



Formulation and Evaluation of Gummy Candy from the Extract of Jathropa Leaf (*Jatropha curcas* L.)

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ABSTRACT

People are becoming more interested in nutraceutical preparations to maintain health as the world's health problems worsen. *Jatropha curcas* leaves (*Jatropha curcas* L.) have anthelmintic properties due to tannin compounds that act as anti-worms. This study aims to produce jelly candy preparations from *Jatropha curcas* leaves and evaluate these preparations. There are two stages of research: raw material preparation and verification, and jelly candy formulation. This study showed that the best concentration of *Jatropha* leaf extract was Formula 2. Based on the phytochemical test, there were alkaloids in the *Jatropha* leaf extract. The pH value of gummy candies preparations of castor leaf extract, weight uniformity test, passed the moisture content test because they met the requirements for a wide range of dosage values. Meanwhile, the Hedonic Test results show that Formula 2 is the most preferred by children. So, based on the evaluation and hedonic test results, Formula 2 is the best preparation for jelly candy from *jatropha* leaves.

Keywords: Jelly candy formulation; *Jatropha* leaves extract; Physical evaluation; Hedonic test

INTRODUCTION

Worm infections have hit more than 1 billion people in the world, especially those living in the tropics. Complex interactions between worms and hosts produce systemic effects on immunity. Some worm infections, if left untreated, can cause chronic sequelae in a much younger population. Worm infection can cause anemia, predisposing individuals to suffer more severe symptoms, including worm co-infection and SARS-Cov 2 in children and pregnant women.^{1,2}

Worm infection is tested positive if worm eggs are found in at least one type of worm in the specimen examined. The lack of a clean and healthy lifestyle can increase the risk of worm infection in children, especially school-age children because children at this age still do not understand the importance of a clean and healthy

lifestyle. Worm infections in children can cause nutritional deficiencies and anemia which can reduce children's learning achievement. Based on data from the World Health Organization (WHO) in 2012, there were 60% of children from around 1.5 billion world population who were infected with worms. In 2012, the prevalence of helminth infections in Indonesia was above 20% with the highest percentage being 76.7%. Based on WHO data in 2016 there are more than 1.5 billion people in the world infected with worms. Countries such as sub-Saharan Africa, America, China, and East Asia are the countries with the highest number of sufferers. Around 55 million children in Indonesia suffer from worm infections, so prevention and education on a clean and healthy lifestyle are still needed. Worm

infections can attack all ages, but children are the most vulnerable age. This infection does not always affect people who have minimal body weight and is not related to the person's economic condition. Worms are a problem that is often found in Indonesia. This infection does not always affect people who have minimal body weight and is not related to the person's economic condition. Worms are a problem that is often found in Indonesia. This infection does not always affect people who have minimal body weight and is not related to the person's economic condition. Worms are a problem that is often found in Indonesia.³⁻⁶

Overcoming the problems above, children need to consume worm drugs that are interesting and have a good taste. There are natural herbs that are efficacious as anthelmintics, one of which is *Jatropha curcas* leaves. *Jatropha curcas* leaves contain alkaloids, saponins, tannins, terpenoids, steroids, glycosides, phenolic compounds and flavonoids through ethanol extract.^{2,7,8}

The ability of *Jatropha* leaf extract as an anti-worm because it contains saponins and tannins. Saponins belong to a class of flavonoids that have an anti-fertilization effect, that is, they can shrink the membrane of worm eggs and larvae, thereby reducing the integrity of the membrane. So that the process of growth of eggs and larvae of *A.galli* worms becomes inhibited, this can suppress the nervous system and the worm's locomotor system, so that the amount of oxygen in the worm's body decreases below normal limits which has an effect on the worm's death. Saponins work to hydrolyze worm cells so that the worms die and their bodies become transparent.^{2,3,9}

The research objective was to make jelly candy formulations and evaluate jelly candy preparations from *Jatropha curcas* leaves. Academically, this research will provide nutraceutical benefits of natural ingredients for health, especially for children.

METHODS

There are two stages of this research, including preparation and verification of raw materials, and formulation of gummy candies.

Equipment and materials

Equipment

Rotary evaporator (Buchi), oven (Memert), sifter (Lionstar), grinder (Miyako), macerator (Harapan Jaya), glass type, filter paper, MH series pocket scales, micro scale, test tube (Iwaki), moisture balance (Sartorius).

Material

Jatropha curcas extract (Herbalux), essence, ethanol 70%, ethanol 96%, sulfuric acid (SmartLab), acetic acid 97% (Smartlab), corn syrup (ThermoFisher, 108, 4), sucrose (Merck, 185.5), PGA (Kimica), gelatin (Eurotrade word commerce), lactose (Caelo), corn oil (Abmole), aquadest (Smartlab), Mannitol 98% (Abmole)

Procedures

Formulation of gummy candies:¹⁰⁻¹²

1. Physical properties of *Jatropha* leaf extract testing

Physical tests of the extract include: organoleptic test and moisture content. Organoleptic tests are: shape, color, smell and taste of the extract. In the moisture content test, using a moisture balance, the test procedure is: weigh 2 grams of *Jatropha* leaf extract, and place it in the moisture balance at a temperature of 105°C. Then the moisture content will appear in percent w/b units.^{2,9,14,15}

2. Ethanol free test of *Jatropha* leaf extract

The purpose of this test is to determine the ethanol content in the extract. The extract was subjected to the ethanol esterification test, namely, the extract was added with concentrated sulfuric acid and acetic acid, then heated. If there is a characteristic odor of ethyl acetate then the result is negative.^{2,9}

3. Formulation of gummy candies preparations

In this study, 3 formulas will be made with different comparisons of ingredients to find out which one is the most stable after being evaluated. The formulas are listed in Table 1. Formulation of gummy candies preparations.

Table 1. Formulation of Gummy Candies

Material	Formula (mg) in weight 2.5gr/seed		
	F1	F2	F3
Condensed extract of Jatropha leaf	200	250	300
Mannitol	350	300	250
Gelatin	350	350	350
Corn syrup	575	575	575
Aquadest	225	225	225
Arabic gum	30	30	30
Lactose	220	220	220
Sucrose	400	400	400
Essence	50	50	20
Corn oil	100	100	100

4. Gummy candies preparation

Mix mannitol and corn syrup as a base. Heat in a water bath at 80°C until homogeneous. Add corn oil when hot. Then dissolve the gum arabic in 10 ml of hot distilled water (50-60 degrees Celsius). Next, mix the gelatin solution into the gum arabic solution, homogenize. Enter the gelatin and gum solution into the base at 70 degrees Celsius.¹¹

Add sucrose, lactose and essence to the mixture while stirring until homogeneous. Remove and pour the preparation into candy molds and cover using aluminum foil. Then leave it for 1 hour at room temperature then put it in the fridge for 24 hours and remove it from the fridge then leave it at room temperature for 1 hour. Remove from the mold and sprinkle with sucrose flour, pack in a tightly closed container.¹⁶⁻¹⁸

5. Evaluation gummy candies^{12,16,17}

Evaluation of gummy candies preparations, namely organoleptic tests, pH tests, weight uniformity tests, moisture content tests, and hedonic tests

a. Organoleptic test

Organoptical evaluation was carried out by visual observation of gummy candies preparations which were obtained through shape, color, taste and smell.

b. pH test

The pH test was carried out using a pH meter to determine the pH value of gummy candies, based on the pH test requirements

c. Moisture content test

1) Extract moisture content test

Examination of the moisture content of castor leaf extract and gummy candies preparations was carried out with a moisture balance. A total of 5 grams of extract and gummy candies were placed in a moisture balance at 105° C at the Central Laboratory for Health Resistance and Health Resources Policy. Health Development Policy Agency - Ministry of Health RI. Moisture content values appear in percent w/w units.

2) Test the moisture content of gummy candies

Weigh the finished preparations and put them into a moisture balance device with a temperature of 105 degrees Celsius at the Central Laboratory for Health Defense System Policy and Health Resources. Health Development Policy Agency - Ministry of Health Republic of Indonesia. Recording the moisture content of the preparation is carried out. Moisture content according to Bussiere & Serpelloni (1985) for gums jelly liquorice is 8% - 22% and chewing gum is 3 - 6%. If it is less or more than that, it can be said that the preparation of gummy candies is not good.

d. Weight uniformity test

Weigh each 20 gummy preparations one by one, then calculate the average weight of each preparation. If 20 pieces of gummy are not sufficient, 10 pieces can be used; In each weighing one by one, none of the preparations deviates more than the average weight determined in column A and none of the weights deviates more than the average weight specified in column B. The coefficient of variation (CV) is calculated with the following formula:

$$CV = (SD/X) \times 100\% T$$

Table 2 is the tolerance limits or requirements for tablet weight deviations that meet the eligibility standards according to the guidelines in the Indonesian Pharmacopoeia.

Preparations of gummy candies in this case are considered tablets.

e. Hedonic test

The hedonic test involved 45 child respondents with an age limit of 12-15 years which was carried out in total sampling to Class XIII Junior High School students who were given 3 preparation formulas. The test indicators include taste, elasticity/texture and the level of preference of the respondents for each of the resulting formulas. The scale used is a numerical scale between 1-3 which indicates a value of 1 = dislike, value 2 = likes, and value 3 indicates very like.¹⁹

Table 2. Requirements for deviation of tablet weights (gummy candies preparations)

No	Average weight	Deviation of the average weight	
		A	B
1	25 mg or less	15%	30%
2	26mg - 150mg	10%	20%
3	151 mg - 300 mg	7.5%	15%
4	More than 300 mg	5%	10%

RESULTS AND DISCUSSION

A. Determination test of *Jatropha curcas* L leaf

Determination of plants carried out at the Directorate of Scientific Collections Management of BRIN Cibinong resulted that the samples identified were *Jatropha curcas* L and the Euphorbiaceae family with identified and authenticated the plant

leaves with ID No. B-1915/II.6.2/DI.06.07/6/2022

B. Physical examination of *Jatropha curcas* L. leaf extract

1. Organoleptic test

Physical examination of *Jatropha* leaf extract included organoleptic tests and moisture content tests. The results of the organoleptic test obtained *jatropha* leaf extract in the form of a viscous extract, dark brown in color with a distinctive odor of *jatropha* leaves and a bitter taste.

2. Moisture content test

The water content obtained in the extract is 5.01% and is in accordance with the quality requirements, namely <10%.^{16,20,21}

3. Phytochemical screening test of *Jatropha curcas* L leaf extract

The phytochemical screening test of *Jatropha* leaf extract in Table 3 resulted that the *Jatropha* leaf extract positively contained alkaloids, flavonoids, tripernoids, saponins and tannins.

Table 3. Phytochemical screening test of *Jatropha* leaf extract

No.	Secondary Metabolites	Results
1	Alkaloids	Positive
2	Flavonoids	Positive
3	Tripernoids	Positive
4	Saponins	Positive
5	tannins	Positive

C. Gummy candies formulation results gummy candies preparation formulation

Based on Table 4 and Figure 1, the results of the formulation of gummy candies containing *Jatropha* leaf extract were made with 3 formulations, namely F1 containing 200 mg *Jatropha* leaf extract and 350 mg mannitol, F2 containing 250 mg *Jatropha* leaves and 300 mg mannitol, F3

Table 4. Formulation of gummy candies

Material	Formula (mg) in weight of 2.5 grams/seed			Function
	F1	F2	F3	
Condensed extract of Jatropha leaves	200	250	300	Active substance
mannitol	350	300	250	Filler
gelatin	350	350	350	binder
Corn syrup	575	575	575	Filler
Aquadest	225	225	225	Solvent
Arabic gum	30	30	30	Emulsifier
Lactose	220	220	220	Filler
sucrose	400	400	400	Flavoring Agent
Essence	50	50	50	Flavoring Agent
Corn oil	100	100	100	binder

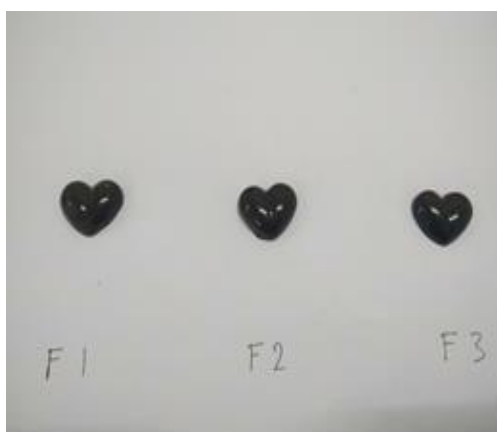


Figure 1 Formulation results of Gummy Candies F1, F2, F3

Note:

- F1 = Formulation of gummy candies containing 200 mg of *Jatropha curcas* L. leaf extract and 350 mg of mannitol
- F2 = Formulation of gummy candies containing 250 mg of *Jatropha curcas* L. leaf extract and 300 mg of mannitol
- F3 = Formulation of gummy candies containing *Jatropha curcas* L. leaf extract (*Jatropha curcas* L.) 300 mg and 250 mg mannitol

containing *Jatropha* leaf extract 300 mg and mannitol 250 mg, and with additional ingredients gelatin 350 mg, corn syrup 575 mg, distilled water 225 mg, gum arabic 30 mg, lactose 220 mg, sucrose 400 mg, essence 50 mg, and corn oil 100 mg. In this study, a formulation of gummy candies was prepared using *Jatropha curcas* L. leaf

extract as an active substance. *Jatropha* leaves contain flavonoids, tannins, saponins, terpenoids and alkaloids, the antihelmintic properties of the alkaloids can be influenced by their biological activity. This biological activation occurs due to the presence of a base group that binds to nitrogen. If this group comes into contact with the worm's body, a reaction occurs with the amino acid compounds that make up the worm's cell wall. Damage to the DNA in the worm cell nucleus causes lysis in the worm's body, which is a metabolic failure that causes the worm to become inactive and destroyed.^{3,5,15}

One of the natural phenolic compounds that is efficacious as an immunostimulator is Flavonoids. Flavonoids work to increase the host's body's response to parasites because these compounds can increase the concentration of IgG which helps the worm eosinophils attach. The eosinophil cell cation protein is a lethal ribonuclease for worms which can break down the tegumen wall due to the action of eosinophil granules. Saponins function as anti-fungal, anti-influenza and laryngitis, are the basis for obtaining saponins which can produce growth hormones in animals. Tannins belong to a class of plant secondary polyphenols with high affinity for proteins and polysaccharides.^{2,7,15}

Jatropha leaf extract as an anti-worm contains saponins and tannins. Saponins are flavonoids that have an anti-fertilization effect, which means they can shrink the egg and larval membranes of *A. galli* worms. Saponins can also cause the worm cells to become hydrolyzed so that the worms die and the worm's body looks transparent. *Jatropha* leaf extract concentrations used were 200 mg, 250 mg concentration was found at a concentration of 20% in *Jatropha* leaf extract. This effect is better than Levamisole as a positive control (+) and at a concentration of 5.49% and 96,006 minutes this extract has LC50 and LT50. Other additional ingredients used are mannitol, gelatin, corn syrup, aquadest, gum arabic, lactose, sucrose, essence, and corn oil.

D. Evaluation of Gummy Candies Preparations

1. Organoleptic test

Table 5. Organoleptic observation results of gummy candies

Formula	Organoleptic				
	Color	Form	Smell	Flavor	Texture
F1	Dark Chocolate	Love	Apple Special	Sweet, slightly bitter	Springy
F2	Dark Chocolate	Love	Apple Special	Sweet, slightly bitter	Springy
F3	Dark Chocolate	Love	Apple Special	Bitter sweet	Springy

Based on Table 5 the results of observations of organoleptic tests carried out on gummy candies where tests were carried out on color, shape, smell and taste. Then the test results are obtained according to the original extract. In this study, visual organoleptic tests were carried out on gummy candies formulations containing *Jatropha curcas* L. leaf extract by observing color, shape, smell and taste. Based on table 5 the results of organoleptic observations F1 has a dark brown color, a love shape, a distinctive apple smell and a slightly bitter sweet taste. F2 has a dark brown color, a love shape, a distinctive apple smell and a slightly bitter sweet taste. F3 has a dark brown color, a love shape, a distinct apple smell and a sweet and bitter taste. Organoleptically, *Jatropha* leaves taste astringent and bitter, usually identified as containing alkaloids. Based on the results of the phytochemical screening, the *Jatropha* leaf extract was positive for alkaloids.^{2,9,14}

2. pH and moisture content testing of the preparations

The pH test was carried out with the aim of knowing the pH value of the preparation being made. A good pH value is in the range 5 - 7 for gummy candy preparations. If the pH value is smaller than the range that should be then it tends to cause syneresis where the dispersion

phase separates from the dispersion medium. The separation of the dispersion phase from the dispersion medium due to low pH can affect the ionic suppression of the carboxylic acid groups which causes loss of hydroxyl groups. From the results of the pH test, it was found that the pH of each formula was different.^{11,17}

Table 6. Data on pH and moisture test results of preparations

No	Test	F1	F2	F3
1	pH	5.54	5,67	5,71
2	Moisture Content	14.61	15, 85	12, 43

Based on the observations in Table 6, the pH value of the gummy candies of *Jatropha* leaf extract was in the range of 5.54 - 5.71. This indicates that all formulas meet the good pH requirements for gummy candies.

Water is an important component in a product because it can affect the appearance, texture and taste of the product. The purpose of this test is to determine the water content of the preparation so that its durability can be estimated. The water content greatly affects the quality of a preparation, the higher it will make it easier for microbes to multiply. The results obtained must comply with the requirements, namely the water content is not more than 20%. Based on table 5, the results of observing the moisture content test on gummy candies preparations showed that the moisture content value of gummy candies preparations of *Jatropha* leaf extract was in the range of 12% - 15%. This indicates that the entire formula meets the requirements for good moisture content for gummy candies.^{11,13,17}

3. Weight uniformity test

as a production parameter to obtain the desired dosage weight. Weight uniformity is closely related to the uniformity of the active substance content in the preparation. The requirement for weight uniformity according to the pharmacopoeia for weighing each preparation is that there may only be less than two preparations

Table 7. Weight uniformity test results

Formula	Average weight (g)	CV (%)	permissible deviations	
			Requirement column A (5%)	Column B requirements (10%)
FI	3,185	2,26	3.025 + 3.345	2.866 + 3.504
FII	3,121	2.37	2.965 + 3.277	2.809 + 3.433
FIII	3,219	2.02	3.058 + 3.380	2,897 + 3,541

Table 8. Results of the hedonic test for gummy candies of Jatropha leaf extract

Formula	Flavor			Elasticity			Like response		
	1	2	3	1	2	3	1	2	3
F1	41	4	-	1	33	11	39	6	-
F2	30	15	-	4	32	9	28	17	-
F 3	32	12	1	4	22	19	18	19	8

Note:

Taste: 1 = not sweet, 2 = sweet, 3 = very sweet

Tenderness: 1 = not chewy, 2 = chewy, 3 = very chewy

Responses: 1 = dislike, 2 = like, 3 = like very much

whose respective weights deviate from the average weight by more than 5% (column A) and none of the candies whose weight deviates from the average weight by more of 10% (column B). The homogeneity of the weight of the manufacture is evaluated by means of a weight uniformity test. Non-uniform weights indicate the amount of active ingredients that are not uniform in each preparation. In the manufacture of gummy candy, the non-uniformity of weight can be caused by difficult calibrated printing equipment, heat stability that is formed during mixing, and the speed of pouring into the mold. The requirement for weight uniformity is no more than two preparations that deviate more from column A (5%) and no preparations that deviate more than column B (10%). The results of the uniformity of weights in the table show that the preparations have uniform weights because there is not found a single preparation that has a weight deviation of more than 5% (Table 5). The CV (coefficient of variation) value obtained from the calculation shows that nothing is greater than 5% so that it can meet the weight uniformity requirements.^{13,17}

4. Results of the hedonic test (Like Level)

The results of the hedonic test conducted on 45 child respondents are presented in Table 8. The hedonic test was conducted to determine public acceptance of gummy candies. This test was carried out to 45 respondents in grade 1 junior high school with an average age of 13 years by providing an assessment of 3 formulas (F1, F2 and F3) for each gummy candies preparation with test indicators namely: taste, chewiness, and respondents' preference for each -each formula. The hedonic test scale is from a value of 1 to 3, namely: a value of 1 indicates a less sweet taste, a value of 2 indicates sweet, and a value of 3 indicates very sweet. The assessment of the sample to be tested is based on the panelist's level of preference. The number of preferences varies greatly, in terms of form, number and conclusion. 14 The gummy candy formula was made into 3 formulas based on the results of the initial study - a formulation with a higher percentage of sucrose in order to obtain a sweeter and better formulation so that it could cover the bitter taste of Jatropha leaf extract where Jatropha leaves extract has a characteristic bitter taste from these plants.

The results of the hedonic test showed that the respondents did not like formulas 1, 2 and 3 because they still tasted slightly bitter from the castor leaf extract gummy candies.

Based on the SPSS test on the taste of gummy candy with Kolmogorov Smirnov with a sig value of $0.00 < 0.005$ which means the data is not normal. The follow-up test used was Kruskal-Wallis with a sig value of $0.015 < 0.05$ so it can be concluded that there is a significant difference between the respondents' taste responses to gummy candies and differences in the gummy candies formula.¹⁶

The results of the SPSS test for elasticity using the Kolmogorov Smirnov showed a sig value of $0.00 < 0.005$ which means the data is not normal. The result of the sig value = $0.129 > 0.05$ from the Kruskal-Wallis follow-up test, which means that the elasticity of the gummy candies and the difference in the gummy candies formula are not significantly different. The results of the SPSS test for the level of preference using the Kolmogorov Smirnov are sig = $0.00 < 0.005$ indicating that the data is not normal. The follow-up test used was Kruskal-Wallis and obtained a sig value of $0.00 < 0.05$, so there is a difference between the level of preference of respondents for gummy candies and the difference in the formula for gummy candies.^{16,21}

Based on the analysis using SPSS, it is known that the different concentrations of extract and mannitol in the gummy candies formula have an effect on the taste response properties and the level of respondents' preference for the gummy candies formula. What was disliked more was Formula 1 compared to Formulas 2 and 3. This could be due to the constraints in the hedonic test implementation process which were not conducive. In order for the results of further research to be better,

Suggestions for further research need to do a dilution process and homogenization process when mixing the ingredients, especially when dissolving Jatropha leaf extract and sucrose, so that it dissolves perfectly and evenly.

CONCLUSION

The best concentration of Jatropha leaf extract is Formula 2. Based on the phytochemical test, there are alkaloids in the Jatropha leaf extract. The pH value of gummy candies preparations of castor leaf extract, the weight uniformity test, the moisture content test of the preparations all good because they met the requirements for a good range of dosage values. Meanwhile, the results of the Hedonic Test show that Formula 2 is the most preferred by children. So based on the results of the evaluation and hedonic test it can be concluded that the best preparation of jelly candy from jatropha leaves is Formula 2.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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