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# Formulation and Characteristic *Effervescent* Tablets of Water Gourd (*Lagenaria siceraria*) With Variation Sodium Bicarbonate Concentration

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**ABSTRACT**

*Lagenaria siceraria,* commonly known as bottle gourd, is a plant from the Cucurbitaceae family that contains bioactive compounds such as flavonoids, vitamin C, and saponins with potential antioxidant properties. This study aimed to develop *effervescent* tablets from *Lagenaria siceraria* using varying concentrations of sodium bicarbonate based on a Full Factorial Design method. The independent variable was the concentration of sodium bicarbonate, while the dependent variables included flow properties, angle of repose, *moisture content*, organoleptic characteristics, weight and size uniformity, hardness, friability, and dissolution time. Results showed that flow rate ranged from 5.1 ± 0.007 to 5.49 ± 0.025 seconds (p = 0.004), angle of repose from 25.21 ± 0.42 to 25.5 ± 0.024 degrees (p = 0.026), and moisture content from 3.08 ± 0.09 to 4.71 ± 0.027% (p = 0.080). The tablets met the requirements for weight and size uniformity. Tablet hardness ranged from 6.44 ± 1.42 to 7.75 ± 0.56 kP (p = 0.016), friability from 0.16 to 0.81% (p = 0.055), and dissolution time from 1.82 ± 0.02 to 1.96 ± 0.01 minutes (p = 0.047). In conclusion, variations in sodium bicarbonate concentration significantly affected flow properties, angle of repose, hardness, and dissolution time, but had no significant effect on *moisture content* and friability.

Keywords**:** *Lagenaria siceraria*; sodium bicarbonate; *effervescent* tablet

## Introduction

Water pumpkin (*Lagenaria siceraria*) is a plant of the Cucurbitaceae family that is classified as an annual, because it only bears fruit once during its lifetime. This plant can grow in both highlands and lowlands, and can adapt to various tropical climate conditions, both cold and hot temperatures (Nur Abdillah *et al.,* 2024). This water pumpkin is widely known as a vegetable that is often used in dishes by the community. However, its use in the form of food is still limited because the texture of the water pumpkin tends to be soft and the taste is bland. This causes low public

interest in consuming it despite having a high nutritional content. The nutritional content in this water pumpkin contains calcium, iron, vitamin C, saponins, and polyphenols which have great potential to improve health (Forestryana *et al.,* 2020). Vitamin C's primary role is as an antioxidant, helping the body fight the negative effects of free radicals. While its polyphenol and saponin content provides additional benefits such as anti-inflammatory, antimicrobial, and protection against various diseases (Sihombing et al., 2016).

Water pumpkin fruit is suitable for processing into *effervescent* tablets. *Effervescent* tablets offer several advantages, such as a sparkling effect or foaming effect when dissolved in water that can mask the bland taste of water pumpkin, making it more attractive and easily accepted by consumers. In addition, these *effervescent* tablets produce CO2 gas when reacting with water, creating a more practical drink that is attractive to consumers, easy to consume and can maintain the stability of active ingredients such as vitamin C and polyphenols until the time of consumption (Forestryana *et al.,* 2020).

*Effervescent* tablets are a dosage form that can increase effectiveness and absorption compared to conventional capsules and tablets, so it is expected to accelerate the achievement of a drug's therapeutic effect. The advantages of *effervescent* tablets are that they can provide a pleasant, refreshing taste and a different sensation when taken, this occurs because of the presence of carbonate which helps improve the taste of several types of drugs (Fadhilla, 2021). The healthy lifestyle trend that encourages the use of natural ingredients is increasingly relevant, making *effervescent* tablets made from water pumpkin with high antioxidant content a potential innovation for health (Chabib *et al.,* 2015).

*Effervescent* tablet formulation requires a combination of acidic and basic ingredients, such as citric acid, tartaric acid, and sodium bicarbonate. Citric acid is chosen because it is easily soluble and inexpensive while tartaric acid has better solubility at certain concentrations. Sodium bicarbonate is influential in producing CO2 gas when reacted with acid. Sodium bicarbonate is the largest source of carbonate with very high solubility in water, free flowing, and non-hygroscopic (Kholidah & Khumaidi, 2014). Based on research conducted by Tanjung Puspita et al., 2019, effervescent tablets can maintain the stability of vitamin C and polyphenols until consumption, which plays a crucial role in maintaining the effectiveness of the active ingredients during consumption and storage. This study was conducted on effervescent tablet formulation with varying sodium bicarbonate concentrations to determine the effect on the characteristic tests (flow properties, angle of repose, moisture content, organoleptic, weight uniformity, hardness, size uniformity, friability, and dissolution time) of effervescent tablets from water pumpkin fruit.

## Methodology

### Research Design

This research uses an experimental research design. This experiment was conducted systematically, carefully, and rationally to control variables under certain conditions.

## Tools and Materials

The tools used in this study included an analytical balance, vernier caliper, flow tester, hardness tester, friability tester, moisture analyzer, stopwatch, tablet press machine, oven, mesh sieve no. 14, mesh sleve no. 80, mortar, and stamper.

The materials used in this study were water pumpkin, citric acid (Kimia Jaya®), tartaric acid (Kimia Jaya®), sodium bicarbonate (Kimia Jaya®), PVP (Kimia Jaya®), PEG 6000 (Kimia Jaya®), lactose (Kimia Jaya®), aspartame (Kimia Jaya®), and distilled water (Kimia Jaya®).

## Research Procedures

### Plant Determination

The water gourd fruit used in this study was first determined at the Faculty of Pharmacy, Universitas Surabaya (UBAYA), to confirm that the sample used was *Lagenaria siceraria* belonging to the Cucurbitaceae family and *Lagenaria* genus.

### Preparation of Bottle Gourd Powder

Fresh pumpkin fruit is first washed using clean water, then cut into thin sheets. The pumpkin pieces are arranged neatly on an aluminum baking sheet without overlapping each other, then dried in the oven at 70°C for 6 hours. After the drying process is complete, the dried water pumpkin is crushed using a blender to form a powder. The resulting powder is then sieved using an 80-mesh sieve. The sieved results are stored in aluminum foil packaging and kept at room temperature until ready for use in the effervescent tablet formulation process.

**Figure 1. Water Pumpkin *(Lagenaria siceraria)***

### Preparation of *Effervescent* Tablets.

Water pumpkin fruit effervescent tablet formulation with four different concentrations of sodium bicarbonate, with each tablet formulated at 250 mg, and a total of 200 tablets in each formulation. Water pumpkin powder, citric acid, tartaric acid, sodium bicarbonate, PVP, PEG 6000, aspartame, and lactose were weighed individually according to the formulation calculation. The acid was ground first then mixed evenly with the excipients/additional ingredients according to the formulation table until a homogeneous mixture was obtained. The mixture was then molded into tablets using a tablet press. The formed tablets were then re-ground into powder form and sieved with a 14 mesh sieve. The sieved results were then re-molded into tablets with each tablet weighing 250 mg.

**Table 1. *Effervescent* Tablet Formulation**

| Material | Function | Range of requirements (%) | Formulation (%) | | | |
|---|---|---|---|---|---|---|
| | | | F1 | F2 | F3 | F4 |
| Water pumpkin powder | Active ingredients | - | 5 | 5 | 5 | 5 |
| Citric acid | Source of acid | 0.3 – 2 | 2 | 2 | 2 | 2 |
| Tartaric acid | Source of acid | 5 – 25 | 25 | 25 | 25 | 25 |
| Sodium bicarbonate | Base source | 15 – 50 | 28 | 32 | 36 | 40 |
| PVP | Binder | 0.5 – 5 | 4 | 4 | 4 | 4 |
| Aspartame | Sweetener | 1 – 5 | 3 | 3 | 3 | 3 |
| PEG 6000 | Lubricant | 1 – 2 | 2 | 2 | 2 | 2 |
| Lactose | Filler | 5 – 80 | 31 | 27 | 23 | 19 |
| Total Weight | | | 250 mg | 250mg | 250 mg | 250 mg |

**Evaluation of Bottle Gourd *Effervescent* Granules**

**1. Flow Properties Test**

Granule flow properties test can be done by weighing 100 grams of granules and then inserting them into a measuring funnel. Calculating the flow time of the granules can be done using a stopwatch starting from opening the lid of the measuring funnel until all the granules come out. The flow properties can be declared good if it is no more than 10 seconds, the speed is calculated in units of g/time (Chabib *et al.,* 2015).

**2. Angle of Repose Test**

The angle of repose was measured using a funnel method. Granules were poured slowly until they formed a cone on a flat surface. The height (h) and base radius (r) of the cone were measured to calculate the angle (Kuncahyo *et al.,* 2021).

**3. Moisture Content Test**

Moisture content testing is carried out by taking 1 gram of sample and placing it in an oven at a temperature of 105℃for 8 hours, then weighed. Then the water content is calculated (Mutiarahma *et al.,* 2019). Based on SNI -4320-1996 which states that the standard water content of effervescent is 0.3%. Meanwhile, based on BPOM, 2015, the water content requirements for effervescent tablets and tablets in health supplements state that the standard water content of effervescent tablets is ≤10%.

**Evaluation of Bottle Gourd Effervescent Granules**

**1. Organoleptic Test**

Organoleptic tests were carried out on the parameters of shape, color, taste, and aroma to determine the character of the preparation made by directly observing the appearance of the *effervescent* tablet (Yulianti *et al.,* 2021).

**2. Weight Uniformity Test**

This was done on 20 tablets in each formula, then weighed to see if the deviation was greater than the average weight determined in column A and none of the tablets had a weight that deviated more than the value determined in column B (Kholidah & Khumaidi, 2014).

**3. Tablet Hardness Test**

A tablet was placed in a hardness tester. The device scale was set to zero, then the screw was turned until the tablet broke. The hardness value in kgf was recorded. The test was repeated 10 times. In the pharmaceutical industry, tablets must have a minimum hardness of 4–8 kgf (Fadhilla, 2021).

**4. Size Uniformity Test**

Tablet thickness and diameter were measured with a caliper. Tablet diameter should not be more than three times and not less than one-third of its thickness (Kuncahyo *et al.,* 2021)

**5. Friability Test**

This test is an indicator for assessing the strength of a tablet's surface against mechanical abrasion. High friability can impact the stability or quantity of active ingredients in the tablet. A tablet is considered to have a good level of friability if the friability value is less than 1% (Fadhilla, 2021).

**6. Dissolution Time Test**

Dissolution time describes the duration required for a tablet in a certain serving size to completely dissolve in a predetermined volume of water (Kuncahyo *et al.,* 2021). In the test, one effervescent tablet is placed into a glass containing 200 ml of distilled water, then the dissolution time is measured using a stopwatch, starting when the tablet is dipped and stopping when the tablet is completely dissolved. A tablet is considered to have good dissolution quality if it dissolves within 1 to 2 minutes (Yulianti *et al.,* 2021).

## Result and Discussion

The purpose of the determination was to identify the exact plant species and obtain the most specific and accurate species identification. This plant identification was conducted at the Center for Information and Development of Traditional Medicine (PIPOT) of the Faculty of Pharmacy, University of Surabaya, and the results showed that the sample was a water gourd of the *Lagenaria siceraria* species, belonging to the Cucurbitaceae family and the *Lagenaria* genus.

In this study, *effervescent* tablets were made using the dry granulation method, where water pumpkin powder, citric acid, tartaric acid, sodium bicarbonate, PVP, PEG 6000, aspartame, and lactose were weighed individually according to the formulation calculation. Citric acid was ground first, then mixed evenly with excipients or additional ingredients according to the formulation table until a homogeneous mixture was obtained. The mixture was then molded into tablets using a tablet molding machine at the Central Drug Evaluation & Analysis (CDEA) Faculty of Pharmacy, University of Surabaya. The formed tablets were then re-pulverized into powder and sieved with a 14 mesh sieve. By carrying out the crushing and re-sieving process, the particles became more uniform and flowable so that when re-molding was carried out, tablets with more stable physical quality could be produced. The sieving results were evaluated first before being re-molded into tablets. After that, re-molded into tablets with a weight of 250 mg each was carried out at the Central Drug Evaluation & Analysis (CDEA) Faculty of Pharmacy, University of Surabaya.

**Table 2. Flow Properties Test**

| Formulation | Replication | | | Mean ± SD | Condition | Information |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | | | |
| F1 | 5.10 | 5.15 | 5.05 | 5.1 ± 0.07 | ≥10 seconds | Meet the requirements |
| F2 | 5.30 | 5.22 | 5.27 | 5.26 ± 0.40 | | Meet the requirements |
| F3 | 5.41 | 5.37 | 5.38 | 5.38 ± 0.22 | | Meet the requirements |
| F4 | 5.49 | 5.47 | 5.52 | 5.49 ± 0.22 | | Meet the requirements |

**Table 3. Angle of Repose Test**

| Formulation | Replication | | | Mean ± SD | Condition | Information |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | | | |
| F1 | 25.64 | 25.22 | 24.79 | 25.21 ± 0.42 | 25°-30° | Meet the requirements |
| F2 | 24.89 | 25.64 | 25.22 | 25.25 ± 0.36 | | Meet the requirements |
| F3 | 25.22 | 25.64 | 25.22 | 25.36 ± 0.24 | | Meet the requirements |
| F4 | 25.64 | 25.22 | 25.29 | 25.5 ± 0.24 | | Meet the requirements |

**Table 4. Moisture Content Test**

| Formulation | Replication | | | Mean ± SD | Condition | Information |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | | | |
| F1 | 5.03 | 4.51 | 4.60 | 4.71 ± 0.27 | ≤10% | Meet the requirements |
| F2 | 4.29 | 4.79 | 4.6 | 4.56 ± 0.25 | | Meet the requirements |
| F3 | 3.29 | 3.09 | 3 | 3.12 ± 0.14 | | Meet the requirements |
| F4 | 3.08 | 2.99 | 3.18 | 3.08 ± 0.09 | | Meet the requirements |

The results of the flow properties evaluation were carried out to determine the flow properties of the granules by looking at the flow time of the granule mass from the hopper to the die molding chamber, so that the molding chamber is filled optimally and tablets with uniform weight are obtained. The flow properties can be said to be good if it is no more than 10 seconds, the time is calculated in units of g/time (Chabib *et al.,* 2015). The results of the flow properties test can be seen in Table 2. Based on the results of the flow properties test on the four formulas, it is known that the flow properties are still in accordance with the specified requirements. In Formula 1, the average flow properties were (5.1±0.07), Formula 2 (5.26±0.40), Formula 3 (5.38±0.22), and Formula 4 (5.49±0.25). The higher the concentration of sodium bicarbonate added, the greater the flow rate. These results are within the required range, which is no more than 10 seconds.

The angle of repose test is carried out to determine the maximum angle formed by the horizontal surface during the test. The optimal angle of repose value for granules is25°-30° (Widjayanti & Setiawan, 2022). The results of the angle of repose test can be seen inTable 3. Based on the results of the angle of repose test on the four formulas, it is known that the angle of repose is still in accordance with the specified requirements. In Formula 1, the average angle of repose was (25.21±0.42), Formula 2 (25.25±0.36), Formula 3 (25.36±0.24), and Formula 4 (25.5±0.24). The higher the

concentration of sodium bicarbonate added, the greater the increase in the angle of repose. This result is still within the required range, namely25°-30°.

The results of the moisture content test were carried out to determine the amount of water content still present in the effervescent tablet after the drying process (Mayefis & Bidriah, 2022). Based on BPOM, 2015, it states that the water content requirements for effervescent tablets and tablets in health supplements state that the standard water content for effervescent tablets is ≤10%.The results of the moisture content test can be seen in Table 4. Based on the results of the moisture content test on the four formulas, it was found that the moisture content was still in accordance with the specified requirements. In Formula 1, the average moisture content was (4.71±0.27), Formula 2 (4.56±0.25), Formula 3 (3.12±0.14), and Formula 4 (3.08±0.09). The higher the concentration of sodium bicarbonate added, the less water vapor is absorbed. This result is still within the 2015 BPOM requirement of ≤10%.

The organoleptic results of the water pumpkin effervescent tablets can be seen in Table 5. Data from the organoleptic test results for the four formulations showed no organoleptic differences. All preparations were round in shape, light brown in color, and had a faint odor.

**Table 5. Organoleptic Test**

| Formula | Form | Color | Color | Information |
|---|---|---|---|---|
| F1 | Round | Light Chocolate | Weak | Meet the requirements |
| F2 | Round | Light Chocolate | Weak | Meet the requirements |
| F3 | Round | Light Chocolate | Weak | Meet the requirements |
| F4 | Round | Light Chocolate | Weak | Meet the requirements |

**Table 6. Weight Uniformity Test**

| Formulation | Mean ± SD | Condition | Information |
|---|---|---|---|
| F1 | 244.55 ± 3.30 | A maximum of two tablets are permitted to have a weight deviation according to the limits listed in column A, but no tablet is permitted to have a weight deviation exceeding the limits in column B. | Meet the requirements |
| F2 | 253.4 ± 5.84 | | Meet the requirements |
| F3 | 262.15 ± 3.86 | | Meet the requirements |
| F4 | 273.15 ± 3.86 | | Meet the requirements |

**Table 7. Tablet Hardness Test**

| Formula | Mean ± SD | Condition | Information |
|---|---|---|---|
| F1 | 6.44 ± 1.42 | 4-8 kgf | Meet the requirements |
| F2 | 6.81 ± 1.30 | | Meet the requirements |
| F3 | 7.10 ± 1.18 | | Meet the requirements |
| F4 | 7.75 ± 0.56 | | Meet the requirements |

**Table 8. Uniformity of Size Test**

| Formula | Mean ± SD Thick | Mean ± SD Diameter | Condition | Information |
|---|---|---|---|---|
| F1 | 0.444±0.011 | 0.932±0.018 | The tablet diameter is not more than three times and not less than one third the tablet thickness. | Meet the requirements |
| F2 | 0.445±0.022 | 0.940±0.015 | | Meet the requirements |
| F3 | 0.460±0.031 | 0.932±0.015 | | Meet the requirements |
| F4 | 0.423±0.047 | 0.941±0.014 | | Meet the requirements |

**Table 9. Tablet Friability Test**

| Formula | Initial weight (mg) | Final weight (mg) | Average | Condition | Information |
|---|---|---|---|---|---|
| F1 | 4,899 | 4,859 | 0.81 | ≤1% | Meet the requirements |
| F2 | 5,240 | 5,215 | 0.47 | | Meet the requirements |
| F3 | 5,048 | 5,039 | 0.17 | | Meet the requirements |
| F4 | 5,456 | 5,447 | 0.16 | | Meet the requirements |

**Table 10. Dissolution Time Test**

| Formula | Replication 1 | 2 | 3 | Mean ± SD | Condition | Information |
|---|---|---|---|---|---|---|
| F1 | 1.95 | 1.96 | 1.98 | 1.96±0.01 | 1-2 minutes | Meet the requirements |
| F2 | 1.92 | 1.96 | 1.99 | 1.95±0.03 | | Meet the requirements |
| F3 | 1.89 | 1.85 | 1.82 | 1.85±0.03 | | Meet the requirements |
| F4 | 1.82 | 1.85 | 1.81 | 1.82±0.02 | | Meet the requirements |

The weight uniformity test was conducted to determine the extent of weight deviation per tablet. In this study, the weight used was 250 mg. According to the Indonesian Pharmacopoeia, Edition VI (2020), the weight uniformity requirement for the 250 mg size is that no two tablets should deviate more than 7.5% from column A, and no tablet should deviate more than 15% from column B. The uniformity of tablet weight is greatly influenced by the process of filling the granules into the tablet mold (die). Granules with good flow properties will fill the mold evenly, resulting in tablets with a uniform weight. Conversely, if the flow properties of the granules are less than optimal, the mold filling will be uneven and can cause weight variations between tablets. Differences in acid and base levels in the formula can also affect the flow properties of the granules, thus becoming one of the factors that can cause non-

uniformity in tablet weight. In addition, other factors that need to be considered are the possibility of non-uniformity in weight due to machine settings and the attachment of material particles to the punch and die during the printing process (Noval *et al.,* 2021).

Tablet hardness is an important parameter that indicates a tablet's ability to withstand physical pressure. Appropriate hardness will ensure the tablet remains intact throughout the production process, packaging, and distribution to consumers (Yulianti & Sutoyo, 2021). A tablet is considered to meet standards if it has a minimum compressive strength of between 4 and 8 kgf (Fadhilla, 2021). The results of the hardness test can be seen in Table 7. Based on the results of the hardness test on the four formulas, it is known that the tablet hardness is still in accordance with the specified requirements. In Formula 1, the average tablet hardness was (6.44±1.42), Formula 2 (6.81±1.30), Formula 3 (7.10±1.18), and Formula 4 (7.75±0.56). The higher the concentration of sodium bicarbonate added, the higher the tablet hardness value. This result is still within the required range of 4-8 kg.

Tablet size uniformity testing is carried out to ensure that each tablet produced has a uniform size. This measurement is usually carried out using a vernier caliper which is used to accurately measure the diameter and thickness of each tablet (Kuncahyo *et al.,* 2021). The results of the size uniformity test can be seen in Table 8. Based on the results of the uniformity test for size on the four formulas, it is known that they still meet the specified requirements, namely that the tablet diameter is no more than three times and no less than one third of the tablet thickness (Noval *et al.,* 2021).

The results of the tablet friability test were carried out to ensure that the tablet has physical resistance to shocks during the distribution and storage process. The requirement for a good tablet is friability of less than 1% (Fadhilla, 2021). The results of the fragility test can be seen in Table 9. Based on the results of the friability test on the four formulas, it was found that the tablet friability still met the specified requirements. Formula 1 obtained an average tablet friability of (0.81), Formula 2 (0.47), Formula 3 (0.17), and Formula 4 (0.16). The higher the concentration of sodium bicarbonate added, the lower the tablet hardness value. This result is still within the required range of less than 1%.

Dissolution time results are used to determine the duration required for a tablet to disintegrate and dissolve completely in a liquid medium. For *effervescent* tablets, rapid dissolution time is crucial because it affects the comfort of use and the effectiveness of the drug. Generally, an effervescent tablet is considered good if it dissolves within 1-2 minutes (Yulianti *et al.,* 2021). The results of the dissolution time test can be seen in Table 10. Based on the results of the dissolution time test on the four formulas, it is known that the dissolution time is still in accordance with the specified requirements. In Formula 1, the average dissolution time was (1.96±0.01), Formula 2 (1.95±0.03), Formula 3 (1.85±0.03), and Formula 4 (1.82±0.02). Meanwhile, research by (Anesakirani et al., 2018) stated that sodium bicarbonate acts as a disintegrant in tablets. When reacting with acid, sodium bicarbonate produces gas that helps the tablet disintegrate and dissolve more quickly. The higher the

concentration of sodium bicarbonate added, the faster the tablet dissolution time. These results are within the required range of 1-2 minutes.

## Conclusion

Based on the results of this study, it can be concluded that the effervescent tablets formulated from water gourd (*Lagenaria siceraria*) meet all the requirements of the physical characteristics and quality evaluated.

### Declaration of Competing Interest

The authors declare that they have no competing interests

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