The effect of addition different types of binders to the effervescent chemical characteristics of Sonneratia casolaris fruits

P W Ratrinia1*, Sumartini1 and N E Hasibuan1

1Processing of Fisheries Product Study Program, Dumai Marine and Fisheries Polytechnic, Dumai 28824, Indonesia

*Corresponding author: p.weningratrinia@gmail.com

Abstract. Sonneratia caseolaris fruit that has not been widely explored is as an effervescent raw material. The purpose of this study was to determine the effervescent chemical characteristics of Sonneratia caseolaris fruit with the addition of several different types of binders. The research design used in this study was a Completely Randomized Design using four treatments using different binders, namely Polyvinyl Pyrrolidone (PVP), gelatin, Pulvis Gummi Arabicum (PGA), and maltodextrin. The test method used in this research is the analysis of water content, pH value, vitamin C, antioxidants, phenols, and soluble time. Statistical analysis used was the analysis of variance (ANOVA) with a 95% confidence level. The results showed that different binders had a significantly different effect (P<0.05) on the test results for water content, pH, vitamin C, antioxidants, phenols, and soluble time. The addition of gelatin to the effervescent gave the best value on the results of the soluble time test, namely water content, antioxidants, and soluble time. Meanwhile, the addition of PGA gave the best value for the phenolic test results. The conclusion obtained from this study is that the addition of different binders can have a significantly different effect on the effervescent chemical characteristics of Sonneratia caseolaris fruit.

Keywords: binders; effervescent; Sonneratia caseolaris

1. Introduction
Sonneratia caseolaris fruit or often called pedada fruit is one of the types of mangrove fruit that is often used as a food processing material because it has a high nutritional content. In addition, Sonneratia caseolaris fruit is often used for pharmacology because it has a high antioxidant compound. Pedada fruit contains bioactive compounds such as flavonoids, steroids, phenol hydroquinone, and tannins [1]. In addition to antioxidant compounds, pedada fruit also contains vitamins needed by the body. Pedada fruit contains vitamin A 221.97 IU, vitamin B 5.04 mg, vitamin B2 7.65 mg, and vitamin C 56.74 mg [2]. In addition, besides having a high vitamin content, it contains other nutrients such as carbohydrates (76.56% grams), fat/glycerol (0.9 grams/fruit), protein (4.83 grams), and mineral substances [3]. The use of pedada fruit in the food and pharmacology industry is as raw material for making fruit leather [2], nano capsules [3], tempeh making materials [4], and instant drinks [5].

One of the uses of mangrove plants in the pharmaceutical industry is as a raw material for making effervescent. The effervescent powder is preferred because it has an attractive color, smell, and taste. In addition, when compared to ordinary powder drinks, effervescent powder has the advantage of being able to produce carbon dioxide gas which gives a fresh taste like sparkling water [6]. Research on the use of pedada fruit as a raw material for making effervescent has not been explored. Research on the manufacture of effervescent using raw materials from mangrove plants has been carried out, namely by using mangrove leaf extract Rhizophora mucronata and Avicennia Officinalis [7].
In this study, the extracts of mangrove leave *Rhizophora mucronata* and *Avicennia Officinalis* has potential as raw materials for the manufacture of effervescent. The addition of a binder in the process of making effervescent can improve the quality and characteristics of effervescent physically and chemically. The addition of PGA binder and gelatin with different concentrations will affect the physical and chemical quality of the effervescent pomegranate [8]. This study aimed to determine the chemical characteristics of the effervescent fruit of *Sonneratia caseolaris* with the addition of several types of binders.

2. Material and method

2.1. Materials

The tools used are glass (pyrex), porcelain cup, oven (memmert), desiccator (Duran), pH meter (Inolab WTW Series), UV-Visible spectrophotometer (UVmini-1240), 20 mesh sieve, and a stopwatch. The materials used in this study were pedada fruit (*Sonneratia caseolaris*), Polyvinyl Pyrrolidone (PVP), gelatin, Pulvis Gummi Arabicum (PGA), maltodextrin, citric acid, tartaric acid, sodium bicarbonate, CMC, Polyethylene Glycol (PEG), Folin reagent, -Ciocalteu, DPPH, and aquadest.

2.2. Method

The samples of pedada fruit (*Sonneratia caseolaris*) were taken in the mangrove ecosystem area of Yogyakarta. The pedada fruit was collected, then peeled and washed with running water. After washing the pedada fruit, then the clean flesh is sliced and dried in direct sunlight. The dried pedada fruit is then mashed using a blender and sieved. After that, the other ingredients were weighed with the formulation presented in table 1. Polyvinyl Pyrrolidone (PVP), gelatin, Pulvis Gummi Arabicum (PGA), maltodextrin were weighed with a concentration of 2.5% for each treatment. The producing method of effervescent refers to [9] done using all the ingredients that have been weighed, put in a drying oven at 50 °C for 5 minutes. Furthermore, the preparation is carried out in a special room with less than 40% humidity. Each formula was mixed in a mixer at 100 rpm for 5 minutes. After finishing mixing, the powder is placed on a plate or tray and put in an oven at a temperature of 33°C – 40°C. During the drying process, the powder is inverted using an acid-resistant stirrer and a sponge-like mass is formed. Furthermore, the powder is made by grinding and filtering using a 20 mesh sieve to obtain effervescent powder of pedada fruit. Furthermore, the resulting powder is packed in a plastic bag clip and closed quickly and tightly.

### Table 1. The formulation of effervescent *Sonneratia caseolaris* fruits.

| Compounding Component | A (PVP 2.5%) | B (Gelatin 2.5%) | C (PGA 2.5%) | D (Maltodextrin 2.5%) |
|----------------------|-------------|-----------------|--------------|----------------------|
| Binder               | 2,5         | 2,5             | 2,5          | 2,5                  |
| Pedada Fruits Powder | 16          | 16              | 16           | 16                   |
| PEG                  | 2           | 2               | 2            | 2                    |
| Natrium              | 37          | 37              | 37           | 37                   |
| Bicarbonat           | 12          | 12              | 12           | 12                   |
| Citric Acid          | 15          | 15              | 15           | 15                   |
| Tartaric Acid        | 15,5        | 15,5            | 15,5         | 15,5                 |
| Sucralose            | 15,5        | 15,5            | 15,5         | 15,5                 |
2.3. Chemical characteristic analysis

2.3.1. Moisture content. The measurement of water content was carried out by the thermogravimetric method. The cup that will be used in the measurement is dried in an oven at a temperature of 100-105°C until a constant weight is obtained, then cooled in a desiccator and weighed. The sample was weighed as much as 5 grams in a cup, then dried in an oven at a temperature of 100-105°C until a constant weight. The sample is cooled in a desiccator and then weighed. The principle of the water content analysis method is based on the evaporation of water contained in the sample. Weight reduction occurs due to the evaporation of water contained in the sample[10].

2.3.2. pH. After the effervescent powder was completely dissolved in the water, the pH test was carried out using a pH meter (Inolab WTW Series). Each formulation was tested three times [11].

2.3.3. Vitamin C. Measurement of vitamin C levels was carried out by the spectrophotometric method. Analysis of vitamin C levels was carried out in several stages: making 100 ppm vitamin C liquor, determining the maximum absorption wavelength of vitamin C solution, then generating a calibration curve. The method of measuring vitamin C levels begins with weighing a sample of 2.5 g, then the sample is dissolved in 50 ml of aquadest to the mark on the volumetric flask. The solution is diluted then absorbance is measured at the maximum wavelength [12].

2.3.4. Antioxidant activity. To the determination of antioxidant activity, 0.2 mL of each sample with various concentrations was pipette with a micropipette and put into a vial, then adds 3.8 mL of 50 M DPPH solution. The mixture was shaken until homogeneous and left for 30 minutes in a dark place, then the absorption was measured by UV-Vis spectrophotometry at the maximum wavelength of DPPH. The antioxidant activity of the sample by the magnitude of the DPPH radical absorption inhibition can be determined by calculating the percentage of DPPH uptake inhibition [13].

2.3.5. Total phenolic content. Total phenol content was determined by the Folin-Ciocalteu method using gallic acid as the standard. 50 l of the sample, added 250 l of Folin-ciocalteu solution, then allowed to stand for 1 minute and added 750 l of 20% NaCO3, then vortexed, and added with distilled water to a volume of 5 ml. After being incubated for 5 minutes at room temperature, the absorbance was measured at a wavelength of 760 nm. Gallic acid was used as the standard and a calibration curve was made with gallic acid from 31.875 to 510 mg/L with r = 0.99. The result of total phenol calculation is mg Gallic Acid Equivalent (EAG) per gram of dry extract. The analysis was carried out in 3 batches with 3 replications each [14].

2.3.6. Dissolving time. The effervescent powder was prepared for each treatment and then dissolved one by one in 200 mL of water at room temperature. Determine the dissolving time of the powder using a stopwatch and record the time in minutes it takes until the sample is completely dissolved in water [15].

3. Result and discussion

3.1. Moisture content

Moisture content is a significant factor in the manufacture of effervescent powders because water content determines the dissolving time and durability of effervescent powders. The lower the water content of the effervescent powder, the better the effervescent product will be. Moisture content that is too high in the effervescent powder will make the powder clot and not dissolve completely in water to form gas. One of
the parameters that must be met in the manufacture of effervescent powder is the water content, where the moisture content of a good effervescent, according to the standard is 2%-6%. Moisture content is a parameter that determines the quality of microcapsules. A good range of moisture content for microcapsules obtained from spray drying is 2-6% [16].

Figure 1 shows that different treatments of the effervescent filler material of *S. caseolaris* mangrove affected the water content produced by the effervescent mangrove fruit (*p*<0.05). The highest water content was obtained from the use of PVP as a filler, while the lowest water content was obtained from effervescent with gelatin as a filler. The water content is closely related to the effervescent *dissolving* time when brewed. The lower the water content, the faster the *dissolving* time. Figure 1 data shows that all treatments met the standard requirements for good moisture content, namely in the range of 2-6%, except for the F1 (PVP) treatment. The water content is also closely related to the molecular weight where the greater the molecular weight, the smaller the ability to absorb water. The molecular weight of polyvinyl pyrrolidone is 40,000-360,000 g/mol [17]. Maltodextrin has a lower molecular weight (less than 4000 g/mol) and a simpler molecular structure so that water can easily be evaporated during the drying process. PGA has a molecular weight of ± 500,000 g/mol and a more complex molecular structure so that the bonds with water molecules are strong, so when the drying process takes place water molecules are difficult to evaporate and require greater evaporation energy [18]. In addition, PGA has a high molecular weight, complex molecular structure, and there is a large amount of starch in it, so it is more hygroscopic and complex, so as result water in the material is more retained and difficult to evaporate the greater the molecular weight, the lower the water absorption power [19].

The lowest water content was obtained in effervescent powder with maltodextrin and gelatin-coating materials. The molecular weight of the two ingredients is lower than PGA and PVP. In addition, the cross-links formed in the molecular structure of gelatin and dextrin are molecules with simple bonds, making them easier to absorb and evaporate water. Dextrin has a lower molecular weight and a simpler molecular structure so that water can easily be evaporated during the drying process, either in the form of free water, physically, or chemically bound. While PGA has a high molecular weight and complex molecular structure,
there is a large amount of starch in it so that it is more hygroscopic and complex, so the result is that the water in the material is more difficult to evaporate [19].

PGA is better at coating the bioactive ingredients of rosella [20]. Maltodextrin can form a good matrix network, but its viscosity is lower than PGA, causing the drying process relatively longer [16]. The simpler the molecular structure of maltodextrin makes it easier to evaporate water during the drying process [18]. Gelatin has weak cross-links so that it is easily hydrolyzed and can reduce the molecular weight of gelatin and result in a decrease in viscosity [21].

3.2. pH
The pH value is an indicator of the degree of acidity of a product. Based on the degree of acidity, a food ingredient can be classified into three groups of degrees of acidity, namely the first low-acid foodstuffs with a pH range of 5.3 to 4.5, the second moderately acidic foodstuffs with a pH range of 4.5 to 3.7 and the last one is high acid food with a pH value below 3.7 [22]. The pH value of this mangrove fruit effervescent powder is by the specified requirements and is classified as a low acid food ingredient. Based on the effervescent quality requirements, the pH value of the product must be < 6. Indicating the effervescent mangrove fruit of S. caseolaris has met the requirements. The pH value of the effervescent must be acidic because sodium bicarbonate requires an acidic reagent. In the presence of hydrogen ions provided by the acid developer, sodium bicarbonate reacts to release carbon dioxide [23].

The basic characteristic of mangrove fruit is its dominant sour taste, so the pH produced by fresh fruit is relatively low and acidic. Half-ripe pedada fruit acidity value is 3.0 and fully ripe pedada fruit acidity value is 3.2 [24]. Some coating materials have a pH in the range of 5.0-7.0 so that when added to the effervescent powder preparation, it will slightly increase the pH of the resulting effervescent powder. PGA is a hydrocolloid that is easily soluble in water, has a low viscosity, and can form a stable solution at pH 5.0-7.0. PGA in food products can also function as an aroma binder in volatile products such as honey, coating and protecting flavor particles from oxidation, evaporation, and water absorption from the air, as well as a binding device. In addition, PGA can increase stability with increasing viscosity. Viscosity will increase in proportion to the increase in concentration. In addition to increasing viscosity, the addition of PGA to honey drinks will have an effect on increasing the pH of the resulting product [25].
3.3. Vitamin C

Determination of vitamin C levels was carried out using a UV-Vis spectrophotometer with a wavelength of 260 nm using standard vitamin C as a positive control. The solvent used is aqua distillate because vitamin C is a water-soluble vitamin. The results of vitamin C testing on effervescent powder from *S. caseolaris* mangrove fruit ranged from 0.62% to 1.17%. Based on the results of vitamin C testing, vitamin C levels in effervescent powder can be influenced by vitamin C levels from the raw material, namely *S. caseolaris* mangrove fruit. Pedada fruit contains vitamin A 221.97 IU, vitamin B 5.04 mg, vitamin B2 7.65 mg and vitamin C 56.74 mg [2]. The most suitable fruit used for processing into food products should have a vitamin C content greater than 0.01%. Thus the levels of vitamin C contained in pedada fruit meet the requirements to be processed into raw materials for effervescent products [26].

Figure 3 shows that different treatments of *S. caseolaris* effervescent fillers affected the vitamin C content produced by mangrove effervescent fruit (P<0.05). Based on the test results, the content of vitamin C in the addition of maltodextrin treatment had the highest level of 1.17%. The addition of maltodextrin
affects the levels of vitamin C in the sample. The higher the added maltodextrin, the less damage to vitamin C in the sample. Vitamin C will be damaged during the heat treatment process so that vitamin C will be oxidized by heat and become damaged, but maltodextrin can at least maintain the vitamin C content in the resulting product so that it is not completely deteriorated [27]. Maltodextrin is an encapsulated material that can protect nutritional components including antioxidant activity, and strong binding capacity to coated compounds. The maltodextrin capsule wall can protect sensitive components such as antioxidant components, flavors, vitamins, colors, and other nutritional components [28].

3.4. Antioxidant activity
Determination of antioxidant activity was carried out by the DPPH method. The antioxidant activity test was carried out by measuring the DPPH reagent solution at the maximum wavelength which was reacted with the test solution and then measured by a spectrophotometer which was expressed by the percentage of attenuation and then plotted against the concentration. The higher the concentration of the test solution, the more antioxidant compounds that become hydrogen or electron donors to the DPPH radical, causing the resulting absorbance to be smaller [29]. Quantitative measurement of the antioxidant activity of a material can be seen from the occurrence of color decaypurple on Diphenylpicrylhydrazyl (DPPH) material. If the DPPH solution is added to ingredients containing antioxidants, the intensity of the color of the DPPH solution will decrease according to the concentration and inhibition of materials containing antioxidants [30].

Based on the results of antioxidant activity testing, the addition of different fillers affected the results of the antioxidant activity test (P<0.05). The results of antioxidant activity in the addition of gelatin treatment had the highest inhibition value of 28.58%. This type of matrix had a significant effect on the antioxidant activity of effervescent tablets [20]. Making effervescent with the addition of a binder in the form of gelatin can reduce the number of free radical neutralization up to 70.72%. The formulation process in effervescent preparations, which is added with gelatin as a binder can also affect the process of neutralizing free radicals [31]. The results of the determination of antioxidant activity in effervescent are also influenced by antioxidant compounds found in the raw material of S. caseolaris mangrove fruit. Pedada fruit extract using methanol has a higher ability to ward off free radicals. In addition, the antioxidant components in pedada fruit extract are known to be polar. The bioactive components found in methanol extract include alkaloids, steroids, flavonoids, carbohydrates, reducing sugars, phenols, hydroquinones, and amino acids [32]. The antioxidant activity of S. caseolaris mangrove fruit can also be influenced by several other environmental factors such as oxygen availability, substrate type, etc. Mangroves have the characteristics and species composition of each mangrove forest influenced by weather factors, coastal landforms, the distance between tides, water availability, oxygen, and soil type [33].

3.5. Total phenolic content
Total phenol analysis in this study used the Folin-Ciocalteu method. Phenols include various compounds of plant origin and have the same characteristic, namely an aromatic ring containing one or two hydroxyl groups. Flavonoids are the largest phenol group; besides that, there are also simple monocylic phenols, phenylpropanoids, and phenolic quinones [32]. Phenol compounds are found as natural antioxidants. Phenol compounds and plant phenol extracts are antioxidants that can inhibit lipid oxidation in seafood [34]. Polyphenol compounds from plants are bioactive sources that can be used as antioxidants, immunostimulants, and antibacterials [35].

Based on the results of this study, the addition of different fillers affected the total phenol test results (P<0.05). The addition of PGA as a filler in effervescent mangrove fruit has the highest total phenol number, 37.7 mGAE/100g. The addition of PGA as a filler affects the total phenol content in the effervescent product. Microencapsulation of rice bran with maltodextrin coating, PGA and a combination of maltodextrin and
PGA where from this study, the highest total phenol was found in the type of encapsulated PGA with a value of 623.99 mg/g microcapsules at a concentration of 10%. In contrast, the lowest total phenol value was found in the type maltodextrin encapsulation was 302.34 mg/g microcapsules at 20% concentration.

The total phenol content in the PGA encapsulated type was higher than in the maltodextrin type because the emulsifying properties of PGA were better than maltodextrin.

In addition, the type of matrix had a significant effect on the total phenol value of the effervescent tablets. The antioxidant activity of effervescent tablets using Arabic gum was 34.02% higher than that using maltodextrin matrix, which was 26.85%. This is because the content of vitamin C and total phenol in the nanocapsules made from PGA is greater than the nanocapsules used in maltodextrin [20].

![Figure 5. Total Phenolic Content of S. caseolaris mangrove fruit effervescent with different binder material. F1: PVP; F2: Gelatin; F3: PGA; and F4: Maltodextrin.](image1.png)

![Figure 6. Dissolving time of S. caseolaris mangrove fruit effervescent with different binder material F1: PVP; F2: Gelatin; F3: PGA; and F4: Maltodextrin.](image2.png)
3.6. Dissolving time

The main parameter that must be met to test the quality of the effervescent powder is the dissolving time. The effervescent powder has a good quality where the powder can quickly dissolve completely in water. Dissolving time testing was carried out with effervescent powder prepared for each treatment and then dissolved one by one in 200 mL of water at room temperature. The dissolving time of the powder was determined using a stopwatch and recorded the time in minutes it took for the sample to be completely dissolved in water. The dissolving time test is carried out to determine the length of time required by a powder preparation to completely dissolve in a certain volume. The dissolving time of the effervescent granules is less than 10 minutes (maximum 600 seconds) [22].

Based on figure 6, the results of the dissolution time test showed that all effervescent powders/ granules of mangrove fruit produced from different types of binders had soluble times according to the standard (<600 seconds). The results of this dissolving time test are closely related to the results of the water content test, wherein Figure 6 the best dissolution time is produced in effervescent powders using maltodextrin and gelatin-coating materials, this is also supported by a lower water content value than effervescent powders which made from PVP coating and PGA. The high solubility of microcapsules is due to the presence of maltodextrin. The factor that affects the solubility in water of maltodextrin is the amount of dextrose equivalency (DE). The higher the DE value, the better the solubility level [25]. In addition, based on the results of this study, the water content of the effervescent with the addition of maltodextrin binder has low water content. The solubility of a material in water is influenced by the water content of the material in question. The high water content in the material causes the material to be difficult to spread in water because the material tends to be sticky so that no pores are formed; as a result, the material is not able to absorb large amounts of water, in addition, materials with high water content have a narrow surface to be wetted because of the high water content. The granules are large so that they stick together between the granules [25]

4. Conclusions

The results showed that the use of different binders had a significantly different effect (p<0.05) on the test results for water content, pH, vitamin C, antioxidants, phenols, and soluble time. The addition of gelatin to the effervescent gave the best value on the results of the soluble time test, namely water content, antioxidants, and soluble time. Meanwhile, the addition of PGA gave the best value for the phenolic test results. The conclusion obtained from this study is that the addition of different binders can have a significantly different effect on the effervescent chemical characteristics of Sonneratia caseolaris fruit.

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