaparan di Indonesia Sustainable Development Goals : A Policy Analysis of Food Diversification to Achieve Zero Hunger in Indonesia Artikel Penelitian Article History :* *8*(1), 812–818. https://doi.org/10.56338/jks.v8i1.6597

Wijiani, N., Kustriyani, A., Udianto, A. M., & Siddiqo, N. F. (2024). Variasi Gula Stevia dan Sirup Jagung dalam Formulasi Sediaan Gummy Candies Infusa Daun Salam (Syzygium polyanthum). *Journal of Islamic Pharmacy*, *9*(1), 1–5. https://doi.org/10.18860/jip.v9i1.23362

Winda, N. O. (2024). Pengaruh Penambahan Ekstrak Bunga Telang (Clitoria ternatea) Terhadap Karakteristik Fisikokimia Dan Organoleptik Permen Karamel Susu Sapi. *Food Technology and Halal Science Journal*, *6*(2), 176–188. https://doi.org/10.22219/fths.v6i2.28346

Winda, N. O., Noval, N., Hakim, A. R., & Budi, S. (2025). Formulasi dan Evaluasi Permen Gummy Ekstra Daun Kelor (Moringa Oleifera) Sebagai Pencegahan Stunting. *Jurnal Surya Medika*, *11*(3), 92–99. https://doi.org/10.33084/jsm.v11i3.11937

Zhao, Y., & Sun, Z. (2018). Effects of gelatin-polyphenol and gelatin–genipin cross-linking on the structure of gelatin hydrogels. *International Journal of Food Properties*, *20*(3), S2822–S2832. https://doi.org/10.1080/10942912.2017.1381111