Formulation of Effervescent Granule from Robusta Green Coffee Bean Ethanolic Extract (*Coffea canephora*)

Hilda Maysarah, Irma Sari, Meutia Faradilla, Kevin Kwok

**Introduction:** Robusta coffee (*Coffea canephora*) is one of the many crops cultivated in Aceh, and at present is only being used as a drink. Research has shown the potential of many pharmacological uses for coffee, including its use as a remedy to treat diabetes. Effervescent granules are one of the oral dosage forms that can not only mask the unpleasant taste of bioactive substances, but also have a high aesthetic value and can contain relatively large doses of bioactive substances. Previous research has shown that ethanolic extract of robusta green coffee beans at 100 mg/kg body weight (BW) rat yielded the highest percentage of glucose reduction. On the basis of that research, the dosage was used in this study to be formulated into effervescent granule. **Aims:** This study aimed to find the best formulation of effervescent granules preparation using various concentrations of effervescent salt that meets the general requirements of effervescent dosage forms. The concentrations of citric acid, tartaric acid, and sodium bicarbonate used in sequence were 7.35%, 14.7%, and 25% (F1); 8.08%, 16.17%, and 27.5% (F2); and 8.82%, 17.64%, and 30% (F3), respectively. Robusta green coffee beans were extracted using the maceration method. **Results:** Secondary metabolite screening of extract showed that it contained alkaloid, saponin, phenolic, and flavonoid metabolites. Effervescent granules were evaluated and F1 and F2 did not qualify the flowability standard of the granules, whereas F3 qualified in all the evaluation standards. **Conclusion:** On the basis of these results, F3 produced the best effervescent granules that met the general standards of the effervescent dosage forms.

**Keywords:** Citric acid, effervescent granules, green coffee bean, sodium bicarbonate, tartaric acid

**INTRODUCTION**

Indonesia is the third largest coffee producer in the world, after Brazil and Vietnam. To this day, high-quality coffee is only used as a beverage, food additive, or in cosmetics. However, current research has shown that coffee has many other benefits such as a psychostimulant, antihyperlipidemic, antidiabetic, and has even been shown to inhibit the growth of cancer cells.[1-4]

Coffee beans contain many compounds, such as chlorogenic acid (4.4%–7.5%), caffeine (1.25%–2.5%), trigonelline (0.8%–1.25%), fat oil (10%–16%), and many others.[5] Coffee also contains flavonoid compounds such as ferulic acid, caffeic acid, cinnamic acid, nicotinic acid, and tannic acid, which have antioxidant, antiviral, hepatoprotective, antibacterial, anti-inflammatory, antihyperglycemic, and hypolipidemic agents.

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Previous studies showed that the chemical compounds of coffee beans, particularly, ethanolic extract of green coffee beans at dose 100 mg/kg body weight (BW) rats (equivalent to 1120 mg/70 kg human BW) could reduce blood sugar levels by 138.09% within 240 min after administration of excessive glucose. It was hypothesized that the chlorogenic acid content in the green coffee bean was responsible for the antidiabetic effect. In this study, robusta green coffee beans were formulated into an effervescent granule as an antidiabetic agent due to its chlorogenic acid content that reached 7.32%.

Effervescent granule preparations have many advantages, for instance, they can be easily dissolved and can mask the taste of active substances that do not have pleasant taste. They also have a high aesthetic value because they can produce fizzy gases. As of yet, there has not been any effervescent formulations conducted for any coffee species, especially for the ethanolic extract from robusta green coffee beans. Therefore, the researchers chose to formulate ethanolic extract of coffee beans into effervescent granule preparations by varying the concentration of effervescent salts to obtain the best effervescent granule preparations.

**Materials and Methods**

Robusta green coffee beans were collected from the Linge District in Central Aceh, Indonesia. Beans were sorted, cleaned, dried, and ground to get coffee powder. Some of the powder was phytochemically characterized, and the rest was extracted using 96% ethanol by the maceration method. The extract obtained was concentrated using a rotary evaporator and characterized as well. Parameters tested were as follows: loss on drying, total ash content, water-soluble content, and ethanol-soluble content.

The robusta green coffee bean ethanolic extract was then formulated into effervescent granules using various concentrations of effervescent salt. The concentrations of citric acid, tartaric acid, and sodium bicarbonate used in sequence were 7.35%, 14.7%, and 25% (F1); 8.08%, 16.17%, and 27.5% (F2); and 8.82%, 17.64%, and 30% (F3), respectively. All three formulations of effervescent granules were made using a dry or fusion method. This method was chosen to avoid the risk of an early effervescent reaction during the manufacturing process, which is characterized by the spontaneous formation of effervescent froth after mixing the acid and base components. In addition, because this research used citric acid monohydrate, the appropriate method of making effervescent granules is the dry or fusion method. The resulting granules contained 3% aspartame (sweetener) and Avicel PH 102 (diluent). All effervescent granules obtained were evaluated for their moisture content (%), flow rate (g/s), angle of repose (°), Hausner ratio, and Carr index.

**Results**

Characterization results for both simplicia and extract are shown in Table 1.

The evaluation results of the effervescent granules from robusta green coffee bean are shown in Table 2.

**Discussion**

The green coffee bean samples contained compounds of alkaloids, saponins, flavonoids, and phenolics. These results support another research study that stated that ethanol extract of robusta coffee beans contains flavonoid, phenolic, tannin, and alkaloid compounds. In this study, effervescent granules used a combination of citric acid and tartaric acid as a component of the acid-forming effervescent salt. The combination was used to produce high-quality effervescent granules. A single ingredient of citric acid would produce a sticky mixture that was difficult to granulate. If tartaric acid was used alone, it would produce granules that easily broke apart. Sodium bicarbonate functions as a base-forming effervescent salt component. It can produce CO₂ from effervescent reactions reaching 52% increasing the level of effervescent user preference. Avicel PH 102 functions as an adsorbent and filler of effervescent granule preparations. It was chosen for its better ability to flow as well as its compressibility characteristics compared to Avicel PH 101.

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**Table 1: Characterization result for both simplicia and extract**

| Test Parameters         | Green coffee bean simplicia Mean (%) ± SD | Green coffee bean ethanolic extract Mean (%) ± SD |
|-------------------------|------------------------------------------|-------------------------------------------------|
| Loss on drying          | 7.57% ± 0.28%                            | 10.37% ± 1.85%                                 |
| Total ash content       | 4.37% ± 0.21%                            | 9.79% ± 3.03%                                  |
| Water-soluble content   | 21.42% ± 2.79%                           | 82.51% ± 7.14%                                 |
| Ethanol-soluble content | 14.17% ± 3.81%                           | 98.67% ± 1.44%                                 |

*Phytochemical screening for green coffee bean ethanolic extract*

- Alkaloids, saponins, phenolics, flavonoids

SD = standard deviation
Maysarah, et al.: Robusta green coffee bean ethanolic extract effervescent granule had a fine granule shape, faded yellow color, and had a distinctive smell of green coffee.

The moisture content parameter of the granules is very closely related to the flow rate of the granules. The higher the moisture content of the granules, the worse the flow rate of the granules will be. In addition, if the moisture content is lower, the preparation of the effervescent granule will be more stable.

A flow rate test was done to determine the ability of granules to flow directly. The characteristics of the flow rate of powders and granules is one of the most important parameters to be tested because the flow rate greatly influences the transfer of material out of the package as well as the mixing between materials, and can also affect the accuracy of the dosage of powders and granules. Powder or granule is said to have a good flow rate if it can flow at a rate of less than 10 g/s (USP, 2012). It is shown that F3 effervescent granules met the requirements for good granule flow rates, whereas F1 and F2 granules did not meet the requirements. This was possibly influenced by the levels of citric acid. The citric acid used in the formulation was crystalline citric acid monohydrate. One of the factors that can influence the flow rate of granules is the particle shape of the granule-forming material. Compounds that have a crystalline form will have a better flow rate compared to amorphous powders. F3 contained greater citric acid compared to F1 and F2 formulas, so that the F3 effervescent granule had a better flow rate of the three formulas.

Angle of repose test was performed to examine the flow properties of the granules indirectly, because it is affected by cohesion bonds between particles. Cohesive bond among particles illustrates friction between particles. Granules are stated to have excellent flow properties if the angle of repose formed is below 20°. If the angle of repose formed is small, it will produce good flow properties and will better illustrate the cohesion and friction bonds between small particles. Results showed that F3 with a combination of effervescent salt concentrations greater than F1 and F2 has a better angle of repose. This was probably due to the increasing levels of effervescent salts, resulting in stronger ionic bonds and weakening of van der Waals bonds, so the effervescent salt formed would have lower cohesivity and friction properties, and better flow properties. However, all three formulas still met very good granule standpoint requirements.

Bulk and tapped density are the basic parameters for calculating the Hausner ratio and Carr index. General parameters that can describe the compressive nature of granules are the Hausner ratio and Carr index. Granules

| Formula | % Moisture content | Flow rate (g/s) ± SD | Angle of repose (°) ± SD | Hausner ratio ± SD | Carr index ± SD |
|---------|-------------------|----------------------|--------------------------|-------------------|----------------|
| F1      | 0.89              | 12.38 ± 1.86         | 16.55 ± 2.94             | 1.220 ± 0.005     | 18.08% ± 0.38  |
| F2      | 1.86              | 11.32 ± 1.45         | 14.86 ± 1.08             | 1.252 ± 0.02      | 20.18% ± 1.54  |
| F3      | 1.42              | 9.49 ± 2.17          | 14.53 ± 0.38             | 1.285 ± 0.04      | 22.17% ± 2.4   |

| Formula | Water (9°C) pH ± SD | Water (30°C) pH ± SD | Water (48°C) pH ± SD |
|---------|---------------------|----------------------|----------------------|
| F1      | 1.55 ± 0.04         | 1.56 ± 0.07          | 1.56 ± 0.07          |
| F2      | 1.48 ± 0.04         | 1.17 ± 0.02          | 1.17 ± 0.02          |
| F3      | 1.31 ± 0.07         | 1.09 ± 0.02          | 1.09 ± 0.02          |
are said to have good compressibility if the Hausner ratio is below 1.2, and bad if it is above 1.6.[13] On the basis of the results, it can be said that the granules of the three formulas have sufficient compressibility.

Granules are said to have a “good” suitability if the Carr index value is in the range of 12%–16%, “enough” if the Carr index value is in the range of 16%–23%, and said to be “bad” if it is in the range of 23%–28%.[13] It is shown that the granules from all three formulas have sufficient compressibility. The Hausner ratio and Carr index are closely related to friction between particles.[13] They describe the nature of flow and ability of granules. The lower the friction between particles, the easier it will be for the granules to flow and compress. On the contrary, if the friction between the particles is greater, it will be more difficult for the granules to flow and compress.

In this study, we found that the combination of the higher effervescent salt concentration produced lower compressibility. This is likely due to sodium bicarbonate, which has poor compressibility.[10] In addition, levels of Avicel PH 102 also affect the compressibility of the granules. Avicel PH 102 has good compressibility, and the higher levels of Avicel PH 102, the better the compressibility.[11] This was shown in the result where F1, formula with the combination of the smallest effervescent salt concentration and the greater Avicel PH 102 level, had better compressibility properties than F2 and F3.

Evaluation parameters that are the essence of effervescent preparations are effervescent cessation time and pH of effervescent solution.[14] In this study, researchers used a 200 mL water volume. The temperature of medium used were 9 °C, 30 °C, and 48 °C. On the basis of the results it was found that F3 requires a shorter time to dissolve than F1 and F2 in all temperature variations. This probably happened due to F3 having a combination of acid–base carbonates that was higher than F1 and F2, so F3 had a higher CO₂ content and made the dissolution process faster than F1 and F2.

In addition, effervescent granules from all the three formulas could also dissolve rapidly in line with rising temperatures. This is in accordance with the principle of Le Chatelier, which states that the solubility speed of an endothermic solid substance is influenced by the temperature of the solvent. If the temperature of the solvent is high, the substance will dissolve faster and vice versa. As the temperature of the solvent lowers, the speed of solubility of the substance will also decrease.[12]

**Conclusion**

From the results of this study, it can be concluded that the F3 formulation produced the best effervescent granule preparations that meet general standards of effervescent preparation.

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**Conflicts of interest**

There are no conflicts of interest.

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