The Effect of Moisture on the Yield of Sweet Passion Fruit
(*Passiflora lingularis* Juss cv. *Gumanti*) Seed Oil from
Indonesia by Mechanical Extraction

Andasuryani¹, Ifmalinda¹, V Derosya², D Syukri²

¹ Agricultural Engineering Department, Andalas University, Limau Manis Padang
25163 Indonesia

² Agricultural Technology Department, Andalas University, Limau Manis Padang
25163 Indonesia

Corresponding author’s email address: andasuryani@ae.unand.ac.id

Abstract. Passion fruit seeds are rich in fat. Oil of the seeds can be obtained through mechanical extraction. Moisture content is one of the factors, determine the result extraction of the seeds. This study investigates the effects of moisture content towards oil produced by pressing tests using a screw press. The seeds were conditioned at 5%, 7%, and 11% moisture content (wet basis); pressing temperature, 62°C. Chemical analyses i.e. refractive index and peroxide value, are conducted to determine the quality of oil through treatment of moisture content that produces the most oil. The result shows that oil yield increases with the increasing moisture content of the seeds. The highest amount of oil (12.32%) produced by 11% moisture content.

Keywords: Sweet Passion Fruit, Moisture Content, Solok, Linoleic, Screw Press

1. Introduction
Passion fruit (*Passiflora* spp) belong to the family of *Passifloraceae* [1], which is one of West Sumatra’s leading horticultural products. The central producer of this fruit in West Sumatra Province is Solok regency, with a production of 64 151.5 tons in 2017 [2]. The type of passion fruit cultivated by society in Solok regency is a sweet passion (*P. ligularis* Juss). The fruit can be consumed directly as fresh fruit because it has a sweet and refreshing taste. Also, the fruit can also be processed further become syrup.

The fruit consists of seeds (6%), pulp in the form of pulp and fiber (43.6%), and skin (50.4%) [3]. Passion fruit seeds are rich in fat. Some studies have reported the high-fat content of seeds from the type of passion fruit acid. The amount of fat content varies even in the same variety; the value of the fat content can be different. For example, fat content of yellow passion fruit seeds (*Passiflora edulis* f. *flavicarpa*) reported by Malacrida and Jorge [4] is 30.39% while Oliveira et al. [5] found 24.8%.

The fat content in the fruit seeds of *P. edulis* Sims var. *flavicarpa* is 20.6%, *P. edulis* Sims var. *edulis* is 18.5%, Kawanda hybrid is 21.4%, and *P. maliformis* L. is 28.3% [6]. These differences occurred due to the climate and geological differences in the location of passion fruit plants [6].
Meanwhile, the fat content of the seeds of sweet passion (P. Ligularis Juss cv. Gumanti) is approximately 21.03%, 20.36%, and 20.83% respectively for the maturity level I, II, and III. However, statistically the values do not vary (P > 0.05) [7]. The fat content of sweet passion fruit (P. ligularis Juss cv. Gumanti) is almost the same as the fat content of soybean seeds, which ranges from 20.63-21.42% [8].

The high-fat content in passion fruit seeds proves that the seeds are a good source of oil [4], thus, potential as a source of vegetable oil for the food industry. Edible oils are one of the products diversifications, derived from the potential of Indonesia's natural resources. Thus, this effort is a part of providing raw materials food that supports food security.

Furthermore, to get oil from passion fruit seeds, extraction process is needed. Nurhayati [9] acknowledged that the extraction method using screw press is more advanced and has been applied in the oil processing industry and suitable for materials with oil content more than 10%. One crucial factor that influences the oil content produced by mechanical extraction methods such as screw press is the moisture content at the time of pressing [10]. Six percent of moisture content is the optimal one for pressing sunflower seeds [11]. For unheated crambe seeds, 5.9% of moisture content is the optimum condition for extraction while seeds with 4.1% of moisture content is unprofitable as it produces more oil sediment [12]. Meanwhile, the results of the extraction with a screw press on crambe seeds soaked and dried in the sun showed oil recovery increased from 78% to 88% with an increase in moisture content from 5% to 7% and dropped to 76% in moisture content 9%. These results show that higher moisture content causes increased plasticity, thereby reducing the level of compression and contributing to the oil produced [13]. Although there have been several studies that reported on the extraction of oil from seeds, however, there is no information about seed oil of sweet passion fruit (P. ligularis Juss cv. Gumanti) from Indonesia using screw press. Therefore, it is necessary to study this matter to obtained information related to the characteristics of sweet passion fruit seed oil (P. ligularis Juss cv. Gumanti). This research aimed to examine the potential of passion fruit seed oil as a source of vegetable oil for the food industry, accurately to analyze the physical and chemical characteristics of seed oil of passion in a specific moisture content level.

2. Methods
The study used an experimental method. There were three stages of this research: (1) sample preparation, (2) determination of moisture content, and (3) oil extraction.

2.1. Sample Preparation
The material used in this research were 1,100 sweet passion fruits cv. gumanti, harvested at a maturity level III (100% yellow). The fruit was put into polyethylene plastic to reduce moisture loss during transportation to laboratory. Furthermore, the seeds were removed from the passion fruit manually, washed with distilled moisture, and dried at room temperature for two weeks. The seeds are then packaged in polyethylene plastic and stored at room temperature until used for analysis [4].

2.2. Treatment of Moisture Content
The first phase was moisture content treatment for the seeds, used 5%, 7%, and 11%. Seeds were oven-dried at 60°C to get certain moisture content. The moisture content of sweet passion fruit was analyzed based on Singh et al. [10]. The seeds were spread on a tray and stirred every 30 minutes during drying. The final seed weight was calculated based on the initial one. The seed weight was used as a quick method for determining the moisture content from time to time until after drying.

2.3. Oil Extraction
Oil extraction was conducted by using an oil press machine for grain type MKS-J03. Pressing temperature was 62°C (based on preliminary research). A total of 200 g passion fruit seed samples was extracted for each treatment of moisture content. The process began with turning on the appliance and setting the pressing temperature. If the desired temperature was reached, the machine would turn the
screw and the seeds ready to be extracted. Oil percentage obtained in this research was calculated using the first equation as followed [14]. Thus, extracted oil was analyzed its chemical properties.

\[ OY = \frac{WO}{WS} \times 100 \]  

(1)

Where, \(OY\) is Oil Percentage from Extraction (%), \(WO\) is Weight of Oil (g), and \(WS\) is Weight of Seeds (g).

2.4. Seeds Oil Analysis

2.4.1. Chemical analysis

Chemical characteristic of seed oil to determine the refractive index (25°C) [16] and peroxide value (meq peroxide/kg) [17]. Refractive index was measured using a refractometer by dropped samples on the surface of the tools to get the index. For peroxide value, samples were weighed as much 1.5 gram in erlenmeyer. Then, 10 ml of chloroform, 15 ml acetic acid, and 1 ml potassium iodide were added. Erlenmeyer was closed and shook for 5 minutes in a dark room. Then, 75 ml distilled water and 1ml of amyllum indicator were added. Natrium thiosulphate was titrated into samples until blue disappear.

2.4.2. Fatty Acid Composition

Fatty acid composition analysis referred to Syukri et al. [18]. Samples were injected into a gas chromatograph (GC, 2010, Shimadzu, Japan) using helium as carrier gas at a flow rate 45.5 mL/min. The initial oven temperature was set at 150°C, and then increased to 200°C at 2°C/min followed by 4°C/min until it reached 230°C. The condition was then maintained at 230°C for 5 minutes.

2.5. Statistical Analysis

Oil extraction of passion fruit seeds were replicated three times. Three replications were also conducted for analysis, while the mean values and standard error were calculated too. Analysis of variance (ANOVA) was used to analyzed experimental data, and the significant data will be analyzed by applying Tukey (HSD) in Microsoft Excel Office 365 software.

3. Results and Discussion

3.1. Effect of Moisture Content on Yield

Based on our study, the lower moisture content of seeds produced the lower oil compared to those with a higher moisture content as shown in Figure 1. The highest oil content was 12.32% from seeds with 11% moisture content. Further, the lowest one was 6.52% extracted from seeds with 5% of moisture content. This phenomenon could be related to a harder skin of lower moisture content seeds; thus, extraction process would be difficult and produced only a limited amount of oil. Based on statistical analysis, the different moisture contents in this research had a significant difference at \(p < 0.05\) to yield of seed oil, as shown in Table 1.
3.2. Seeds Oil Chemical Characteristics

Quality analysis results on refractive index and peroxide value were showed on Figure 2 and 3. The refractive index illustrated a lower value with increasing moisture content. The highest refractive index came from 5% of moisture content, while the lowest refractive index number was from 11%. A followed test using Tukey analysis (HSD) found a significant difference (p<0.05) between the moisture content level of sweet passion seeds and its refractive index (Table 2).

Refractive index from different moisture content were between 1.474 and 1.481. Similar to this result, refractive index from several vegetables oil such as olive oil (1.468-1.471), sunflower seed oil (1.461-1.468), soybean oil (1.466-1.470), maize oil (1.465-1.468), cottonseed oil (1.458-1.466), grape seed oil (1.467-1.477), and sesame seed oil (1.465-1.469) [17].
Table 2. Chemical characteristics of passion fruit seed oil

| Moisture Content (% wb) | Refractive index (25°C) | Peroxide value (meq peroxide/kg) |
|-------------------------|-------------------------|---------------------------------|
| 5                       | 1.481 ± 0.0005          | 2.274 ± 0.322                   |
| 7                       | 1.479 ± 0.0005          | 3.967 ± 0.679                   |
| 11                      | 1.474 ± 0.0005          | 2.559 ± 0.634                   |

Note: ¹ Mean value ± standard deviation (n = 3); and ab, c Means in the same column with different superscripts are significantly different (P < 0.05).

Based on Codex Alimentarius Commission [18], peroxide value is one of the quality aspects of vegetable oil with 10 meq/kg maximum for refined oils and 15 meq/kg for cold-pressed and virgin oils. Besides, the highest peroxide value and the lowest one came from 7% and 5% of moisture content, respectively. Based on Tukey’s analysis, a significant difference was found between the peroxide value of 5% and 7% as illustrated in Table 2. Peroxide value of passion seeds oil from this study meets the standard, as noted by Malacrida and Jorge [4], which indicated no oil destruction on all moisture content treatments.

3.3. Fatty Acid Composition

The fatty acid composition is an important and beneficial component of vegetable oil related to its origin and oil purity, as explained by Liu et al [19]. In this study, there was amount of fatty acid composition in sweet passion (Passiflora lingularis Juss cv. Gumanti) seed oil. The fatty acids were linoleic acid (C18:2) and oleic acid (C18:1), as shown in Figure 4. The highest amount of linoleic acid and oleic acid was from seed oil, with 7% of moisture content with 70.928±17.430% of linoleic acid and 17.947±6.944% of oleic acid. High amount of fatty acid in 7% seed oil might be related to its peroxide value. As explained by Karima [20] that high peroxide value could be a result of high amount of unsaturated fatty acid in particular oil. As the result of Tukey test (HSD), there is a significant difference in linoleic acid between 5% and 7% of moisture content. However, there is no significant effect on oleic acid from three moisture content treatments, as displayed in Table 3.

Higher amount of linoleic acid in sweet passion seeds oil (P. lingularis Juss cv. Gumanti) was found compared to those from sweet passion seeds P. edulis Sims var. flavicarpa (67.8 ± 0.2%) and Kawanda hybrid (67.9 ± 0.2%) [6]. However, our seeds oil has less amount of linoleic acid compared to those of seeds oil from P. maliformis L (71.9 ± 0.3%), P. edulis Sims var. edulis (74.3 ± 0.3%) [6], ‘Tainung No. 1’ passion fruit seed oil (72.69 ± 0.32%) [19].

The amount and composition of unsaturated fatty acid in oil define oil quality and digestibility of edible vegetable oils [4]. Thus, seed oil from sweet passion fruit (P. lingularis Juss cv. Gumanti) has potency as edible vegetable oils since it contains an amount of linoleic and oleic acid belong to unsaturated fatty acid.
Table 3. Fatty acid composition of passion fruit seed oil

| Moisture Content (% wb) | Linoleic acid (%)\(^1\) | Oleic acid (%)\(^1\) |
|-------------------------|------------------------|---------------------|
| 5                       | 38.031 ± 1.440 \(^b\)  | 9.191 ± 1.944 \(^a\) |
| 7                       | 70.928 ± 17.430 \(^a\) | 17.947 ± 6.944 \(^a\) |
| 11                      | 47.301 ± 8.708 \(^ab\) | 13.533 ± 0.048 \(^a\) |

Note: \(^1\) Mean value ± standard deviation (n = 3); and \(^a,b,c\) Means in the same column with different superscripts are significantly different (P < 0.05).

4. Conclusions
It can be concluded from this research that moisture content of seed from sweet passion (*P. lingularis* Juss cv. *Giumanti*) affected extracted oil percentage and its chemical characteristics. Linoleic acid and oleic acid are unsaturated fatty acids and available in a high amount of oil from sweet passion seed that becomes a potency as edible vegetable oils.

Acknowledgment
This publication is part of the research funded by DIPA FATETA No. 01N/PL/DF-DIPA/FATETA-2019 on March 4th, 2019, Faculty of Agricultural Technology, Andalas University to Andasuryani.

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] BPS-Statistics of Solok Regency 2018 *Solok Regency in Figures 2018* CV.Demy. Edition 1.
[3] Sianipar J, Krishnan R, Simanipuruk K, and Batubara L P 2006 Evaluasi tiga jenis limbah pertanian sebagai pakan kambing potong *Prosiding Seminar Nasional Teknologi Peternakan dan Veteriner* 480-489
[4] Malacrida C R and Jorge N 2012 Yellow Passion Fruit Seed Oil (*Passiflora edulis* f. flavicarpa): Physical and Chemical Characteristics *55*(1) 127-134
[5] Oliveira R C, Rossi R M, Gimenes M L, Jagadevan S, Giufrida W M, and Barros S T D 2013 Extraction of passion fruit seed oil using supercritical CO\(_2\) a study of mass transfer and rheological property by Bayesian inference *Grasas Y Aceites* 64(4) 400-406
[6] Nyanzi S, Carstenen 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
[7] Andasuryani, Ifmalinda, and Wulandari P 2018 *Pengembangan Metode Pengukuran Kualitas Internal Biji Markisa secara Nondestruktif dengan Spektroskopi Near Infrared* [Laporan Penelitian]
[8] Bargalea P C, Fordb R J, Sosulskic F W, Wulfsohnb D, and Irudayaraj J 1999 Mechanical Oil Expression from Extruded Soybean Samples *JAOCS* 76(2) 223-229
[9] Nurhayati 2014 Proses pengolahan bahan baku biomassa menjadi biodiesel *Kementerian Pendidikan dan Kebudayaan* [Laporan Penelitian]
[10] Singh K K, Wiesenborn D P, Tostensonb K, and Kangas N 2002 Influence of Moisture Content and Cooking on Screw Pressing of Crambe Seed *JAOCS* 79(2) 165-170
[11] Singh M S, Farsai A, Stewart L E, and Douglass L W 1984 Development of Mathematical Models to Predict Sunflower Oil Expression *Trans. ASAE* 27 1190–1194
[12] Vargas-Lopez J M, Wiesenborn D, Tostenson K, and Chacek L 1999 Processing of Crambe for Oil and Isolation of Erucic Acid *J. Am. Oil Chem. Soc.* 76 801–809
[13] Singh J and Bargale P C 1990 Mechanical Expression of Oil from Linseed (*Linum usitatissimum* L.) *J. Oilseeds Res.* 7 106–110
[14] Orhevba B A, Chukwu O, Osunde Z D, Ogwuagwu V 2013 Influence of Moisture Content on the Yield of Mechanically Expressed Neem Seed Kernel Oil Academic Research International 4(5) 252-257
[15] AOAC 1990 Official methods of analysis 15th ed Washington DC: Association of Official Analytical Chemists
[16] Sudarmadji S 1989 Analisa bahan makanan dan pertanian Yogyakarta: Liberty Yogyakarta bekerja sama dengan Pusat Antar Universitas Pangan dan Gizi Universitas Gadjah Mada
[17] Syukri D, Thammawong M, Naznin H A, and Nakano K 2019 Role of raffinose family oligosaccharides in respiratory metabolism during soybean seed germination Environ. Control Biol. 57(4) 107-112
[18] Codex Alimentarius Commission 2001 Codex Alimentarius: Fat, Oil, and Related Product Rome: 2001- Codex-Stan 210: codex standard for named vegetable oils
[19] Liu S, Feng Y, Jiali L, Chaohua Z, Hongwu J, and Pengzhi H 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
[20] Karima R 2015 Quality of Crued Rubber Seeds Oil for Alternative Edible Oil after HCN Reduction Jurnal Riset Industri Hasil Hutan 7(2) 17–22