Diversify the processing of chayote (Sechium edule) into dodol to increase its added value

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Abstract. Chayote (Sechium edule) or often called jipang or labu siam in Indonesian, is generally consumed by the public as a vegetable. If the harvest is abundant, the chayote's price will be low; thus, many of the chayotes are left alone or thrown away or become livestock feed. The chayote processing into "dodol" is an alternative to overcome the abundance of chayote during the harvest season so that the chayote farmers still have a decent income from their chayote farming. This research was conducted in Bernung Village, Gedong Tataan District, Pesawaran Regency, Lampung Province, from October to December 2018. The parameters observed were the content of water, ash, crude fiber, fat, protein, carbohydrate, vitamin C, energy levels, consumer preference (color, flavor, taste, and stickiness), and economic analysis of the chayote dodol. The results of this research showed that the chayote dodol contained complete nutritional content, i.e., water (20.07%), ash (1.26%), crude fiber (1.18%), fat (3.09%), protein (2.15%), carbohydrate (72.24%), vitamin C (0.46 mg/g), and energy (701.03 cal/g). Moreover, consumer acceptance for the color, flavor, taste, and stickiness were excellent, with an average score of > 4 (very like) and very feasible to develop into commercial, with an R/C ratio of 1.95.

1. Introduction
Chayote (Sechium edule) is a type of vine, and the part that is eaten is the fruit and young shoots. Chayote contains various nutrients and vitamins that are very important and beneficial for body health, such as vitamin C, vitamins such as B complex, folic acid, riboflavin, niacin, thiamin, and pantothenic acid. Besides, chayote also contains high fiber content, namely 1.7 g/100 g, and several mineral contents, such as Mn, Fe, Zn, and P [1]. Consumption of adequate amounts of fiber can overcome constipation, safe for sensitive stomachs or colitis and can obviously increase stool frequency [2,3]. Research by Saade R L (1996) and Modgil M et al. (2004) shows that 100 grams of chayote contain calories (26-31 kcal), protein (0.9-1.1%), fiber (0.4-1.0%), flavonoids (0.95%), calcium (12-19 mg), vitamin A (5 mg), and other ingredients that benefit to the human body [4,5].

Dodol is a traditional food and is usually eaten as a snack, has a sweet, savory, brown color, soft texture, and classified as semi-wet food [6]. Even though it is included in the semi-wet food category, dodol can last longer due to sugar added. Sugar is added to improve the flavor [7]. It can also be used as a preservative [8]. The manufacture of dodol usually only uses the main ingredients, such as glutinous rice flour, sugar, and coconut milk. Nowadays, dodol is being produced with the addition of
other products such as fruit, one of which is chayote. Chayote is usually used as vegetables, but with a simple innovation, chayote can be processed into dodol. Dodol contains nutrients and vitamins that are very useful for health. It has a higher selling price compared to selling in raw form. Chayote dodol is categorized into fruit dodol. It can be defined as a type of preserved food made from fruit juice or fruit pulp with added sugar and glutinous rice flour, which cooked until thickened and not sticky [9]. Chayote dodol is one of the new alternatives for food processing with a different taste. It has a distinctive flavor, but the texture is still in accordance with the characteristics of standard products and can be accepted by the public. Chayote dodol is one of the safe and healthy processed foods. It does not contain saturated fat or cholesterol and also harmful food additives. However, the exact composition of chayote dodol is not known in the manufacturing process [10].

The chayote fruit used as raw material for making dodol is a low-quality fruit. The size of such fruit does not meet the standard, or the fruit is too ripe, so it is not suitable to be processed as vegetables. Thus, the processing of chayote into dodol can be a solution to increase the price of rejected chayote. Therefore, this study aimed to determine the opportunities to process chayote into dodol on its nutritional quality, consumer acceptance, and economic analysis.

2. Materials and methods
This research was conducted at Bernung Village, Gedong Tataan District, Pesawaran Regency, from October to December 2018. The treatment applied in this study was a single treatment, namely making chayote dodol. The quality of the chayote dodol was measured using parameters such as proximate analysis (water, ash, crude fiber, fat, protein, and carbohydrate), vitamin C, energy, and consumer preference level (color, flavor, taste, and stickiness). The economic analysis of the chayote dodol production was also carried out to determine its feasibility. Quality analysis of the chayote dodol was carried out in the Laboratory of Agricultural Product Technology, Lampung State Polytechnic. Consumer preference analysis was carried out by 25 panelists using a hedonic scale with score of 1-5 (score 1 = dislike; score 2 = rather like; score 3 = like; score 4 = very like; score 5 = very, very like). The economic analysis of the chayote dodol was carried out by calculating the difference between the input and output components. The collected data were analyzed qualitatively descriptive.

The ingredients used for making dodol chayote were chayote, sugar (15%), brown sugar (25%), glutinous rice flour (10%), jelly (0.1%), and thick coconut milk (25%). The amount of ingredients used were based on the weight of the chayote. The flow chart for making chayote dodol was presented in figure 1.
Chayote

Stripping

Grated

Grated chayote + brown sugar + granulated sugar + glutinous rice flour + gelatin, mixed coconut milk until homogeneous

Cooked while stirring until thickened

Pour into a plastic tray, let it hardened and can be cut into pieces

Packing

Chayote dodol

Figure 1. Flowchart of making chayote dodol.
3. Results and analysis

The result of the proximate analysis of chayote dodol was presented in Table 1. The result of the nutritional content analysis of chayote dodol (Table 1) showed that most of the chayote dodol content was carbohydrates (72.24%), which meant that chayote dodol could be used as a good source of energy. The high level of carbohydrates in the chayote dodol was caused by glutinous rice flour added in dodol. Glutinous rice flour is one of a source of carbohydrate [11]; hence, it affected the carbohydrate content of the dodol produced [12]. The result of this study also indicated that the chayote dodol contained other nutrients such as ash (1.26%), crude fiber (1.18%), protein (2.15%), and fat (3.09%), which contributed from the nutrients in the chayote and other ingredients used. According to Agbaje R et al. (2016), besides carbohydrates as its main component, glutinous rice flour also consisted of several other nutrients, such as protein, fat, ash, vitamins, and minerals [10].

Table 1. The result of the proximate analysis of chayote dodol.

| No. | Parameter         | Total content (%) (w/w) |
|-----|-------------------|-------------------------|
| 1.  | Water content     | 20.07                   |
| 2.  | Ash content       | 1.26                    |
| 3.  | Crude fiber       | 1.18                    |
| 4.  | Protein           | 2.15                    |
| 5.  | Fat               | 3.09                    |
| 6.  | Carbohydrate      | 72.24                   |

The ash content in the chayote showed also the content of the mineral. The research results of Lage MD et al. (2019) and Vieira EF et al. (2019), showed that chayote contains the minerals potassium, magnesium, and sodium [13,14]. The crude fiber was an important component of chayote, because it eased human digestion. Data of USDA (2013) showed that chayote has a fairly good crude fiber content, namely 1.7% [1], while from the results of this study, the crude fiber content in chayote dodol was lower namely 1.18%. This was due to the addition of other ingredients such as sugar, glutinous rice flour, and coconut milk, which caused a change in the total percentage of each nutritional component contained in the chayote dodol. Consumption of adequate amounts of fiber was very good for dealing with constipation and safe for sensitive stomachs or colitis [15]. Dietary fiber can also reduce the risk of cancer caused by an imperfect digestive system because, while in the digestive tract, food fiber will bind carcinogenic (cancer-causing) substances. In addition, dietary fiber was able to reduce the transit time of food from the oral cavity until the food scraps were excreted in the form of feces, as a result, the chance of cancer was getting smaller [16]. The protein content in chayote dodol was contributed by the ingredients, such as glutinous rice flour and jelly, while the fat content in chayote dodol was mostly contributed by coconut milk.

Chayote dodol contained a quite good vitamin C and energy, in addition to other nutritional content. The analysis results of vitamin C and energy were presented in Table 2.

Table 2. The results of vitamin C and energy of chayote dodol.

| No. | Parameter        | Total Content   |
|-----|------------------|----------------|
| 1.  | Vitamin C (mg/g) | 0.46           |
| 2.  | Energy (cal/g)   | 701.03         |

Table 2 showed that the chayote dodol produced 0.46 mg/g of vitamin C content and 701.03 cal/g of energy level. Chayote contained nutrients that were good for health, such as vitamins A and C, calcium, calories, and saponins [17]. They were beneficial in inhibiting and preventing strokes, preventing cancer, and lowering blood pressure. The content of vitamin C in processed chayote varied, depending on the additional ingredients used and the type of preparation being made. This statement was evident from vitamin C content in chayote in this study, namely 0.46 mg/g, which was higher than that in candied chayote from the research of [18], which ranged from 0.13 mg/g until 0.26 mg/g.
Meanwhile, the Indonesian Food Composition Table data showed that fresh chayote contained vitamin C of 0.18 mg/g [17]. The higher vitamin C content in the current study was due to the additional ingredients used for making Chayote dodol, such as coconut milk and jelly, which have complex nutritional elements, including vitamin C [19,20]. The calorie of the chayote dodol in this study was 701.03 cal/g. Meanwhile, the data of USDA (2013) showed that the calorie of fresh chayote was 190 cal/g [1]. The increase in calorie levels in chayote dodol was caused by the addition of sugar and glutinous rice flour as a source of calories.

Chayote dodol is a new type of chayote processed; therefore, it is necessary to test the level of consumer preference. The result of the level of consumer preference of chayote dodol was presented in figure 2.

3.1. Color
The color assessment of the chayote dodol was done visually using the sense of sight. Chayote dodol has a brownish color, caused by the browning reaction due to the Maillard reaction and caramelization. Maillard reaction occurred when sugar was heated. Meanwhile, caramelization occurred when sugar was heated above its melting point and changed the color into brown, accompanied by additional flavors [21].

3.2. Flavor
Assessment of the flavor of the chayote dodol was carried out using the sense of smell. The flavor of a food ingredient was influenced by the volatile compounds contained in it. Volatile compounds were organic compounds that have a molecular weight range of 50-200 Dalton. In a low molecular weight ingredient, volatile compounds can quickly evaporate and diffuse in the gas phase and biological systems [22]. However, Chayote does not contain distinctive volatile compounds, so the flavor of chayote dodol was almost the same as ordinary dodol.

3.3. Taste
The assessment of the preference level for taste was carried out using the sense of taste. Chayote dodol has a sweet taste caused by the addition of sugar and brown sugar as sweeteners. According to Lukito et al. (2017), apart from providing sweetness, the addition of sugar and brown sugar caused the texture of dodol to chewier [23].
3.4. Stickiness
The stickiness was tested by pressing dodol using the panelist’s finger. The stickiness was caused by glutinous rice flour added. The function of glutinous rice flour was to form the structures of dodol and bind it with the other food ingredients. Glutinous rice flour will undergo gelatinization when heated with the addition of liquid. Its high amylopectin content will cause the dodol dough more compact and dense, following the desired dodol texture [24]. Figure 1 showed that the chayote dodol stickiness of this study was accepted by the consumer, determined by a score of > 4 (really like). This score indicated that chayote processing into dodol has good prospects to develop into a broader business scale.

3.5. Economic analysis
A revenue cost ratio (R/C ratio) was calculated to determine the feasibility of making chayote dodol. The data were presented in table 3.

| No. | Description of activities         | Volume | Unit (Rp) | Total (Rp) |
|-----|----------------------------------|--------|-----------|------------|
| A.  | Activity Materials               |        |           |            |
| 1   | Chayote                          | 30 kg  | 2,000     | 60,000     |
| 2   | Coconut                          | 30 pc  | 2,500     | 75,000     |
| 3   | Glutinous Rice Flour             | 2.5 kg | 8,000     | 20,000     |
| 4   | Brown sugar                      | 7.5 kg | 14,000    | 105,000    |
| 5   | Sugar                            | 5 kg   | 11,000    | 55,000     |
| 6   | Jelly                            | 10 pc  | 2,000     | 20,000     |
| 7   | Salt                             | 0.5 ounce | 1,000 | 5,000     |
| 8   | Packing                          | 80 pc  | 350       | 2,000      |
|     | Total Material Costs             |        |           | 363,500    |
| B.  | Labor wages making chayote dodol | 5 day  | 50,000    | 250,000    |
|     | (5x0.5 day)                      |        |           |            |
|     | Total Cost of labor              |        |           | 250,000    |
|     | Total Production Costs (A + B)   |        |           | 613,500    |
| C.  | Output                           |        |           |            |
|     | Chayote dodol (20 kg)            | 80 pc  | 15,000    | 1,200,000  |
| D.  | R/C ratio                        |        |           | 1.95       |

The processing of chayote into dodol has considerable opportunity to be developed on a business scale. Based on the calculation of the economic analysis, it showed that the processing of dodol gives a real advantage with an R/C ratio of 1.95. Revenue cost ratio is a test of feasibility analysis that compares total revenue with total costs incurred. The criteria used in this analysis are as follows: if the value of R/C > 1, then the business is profitable and feasible to run because the amount of income is greater than the costs incurred. On the contrary, if the value of R/C is <1, then the business is a loss and not feasible to be done [25]. For marketing strategies, one can refer to the research of Achmadi N S et al. (2018), which applies the marketing mix or 4P system, namely product, place, price, and promotion [26].

4. Conclusions
Processing chayote into dodol can be used as one solution for product diversification to increase its added value. It has a fairly complete nutritional content i.e.: water (20.07%), ash (1.26%), crude fiber (1.18%), fat (3.09%), protein (2.15%), carbohydrate (72.24%), vitamin C (0.46 mg/g), and energy (701.03 cal/g). Moreover, the levels of consumer acceptance for the color, aroma, taste, and stickiness
are great, with an average score of > 4 (very like). It is very feasible to operate commercially, with a B/C ratio of 1.95.

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