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FORMULATION DEVELOPMENT OF GUMMY COMPRISING GINGER (*Zingiber officinale*), CURCUMA (*Curcuma xanthorrhiza*), AND LEMONGRASS (*Cymbopogon citratus*)

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Abstract

Ginger (*Zingiber officinale*), Curcuma (*Curcuma xanthorriza*), and lemongrass (*Cymbopogon citratus*) are widely recognized herbal plants known across all ages to maintain health for various ages, including children. Even though they are beneficial, children tend to find it challenging to accept herbs because of their bitter taste. One effective approach to reduce the bitter taste of herbs is to formulate them into a gummy. Therefore, this study aimed to formulate those herbal plant extracts into gummy using gelatin. The gummy manufacturing method involved heating, mixing, filtering, molding, and cooling. To ensure the pH stability of Curcuma, citric acid or tamarind was used as the acid source. Several tests were carried out to assess the safety and quality of the gummies, including organoleptic tests, weight and dimension uniformity, water content determination, microbial contamination tests, and metal contamination tests. The results revealed that the gummy formulation had met the organoleptic requirements, weight uniformity, and the dimensions of the gummy.

Keywords: Taste Masking; Candy; Herbal Medicine; Pharmaceutical Dosage Form; Children

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INTRODUCTION

Indonesian communities have used hundreds of herbal plants inherited from their ancestors to treat and prevent various diseases. Several herbal plants, such as ginger (*Zingiber officinale*), Curcuma (*Curcuma xanthorriza*), and lemongrass (*Cymbopogon citratus*), are widely known for their potential to maintain immunity and are relatively safe for children to consume.[1,3] These three herbs are often processed and used in various concoctions to improve the immune system, such as teas, honey mixtures, and multiple dishes.[4] Even though they have good benefits, children are reluctant to consume these products. Children are more sensitive to bitter taste than adults.[5] Therefore, innovation is needed to reduce the bitter taste of herbals so that children can accept them.

Gummy has gel-like textured with a sweet and sour taste and has various colors.[6] The sweet and sour taste of the gummy is used to cover the bitter taste of the herbal plants, while the chewy texture and attractive shape are expected to increase children's excitement in consuming them. The production process of gummy is relatively easy to make, involving heating, mixing, and molding.[7]

Considering that children may consume up to three gummies a day, several tests need to be carried out to ensure the safety and quality of gummy candy.[8] The tests carried out for gummies include organoleptic, weight and dimension uniformity, water content, microbial contamination, and metal contamination test.[9,10] Apart from ensuring the safety and quality of gummies, this testing result can increase public confidence in using the gummies that have been produced.

METHODS

Materials

Gelatin (HaysFood, Indonesia), distilled water, agave syrup (Sunny Via, Canada), sorbitol (Lansida, Indonesia), rock sugar (Ranesa, Indonesia), technical citric acid (Ensign, China), tamarind (ABFood, Indonesia), pure and food grade ginger powder (BeOrganik, Indonesia), Curcuma powder (BeOrganik, Indonesia), and lemongrass powder (BeOrganik, Indonesia) were used as materials in this study.

Tools

Analytical balance (Merk: Ohaus | Readability: 0,001 g | Max: 210 g), pH indicator strips McQuant, Oven Drying Memmert UN 500, electronic digital caliper, and Pyrex glass tools were utilized.

Gummy Production Procedure

The gummy formula is referred to as natural-based gummy (7). The gummy production process consisted of heating, mixing, filtering, molding, and cooling. Gelatin hydration was carried out by sprinkling gelatin powder on distilled water heated to 70°C. In a separate container, the process of mixing syrup and sweetener was also performed at 70°C. The syrup solution was poured into dissolved gelatin. Ginger, Curcuma, lemongrass, and tamarind were added. Everything was mixed to get a viscous preparation. The mixture was then filtered through a tofu filter bag to eliminate any dregs. Next, the viscous preparation was poured into a silicone mold and then cooled in the refrigerator for 24 hours. The prepared gummy candy made from ginger, Curcuma and lemongrass would be evaluated for its quality. The composition of the ingredients used in the gummy-making process can be seen in Table 1.

Table 1. Gummy Preparation Formula Design for Ginger (*Zingiber officinale*), Curcuma (*Curcuma xanthorriza*), and Lemongrass (*Cymbopogon citratus*)

Ingredients	Formula			
	Formula 1	Formula 2	Formula 3	Formula 4
Gelatin	10.7 %	10.7%	12.6%	12.4%
Water	45 %	45%	44.1%	43.4%
Agave Syrup	30.1%	30.1%	29.4%	28.9%
Sorbitol	8.6%	8.6%	8.4%	-
Rock Sugar	-	-	-	8.3%
Citric Acid	0.4%	-	-	-
Tamarind	-	0.4%	0.4%	2.1%
Ginger	2.6%	2.6%	2.5%	2.5%
Curcuma	1.3%	1.3%	1.3%	1.2%
Lemongrass	1.3%	1.3%	1.3%	1.2%

Evaluation of Gummy Candy

Based on the provisions of BPOM Regulation No. 29 of 2023 concerning Safety and Quality Requirements for Natural Medicines for chewable gummy, as well as the tests that had been carried out in previous research, the tests to be carried out next were organoleptic, weight uniformity, uniformity of dosage dimensions, water content, microbial contamination tests, and metal contamination tests.[10] A team of testers from the Integrated Research and Testing Laboratory at Gadjah Mada University carried out the testing for microbial and metal contamination. The other tests were conducted at the Pharmacy Laboratory at Sanata Dharma University.

Organoleptic and pH Tests

The organoleptic test was carried out by observing the color, smell, shape, and taste of the gummy.[9] The shape and color of the gummy were observed after it had been rested for 30 minutes or after its temperature reached 25-30°C. The pH test was conducted on the viscous gummy preparation using McQuant pH indicator strips. The indicator strip was dipped in the preparation and then rested for a while until the color changed. The test results were compared with the indicator sheet contained in the packaging.

Weight and Dimensions Uniformity

The weight uniformity test is a mandatory test for chewable gummies.[9] It ensures that gummy candies have uniform weights as they relate to each gummy's homogenous composition. Their variation might be caused by the manual pouring process, which can differ for each person. The test was carried out on 20 samples. Each was weighed on an Ohaus analytical balance with a reading accuracy of 0.001 g. The weighing results were then calculated to find the average. The gummies are considered to have suitable weight uniformity if none of the 20 primary packages whose weight deviates from the average weight is more significant than 7.5%.[9]

Also, dimensional uniformity measurements are needed to determine the homogeneity of gummy candy. Dimensional uniformity testing was conducted using a vernier caliper on 10 samples. Measurements were made on the gummy's length, width, and thickness. Gummy candy is considered to have good dimensional uniformity if the coefficient of variation value is less than 5%.[10]

Water Content Test

The water content test is also mandatory for chewable gummies. Gummies contain sugar, which provides the perfect environment for bacterial growth. Therefore, their water content must be controlled. The water content is determined using the gravimetric method for plant medicines.[9] Five grams of the sample were weighed and dried at 105°C with a Memmert UN 500 Drying Oven for five hours. After the first drying process, the sample was weighed. The sample was heated again at 105°C for one hour. The heating was stopped when the results of the second heating did not show a difference of more than 0.25% compared to the first heating.

RESULTS AND DISCUSSION

The gummy formula containing 0.4% citric acid (F1) produced a sour taste and a strong bitter aftertaste. Even though a combination of sweeteners in the form of agave syrup and sorbitol has been used, the gummy's bitterness persists despite sweeteners. Based on previous research, sour tastes can also produce a bitter taste on the tongue.[11] Citric acid's bitter taste synergizes with herbal plants' bitter taste.

In Formula 2 (F2), 0.4% citric acid was replaced with 0.4% tamarind, containing 10.56-16.69% tartaric acid, resulting in the tartaric acid contained in F2 of 0.04-0.06%.[12] The pH produced by Formula 2 was 5.0. Even though the pH of Formula 2 was the same as Formula 1, the intensity of the sour taste created by Formula 2 was lower. Apart from the different acid concentrations, one factor influencing tongue receptors' ability to taste is the compound's solubility.[13] Seen from its solubility, citric acid has a higher solubility than tartaric acid. Citric acid has a water solubility of 62.07% at 25°C, while tartaric acid has a water solubility of 58.48% at 25°C.[14] The structures of citric acid and tartaric acid, as observed in Figure 1, show that tartaric acid consists of 2 carboxylic groups and 2 hydroxyl groups, while citric acid encompasses 3 carboxylic groups and 1 hydroxyl group. The carboxylic group can form more hydrogen interactions than the hydroxyl group, so theoretically, the solubility of citric acid is higher than that of tartaric acid.

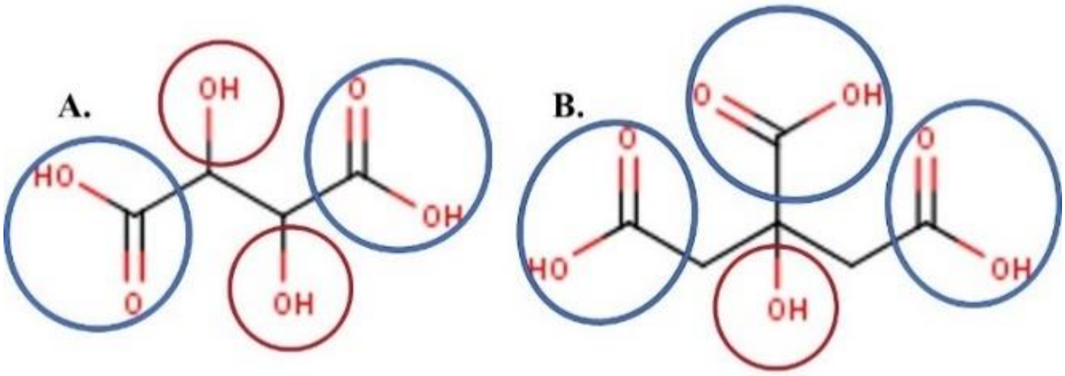

Figure 1. A. Tartaric Acid Structure, B. Citric Acid Structure. While the blue circle indicates the carboxylic group, the red circle shows the hydroxyl group.

The addition of gelatin to 12.6% and decreasing agave syrup to 29.4% and sorbitol to 8.4% (F3) produced a denser gummy. Gelatin works as a gelling agent, which increases the gummy's cohesive properties.[7] Gummies have a very high sugar content. Due to the hygroscopic nature of sugar, gummy can absorb water from the air, which increases its adhesive properties, thus affecting its density.[15] The higher the adhesive properties of a gummy, the more susceptible it is to sticking.[16] Additional gelatin increased the cohesive properties of the gummy.

As a result, the gummy became less sticky. This aligns with previous research, which stated that adding gelatin results in a denser gummy candy.[7] Afterward, replacing the sorbitol sweetener with rock sugar (F4) eliminated the bitter taste and increased the sweet taste of the gummy. Rock sugar was made by cooling a supersaturated sucrose solution until crystals were formed.[17] Compared to sorbitol, sucrose can produce a higher sweetness intensity.[18,19]

Previous research found that the tendency of a compound's affinity for different types of sweet taste receptors could be one of the factors that influence the intensity of the sweet taste.[20] Besides the types of receptors, the strength of the compound's affinity for the receptor also influences the intensity of the sweet taste. Sorbitol, which has a lower affinity, produces a lower sweet intensity than xylitol, which has a higher interaction affinity on the same receptor as sorbitol does.[21,22]

Table 2. Organoleptic Test Results

Formula	Taste	Odor	Color and form*	pH
F1	It tastes very sour and has an unpleasant bitter aftertaste.	Strong smell typical of herbs concoction	Brown, sticky, and unable to hold shape	5.0
F2	It tastes sweet but has a slightly bitter aftertaste.	Strong smell typical of herbs concoction	Brown, sticky, and unable to hold shape	5.0
F3	It tastes sweet and has a slightly bitter aftertaste.	Strong smell typical of herbs concoction	Brown, chewy, and able to hold shape	5.0
F4	It tastes sweet and does not have bitter aftertaste.	It smells slightly typical of an herb concoction.	Brown, chewy, and able to hold shape	5.0

*** = The gummy's condition after being rested for 30 minutes**

Furthermore, the molding process used a bear-shaped silicone mold. Silicone is a synthetic rubber that is commonly used for molds because it is reusable, non-sticky, and easy to clean.[23] The aim of using silicone molds was to maintain gummy shape and weight uniformity. Even though it is easy and practical to use, silicone particles have a risk of being transferred to food if exposed to extreme temperatures. Hence, the gummy molding process was carried out after the preparation reached 55°C. The cooling process was then performed at a temperature of 4°C.[24] The result can be seen in Figure 2.

Figure 1. Gummy Bear Using Silicone Mold

Weighing 20 gummies with analytical scales produced a CV value of 0.0652%, while the measurements of 10 gummies showed that the length, width, and thickness of gummy candy had CV values of 0.05%, 0.1% and 0.2%, respectively. The tests for weight and dimension uniformity fulfilled the requirements. Based on these tests, it can also be concluded that the use of silicone molds in gummy making could ensure consistency of size and weight.

Since gummies may be consumed repetitively, more than one piece per day, due to their sweet taste, any heavy metal contamination can cause various health problems, such as cognitive problems, decreased immune system, and increased cardiovascular risk.[25,26] Heavy metals can come from soil and fertilizers used to grow plants as well as from water used to process preparations.[27,28] Testing for heavy metals such as cadmium (Cd), lead (Pb), and mercury (Hg) can be a safety parameter for gummy candy.

In this study, the cadmium, lead, and mercury levels in the gummy candy have fulfilled the requirements for safe and quality preparations based on BPOM Regulation No. 29 of 2023 concerning Safety and Quality Requirements for Natural Medicines. The lead (Pb) levels test results were 1.99 mg/kg, while the lead content limit requirement was ≤ 10 mg/kg. While the mercury level detected was 0.00617 mg/kg, the limit was ≤ 0.3 mg/kg BW. No cadmium content was detected by a tool with a detection limit of 0.1 mg/kg BW.

Before heating, the weight of the gummy was 4.96 grams, while the weight of the gummy after heating was 2.51 grams. Based on the results obtained, the water content in the candy was 49.4%. Based on RI POM Regulations, 2023, the water content acceptance is <10%. Thus, the gummy did not meet the requirements. Higher water content in the gummy can increase the growth of bacteria, mold, and yeast. This problem will lead to short storage time. It can also affect the texture of the gummy during the delivery period. High water content in the gummy can affect the gummy's density, making gummies stick more easily to the packaging when exposed to moisture during distribution and storage.[16,29]

Additionally, the microbial contamination tests are the Yeast and Mold Count (MYC) and Total Plate Count (TPC) tests. MYC and TPC test results need to be carried out to show the quality and safety of the gummy candy.[9] The presence of pathogenic microbial contamination in the gummy can cause various diseases in the consumers and change the organoleptic properties of the gummy, such as decreasing the sweet taste of the candy and changing its color.[30,31]

The test results obtained for the MYC test were 6.5×10^2 cfu/gram, while the TPC test showed a value of 1.33×10^3 cfu/gram. The TPC value has met the provisions for the bacterial contamination limit set by the Indonesian POM Agency, 2023, which is ≤ 10^5 cfu/gram, but has not met the limit for mold and yeast contamination, which is ≤ 10^3 cfu/gram. Although there have been no visible organoleptic changes in the gummy, their safety cannot be guaranteed. To maintain the safety of gummy, it is necessary to use safe preservatives for herbal pharmaceutical dosage form, including benzoic acid, potassium benzoate, sorbic acid, ethyl para-hydroxybenzoate, and methyl para-hydroxy benzoate with a maximum daily consumption limit of 2000 mg/kg BW.[9]

CONCLUSIONS

The ginger, Curcuma, and lemongrass gummies have met organoleptic requirements, weight and dimensions uniformity, the Total Plate Count, and metal contamination such as cadmium (Cd), Lead (Pb), and mercury (Hg). Nevertheless, the gummy candies and the Yeast Mold Count did not meet water content requirements. As such, food preservatives must be added to the preparations to improve the quality and safety of gummy candy.

CONFLICT OF INTEREST

The authors have no conflicts of interest regarding this investigation.

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REFERENCES

1. Inacio RFB, Pereira AMS, Carmona F. Consumption of medicinal plants and herbal medicines by children and adolescents with chronic conditions: a survey in a tertiary-care outpatient clinic. Med (Ribeirão Preto). 2023;56(1).
2. Pardamean B, Rahutomo R, Sudigyo D, Trinugroho JP, Nirwantono R, Hidayat AA, et al. Evaluation of childhood stunting reduction treatments in Indonesia. Res Sq. 2023.
3. Nocerino R, Cecere G, Micillo M, De Marco G, Ferri P, Russo M, et al. Efficacy of ginger as antiemetic in children with acute gastroenteritis: a randomised controlled trial. Aliment Pharmacol Ther. 2021;54(1):24–31.
4. Rani R, Eva DK, Asep AR. Buku saku penggunaan olahan herbal dan suplemen dalam meningkatkan imunitas [Internet]. 1st ed. Dwi N, editor. Tasikmalaya: Lingkar Pakar; 2020 [cited 2025 Feb 27]. Available from: http://repo.poltekkestasikmalaya.ac.id/id/eprint/424
5. Rodrigues L, Silverio R, Costa AR, Antunes C, Pomar C, Infante P, et al. Taste sensitivity and lifestyle are associated with food preferences and BMI in children. Int J Food Sci Nutr [Internet]. 2020;71(7):875–83. Available from: https://doi.org/10.1080/09637486.2020.1738354
6. Teixeira-Lemos E, Almeida AR, Vouga B, Morais C, Correia I, Pereira P, et al. Development and characterization of healthy gummy jellies containing natural fruits. Open Agric. 2021;6(1):466–78.
7. Čižauskaite U, Jakubaityte G, Žitkevičius V, Kasparavičiene G. Natural ingredients-based gummy bear composition designed according to texture analysis and sensory evaluation in vivo. Molecules. 2019;24(7).
8. Chan SY, Miskam M, Ganesan S. Analysis of sugar content in selected children's health supplements in Malaysia. Malaysian J Anal Sci.

2021;25(6):998–1006.
9. Badan POM RI. Persyaratan keamanan dan mutu obat bahan alam. Jakarta: Badan Pengawas Obat dan Makanan; 2023.
10. Rani KC, Jayani NIE, Feneke F, Melanda S. Preparation and evaluation of gelatin and pectin-based *Moringa oleifera* chewable-gummy tablets. IOP Conf Ser Earth Environ Sci. 2021;913(1).
11. Meiselman HL, Dzendolet E. Variability in gustatory quality identification. Percept Psychophys. 1967;2(11):496–8.
12. Takhellambam RD, Pushpa B. Effect of storage on quality of tamarind (*Tamarindus indica* L.) clones. Int J Curr Microbiol Appl Sci. 2020;9(8):2409–16.
13. Shallenberger RS. Taste recognition chemistry. Pure Appl Chem. 1997;69(4):659–66.
14. Dalman LH. The solubility of citric and tartaric acids in water. J Am Chem Soc [Internet]. 1937 Dec 1;59(12):2547–9. Available from: https://pubs.acs.org/doi/abs/10.1021/ja01291a018
15. Kovács A, Kerti KB, Somogyi L. The effect of sugar substitution on model confectionary systems. Prog Agric Eng Sci [Internet]. 2021 Feb 20;16(S2):1–8. Available from: https://akjournals.com/view/journals/446/16/S2/article-p1.xml
16. Wang R, Hartel RW. Confectionery gels: gelling behavior and gel properties of gelatin in concentrated sugar solutions. Food Hydrocoll. 2022;124.
17. Lim TSE, Chia KF, Loo LM, Wong SY. Rock sugar crystallization: the effect of mineral impurities. Sugar Tech [Internet]. 2021;23(6):1432–9. Available from: https://doi.org/10.1007/s12355-021-00991-7
18. Tan VWK, Wee MSM, Tomic O, Forde CG. Temporal sweetness and side tastes profiles of 16 sweeteners using temporal check-all-that-apply (TCATA). Food Res Int [Internet]. 2019;121(March):39–47. Available from: https://doi.org/10.1016/j.foodres.2019.03.019
19. Moskowitz HR. Ratio scales of sugar sweetness. Percept Psychophys. 1970;7(5):315–20.
20. Nie Y, Vigues S, Hobbs JR, Conn GL, Munger SD. Distinct contributions of T1R2 and T1R3 taste receptor subunits to the detection of sweet stimuli. Curr Biol. 2005;15(21):1948–52.
21. Kilcast D, Portmann MO, Byrne BE. Sweetness of bulk sweeteners in aqueous solution in the presence of salts. Food Chem. 2000;70(1):1–8.
22. Mahalapbutr P, Darai N, Panman W, Opasmahakul A, Kungwan N, Hannongbua S, et al. Atomistic mechanisms underlying the activation of the G protein-coupled sweet receptor heterodimer by sugar alcohol recognition. Sci Rep. 2019;9(1):1–11.
23. Teisala H, Baumli P, Weber SAL, Vollmer D, Butt H-J. Grafting silicone at room temperature—a transparent, scratch-resistant nonstick molecular coating. Langmuir [Internet]. 2020

Apr 28;36(16):4416–31. Available from: https://pubs.acs.org/doi/10.1021/acs.langmuir.9b03223

24. Asensio E, Uranga J, Nerín C. Analysis of potential migration compounds from silicone molds for food contact by SPME-GC-MS. Food Chem Toxicol [Internet]. 2022;165(May):113130. Available from: https://doi.org/10.1016/j.fct.2022.113130
25. Bair EC. A narrative review of toxic heavy metal content of infant and toddler foods and evaluation of United States policy. Front Nutr. 2022;9(June):1–9.
26. Mielech A, Puścion-Jakubik A, Socha K. Assessment of the risk of contamination of food for infants and toddlers. Nutrients. 2021;13(7):1–21.
27. Habte G, Mekonen N, Desse G, Kassa G. Heavy metal contamination and health risk assessment of horticultural crops in two sub-cities of Addis Ababa, Ethiopia. Toxicol Reports [Internet]. 2023;11(April):420–32. Available from: https://doi.org/10.1016/j.toxrep.2023.09.002
28. Sonone SS, Jadhav S, Sankhla MS, Kumar R. Water contamination by heavy metals and their toxic effect on aquaculture and human health through food chain. Lett Appl NanoBioScience [Internet]. 2020 Oct 21;10(2):2148–66. Available from: https://nanobioletters.com/wp-content/uploads/2020/10/22846808102.21482166.pdf
29. Tireki S, Sumnu G, Sahin S. Correlation between physical and sensorial properties of gummy confections with different formulations during storage. J Food Sci Technol [Internet]. 2021;58(9):3397–408. Available from: https://doi.org/10.1007/s13197-020-04923-3
30. Sari RI, Dewi SS, Wilson W. Total mikrobia jamu serbuk kemasan dan tanpa kemasan Banjarmasin. J Media Anal Kesehat [Internet]. 2020 Jun 30;11(1):1. Available from: http://journal.poltekkes-mks.ac.id/ojs2/index.php/mediaanalis/article/view/1298
31. Ulya M, Aronika NF, Hidayat K. Pengaruh penambahan natrium benzoat dan suhu penyimpan terhadap mutu minuman herbal cabe jamu cair. *Rekayasa* [Internet]. 2020 Mar 25;13(1):77–81. Available from: https://journal.trunojoyo.ac.id/rekayasa/article/view/5385