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OPTIMIZATION OF GELATIN CONCENTRATION IN TABLET WITH AFRICAN LEAF EXTRACT (Vernonia Amygdalina)

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ABSTRACT

African plants, especially the leaves, are a type of medicinal plant used by the community. This African leaf contains active lavonoids that can be used to measure blood glucose levels. Tablet preparations have the advantage that they are easy to consume, so in this study African leaves (Vernonia Amygdalina) were made into tablets. The ratios of the binder used were 4%, 5%, and 6%. After obtaining the evaluation results, data analysis was performed using the Kruskal–Wallis SPSS statistical test with a confidence level of 95%. The evaluation results showed that the three formulations only fulfilled the respective requirements, namely for the angle of repose test between 16.6° - 21.3°, the granule thickening test of all formulations is below <20% and meets the requirements, the weight uniformity test has an average of 191-192 mg meeting the predetermined requirements, namely not more than 3 times with an average of 7.35 -7.36 mm and a thickness of mean ± SD 0,47 the disintegration time test of all formulations stated that they met the requirements that had been determined that is not more than 15 minutes, the friability test only on formulation III which met the requirements to get a result of 0.54% in formulations I and II did not meet the specified requirements, the hardness test of all formulations did not meet the specified test requirements.

Keywords: African leaf extract, gelatin, tablets.

INTRODUCTION

Diabetes mellitus (DM), a disease that has become a major health concern in the 21st century, is characterized by elevated blood sugar levels. Consequently, individuals with diabetes are often advised to limit their intake of foods and beverages high in fat, carbohydrates, sugar, and excessive sweeteners (Abdullah, 2017). Traditional herbal medicines have been widely used for therapeutic purposes in Indonesia, particularly in West Java. Currently, there is a resurgence in interest in traditional medicine, with people increasingly turning to natural remedies. One traditional remedy for diabetes is the African leaf (*Vernonia Amygdalina*). Known as the "insulin leaf," Vernonia Amygdalina is recognized for its bitter taste (Pahlawan & Oktaria, 2016).

Research by Santoso revealed that extracts from Vernonia Amygdalina leaves contain active compounds, mainly chalcone-type flavonoids, which have the potential to lower blood glucose levels (Nugraha et al., 2024). These flavonoids provide protective benefits against diabetes. The chalcone-type flavonoids are suspected to act as antidiabetic agents. Flavonoids provide protection against diabetes, and their antioxidant effects are beneficial for preventing cancer and atherosclerosis. These flavonoids are believed to contribute to their antidiabetic properties (Edo et al., 2023).

Tablets are solid dosage forms containing one or more medicinal substances with or without excipients. Based on their manufacturing method, they can be classified into compressed and molded tablets. Compressed tablets are produced by compressing moist powder masses under low pressure into molds. This type of tablet is manufactured using wet granulation

(Abdullah, 2017). The excipients present in tablet preparations are fillers, binders, disintegrants, sweeteners, and lubricants. Fillers function to increase the weight or mass of a preparation so that it can meet the requirements, binders function to increase the binding power of the powder in forming granules which in the compression process can form a compact tablet mass, disintegrants function to achieve the desired dissolution rate, sweeteners function to add sweetness in the tablet, lubricants function to reduce friction between the surfaces of drug particles, friction between the surfaces of the tools used and to ensure the continuation of the production process (Gerhardt, 2013).
Nonetheless, the variation in gelatin concentration did not affect the tablet weight uniformity. All three tablet formulas met the standards for the physical properties of tablets. Increasing gelatin concentration was shown to increase the hardness and reduce the friability of rosella petal extract chewable tablets prepared by wet granulation method (Fadhilah & Saryanti, 2019). Based on this background, it is necessary to conduct research entitled Formulation and Evaluation of Tablet Preparations with African Leaf Extract (*Vernonia Amygdalina*). Variations in gelatin concentration were used as a binder to determine the effect of differences in concentrations of 4%, 5%, and 6% on the evaluation of the preparation, including the angle of repose, tapping, tablet weight uniformity, tablet diameter, disintegration time, friability, and tablet hardness.

RESEARCH METHODS

The research method used in this study is an experimental study that aims to make and evaluate tablet preparations with African leaf extract (*Vernonia Amygdalina*) with variations in gelatin concentration as a binder. Gelatin concentrations of 4 %, 5 %, and 6% were used.

Equipment and Materials

The equipment used included an analytical balance, water bath, thermometer, blender phillips, stirring rod, hardness tester, friability tester, disintegration tester, and a single punch tool.

The materials used included African leaf, 70% ethanol (Technical, Bratachem, Indonesia), gelatin (Food grade, Merck, Germany), Avicel pH 102 (Technical, Farmacy Grade, China), sucrose (Technical, Pharmacy Grade, China), magnesium stearate (Technical, Pharmacy Grade, China), PVP (Technical, Pharmacy Grade China), and distilled water (Technical, Pharmacy Grade, Indonesia).

Research Procedure

1. African Leaf Extraction

The African leaf extract was prepared using the maceration method. The solvent used to extract African leaves was 1.8 liters of 70% ethanol. The procedure was as follows: the equipment for the maceration process was prepared, 180 grams of African leaf powder was placed in a beaker, and 70% ethanol was added as a solvent. Maceration is carried out for 3 days with 3 repetitions of solvent replacement while stirring occasionally (Nugraha et al., 2023), then filtered to obtain the macerate (Solikhah et al, 2018). The obtained macerate is evaporated over a beaker containing hot water with a temperature not exceeding 70ºC to obtain a thick extract, adjust the temperature using a mercury thermometer (Dwi Puspitasari et al., 2017).

2. Formulation

Each tablet contains :

Table I. Tablest Formulations

No	Materials	Tablets Formulation			
		F 1	F 2	F 3	Kontrol Negatif
1	African Leaf Extract	100 mg	100 mg	100 mg	100 mg
2	Avicel pH 102	200 mg	200 mg	200 mg	200 mg
3	Polivinil Pirolidon (PVP)	50 mg	50 mg	50 mg	50 mg

4	Gelatine	40 mg (4%)	50 mg (5%)	60 mg (6%)	-
5	Sucrose	40 mg	40 mg	40 mg	40 mg
6	Magnesium stearate	10 mg	10 mg	10 mg	10 G

3. Wet Granulation Process

African leaf extract, Avicel, and PVP were placed in a mortar and ground to homogeneity. Gelatin solution was added by first dissolving gelatin in 100 ml of hot water, and then added gradually until the mass was clumped. Sieve the granules, then dry the granules in the oven for 24 hours at 40ºc. The dry granules are sieved again, then magnesium stearate is added (Yunitasari et al., 2024).

4. Tablets Process

The granules were compressed into tablets by using a single-punch tablet press.

Data Analysis

This physical property analysis provides useful data for optimizing the formula of African leaf extract tablets with a gelatin binder. All the above parameters must meet the standards so that the tablet product can be used effectively as an anti-glycemic agent.

Based on the data collected from the physical properties, determination of the tablet formula with gelatin concentrations of 4%, 5%, and 6% was carried out to produce tablets with the best physical properties.

RESULTS AND DISCUSSION

The tablet-making process was performed using the wet granulation method with the aim of improving the flowability and compressibility properties. The organoleptic granules obtained a light green color due to the green color of the leaves, the smell of the granules was a characteristic extract smell, and the shape of the granules had small grains with a size of 18 mesh sieve, which was 1.000 mm. The average water contents of the granules for formulations I, II, and III were 13.8 %, 13.2%, 10.5%, and the negative control gets 18.75%, respectively. These results indicate that the water content of the granules does not meet the established requirements, which is 2-5%. The results show that the water content in the granules is still high, so there is still a lack of drying. Therefore, further drying should be carried out until the water content meets the standard of 2-5%. The average formulation obtained, formulation III, obtained the smallest value compared to formulations I and II, meaning that the higher the concentration of the solution used, the better the drying. After pressing the tablet, the next step was tablet testing.

The high moisture content in the granules after the drying process can lead to tablets that are non-uniform, easily disintegrated, and fail to meet quality standards. This occurs because the granules become soft, sticky, and prone to breakage, especially when varying concentrations of gelatin are used as a binder in the wet granulation method. While higher gelatin concentrations can result in a stronger matrix, they can also lead to several issues, such as drying difficulties, overly hard tablets, and increased production costs. Therefore, it is crucial to find the optimal gelatin concentration that produces tablets that are strong, easily swallowed, and dissolve well, without significantly increasing costs (Gabbott et al., 2016). To determine the optimal gelatin concentration, a series of trials with varying gelatin concentrations were conducted. The trial results were analyzed to determine the concentration that yielded tablets with the desired physical and chemical properties, such as hardness, friability, dissolution, and weight uniformity. Thus, there is no "one size that fits all" gelatin concentrations. The optimal concentration must be determined based on the specific needs of each tablet formulation (Dalabasmaz et al., 2024)

Tablet Weight Uniformity Test

Table II. Weight Uniformity Test

Formulation	Average	Deviation	
		7,5%	15%
Formulation I	191,3 mg	-	-
Formulation II	190,6 mg	-	-
Formulation III	191,6 mg	-	-
Negative Controll	192,6 mg	-	-
Positive Controll	180,0 mg	-	-

The tablet weight uniformity test is an initial indicator of the uniformity of the content or active ingredient, and assumes that the granule mixture is perfectly homogeneous. The test results show that the tablet weights with the average of each formulation listed in Table 2, none of the tablets deviate from 7.5% and none of the tablets deviate from 15%. These results indicate that tablets of formulas I, II, and III meet the requirements for tablet weight uniformity set by Indonesian Pharmacopoeia III. In contrast to the positive control, the average results were obtained because the tablets used were smaller than the tablets made, but the results were still the same, not deviating from 7.5% and 15%.

Increasing the gelatin concentration in tablet formulations enhances tablet weight uniformity as gelatin forms a more solid and robust matrix, leading to tighter binding of the active ingredient and excipient particles, reducing the likelihood of particle detachment. However, other factors can also influence the tablet weight uniformity. Therefore, optimizing tablet formulation is crucial to ensure good weight uniformity (Sohail Arshad et al., 2021).

The Kruskal-Wallis analysis results show that the weight uniformity is 0.179 > 0.05, indicating that the weight uniformity test shows no difference in the average in the weight uniformity test. Formulation III exhibited good weight uniformity.

Friability Test

Table III. Friability Test

Formulation	Average	SD
Formulation I	23,7%	12,25
Formulation II	4,2%	5,29
Formulation III	**0,54%**	0,29
Negative Controll	92,8%	0
Positive Controll	0,40%	0

The friability test is another indicator of tablet hardness, which is related to the strength of the particle bonds on the edges and surface of the tablet. The requirement for a good tablet is no more than 1%. Factors that affect tablet friability include the pressure of the machine during tableting, which can also be influenced by the binder, which increases the binding of the granules so that they become strong, and the drying factor, while still in the form of granules, also affects the friability of the tablet. The negative control obtained a result of 92.8%, formulation I obtained a result of 23.7%, and formulation II obtained a result of 4.2%, indicating that the percentage of friability did not meet the requirements because the binder used was only a little, and the drying process affected the friability of the tablet. The positive control obtained a result of 0.40%, formulation III obtained a result of 0.54%, and the percentage of friability met the requirements of no more than 1%, where the amount of binder used was more, namely 6%, than formulation I with 4% gelatin solution and formulation II with 5% gelatin solution. Formulation III is better than the friability test and meets the test determined.

Increasing the gelatin concentration in tablet formulations enhances the resistance of the tablet to abrasion and friction, resulting in lower friability values because the tablet matrix

becomes more solid and robust. However, other factors, such as granulation method, gelatin type, and other excipients, can also influence the friability test results. Therefore, optimizing tablet formulation is crucial to ensure tablets have sufficient resistance to abrasion and friction during handling and packaging processes (Permadi et al., 2022).

The Kruskal-Wallis analysis results show that the friability test has data of 0.023 < 0.05, which means that there is a difference in the average friability test of the three gelatin formulas. Formulation III had a good friability value.

Disintegration Test

Table IV. Disintegration Test

Formulation	Average	SD
Formulation I	4,3 minutes	0,58
Formulation II	7,3 minutes	0,58
Formulation III	10 minutes	0
Negative Controll	2 minutes	0
Positive Controll	5 minutes	0

A tablet disintegrates if it dissolves in the tester or breaks down into many particles. The function of the disintegrant is to draw water into the tablet, causing it to break into small pieces. The disintegration time test was conducted to determine the time it takes for a tablet to disintegrate into a liquid, which is conditioned as a gastrointestinal fluid. The average results in **Table IV**, formulation I obtained a result of 10 minutes, formulation II obtained a result of 7.3 minutes, formulation III obtained a result of 4.3 minutes, the negative control obtained a result of 2 minutes, and the positive control obtained a result of 4 minutes. The results showed that all formulations met established requirements. The negative control had a very low result because it did not have a binder, and formulation III compared to the positive control showed similarity in the disintegration time test. The disintegration time test results indicated that the higher the gelatin solution used, the faster was the disintegration time of the tablet.

Increasing the gelatin concentration in tablet formulations slows down the disintegration time because gelatin forms a more solid and robust tablet matrix, making the tablet more resistant to disintegration. However, other factors, such as granulation method, gelatin type, and other excipients, can also influence the disintegration test results. Therefore, optimizing the tablet formulation is crucial to ensure that tablets have an appropriate disintegration time, allowing for the rapid and efficient release of the drug. The ideal disintegration time for tablets is generally less than 15 minutes. Proper disintegration time is essential to achieve the desired therapeutic effect, as too fast disintegration can lead to too rapid drug release, while too slow disintegration can cause delayed drug release (Berardi et al., 2021).

The analysis results show that the disintegration time test has a p-value = 0.023 < 0.05, meaning that there is a difference in the average disintegration time test. In the disintegration time test, formulation III has a good value.

Tablet Diameter Test

Table V. Tablet Diameter Test

Formulation	Average	SD
Formulation I	7,36 mm	0,0058
Formulation II	7,35 mm	0,0058
Formulation III	7,36 mm	0,0058
Negative Controll	7,36 mm	0
Positive Controll	6,31 mm	0

The tablet diameter is influenced by the size of the tablet die. The results of the diameter test are the average results of each formulation tested with 10 tablets according to the established requirements, namely the diameter is not more than 3 times or not less than 1 1/3 tablet thickness. Formulation I obtained an average diameter of 7.36 mm with a thickness of 4.00 mm, formulation II obtained an average diameter of 7.35 mm and a tablet thickness of 4.00 mm, formulation III obtained an average diameter of 7.36 mm and a tablet thickness of 4.00 mm, the negative control obtained an average diameter of 7.36 mm and a thickness of 4.00 mm, and the positive control obtained an average diameter of 6.31 mm with a thickness of 3.00 mm. The results obtained for each formulation of the tablet diameter are in accordance with the requirements and the tablet thickness is not less than 1 1/3 tablet thickness.

Gelatin concentration in tablet formulations can influence the diameter test results, which measure the uniformity of the tablet size. Higher gelatin concentrations tend to produce tablets with more consistent diameters because of the stronger tablet matrix, but other factors, such as material compressibility and granulation method, can also affect tablet diameter. Diameter testing is an essential part of quality control to ensure tablet size uniformity, which can affect appearance, handling, and drug release. Optimizing tablet formulation is crucial to ensure that tablets have an appropriate and consistent diameter, considering all factors that can influence diameter, including gelatin concentration, material compressibility, and granulation method (Jones et al., 2011).

The Kruskal-Wallis analysis results showed that the disintegration time test had a p-value = 0.304 > 0.05, meaning that the tablet diameter test showed no difference in the average in the tablet diameter test. The tablet diameter test of formulations I and III has good weight uniformity

Hardness Test

Table VI. Hardness Test

Formulation	Average	SD
Formulation I	1 kg	0
Formulation II	1 kg	0
Formulation III	1,5 kg	0
Negative Controll	1 kg	0
Positive Controll	6 kg	0

The hardness test results from the table above show that formulations I, II, and the negative control obtained a result of 1 kg, and formulation III obtained a result of 1.5 kg, so they did not meet the established requirements, which range from to 4-8 kg compared to the positive control, which meets the requirements of an average of 6.2 kg. The factors that influence tablet hardness are the compression pressure on the tool and the drying of the granules, so they do not make the tablets compress better because in the calculation of the water content of the granules, the results are above the established requirements. Hardness was used as a measure of the compaction pressure. The pressure applied if it is greater during tableting will increase the hardness of the tablet, and there is a possibility that the compression is not very large and pressure is applied. Although it does not meet these requirements, the results show that the concentration of the binder used affects the hardness of the resulting tablet. The higher the concentration of gelatin as a binder, the higher the hardness of the tablet produced, although the results obtained were below the standard. In conclusion, the tablet hardness test did not meet these requirements.

Increasing the gelatin concentration in tablet formulations increases tablet hardness, because gelatin forms a more solid and robust tablet matrix, making the tablet more resistant to

pressure and more stable. However, other factors, such as the granulation method, gelatin type, and other excipients can also influence the hardness test results. Therefore, optimizing tablet formulation is crucial to ensure tablets have an appropriate hardness, so they can withstand handling, packaging, and storage processes (Rani et al., 2021).

The Kruskal-Wallis analysis results showed that the disintegration time test had a p-value = 0.1000 > 0.05, meaning that the tablet hardness test showed no difference in the average in the tablet hardness test.

CONCLUSION

African leaf extract (Vernonia amygdalina) can be formulated into tablets using gelatin as a binder using the wet granulation method. The evaluation results show that Formulation III, with a 6% gelatin concentration, outperforms Formulations I with 4% gelatin concentration and Formulation II with 5% gelatin concentration in terms of tablet quality. Formulation III successfully met all test requirements, including the hardness and friability tests, suggesting that the resulting tablets are stronger and more durable. Conversely, Formulations I and II exhibited deficiencies in hardness and friability tests, indicating that the resulting tablets were less solid and prone to disintegration. This difference could be attributed to the gelatin concentration used in each formulation. Formulation III, which met all the requirements, while Formulations I and II, which exhibited deficiencies, may have a gelatin concentration that is too low, resulting in a less solid and easily disintegrated tablet matrix..

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