Chemical characteristic of sweet passion fruit (Passiflora lingularis Juss) seeds from Indonesia based on maturity levels

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Abstract. Sweet passion fruit (Passiflora ligularis Juss) cv. Gumanti is superior varieties of sweet passion fruit that is widely cultivated in Solok Regency of West Sumatra Province, Indonesia. This fruit can consume directly as fresh fruit and can be processed into juice that gave a by-product such as the seeds. The purpose of this research is to analyse the chemical properties of sweet passion of cv. Gumanti seed based on maturity level so that the nutritional content is known. Chemical analyses were performed such as proximate analysis, total phenol and antioxidant activity. Proximate analysis showed that the seeds of passion fruit are rich in carbohydrates+fibre (61.04%, 58.40% and 60.39% and crude fat (21.03%, 20.36% and 20.83%, respectively for maturity level I, II, and III), didn’t give significant difference based on maturity level (P>0.05). Furthermore, the result showed strong antioxidant activity (IC$_{50}$: 50-100 ppm), where there was a significant based on maturity level (P < 0.05). Total phenol analysis showed a linear relationship with antioxidant activity. Thus, the seeds of sweet passion fruit also have potential as a raw in the food industries, chemical, and pharmacy such as the seeds of acid passion fruit that have been reported by previous researchers.

1. Introduction
Passion fruit plants (Passiflora spp) is part of Passifloraceae family which is one of the horticultural products cultivated in Indonesia [1]. There are three types of passion fruit grown in Indonesia, namely passion fruit with purple fruit (P. edulis f. edulis Sims), sour passion fruit with yellow rind or yellow passion fruit (P. edulis Sims f. flavicarpa Deg.), and sweet passion fruit (P. ligularis Juss) [2]. Sweet passion fruit (Juss P. ligularis) with superior varieties Super Solinda and Gumanti are types of passion fruit that are widely cultivated in West Sumatra, one of the provinces in Indonesia. The passion fruit or sweet passion fruit can be consumed directly as fresh fruit because it has a sweet and refreshing taste, as well as be processed into juice or syrup.

When passion fruit is extracted into juice or syrup, passion fruit seeds are often ignored in the fruit processing. Although its composition in passion fruit is quite small at 6% compared to pulp in the form of pulp and fiber (43.6%) and skin (50.4%) [3], the seed can contribute to an environmental problem when the amount is quite large. In fact, several studies reported that passion fruit seeds contain nutritional components such as protein, fiber, carbohydrates, fats, and minerals [4-6]. In addition, the fruit seeds are also a good source of oil. Studies on the content of passion fruit seed oil have been conducted by previous researchers for the yellow passion fruit passion fruit oil (P. edulis Sims f. Flavicarpa Deg.) [5,7,8]. The purple fruit (P. edulis Sims var. edulis), the purple Kawanda hybrid which is a cross between yellow with purple fruit and passion-fruit light yellow fruit (Passiflora maliformis
L.) [8], and the passion fruit Tainung No. 1, a type of passion fruit produced by a cross of yellow with purple passion fruit that is widely cultivated in China [4]. Meanwhile, there is no information on the chemical components of sweet passion fruit seeds from West Sumatra.

The chemical components contained in the fruit directly affect the quality of the fruit and the processed products it produces. One of the factors that influence the quality of fruit and processed products is level of maturity. Patel et al. acknowledged that important factors that affect fruit quality and the changing of the level of quality during postharvest handling is harvesting at the appropriate level of maturity [9]. However, there is still little information about the quality of seeds from fruit based on the level of fruit maturity. Therefore, the purpose of this study is to analyze the chemical properties of seed of CV. Gumanti is widely cultivated in Solok, West Sumatra based on fruit maturity levels, to obtain information of its nutritional content.

2. Materials and methods

2.1. Sample preparation
Passion fruit seeds were obtained from the sweet passion fruit of Gumanti variety which had been harvested from farmer’s land in Air Dingin Village, Solok Regency, West Sumatra, Indonesia (height of 1458 m AMSL and coordinates 010 57’ 18” - 010 13’ 32” LS and 1000 44’ 48” – 1000 55’ 45” BT). Passion fruits were harvested at three maturity levels based on skin color, i.e. maturity level I (skin color 90% green), level II (skin color 25% green and 75% yellow) and level III (skin color 100% yellow). The passion fruit seeds were removed from passion fruit manually prior to wash with distilled water and dried at room temperature for two weeks. The seeds were then packed in polyethylene plastic and stored at room temperature until they were used for analysis [5].

2.2. Chemical analysis
The chemical analysis carried out was the analysis of proximate composition, fatty acid composition, antioxidant activity, and total phenolic compounds. Before the chemical analysis was conducted, passion fruit seeds were reduced in size using a blender.

2.2.1. Proximate composition of the seeds. The measurement of proximate composition refers to the standard method, namely Association of Official Analytical Chemists [10]. The proximate composition parameter includes water, protein, fat, ash, carbohydrate and fiber content. Moisture content was determined using oven method by drying the sample until the water content was constant at 105 °C. Proteins were determined using the Kjeldahl method and crude protein was calculated using the multiplication factor 6.25. Coarse fat was determined using the Soxhlet method with n-hexane solvent. Ash content was determined using the gravimetric method. Carbohydrates and fibers contents were calculated by subtracting the sum of the percentages of moisture, lipids, protein and ash from 100%. The analysis was carried out with three replications.

2.2.2. Fatty acid composition. Analysis of fatty acid levels refers to AOAC [10]. In this method, the fat is extracted into ether and then methylated to obtain fatty acid methyl esters (FAMEs). Furthermore, FAMEs were identified by gas chromatography, using a Shimadzu GCMS QP2010 (Shimadzu Corporation; Tokyo, Japan). The injector and detector temperatures were 230°C and 250°C, respectively. The oven temperature was initially held at 50°C, and then increased to 250°C at 5°C / min and held at 250°C for 20.55 min. Helium was used as a carrier gas at a pressure of 119.3 kPa.

2.2.3. Total Phenolic Content (TPC). The content of the total phenolic compounds (mg/g) in the methanol extracts was determined by the Folin-Ciocalteu method. The absorbance was read at 725 nm against a reagent blank using a UV-vis spectrophotometer (Shimadzu, Kyoto, Japan).
2.2.4. **Antioxidant activity.** Antioxidant activity was measured using DPPH (2,2-diphenyl-1-picrylhydrazyl radical) method referring to Brand-Williams et al. [11]. The extracts were solubilized in methanol at different concentrations. The absorbance of the resulting solution was measured at 517 nm using UV-vis spectrophotometer (Shimadzu, Kyoto, Japan). The number of samples needed to reduce the initial DPPH concentration by 50% (EC50) was calculated graphically by plotting the remaining DPPH percentage, estimated according to the standard curve, to the sample concentration (10, 25, 50, 75 and 100 mg / mL). The analysis was carried out with three replications.

2.3. **Statistical analysis**

Data collected from this study were analyzed by One-way analysis of variance and the Duncan test using IBM SPSS Statistics 19. Evaluations were based on the P< 0.05 significance level.

3. **Results and discussion**

3.1. **Proximate analysis**

The composition of the components or nutrients contained in the *Passiflora ligularis* Juss cv. Gumanti seeds at different maturity levels is shown in Table 1. Sweet passion fruit seeds are rich in carbohydrates + fiber (61.04%, 58.40% and 60.39%) and fat (21.03%, 20.36% and 20.83%) respectively for maturity level I, II, and III. However, it contains little protein (6.40%, 8.25% and 6.40%), and ash (1.91%, 2.70% and 2.58%) respectively for maturity levels I, II, and III. Carbohydrate + fiber content in *Passiflora ligularis* Juss cv. Gumanti seeds is bigger than the yellow passion fruit (*Passiflora edulis* f. *Flavicarpa*) seed as reported by Malacrida and Jorge [5] which was 48.73%. According to Chau and Huang [12], passion fruit seeds contained a lot of total dietary fiber (64.8%) and insoluble fiber was the most abundant fiber fraction, so it is a source of fiber that is beneficial for digestion.

Furthermore, *Juss Passiflora ligularis* cv. Gumanti seeds is also rich in crude lipids which is almost the same as Kawanda hybrid (21.4%), and *Passiflora edulis* Sims var. flavicarpa (20.6%), higher than 18.5% of *Passiflora edulis* Sims var. edulis [8]. However, its number is smaller than 30.39% of *Passiflora edulis* f. flavicarpa [5], 28.3% of *Passiflora maliformis* L. [8], 24.5% of Tainung No. 1 passion fruit seeds [12]. The high content of crude lipids in passion fruit seeds shows that passion fruit seeds was a good source of oil which was higher than soybean oil (18%) [5] and could be used in specialty foods and salad dressings [13].

| Table 1. Chemical composition and antioxidant activity of passion fruit seeds. |
|-------------------------|-------------------------|-------------------------|-------------------------|
| Proximate composition   | Value \(^1\)             | Maturity level          |
|                         | I                        | II                      | III                     |
| Moisture (%)            | 9.53 ± 0.19 \(^b\)       | 10.29 ± 0.21 \(^a\)     | 9.80 ±0.13 \(^b\)       |
| Crude Lipid (%)         | 21.03 ± 1.47 \(^a\)      | 20.36 ± 0.78 \(^a\)     | 20.83 ±1.87 \(^a\)      |
| Crude Protein (%)       | 6.49 ± 0.28 \(^b\)       | 8.25 ±0.09 \(^a\)       | 6.40 ±0.22 \(^b\)       |
| Ash (%)                 | 1.91 ± 0.08 \(^b\)       | 2.70 ±0.06 \(^a\)       | 2.58 ±0.03 \(^a\)       |
| Carbohydrate + Fibre (%)| 61.04 ±1.41 \(^a\)       | 58.40 ±0.77 \(^a\)      | 60.39 ±2.04 \(^a\)      |
| Total phenolic (mg /g)  | 50037.71 ± 261.95 \(^a\)| 46333.2 ±164.61 \(^b\)  | 45519.3 ±117.87 \(^c\)  |
| Antioxidant activity    | 60.05 ± 0.31 \(^a\)      | 55.61 ±0.19 \(^b\)      | 54.63 ±0.14 \(^c\)      |

\(^1\) Mean value ± standard deviation (n = 3).

Means in the same row with different superscripts are significantly different (P < 0.05).

Proximate composition varied from 9.53 to 10.29%, from 20.36 to 21.03%, from 6.40 to 8.25%, from 1.91 to 2.70% and from 58.40 to 61.04% respectively for water content, crude lipid, crude protein, ash,
carbohydrate and fiber. The highest crude lipid content (21.03%) and the highest carbohydrate + fiber (61.04%) from passion fruit seeds were found in fruit with maturity level I, but not statistically significantly different from the maturity levels II and III (P> 0.05). Meanwhile, water content, crude protein, and ash were influenced by the level of maturity (P <0.05). The fruit with maturity level II produced highest water content (10.29%), highest protein (8.25%) and highest ash (2.70%). Changes in the composition of these components were similar to the increase in the components of nitrogen and phosphorus proteins from mature sweet gum seeds [14].

In this study, the maturity level of passion fruit was determined based on changes in fruit color. Fruit color changes was still the best maturity index and could show the maturity phase of the seeds (Bonner, 1972). Phenomenon of change (decrease and increase) of crude lipid and carbohydrate + fiber content of Passiflora ligularis Juss seeds cv. Gumanti was similar to changes in the total dissolved solid content of acid passion fruit, although the maturity index used was different [15]. Maturity level I was the culmination of the fruit growth process, although the respiration process was still low so that carbohydrate changes were small. Maturity level II was climacteric peak where the respiration process was higher so that a lot of carbohydrate changed into organic acids is shown by the reduced amount of carbohydrate content. Furthermore, at the maturity level III, respiration occurred again, but followed by a change of starch into simple sugars.

3.2. Fatty acid composition
Passion fruit oil chromatography profile for all three maturity levels together shows that there were 50 peaks which indicate there were 50 possible compounds in passion fruit seed oil. The largest area was 24.9% with retention time of 33,677, 35.10% with retention time of 33,764, and 40.10% with retention time of 33,735 respectively for maturity levels I, II and III. The compound indicated by this area was 9,12-Octadecadienoic acid (Z,Z) with the chemical formula C\textsubscript{18}H\textsubscript{32}O\textsubscript{2} and 280 molecular weight which were stereoisomers of linoleic acid. These types of fatty acids include unsaturated fatty acids which were also found in corn, sesame, soybean, as well as sunflowers, were commercial fatty acids [13]. Passion fruit oil could also be used in the food industry and cosmetics products.

3.3. Total Phenolic Content (TPC)
The result of this study indicates that passion fruit seed TPC is influenced by the level of fruit maturity (P <0.05). The TPC value of passion fruit seeds decreases with maturity of passion fruit. It similar to study by Murukan and Murugan for TPC content of mature and young teak leaves extracts, i.e. 30.28 mg GAE/g and 46.12 mg GAE/g respectively [16].

3.4. Antioxidant activity
The antioxidant power of passion fruit seeds with DPPH method (60.05, 55.61 and 54.63 respectively for maturity levels I, II and III) showed a strong antioxidant value. However, this antioxidant value is lower than the antioxidant value of seed oil of Passiflora edulis f. flavicarpa [5]. They found that the Passiflora edulis f flavicarpa seed oil had very strong antioxidant value which was indicated by the low EC\textsubscript{50} value of 10.62.

Furthermore, the antioxidant power of the Passiflora ligularis Juss cv. Gumanti seed oil is also influenced by the level of fruit maturity (P <0.05). The antioxidant power decreases as the fruit grows. However, all three levels of fruit maturity indicate that passion fruit seeds have strong antioxidant power. Murukan and Murugan also found that the antioxidant activity of young teak leaves extracts was stronger than the mature one [16].

Activity value of antioxidant of Passiflora ligularis Juss cv. Gumanti seed oil shows a linear relationship with the TPC value. It can be explained that plants that have antioxidant and pharmacological properties were related to the presence of phenolic compounds, especially phenolic acids and flavonoids [17]. Thus, Passiflora ligularis Juss cv. Gumanti seed oil can be used as a food preservative or health.
4. Conclusion
The results of this study indicated that the level of maturity of sweet passion fruit cv. Gumanti affects the chemical components of passion fruit (moisture, protein, ash, total phenolic, and antioxidants). Passion fruit seeds had the potential as a source of carbohydrates + fiber and oil. Passion fruit oil could be used in the food industry, as well as make-up and health products since they contained powerful antioxidants.

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References
[1] Do Nascimento E, Mulet A, Ascheri J, de Carvalho C and Carcel J A 2016 “Effects of high intensity ultrasound on drying kinetics and antioxidant properties of passion fruit peel,” J. Food Eng. 170 108-118
[2] Marpaung A E and Karo B B 2016 “Karacterisasi dan Evaluasi Markisa Asam Hibrid Hasil Persilangan Markisa Asam Ungu dan Merah (Passiflora sp.) [Characterization and Evaluation of Hybrid Acid Passion from Crossing between the purple and the Red Acid Passion Fruit (Passiflora sp.)],” J. Hort. 26(2)
[3] Sianipar J, Krishnan R, Simanihuruk K and Batubara L P 2006 “Evaluation of three types of agricultural waste as feed for cut goats [Evaluasi Tiga Jenis Limbah Pertanian Sebagai Pakan Kambing Potong],” Proceedings of National Seminar on Animal and Veterinary Technology [Seminar nasional teknologi peternakan dan veteriner] pp. 480-489.
[4] Shucheng L, Yang F, Li J, Zhang C, Ji H and Hong P 2008 “Physical and chemical analysis of Passiflora seeds and seed oil from China,” International Journal of Food Sciences and Nutrition 59(7-8) 706-715
[5] Malacrida C R and Jorge N 2012 “Yellow Passion Fruit Seed Oil (Passiflora edulis f. flavicarpa): Physical and Chemical Characteristics,” Brazilian Archives of Biology and Technology 55(1) 127-134
[6] Silva R M, Plácido G R, Silva M A P D, Castro C F D S, Lima M S and Caliari M 2015 “Chemical characterization of passion fruit (Passiflora edulis f. flavicarpa) seeds,” African Journal of Biotechnology 14(14) 1230-1233
[7] Oliveira R C, Rossi R M, Gimenes M L, Jagadevan S, Giufriada W M, Barros S T D 2013 “Extraction of passion fruit seed oil using supercritical CO a study of mass transfer and rheological property by Bayesian inference,” Grasas Y Aceites 64(4) 400-406
[8] Nyanzi S, Carstensen B and Schwack W 2005 “A comparative study of fatty acid profiles of Passiflora seed oils from Uganda,” J Am Oil Chem Soc 82 41-44
[9] Patel R K, Singh A, Prakash J, Nath A and Deka B C 2014 “Physico-biochemical changes during fruit growth, development and maturity in passion fruit genotypes,” Indian J. Hort. 71(4): 486-493
[10] AOAC 1990 Official methods of analysis 15th ed (Washington, DC: Association of Official Analytical Chemists)
[11] Brand-Williams W, Cuvelier M E and Berset C 1995 “Use of a Free Radical Method to Evaluate Antioxidant Activity,” Lebensm-Wiss. u.-Technol. 28 25-30
[12] Chau C F and Huang Y L 2004 “Characterization of passion fruit seed fibres-a potential fibre source,” Food Chem 85 189-194
[13] Shahidi F 2005 Bailey's industrial oil & fats products 6th ed./edited (Hoboken, New Jersey. USA: John Wiley & Sons, Inc.)
[14] Bonner F T 1972 “Maturation of Sweetgum and American Sycamore Seeds,” Forest Science 18(3) 223-223
[15] Silalahi F H, Hutabarat R C, Marpaung A E and Napitupulu B 2007 “Effect of Spatial Systems and Fruit Maturity Levels on Acid Passion Quality,” *J. Hort.* 17(1) 43-51

[16] Murukan G and Murugan K 2018 “Comparison of Phenolic Acids and Antioxidant Activities of Young and Mature Leaves of Tectona Grandis L F,” *Asian J Pharm Clin Res* 11(1) 60-66

[17] Gülçin İ 2012 “Antioxidant activity of food constituents: an overview,” *Arch Toxicol* 86 345–391