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Characterization, Formulation, and Evaluation of Tablet Containing Johar Leaves (*Cassia siamea* Lamk.) Extract with Hydroxypropyl Methylcellulose (HPMC) as Tablet Binder

Adryan Fristiohady [1,*], Suryani Suryani [1], La Ode Muhammad Fitrawan [1], Rina Andriani [1], Vica Aspadiah [1], Saripuddin Saripuddin [1], La Ode Muhammad Julian Purnama [1], Rini Hamsidi [2], Astrid Indalifiany [1]

[1] Faculty of Pharmacy, Halu Oleo University, Kendari 93232 South East Sulawesi, Indonesia
[2] Faculty of Vocational Studies, Universitas Airlangga, Surabaya 60286, Indonesia
* Correspondence: adryanfristiohady@uho.ac.id;

Scopus Author ID 57194056821
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Abstract: Utilization of Johar leaves (*Cassia siamea* Lamk.) as an herbal remedy requires development into tablet formulation. The selection of binders in the tablet formulation is a strategy for producing quality tablets. Thus, this study aims to formulate Johar leaves extract by using HPMC in various concentrations as the binder (2%, 3%, and 4%) into tablets and evaluate their physical properties. Johar leaves extract is characterized and formulated into tablets in 3 various concentrations of HPMC as the binder. The physical properties of the tablets were evaluated. Johar leaves extract was gum-like, blackish brown, Johar leaves-specific odor, and bitter taste; moisture content, ash content, solubility in water, and solubility in ethanol were 5.2; 2; 11.7; and 38.3%, respectively. The organoleptic evaluation showed the round and flat texture of the tablet, and still experiencing mottling in all formulation; deviation of tablet in all formulas were 11.83; 18.33; and 18.56 mg, respectively; in the uniformity of tablet size showed that the diameter of the tablet were 1.48, 1.51, and 1.48 times of tablet thickness; tablet hardness all formulas were similar, i.e., 20.39 $kg.cm^{-2}$, and lastly, the disintegration time of formulas were 10, 9, and 12 minutes, respectively. In conclusion, tablets have good physical properties by using various concentrations of HPMC as a binder.

Keywords: Johar leaves (*Cassia siamea* Lamk.); tablet formulation; HPMC.

1. Introduction

Indonesia is a tropical country, where temperature and humidity, as well as rainfall, affect Malaria transmission. Malaria is a parasitic infection caused by the infection of *Plasmodium* sp. [1]. In Indonesia, Johar leaves (*Cassia siamea* Lamk.) empirically have been used as an herbal remedy to treats Malaria. Johar leaves (*Cassia siamea* Lamk.) are belonging to *Fabaceae* family. A reported study showed that Johar leaves have antimalarial activity, as well as its stem barks [2-4].

In other that, Johar leaves have been used to treat jaundice, diabetes, urinary stones, gastrointestinal disorder, and so on [5]. The utilization of Johar leaves as a traditional medicine in decoction form is less accepted by people due to impractical. In developing a tablet formulation, it is important to consider the physical properties that must be possessed by

tablets, such as durability to shock during production, packaging, shipping, and use, uniformity in weight and content, and have a good appearance [6]. Therefore, it requires formulating into dosage form, thus considering physical, chemical properties and biological properties of tablets to achieve a product that is stable, efficacious, attractive, easy to administer, and safe [6].

Among the ingredients used in formulating tablets, the binder is important in achieving the desired quality of tablets [7]. Binder plays a role in increasing the flow properties of granules and increases the cohesiveness of ingredients without slowing down the disintegration time. Hydroxypropyl methylcellulose (HPMC) is one of the ingredients that can be used as a binder. HPMC provides good tablet hardness in low concentration, minimizes the tablet size, and maximizes the other ingredient usage, and optimizes other tablet characters [8,9].

The aims of this study are to investigate the ability of HPMC as a binder in tablet formulation with Johar Leaves (*Cassia siamea* Lamk.) extract as the active ingredient and observe the effect of variations in HPMC concentrations (2%, 3%, and 4%) on the physical properties of tablets.

2. Materials and Methods

2.1. Materials.

The material used in this study were Johar Leaves (*Cassia siamea* Lamk.), 70% ethanol (Technical grade), *Croscarmellose sodium*/ Ac-Di-Sol, *hydroxypropyl methylcellulose* / HPMC, Stearic Acid (Brataco®), Talc (Brataco®), Lactose (Brataco®), methylparaben (Brataco®), distilled water, and filter paper (Whatmann®).

2.2. Plant collection and extraction.

Johar leaves (*Cassia siamea* Lamk.) collected from Halu Oleo University's neighborhood. The sample collected was determined at UPT Balai Konservasi Tumbuhan Kebun Raya Purwodadi.

The sample was cleaned and separated from its petiole. The sample was then washed by using running water, air-dried, and avoided from sunlight for 5 days. The dried sample (1000 g) was macerated by using 70% ethanol (3x24h) then concentrated by using a rotary vacuum evaporator (55°C). concentrated extract yielded was 117.43 g of gum-like extract. The concentrated extract was then freeze-drying, obtained 71.3 g dried extract.

2.3. Extract characterization.

2.3.1. Organoleptic.

The extract was observed by its color, appearance, odor, and taste.

2.3.2. Moisture content analysis [10].

0.5 g of extract (A2) was put in an evaporating dish (A0) and dried in an oven (105ºC) until constant weighed. Then, it was put in desiccators for cooling down, followed by weighing (A1).

The moisture content, calculated by using the formula:

$$\text{moisture content} = \frac{(A1-A0)}{A2} \times 100\%$$

2.3.3. Ash content [10].

0.5 g of extract (A2) was put in kruz (A0), flamed for 30-45 m (500ºC), and slowly raised at 900ºC for 60-90 m. Then, the extract was cooled and weighed (A1).

The ash content, calculated by using the formula:

$$\text{Ash content} = \frac{(A1-A0)}{A2} \times 100\%$$

2.3.4. Solubility of extract level [11].

1 g of extract (A2) was put in a volumetric flask, added with 100 mL of distilled water. They were mixed for 6 hours and left for 18 hours. 20 mL filtered filtrated, then put in a pre-weighed evaporating dish (A0) and evaporated at a temperature of 105ºC by using oven until constant weighed (A1).

The same procedure was performed in determining the solubility extract in ethanol, except the solvent used was ethanol.

The solubility extract level was calculated by using the formula:

$$\text{Solubility extract level} = \frac{(A1-A0)}{A2} \times 100\%$$

2.4. Preparation and formulation of a tablet.

Tablet was produced as 3 formulas (350 mg, each) with a variation of binder used, which was HPMC. The concentration used was 2%, 3%, and 4%. Tablet was produced with a direct compression method. It was carried out by weighing and sieving all material until homogenous. Homogenous extract then mixed with lactose, followed by the addition of *Croscarmellose* sodium, HPMC, and methylparaben, respectively. Lastly, stearic acid and talk were added, and the mixture was printed.

2.5. Evaluation of tablet.

2.5.1. Organoleptic Evaluation [12].

The organoleptic evaluation was performed by observing its physical appearance, including surface, color, and shape of tablets.

2.5.2. Weight Uniformity Evaluation [13].

The amount of 10 tablets were weighed and calculated their average weight.

2.5.3. Size uniformity evaluation [13].

Size uniformity was performed by measuring the diameter and thickness of tablets.

2.5.4. Hardness Evaluation [8].

Hardness evaluation of the tablet was performed under Monsato® hardness tester instrument.

2.5.5. Disintegration time evaluation [14].

Six tablets were put in the basket of apparatus, and the basket was raised and lowered constantly for 30 cycle/ m. The time required to dissolve 6 tablets is not exceeded than 15 m.

3. Results and Discussion

3.1. Extract characterization.

Extract requires meeting the specified standard thus can be produced into the drug. The characterized extract was conducted to determine the feasibility of extract to have constant parameters. The result of the extract characterization is presented in Table 1.

Table 1. The result of Johar leaves extract characterization.

Extract Characterization	Results	Requirement
Specific		
Identity		
Scientific nomenclature	*Cassia siamea* Lamk.	*Cassia siamea* Lamk.
Part used	Leaves	Leaves
Local name (Indonesia)	Johar Leaves	Johar Leaves
Organoleptic		
Color	Blackish brown	-
Appearance	Gum-like extract	-
Odor	Johar leaves - specific	Johar leaves - specific
Taste	Bitter	-
Non-specific		
Water content	5.2%	<10%
Ash content	2%	<5%
Solubility in water	11.7%	>21.5%
Solubility in ethanol	38.3%	>12%

The moisture content of the extract obtained in the study was 5.2%. It met the specified standard of moisture content of Johar leaves extract. The high content of water in the extract can lead to bacteria's growth and enzymatic activity of extract [13]. Ash content was performed to evaluate the internal-mineral contained in the extract, as well as the external-mineral. The ash content was 2% [13].

The solubility of extract in water and ethanol were 11.7% and 38.3%, respectively. However, its solubility in water did not meet the specified standard, although they met the specified standard of solubility in ethanol. It was thus concluding that the contained compound in the extract is more soluble in ethanol than water [13].

3.2. Formulation of the tablet.

The designated formulas were presented in Table 2. Production of tablets was conducted by using the direct compression method. This method is suitable for active ingredients with poor rheology and cohesiveness properties, hygroscopic, and sensitive to heat. Other than that, the active ingredient release rate of tablets will be faster due to the active ingredient immediately released from the mass of the tablet, in the form of free particles, when dissolving [14-17].

Table 2. The Formula of Johar leaves a tablet.

Ingredients	Category	F 1 (w/w)	F 2 (w/w)	F 3 (w/w)
Dried Johar Leaves Extract	Active ingredient	30%	30%	30%
Croscarmellose sodium	Disintegrant	3%	3%	3%
HPMC	Binder	2%	3%	4%
Stearic Acid	lubricant	2%	2%	2%
Aspartame	Lubricant, glidant	5%	5%	5%
Methylparaben	preservative	0.1%	0.1%	0.1%
Lactose ad	Filler	100 %	100 %	100%

3.3. Evaluation of tablet.

The tablet must meet physical quality standards such as uniformity in weight, thickness, hardness, and disintegration time. Tablets tend to experience problems such as forming powder, breaking, cracking, and experiencing mottling when printed. This can reduce the appearance and acceptance of consumers, cause the weight of tablets that are not uniform and also cause problems of uniformity of the contents of these tablets. These factors must be controlled during and after production to ensure that the tablets meet the specified quality standards [6].

3.3.1. Organoleptic of the tablet.

Tablet printed based formulated formula (FI, FII, FIII) was organoleptically observed based on their appearance. The result was shown in Table 3.

Table 3. Result of organoleptic observing.

Evaluation	Result		
	FI	**FII**	**FIII**
Appearance			
Shape	Round	Round	Round
Surface Texture	Flat	Flat	Flat
Color	Brown, mottling	Brown, mottling	Blackish brown; mottling

Tablet in all formulas showed appearance uniformity with flat texture and round shape. However, tablets were experiencing mottling. Mottling on tablets is a term used to describe the uneven distribution of colors on the surface of a tablet. It is due to the active ingredient used, which was Johar Leaves extract, were brown/ blackish-brown, and the mixture was not homogenous, thereby resulting in the mottling [15].

3.3.2. Weight uniformity of tablets.

According to Table 4, it showed that all formulas have good weight uniformity. If referred to specified quality standards [16], the tablet must not deviate more than 5% and 10% of the weighted average of tablets. It showed that all formulas have good flow properties at the time of printing. Weight uniformity describes the uniformity of content, thus affect the uniformity of the dose in achieving the desired dose [18-21].

3.3.3. Size uniformity of tablets.

Tablet size uniformity demonstrates the reproducibility and aesthetic factor of tablets. It is conducted; thus, tablets can be acceptable to consumers and simplifier packaging processes.

As shown in Table 4, all formulas have uniformity of tablet size. The formula I (FI) have a tablet with a diameter of 1.44x than the thickness of the tablet, formula II (FII) have a tablet with a diameter of 1.51x than the thickness of the tablet, and formula III (FIII) have a tablet with a diameter of 1.48x than the thickness of the tablet. They met specified standards of size uniformity of tablet, which were the diameter of the tablet must not exceed 3x and less than 4/3 of tablet's thickness [17,18,20].

Table 4. Result of tablet evaluation.

Evaluation	**Formula I (FI)**	**Formula II (FII)**	**Formula III (FIII)**
WeightUniformity (mg)	367,64	366,70	371,23
SD 5% (mg)	18,38	18,33	18,56

Evaluation	Formula I (FI)	Formula II (FII)	Formula III (FIII)
SD 10% (mg	36.76	36.67	37.12
Size Uniformity			
Average diameter (cm)	0,825	0,817	0,810
Average thickness (cm)	0,556	0,538	0,546
Tablet Hardness (N)	200	200	200

3.3.4. Hardness of tablet.

Tablet hardness shows the durability of the tablet against mechanical stress such as shock, collision, and cracking during packaging, storage, transportation, and when delivered to consumers.

According to the result obtained (Table 4**)**, all formulas have similar hardness values, which were 200 N or 20.39 $Kg.cm^{-2}$. It means, tablets printed were too hard and exceed the specified standard of tablet hardness, which is 4-10 $Kg.cm^{-2}$. This is possibly due to the interlocking of particles experiencing plastic deformation by the binder used, HPMC [18,19,23,24]. Besides that, the high concentration of lubricants affects the hardness of tablets [8]. The hardness of tablets affects the disintegration time of tablets.

3.3.5. Disintegration time of tablet.

As shown in Figure 1, all formulas showed disintegration time was less than 15 minutes. They met the requirement of disintegration time [8]. Disintegration time is affected by the disintegrated agent used in formulation, as well as the method is chosen, the type and concentration of lubricant, the pressure of apparatus when printed, and the physiochemical properties of ingredient used, including binder used [15].

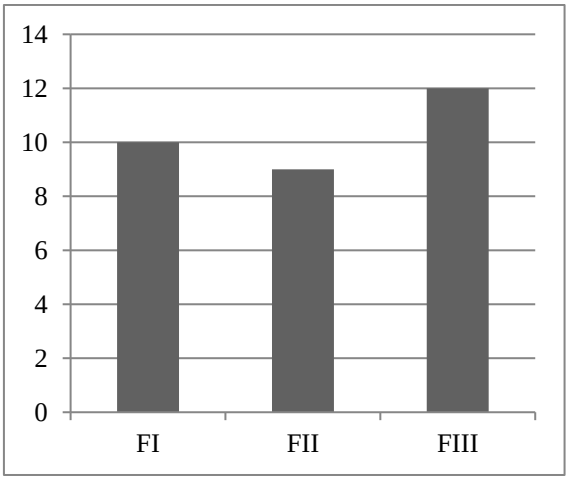

Figure 1. Difference of disintegration time of formulas.

The tablet must be disintegrated, dissolve, and available into smaller particles, thus absorbed immediately in the gastrointestinal tract after administration. Tablets disintegrate rapidly, affect the dispersion of tablets into a smaller particle before reaching the gastrointestinal tract, thus affect the therapeutic effect. Disintegration time is related to the bioavailability of drugs [25-27].

4. Conclusions

Johar leaves (*Cassia siamea* Lamk.) extract can be formulated into a tablet using Hydroxypropyl methylcellulose (HPMC) as a binder with various concentrations (2%, 3%, and

4%). According to the tablets evaluation, all formulas (FI, FII, and FIII) met the specified standard, although the tablet hardness was not meeting the specified standard.

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Conflicts of Interest

The authors declare no conflict of interest.

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