International Journal of Applied Pharmaceutics

ISSN- 0975-7058 Vol 17, Special Issue 1, 2025

Original Article

EFFERVESCENT TABLET FORMULATION OF TURMERIC EXTRACT (*CURCUMA DOMESTICA*) WITH *ARTOCARPUS HETEROPHYLLUS* SEED STRACH AS A BINDER AND *SIRAITIA GROSVENORII* AS A SWEETENER

MOCHAMAD LUQNI MAULANA[1], MUHAMMAD ALFIAN[2*], NURUL FAIZAH[3]

[1,2,3]**Departement of Pharmacy, Faculty of Halal Industry, Universitas Nahdlatul Ulama Yogyakarta, Sleman-55293, Yogyakarta, Indonesia**
[*]**Corresponding author: Muhammad Alfian; [*]Email: muhammadalfian@unu-jogja.ac.id**

Received: 28 Aug 2024, Revised and Accepted: 20 Nov 2024

ABSTRACT

Objective: The appropriate processing of natural ingredients, such as turmeric, into forms that are well-received by the public is anticipated to enhance practicality and public interest. One approach involves incorporating natural ingredients, like *Artocarpus heterophyllus* seed starch as a binder and *Siraitia grosvenorii* as a sweetener, into turmeric extract effervescent tablets.

Methods: Turmeric extract is formulated into three different groups: K(-) negative group without binders and sweeteners, K(+) positive group with PVP and aspartame, F1 (Formula 1), F2 (Formula 2), and F3 (Formula 3) with varying proportions of jackfruit seed starch and *lo han kuo* granules (3:15%, 5:25%, and 7:35%). Effervescent tablets are produced using the wet granulation method. Each formulation undergoes physical evaluation tests for the granules, including for moisture, flow time, angle of repose, and compressibility. Following this, the physical properties of the effervescent tablets are evaluated for weight uniformity, size uniformity, hardness, friability, dissolution time, pH, dissolution, curcumin content, and hedonic aspects with the use of statistical tests.

Results: The turmeric extract contained 76.44% curcumin. Different concentration of *Artocarpus heterophyllus* seed starch had a significant impact ($p<0.05$) on enhancing various characteristics of effervescent granules, including the angle of repose, compressibility, weight uniformity, hardness, and dissolution time of effervescent tablets. However, these variations did not significantly affect ($p>0.05$) the moisture test, effervescent granule flow time, uniformity of size, pH, dissolution, and curcumin content in effervescent tablets.

Conclusion: F3 is the ideal formula for testing the physical properties of granules and effervescent tablets. It is the most preferred due to its color, aroma, and taste.

Keywords: Effervescent tablet, Turmeric extract, *Artocarpus heterophyllus* seed starch, *Siraitia grosvenorii*

DOI: https://dx.doi.org/10.22159/ijap.2025.v17s1.14 Journal homepage: https://innovareacademics.in/journals/index.php/ijap

INTRODUCTION

Degenerative diseases, which cause a decline in the function of tissues and organs, are a significant factor in many cases of mortality. One of the primary contributors to degenerative diseases is oxidative stress resulting from the presence of free radicals in the body [1]. The harmful effects of oxidative stress can be mitigated by antioxidants, which act as scavengers. Turmeric contains curcuminoid compounds consisting of curcumin, demethoxy curcumin, and bisdemethoxy curcumin [2]. This compound has been reported to have various pharmacological activities, such as antioxidant, anti-inflammatory and antifungal activities [3]. In study, turmetic extract showed the highest scavenging activity with IC50 (26.5 µg/ml), which was not significantly different with the IC50 value of the standard antioxidant Trolox (IC50: 23.2 µg/ml) [4]. Turmeric-based products are commonly used in traditional herbal medicine, although they are often associated with a bitter taste. According to Bolger (2022), curcumin exhibits poor pharmacokinetic properties attributed to its poor water solubility under physiological pH, chemical instability, metabolic instability, and poor oral absorption leading to low systemic concentrations [5]. To make turmeric extract more palatable to the general public, it can be formulated into effervescent tablets. Effervescent masks unpleasant tastes through the carbonation reaction between citric/tartaric acid and sodium carbonate/bicarbonate [6]. In the study, the level of preference for turmeric extract effervescent tablets produced a bitter taste that had not been covered [7]. *Lo han kuo* fruit (*Siraitia grosvenori*) has the potential to serve as a natural sweetener with low calorie and a high level of sweetness, making it an ideal sugar substitute for individuals dealing with diabetes and obesity [8]. The sweetness of monk fruit extract comes from its high concentration of mogrosides, for instance, mogroside V is the major component with approximately 250 times of sweetness compared to sucrose. In the study of Zhou *et al.* (2009), they observed significant activity of monk fruit extract and pure mogroside V to stimulate insulin secretion in pancreatic beta cells. Mogroside V could significantly suppress maltose-induced increase in blood glucose levels by inhibiting intestinal maltase [9].

While formulating effervescent tablets using wet granulation, a binding agent is utilized to ensure the resulting tablets have good compactability. Jackfruit seeds (*Artocarpus heterophyllus* Lamk.), a type of underutilized waste, could serve as an alternative starch producer. Considering that Indonesian Central Bureau of Statistics (BPS RI) reported 824,086 tons of jackfruit production in 2020, leading to a significant amount of by-product in the form of jackfruit seeds. The starch derived from jackfruit seeds contains 25% amylose and 75% amylopectin, making it suitable for innovation as a binding agent in effervescent tablets [10]. Amylose has the property of easily absorbing water and exhibits good swelling power, making it suitable as a disintegrant in tablets. Conversely, amylopectin, being more sticky and capable of forming a gel when suspended in water, can bind particles to form aggregates, thus serving as a binding agent in tablet formulations [10]. Based on the research, variations in jackfruit seed starch of 5%, 10%, and 15% did not affect the physical properties of effervescent granule preparations [10]. From the background above, this research is to formulate turmeric extract into effervescent tablets using jackfruit seed starch as a binder and *lo han kuo* sweetener with a ratio of (3:15%), (5:25%), and (7:35%).

MATERIALS AND METHODS

The material is turmeric powder (CV. Inbi Nusantara Sejahtera), Jackfruit seeds (Traditional market in Yogyakarta), *lo han kuo* fruit (Thay An Tjan herbal store in Yogyakarta), citric acid, tartaric acid, natrium bicarbonate, PVP, lactose, aspartame, ethanol 70%, filter papper, aluminium foil, curcumin standart, aceton, and ethanol 98% PA (Nitra Kimia).

Extraction of turmeric

Determination of the levels of turmeric plant compounds (*Curcuma domestica* Val.) was carried out with number 239/lab. Bio/B/V/2024 at the Biology Learning Laboratory, Faculty of Applied Science and Technology, Ahmad Dahlan University, Yogyakarta. Turmeric extract was made by maceration method by weighing 500 gs of turmeric powder and 1.5 liters of 70% ethanol for 48 h at room temperature while stirring periodically [11]. Furthermore, the liquid extract was filtered and concentrated using a rotary evaporator set at a temperature of 40ºC and a pressure of 100 mBar [12].

Analysis of curcumin levels in turmeric extract and method validation

To prepare curcumin stock solution, 25 mg of standard curcumin was weighed and dissolved in acetone in a 25 ml volumetric flask. Next, 12.5 ml of the resulting solution was transferred and added to 98% PA ethanol in a 25 ml volumetric flask to obtain a working solution of 500 ppm. Determination of the maximum wavelength of curcumin by pipetting of 0.65 ml from the 500 ppm standard solution was extracted and subsequently diluted with 98% PA ethanol in a 25 ml measuring flask and the absorbance was measured at a wavelength range of 200-400 nm. Determination operating time of curcumin using the same solution, next the absorbance was recorded at the maximum wavelength at 1-minute intervals for 10 min to ensure a relatively constant and stable absorbance. A concentration series was created by diluting a standard solution of 500 ppm to 7, 9, 13, 17, 21, and 25 ppm using 98% PA ethanol in a 25 ml volumetric flask [13]. Calibration curves were created by relating the absorbance values to the concentrations, and regression equations were established to analyze [14].

Accuracy is expressed as % recovery determination using standard series of concentrations of 17, 21, and 25 ppm. From the accuracy absorption data, the average % recovery value is obtained, then the Relative Standard Deviation (RSD) value is calculated [13]. LoD and LoQ calculated by the linear equation of the calibration curve. Determination of curcumin levels by weighing 37.5 mg of thick turmeric extract and then dissolved in acetone in a 25 ml measuring flask. Next, 1 ml of the solution was pipetted and added to ethanol with 98% purity in a separate 25 ml measuring flask. Finally, the absorbance at the nm and the operating time were recorded [15].

Jackfruit seed starch

Jackfruit seed starch is obtained by the decantation process involves soaking the ground jackfruit seeds in a 1:12 ratio of jackfruit seeds to distilled water (1 g of jackfruit seeds with 12 g of distilled water) for 24 h. The starch that forms is then separated and dried in an oven at 60 °C for 24 h [16].

Manufacture *Lo han kuo* granules

Lo han guo sweetener is obtained through the infusion method by placing 100 g of *lo han kuo* powder in an infusion pan for 15 min at a temperature of 90 °C and then caramelized [17]. *Lo han kuo* caramel is mixed with lactose in a 1:4 ratio. The mixture is then sieved with a 40 mesh sieve and placed in an oven at 40 °C for 2 h [18].

Table 1: Effervescent tablet formulation

Ingredients	Formula (mg)					Function
	K(-)	K(+)	F1	F2	F3	
Turmeric Extract	86.2	86.2	86.2	86.2	86.2	Active Ingredients
Citric acid	57	57	57	57	57	Acid phase
Tartaric acid	119	119	119	119	119	Acid phase
Natrium Bicarbonate	212.5	212.5	212.5	212.5	212.5	Alkali phase
Mg Stearate	1.2	1.2	1.2	1.2	1.2	Lubricant
Talk	11	11	11	11	11	Glidan
PVP	-	42.5	-	-	-	Binder
Aspartame	-	85	-	-	-	Sweetener
Jackfruits seed strach	-	-	25.5	42.5	59.5	Binder
Granules *Lo han kuo*	-	-	127.5	212.5	297.5	Sweetener
Lactose	363.1	235.6	210.1	108.1	6.1	Filler
Total	850	850	850	850	850	

Information: K(-) = Negative Group without binders and sweeteners, K(+) = Positive Group with PVP binder and aspartame sweetener, F1 (Formula 1) = Jackfruit seed starch 3% and Lo han kuo 15%, F2 (Formula 2) = Jackfruit seed starch 5% and Lo han kuo 25%, F3 (Formula 3) = Jackfruit seed starch 7% and Lo han kuo 35%

Manufacture effervescent granules

Jackfruit seed starch mucilage was prepared by dissolving it in hot distilled water. Subsequently, a mixture of acid components (citric acid, tartaric acid, turmeric extract, lactose, and half of the starch mucilage of jackfruit seeds) and basic components (sodium bicarbonate, *lo han kuo* granules, and half of the starch mucilage of jackfruit seeds) was prepared, with each component being sieved through a 20 mesh and was dried in an oven at 60 °C for 3 h [18].

Evaluation of effervescent granules

Granule moisture test

A total of 5 g of dry granules were weighed, then placed in an oven at 105 °C for 15 min and the dried granules were then weighed again [19]:

$$\% \text{ Loss of Drying} = \frac{\text{Wet granule weight} - \text{Dry granule weight}}{\text{Wet granule weight}} \text{ x } 100\%$$

Flow time test

The effervescent granules were weighed at 10 g, then placed in a flow rate test funnel. Next, the funnel cover is opened while counting the time the granules come out using a stopwatch [19].

Repose angle test

To conduct the experiment, it is imperative to first measure out an exact weight of 60 g of granules. Subsequently, carefully place the granules into a funnel. Once in place, the funnel cover should be opened to allow the granules to flow freely until they form a conical shape. Following this, precise measurements of the diameter (d) of the base of the granule cone and its height (h) should be taken [19]:

$$\theta = \tan^{-1}\frac{h}{r}$$

Compressibility test

In the experimental procedure, the effervescent granules are carefully poured into a 100 ml measuring cup, and the initial volume (V0) is meticulously recorded. Following this, the Tap Density apparatus is set into motion 100 times, and the final volume (Vt) is then meticulously recorded [20]:

$$\text{Compressibility} = \frac{V0 - Vt}{V0} \text{ x } 100\ \%$$

Evaluation of effervsecent tablets by wet granulation method

Organoleptic test

Effervescent tablets were observed visually, including shape, color

and odor [21].

Weight uniformity test

A total of 10 effervescent tablets for each formulation were weighed, and then the average tablet weight was calculated [21].

Size uniformity test

In this study, the diameter and thickness of ten effervescent tablets for each formulation were measured using a caliper [20].

Tablet hardness test

One recommended method to measure tablet hardness involves using a hardness tester and testing 5 tablets from each formulation. This involves placing the tablets on the device and observing the tablet hardness results [21].

Tablet friability test

A total of 5 effervescent tablets should be weighed to determine the initial weight (W0). Next, the tablets should be placed in a friability tester set at a speed of 100 rpm. Upon completion, the tablets should be removed, cleaned from dust, and the final weight of the tablets (W1) should be accurately measured [21]:

$$Friability = \frac{W0-W1}{W0} \times 100\%$$

Tablet solubility time test

The tablets of each formulation are first taken and placed in 100 ml of distilled water. The time required for complete tablet disintegration is then observed [22].

pH test

The effervescent tablets of each formulation should be placed in 100 ml of distilled water and completely dissolved. Then, the pH should be measured using a pH meter to observe the resulting pH [23].

Dissolution test

In the dissolution testing, a paddle type dissolution tester is used. The chamber in the dissolution test equipment is filled with 900 ml of phosphate buffer medium with a pH of 6.8±0.05 and a mixture of 0.5% SLS [24]. The rotation speed of the tool is set at 50 rpm with a temperature of 37 °C±0.5. The test is conducted for 30 min with sample collection times at 1, 5, 15, and 30 min for 5 ml each. Subsequently, the collected samples are analyzed using a spectrophotometer at the 325 nm of the curcumin standard [25].

Hedonic test

The effervescent tablet preference test received approval from the Stikes Surya Global Yogyakarta Health Research Ethics Committee number 3.21/KEPK/SSG/III/2024. The Likeability Test involved 20 respondents with inclusion criteria student Faculty of Halal Industry, aged 17-35 y, willing to be a panelist, able to communicate well, and not suffering from ageusia. Each participant sampled three effervescent tablet formulations to evaluate color, aroma, and taste. The responses included the following levels of preference: where scale 5 = really like, 4 = like, 3 = netral, 2 = dislike, and 1 = really dislike [26].

Effervescent tablet curcumin content test

Tablets of each formulation was ground and weighed as much as 2.5 mg. Furthermore, it was dissolved with acetone in a 25 ml volumetric flask and shaken until the mixture became homogeneous. Then, 1 ml of the solution was added to 98% PA ethanol in a 25 ml volumetric flask and the absorbance at 425 nm and the operating time was read [15].

Statistical analysis

The experiments were conducted three times, and the results are presented as mean and standard deviation. The physical properties of effervescent tablets were analyzed using SPSS 26.0. The data for each variable was assessed for normality and homogeneity before being subjected to one-way Analysis of Variance (*ANOVA*) parametric test and the *Kruskal Wallis* non-parametric test with a confidence level of 95% ($p<0.05$). The hedonic test results for effervescent tablets were analyzed using the Univariate method with a confidence level of 95% ($p<0.05$), followed by *Post Hoc* Duncan.

RESULTS

Result of turmeric extraction and analysis of curcumin levels

The result was a thick extract weighing 63.75 g from 500 g of turmeric powder, resulting in an extract yield of 12.75%. The maximum wavelength of curcumin was determined to be 425 nm with a maximum absorption of 0.770 with operating time 3 min for each absorption measurement. Result of linear regression equation of y = 0.0632x-0.0198 with a correlation coefficient of r = 0.9994. The % recovery value was found to be 99.085%. Base analyzing the curcumin content of the turmeric extract, an RSD value of 0.038% was obtained. LoD value of 0.506 ppm and LoQ is 1.899 ppm. The turmeric extract was found to have an average curcumin content of 76.443%.

Table 2: Granule evaluation result

Evaluation	K(-)	K(+)	F1	F2	F3	Condition	p-value
Humidity (%)*	3.87±0.5	2.73±0.42	3.4±0.4	3±0.72	3.74±0.7	≤ 5%	0.205>0.05
Flow time (second)*	1.27±0.16	1.34±0.14	1.36±0.19	1.31±0.05	1.31±0.06	<10 second/100 gr	0.924>0.05
Repose angle (°)*	21.63±0.3	28.5±1.2	26.15±0.64	28.05±2.11	25.56±0.75	<30°	0.033<0.05
Compressibility (%)*	15.56±0.83	6.11±0.96	5.83±0.48	5.28±0.48	4.72±0.48	5 – 16%	0.037>0.05

*Result are expressed as an mean±SD, n=3, Condition: Specification limits or criteria used for evaluation, p-value: Probability value indicating statistical significance (threshold set at<0.05), from the results above in table 2, the evaluation of humidity and flow rate showed no significant differences between formulations (p>0.05). However, in the angle of repose and compressibility there were significant differences between formulations (p<0.05).

K(-) **K(+)** **F1** **F2** **F3**

Information: K(-) = Without binders and sweeteners, K(+) = PVP binder and aspartame sweetener, F1 = Jackfruit seed starch 3% and *Lo han kuo* 15%, F2 = Jackfruit seed starch 5% and *Lo han kuo* 25%, F3 = Jackfruit seed starch 7% and *Lo han kuo* 35%

Fig. 1: Result of effervescent tablets

From the results, all formulations were in the form of round effervescent tablets. In the K(-) group, it had a uniform yellow color, while in the K(+) group, it was yellow with white spots caused by the aspartame sweetener. In F1, F2, and F3, tablets were produced with a brownish-yellow color originating from turmeric extract and *lo han kuo* granules.

Table 3: The result of physical properties of effervescent tablets

Evaluation	K(-)	K(+)	F1	F2	F3	Condition	p-value
Weight (mg)±%CV	761.2±2.3	852.2±1.04	834.9±1.73	844.1±1.75	840.08±1.42	Column A ≤ 2	0.000<0.05
Weight uniformity:	723.1-799.3	809.6-894.8	793.2-876.6	801.9-886.3	798.8-882.8	tablet	
Column A (5%)	685.1-837.3	767-937.4	751.4-918.4	759.7-928.5	756.7-924.9	Column B = 0	
Column B (10%)						tablet	
Size uniformity:							
Diameters (mg)±%CV	11.72±2.4	11.96±1	11.72±2.7	11.84±1.5	11.74±2.5	1 1/3t<d<3t	0.492>0.05
Thicknes (mm)±%CV	7.71±3.4	7.88±3.3	7.9±2.8	7.98±3.2	8.06±1.9		
Hardness (kg)*	1.12±0.17	4.45±1.26	3.38±0.29	5.53±1.53	5.70±0.90	4 – 8 kg	0.001<0.05
Friability (%)*	4.59±1.99	0.63±0.14	1.03±1.03	0.95±0.95	0.64±0.14	<1%	0.000<0.05
Solubility time (min)*	0.49±0.06	2.47±0.08	2.08±0.03	2.23±0.06	2.58±0.02	<5 min	0.001<0.05
pH*	5.45±0.28	5.39±0.37	5.45±0.28	5.41±0.19	5.42±0.04	4-6	0.998>0.05
Curcumin Levels (%)*	-	-	93.67±0.40	95.12±0.82	94.73±1.87	95%-105%	0.374>0.05

*Result are expressed as an mean±SD, n=3, Condition: Specification limits or criteria used for evaluation, p-value: Probability value indicating statistical significance (threshold set at<0.05)

From the results above in table 3, the test of uniformity of weight, hardness, friability, and dissolution time of effervescent tablets showed significant differences (p<0.05). Meanwhile, in the test of uniformity of size, pH, and curcumin content in effervescent tablets, there were no significant differences between formulations (p<0.05).

Table 4: Effervescent tablets dissolution result

Formulation	Time (min)				p-value
	1	5	15	30	
F1	7.098%±1.392	11.047%±2.349	21.544%±3.803	28.684%±4.265	0.302>0.05
F2	5.336%±1.158	9.578%±2.582	17.341%±1.587	25.669%±1.385	
F3	4.923%±0.501	7.759%±0.894	20.935%±2.967	26.833%±3.610	

From the results of the dissolution test in table 4, the longer the time, the more curcumin will be dissolved. However, from the 3 formulations, there was no significant difference between the formulations (p<0.05).

DISCUSSION

Evaluation of effervescent granules

Humidity test

The effervescent granules in K(-), K(+), F1, F2, and F3 were oven-baked at 60 °C for 3 h, resulting in a moisture content of less than 5% depict. The results of ANOVA variance analysis showed not significant difference (p>0.05) in the humidity test for five formulations. This ensured that the granules had good flow properties and stability during storage [27]. It is important to note that granules with high humidity (humidity>5%) can pose challenges during the compression process, potentially leading to capping of the tablet due to sticking to the machinery. Conversely, granules with low humidity (humidity<2%) can yield brittle tablets due to reduced binding force between the particles [28].

Flow time test

Effervescent granules in K(-), K(+), F1, F2, and F3 meet the requirements for a good flow rate<10 seconds/100 g. The results of ANOVA variance analysis showed not significant difference (p>0.05) in the granule flow time for five formulations. Higher binder concentration enhances granule density, thus improving their flow properties. The presence of a binder minimizes friction between the granule particles and the container, ultimately increasing the granule flow rate. The flow time test result is associated with the uniformity of weight and the uniformity of the active substance on tablets, as it affects the filling of the tablet printing space (die) [29].

Repose angle test

The result of repose angle test have excellent flow property (range 25°–30°) [30]. The Kruskal-Wallis test showed a significant difference (p<0.05). The result of *post hoc independent samples* test indicate that group K(-) significant difference with K(+) and F2 (5:25%). Increasing the percentage of binder is associated with reduced friction between particles, leading to a decrease in the angle of repose of the granules. A higher concentration of binder results in increased interaction with the starch, consequently leading to greater granule density. As a result, the granules become denser, leading to a smaller angle of repose and improved flow properties.

Compressibility test

The Kruskal-Wallis test showed a significant difference (p<0.05) in granule compressibility. The result of *post hoc independent samples* test indicate that K(-) formula significant differenct with F2 (5:25%) and F3 (7:35%). But the K(+) and F1 formulations, there was no significant difference with K(-) because the addition of 5% PVP and 3% jackfruit seed starch has not yet produced a strong particle bond, but still meets the requirements. A higher concentration of binder resulted in larger granule size, thereby decreasing the compressibility value [31]. Evaluation of the compressibility of these granules is related to the time of tablet printing, granules that have poor compressibility will require high pressure when printing them into tablets [32]. The compressibility test determines the hardness and compactness of a tablet preparation; the smaller the compressibility value, the higher the tablet hardness value [33].

Effervescent tablet evaluation

Weight uniformity test

The results of ANOVA variance analysis showed significant difference (p<0.05) in weight uniformity test for five formulations. Post hoc Bonferroni test showed that the K(-) formulation was significantly different from the K(+), F1, F2, and F3 formulations. But

F1, F2, and F3 did not exhibit significant differences from K(+), so that jackfruit seed starch concentrations of 3%, 5%, and 7% resulted in effervescent tablets with uniform weight, facilitated by improved flow properties of the granules. The flow characteristics of the granules play a pivotal role in the compression chamber filling process by hopper and die, as granules with poor flow properties hinder the tablet weight uniformity and filling process [32].

Size uniformity test

Size uniformity test results, it can be inferred that all five formulas have satisfied the requirements for tablet size uniformity, specifically that the tablet diameter falls between 1 1/3 and 3 times the tablet thickness. The results of ANOVA variance analysis showed not significant difference ($p>0.05$) in size uniformity test for five formulations. Factors affecting tablet thickness include compression during tablet printing, the amount of granule mass filled in the tablet printing chamber, and the mass density of the printed tablet [34].

Tablet hardness test

Based on the result, the average hardness of tablets in the K(-) and F1 (3:15%) groups still does not meet the required standard of 4-8 kg/cm^2 for good tablet hardness. The Kruskal-Wallis test showed a significant difference ($p<0.05$) in hardness test. The result of *post hoc independent samples* test indicate that K(-) formula significant diferent with K(+), F2, F3, and between F1 with F2 and F3. The tablet hardness test revealed that tablet hardness increases with the concentration of jackfruit seed starch binding agent [21]. Jackfruit seed starch contains amylopectin, which has adhesive properties and can form a gel when suspended in water. Additionally, jackfruit seed starch, made from mucilage, exhibits viscoelastic properties that enhance binding capacity, resulting in easily compressible granules [25]. The tablet hardness test is related to the disintegration time of the tablet; the more starch is added, the tablet hardness will increase and the tablet disintegration time will be longer [35].

Tablet friabillity test

Based on the result, it is apparent that the average % friability of the K(-) and F1 (3:15%) groups still does not meet the requirement for good tablet friability, which is<1% [21]. The results of ANOVA variance analysis showed significant difference ($p<0.05$) in friability test for five formulations. Post hoc Bonferroni test showed that K(-) formulation was significantly different from the K(+), F1, F2, and F3 formulations. The tablet friability test suggests that the decrease in tablet friability is proportional to the increase in the concentration of jackfruit seed starch binder. This is due to the higher starch mucilage content of jackfruit seeds, which results in denser, more compact granules with lower porosity, making the tablets stronger and less brittle [29]. Tablet friability test to determine the strength of the tablet which is related to the binding power between particles against impacts or shocks without collapsing during production, packaging, distribution, and use by consumers [21].

Tablet solubility time test

Based on the result, all formulations of the turmeric extract effervescent tablets meet the requirement for a good solubility time, which is less than 5 min. The results of ANOVA variance analysis showed a significant difference ($p<0.05$) in solubility time test for five formulations. Post hoc Bonferroni test showed that K(-) formulation was significantly different from the K(+), F1, F2, and F3 formulations. Tablet hardness is also related to the solubility time, with higher tablet hardness resulting in longer solubility times. The study indicates that increasing the concentration of the jackfruit seed starch binder to 3%, 5%, and 7% elevated tablet hardness and prolonged the dissolution time of the effervescent tablets [35].

pH test

The results of pH test indicate that all five formulas meet the pH requirements for effervescent tablets as a healthy beverage, falling within the 4-6 range [36]. The results of ANOVA variance analysis showed not significant difference ($p>0.05$) in pH test test for five formulations. Effervescent tablets typically have a sour taste, providing a refreshing sensation preferred by consumers. This taste is attributed to the increase in H^+ions resulting from the addition of citric acid and tartaric acid [37].

Dissolution test

The result indicate a gradual increase in the percentage dissolution of dissolved curcumin over time. The results of ANOVA variance analysis showed not significant difference ($p>0.05$) in dissolution test for F1, F2, and F3. The insignificant results was due to improper storage of effervescent tablets. Good storage conditions for effervescent tablets are at a temperature of 20 °C and RH 43.2% so that the stability of the tablet components can be maintained [38]. In this study, temperature and humidity were not controlled, in high humidity the water content of the tablets will also increase so that it will result in an early effervescent reaction, so that when dissolved the carbonation reaction will run slowly. Moreover, in the Biopharmaceutical Classification System (BCS), curcumin is classified as a class IV compound due to its low solubility and permeability [5].

Hedonic test

The results of the univariate test for the color and aroma category of effervescent tablets indicate not significant diferent ($p>0.05$). However, according to Duncan's test for the color and aroma category, F3 ratio of 7:35 of jackfruit seed starch and *lo han kuo* granules exhibited the highest subset value of 3.25 and 3.30, suggesting that respondents had a neutral or normal response to the color and aroma. Conversely, the univariate test for the taste category of effervescent tablets indicate a significant diferent ($p<0.05$). Notably, F3 received the highest assessment score of 4.40, indicating that the formulation with 35% *lo han kuo* sweetener was most favored by the respondents due to its sweeter taste.

Effervescent tablet curcumin content test

Upon further evaluation, it was found that F1 (3:15%) and F3 (7:35%) did not meet the requirements, while F2 met the standards for the active substance content in the drug, which is within 95%-105% [39]. The variance in curcumin levels in the effervescent tablets is attributed to the process of ovening the granules at 60 °C for 3 h, leading to a decrease in curcumin levels. However, several literature reports indicated that curcumin in curcuminoids compound could tolerate temperatures ranging from 80 °C-85 °C [40]. This instability is due to the analysis of curcumin in effervescent tablets not being carried out after tablet production, so that during storage at temperatures not exceeding 20 °C and RH 43.2% it can cause an earlier carbonation reaction which causes curcumin to degrade. Additionally, a higher binder concentration of jackfruit seed starch results in stronger particle bonds between the tablet ingredients, attributed to the sticky properties of amylopectin [10].

CONCLUSION

The composition of jackfruit seed starch and *lo han kuo* sweetener in formulations F1 (3:15%), F2 (5:25%), and F3 (7:35%) has a notable impact on the physical characteristics of the turmeric extract granules and effervescent tablets manufactured. Among the tested formulations, F3 emerges as the optimal choice for assessing the physical properties of both granules and effervescent tablets, as it excels in color, aroma, and taste. However, F2 has a curcumin content that meets the requirements for therapeutic efficacy. Suggestions for further research to conduct effervescent tablet stability tests to determine the stability of curcumin and its storage.

ACKNOWLEDGMENT

Thank you to all the staff of the pharmacy department and the Halal Industry Faculty laboratory for their support in this research

FUNDING

Nil

AUTHORS CONTRIBUTIONS

Every author contributed an equel contribution, Maulana L: Data Curation, Formal Analysis Writing–Original Draft Preparation,

Editing; Alfian M: Funding Acquisition, Supervision, Methodology, Validation, Review and Conceptualization; Faizah N: Methodology, Supervision, Review and Conceptualization.

CONFLICT OF INTERESTS

All authors have none to declare

REFERENCES

1. Nuzul ZR, Anwar C, Husna A, Maisurah. Relationship of knowledge of Gegenerative of degenerative disease with the implementation of a healthty living community movement programs (GERMAS) Bhayangkara Hospital Banda Aceh City. J Heal Technol Med. 2022;8(2):1027-35.
2. Wahyuningtyas SE, Permana ID, Wiadnyani AA. The effect of the kinds of solvent to curcumin content and antioxidant activity of the extract turmeric (Curcuma domestica Val.). ITEPA. 2017;6(2):61–70. Available from: https://ojs.unud.ac.id/index.php/itepa/article/view/36950/22387. [Last accessed on 13 Jan 2025].
3. Ardana T, Yuandani, Satria D, Lux Putra ED, Muhammad M, Rosidah. Acute toxicity evaluation of curcuma domestica vahl. rhizome vco curcuminoid extract. Int J App Pharm. 2024;16:44-51. doi: 10.22159/ijap.2024v16s4.52268.
4. Akter J, Hossain MA, Takara K, Islam MZ, Hou DX. Antioxidant activity of different species and varieties of turmeric (Curcuma spp): isolation of active compounds. Comp Biochem Physiol C Toxicol Pharmacol. 2019;215:9-17. doi: 10.1016/j.cbpc.2018.09.002, PMID 30266519.
5. Sudjarwo S, Bobsaid J, Windianto FR, Rizkyah C, Shaffiqa N, Putra AS. Improving the bioavailability of curcumin in curcuma heyneana by preparing solid dispersion. BIKFAR. 2023;10(1):23-7. doi: 10.20473/bikfar.v10i1.44546.
6. Majee SB, Mishra T, Gupti S. Gastroretentive effervescent floating tablets (Greft) of drugs acting on cardiovascular diseases. Int J Pharm Pharm Sci. 2024;16(7):21-7. doi: 10.22159/ijpps.2024v16i7.51296.
7. Anwar K. Formulation of turmeric (Curcuma domestica Val.) extract effervescent tablet with amount variation of citric acid-tartaric acid as acid source. Pharm Study Program FMIPA Unlam. 2011;44(8):168-78.
8. Gong X, Chen N, Ren K, Jia J, Wei K, Zhang L. The fruits of Siraitia grosvenorii: a review of a Chinese food-medicine. Front Pharmacol. 2019;10:1400. doi: 10.3389/fphar.2019.01400, PMID 31849659.
9. Pandey AK, Chauhan OP. Monk fruit (Siraitia grosvenorii)-health aspects and food applications. Pantnagar J Res. 2019;17(3):191-8.
10. Sari NW, Nurcahyo H, Santoso J. The effect of jackfruit seed starch binding concentration (Artocarpus heterophyllus Lamk.) on effervescent granule preparation formulation. J Ilm Farm. 2021;X(X):1-10.
11. Nikmah LM, Fajariyah S, Mahriani. Effect of ethanol extract of turmeric rhizome (Curcuma longa) on the histological structure of the rectum of white rats (Rattus norvegicus) induced by dextran sodium sulphate (DSS). J Ilmu Dasar. 2019;20(1):13-8.
12. Alfian M, Hasanudin MN, Maulana ML, Mustainin M. *In vitro* test of sunscreen activity of turmeric extract and lotion (Curcuma domestica Val.) using UV-vis spectrophotometer. J Ilm Ibnu Sina. 2024;9(1):78-88.
13. Musiam S, Alfian R. Validation of uv spectrophotometry method in analysis of mefenamic acid levels determination in generic tablet preparations. J Ilm Ibnu Sina. 2017;2(1):31-43.
14. Nadendla RR, Mounika M, Ranjithadubba VS, Jahnavi M, VSP, Yakshithayarra SP. Development and verification of uv spectrophotometric technique for determining N-acetylcysteine in tablet formulations. Int J Pharm Pharm Sci. 2024;16(10):30-5. doi: 10.22159/ijpps.2024v16i10.51004.
15. Sugiandi S, Afriani K, Hamidi A, Maulia G. The effect of solvents and extract types on curcumin levels in turmeric and Javanese ginger simples by visible light spectrophotometry. War Akab. 2021;45(2):6-11. doi: 10.55075/wa.v45i2.48.
16. Rosa Y, Alwi M, Ramadoni P. Potential of pregelatinated starch from jackfruit seeds as a disintegrator in the manufacturing of paracetamol tablets by direct compression method. J Kesehat J Ilm Multi Sci. 2020;X(1):67-76.
17. Gazali G. Activity of lo han kuo (Siraitia grosvenorii) fruit infusion on the biofilm formation of-candida albicans ATCC 10231' Skripsi; 2020. Available from: http://repository.wima.ac.id/22658.
18. Zuraidah N, WD Ayu, A Mirhansyah. The effect of variations in citric acid and tartaric acid concentrations on the physical properties of effervescent granules from jackfruit leaf extract (*Artocarpus heterophyllus L.*). Proceeding Mulawarman Pharm Conf. 2018;8:48-56. doi: 10.25026/mpc.v8i1.302.
19. Oktavina WR, Imtihani HN. Formulasi dan evaluasi suspensi granul effervescent ekstrak kitosan cangkang kepiting bakau (Scylla serrata) dengan perbandingan natrium bikarbonat. J Islamic Pharm. 2023;8(2):62-7. doi: 10.18860/jip.v8i2.23533.
20. Salmatuzzahro A, Nawangsari D, Fitriana AS. Physical properties test of effervescent tablets from banana peel extract (musa X paradisiaca L) with a comparison of citric acid and sodium bicarbonate. Skripsi. 2022.
21. Haryono IA, Noval N. Formulasi dan evaluasi tablet effervescent dari ekstrak buah tampoi (Baccaurea macrocarpa). J Surya Medika. 2022;7(2):34-44. doi: 10.33084/jsm.v7i2.3201.
22. Sagala RJ, Rachmawati P, Kambira PF. 'Literature study of ingredients affecting dissolution time of herbal effervescent tablets. JFI. 2021;13(2):174-84. doi: 10.35617/jfionline.v13i2.44.
23. Mayefis D, Bidriah M. Formulasi sediaan tablet effervescent ekstrak herbal meniran (Phyllantus niruri L) dengan variasi konsentrasi sumber asam dan basa. Ahmar Metastasis Health J. 2022;2(2):75-86. doi: 10.53770/amhj.v2i2.122.
24. Puspita OE, Ebtavanny TG, Fabyoke AF. Study of the effect of binder types of turmeric solid dispersion tablet preparations on the dissolution profile of turmeric extract (Curcuma domestica). Pharm J Indones. 2022;8(1):95-102. doi: 10.21776/ub.pji.2022.008.01.10.
25. Sari LO, Berlianti T, Irawan ED. Formula optimization of effervescent tablet of meloxicam solid dispersion using factorial design. Pustaka Kesehat. 2018;6(2):225. doi: 10.19184/pk.v6i2.7571.
26. Praponco H. Formulation and physical properties of effervescent tablet from combinations of coffee extracts (Coffea. Sp) and cinnamon wood extracts (Cinnamomum Burmannii) with citric acid variations as sources acid coffee. Karya Tulis Ilmiah, Politek. Harapan Bersama Tegal; 2019.
27. Handayani R, Syaqib N, Najihudin A. Evaluation of effervescent granules from various extracts. Parapemikir J Ilm Farm. 2021;10(1):17. doi: 10.30591/pjif.v10i1.2095.
28. Cheiya IV, Rusli R, Fitriani N. Pemanfaatan limbah pati kulit pisang (Musa paradisiaca) sebagai bahan pengikat granul parasetamol dengan metode granulasi basah. J Sains Kes. 2023;5(1):44-9. doi: 10.25026/jsk.v5i1.1606.
29. Zulfa E, Prihantini M. Paracetamol tablet formulation with starch binder of Gembili tuber (Dioscorea esculenta L.). J Pharmascience. 2019;6(2):55. doi: 10.20527/jps.v6i2.7351.
30. Juweira A, Ratnamala KV. Formulation and evaluation of sintered gastroretentive tablets of pioglitazone using design of experiment. Int J Pharm Sci Rev Res. 2021;69(1). doi: 10.47583/ijpsrr.2021.v69i01.007.
31. Adiari NK, Putra IG. Article review: the effect of variation in binder concentration in the formulation of antibacterial lozenges from natural ingredients on the physical properties of the preparation. In: Proceedings of the Natl Pharm Work. Semin. 2023;2:580-92. doi: 10.24843/wsnf.2022.v02.p46.
32. Rijal M, Buang A, Prayitno S. The effect of PVP K-30 concentration as a binder on the physical quality of tekelan leaf extract tablets (Chromolaena odorata. (L.). J Kesehat Yamasi Makasar. 2022;6(1):98-111.
33. Laili N, Komala AM, Maulida H, Suprapto S. Optimasi konsentrasi amylum sagu (Metroxylon rumphii) sebagai co-processed pada pembuatan tablet teofilin. Pharmacon. 2019;14(2):72-80. doi: 10.23917/pharmacon.v14i2.6422.
34. Apriyanto BH, Rusli R, Rahmadani A. Evaluation of taro starch (Colocasia esculenta Schott) as a filler in paracetamol tablet preparations. Proceeding Mulawarman Pharm Conf. 2017;5:69-79. doi: 10.25026/mpc.v5i1.222.

35. Ainurofiq A, Azizah N. Comparison of the use of intragranular, extragranular and combination disintegrants. J Pharm Sci Clin Res. 2016;1:1-9.
36. Yulia M, Wulandari Y. Effervescent powder formulation of Kundur fruit extract (Benincasa hispida (Thunb.) Cogn.) with sodium bicarbonate variations. SITAWA J Farm Sains Obat Tradis. 2022;1(2):41-9. doi: 10.62018/sitawa.v1i2.6.
37. Octavia DR, Nurafifah D, Muhtaromah, Utami PR. Formulation and hedonic test of turmeric extract effervescent powder with variations of citric acid and tartaric acid. Wind Heal J Kesehat. 2021;4(4):348-57.
38. Ansar. Influence of temperature and relative humidity on the quality of fruit juice effervesent tablet during storage. Teknol Ind Pangan. 2011;XXII(1):73-7.
39. Munir MB. Formulation of effervescent tablet containing curcuma xanthorrhiza roxb. Extract curcuma. Skripsi; 2012.
40. Peram MR, Jalalpure SS, Palkar MB, Diwan PV. Stability studies of pure and mixture form of curcuminoids by reverse phase-HPLC method under various experimental stress conditions. Food Sci Biotechnol. 2017;26(3):591-602. doi: 10.1007/s10068-017-0087-1, PMID 30263583.