

The Effect of Fruit Storage Time on the Characteristics and Antioxidant Activity of Pumpkin Seed Oil (*Cucurbita moschata*) "Butternut type"

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Abstract: Pumpkin (*Cucurbita moschata*) contains bioactive compounds that are spread almost throughout the organs. One of the important contents of pumpkin is seed oil which has antioxidant activity. Antioxidants play a role in counteracting free radicals so that it is widely used to improve health quality. Fruit storage can affect seed quality and antioxidant activity in it. The purpose of this study was to evaluate and compare the chemical characteristics and antioxidant activity of pumpkin seed oil with different fruit storage times. The method for obtaining pumpkin seed oil from fruit storage for 10, 20, and 30 Days After Anthesis (DAH) was carried out using the soxhlet extraction method. The extracted oil was thickened using a rotary evaporator. Furthermore, its chemical characteristics were tested including yield, acid number, peroxide number, saponification number, water content. Pumpkin seed oil was measured for its antioxidant activity using the DPPH method. Absorbance was measured at a wavelength of 526 nm using a UV-Vis spectrophotometer. The data obtained were analyzed using ANOVA followed by the DMRT test with a 95% confidence interval. The results showed that there were significant differences in the variation of fruit storage time including oil yield, acid number, saponification number, and antioxidant activity, while there was no difference in water content. Fruit storage time of 30 DAH gave the most optimal results in all parameters tested. The conclusion that can be drawn from this study is the characteristics and antioxidant activity of pumpkin seed oil at a storage time of 30 DAH produced better oil quality compared to storage times of 10 and 20 DAH.

Keywords: Antioxidants; *C. moschata*; Oil characteristics; Post-harvest

Introduction

The yellow pumpkin plant (*Cucurbita moschata*) is a multifunctional plant, because it can be used as an alternative food, cosmetics, and has various health benefits (Akhtari and Rosalina 2023; Ariyanti 2021; Men et al. 2021). Almost all parts of the pumpkin plant have beneficial content. Pumpkin fruit contains carbohydrates, protein, fat, fiber, vitamin C, phenol, beta carotene (Cao et al. 2010; Tjiptowibisono et al. 2015). Pumpkin leaves contain alkaloids, flavonoids, terpenoids, saponins (Suradkar et al. 2017; Suranto et al. 2023). The flowers contain protein, fat, fatty acids, carbohydrates, calcium, magnesium, potassium, iron,

zinc, manganese, carotene, polyphenols (Biezanowska-Kopeć et al. 2022) and the seeds contain protein, unsaturated fatty acids (linoleic acid, oleic acid, palmitic acid, and stearic acid) (Enneb et al. 2020; Indrianingsih et al. 2019; Prommaban et al. 2021).

Studies show that pumpkin seed oil can be used as an antihelminthic, antidiabetic, antihypertensive, antidepressant, anti-inflammatory, antimicrobial, and antioxidant (Bakeer et al. 2021; Hesari et al. 2020; Kim et al. 2016; Majid, Ahmed, and Khan 2020; Nadjiba et al. 2018; Suwannapong, Talubmook, and Promprom 2023). The presence of antioxidant compounds in pumpkin seeds is believed to be able to cure various diseases. Consumption of foods with high total antioxidant

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capacity is reported to prevent hypertension (Villaverde et al. 2019). High levels of antioxidants are needed to manage oxidative stress which is one of the causes of chronic diseases such as diabetes, cancer, and cardiovascular disease (Farhat et al. 2020).

Pumpkin seed oil is obtained after the fruit is harvested (Vinod et al. 2014). However, pumpkin is a fruit that can be stored for a fairly long period of time after harvest, namely up to 6 months (Arumsari et al. 2017). During storage time, fruit can undergo respiration to produce organic acids, so that sugar levels decrease (Sari and Putri 2018). In addition, the content of potassium, calcium, and magnesium, which are essential macronutrients for germination, decreased (Colombari et al. 2022). The results of the study showed that the length of storage of pumpkin fruit causes the antioxidant levels in the fruit to decrease (Arumsari et al. 2017; Martínez et al. 2021). The decreasing antioxidant levels in pumpkin fruit are not yet known to be accompanied by changes in the characteristics and antioxidant activity of pumpkin seed oil.

Studies on pumpkin seed oil and the factors that influence it continue to develop. Efforts to increase the content of pumpkin seed oil are carried out in various ways. Pruning the main stem can increase the production of pumpkin oil which aims to extend the time of maturity and fruit ripening (Gholipouri and Nazarnejad 2007). In addition to these methods, the provision of NPK fertilizer can increase the productivity of pumpkin seed oil, but the provision of NPK above 100 kg/ha reduces the production of pumpkin seed oil (Oloyede et al. 2012). So far, research discussing the quantity and quality of pumpkin seed oil has been carried out by roasting (Soetjipto et al. 2018) and extraction methods. Extraction methods used to obtain pumpkin seed oil include maceration, cold press extraction, enzymatic, and mechanical methods. Among these methods, the soxhlet method provides more optimal results than others (Acacio et al. 2015; Singh and Kumar 2023; Soetjipto et al. 2018). In addition to pre-harvest treatment and the use of various methods, the age of harvest and post-harvest treatment can affect the characteristics and content of pumpkin seed oil. The study stated that the highest quantity of pumpkin seed oil was in fruit harvested at 60 DAA (Day After Anthesis) after 10 days of maturity (Vinod et al. 2014). This is because pumpkin seeds physiologically experience maturity after 50-60 DAA which results in reduced water content and stability of electrical conductivity (Acacio et al. 2015). In addition to affecting the content and characteristics of oil in plants, various post-harvest treatments such as cold storage, heat treatment, packaging, and administration of chemical compounds can affect the antioxidant activity of the Cucurbitaceae family (Martínez et al. 2021). The results

of the study showed that storage for 20 days reduced the antioxidant activity of pumpkin fruit (Rosales et al. 2023). In this study, the plant organs studied were only the fruit, so it is necessary to expand by looking at the characteristics and antioxidant activity of pumpkin seed oil when given treatment in the form of fruit storage time. The characteristics of oil and antioxidant activity of pumpkin seed oil need to be known to determine the optimal fruit storage time, so this study is expected to be used as a basis for producing natural product materials in the form of pumpkin seed oil with better quantity and quality.

Method

Tools and materials

The tools used in this study were Soxhlet apparatus, rotary evaporator DLAB RE 100-Pro, Memmert oven, Shimadzu UV Vis spectrophotometry, Ohaus analytical balance, Philipps blender, desiccator, burette and stand, 40/70 mesh sieve, Erlenmeyer flask, porcelain cup, dark pipette bottle, filter paper.

The materials used in the study were n-hexane, ethanol 96% Merck, PP Merck indicator, NaOH Merck, glacial acetic acid Merck, Chloroform Merck, Potassium iodide Merck, Na₂S₂O₃ Merck, Starch indicator Merck, KOH Merck, HCl, DPPH smartlab, ascorbic acid Merck, Aquades, ethanol pro analysis Merck, C. moschata "butternut" fruit.

Seed preparation

Pumpkin seeds of the "butternut" type obtained from farmers with fruit storage ages of 10, 20, 30 Days After Anthesis (DAA) were air-dried for approximately 3 days at room temperature. The dried pumpkin seeds were ground using a blender and sieved using a 40/70 mesh sieve to obtain the same powder size.

Pumpkin seed extraction

As many as 45 grams of pumpkin seed powder was extracted using a soxhlet apparatus. The solvent used was n-hexane. (Singh and Kumar 2023). Pumpkin seeds were extracted at 60°C for 6 hours. The extract obtained was thickened using a rotary evaporator at 400°C. The thick extract obtained was weighed and stored in a dark bottle for further testing. (Abdillah et al. 2014).

Testing the chemical properties of pumpkin seed oil

Testing The chemical properties of pumpkin oil were determined according to the method Julianty et al. (2021) with slight modifications including oil yield, acid number, saponification number, peroxide number, and water content. Oil yield is determined by Formula 1.

$$\text{Rendemen (\%)} = \frac{\text{Massa minyak}}{\text{Massa Sampel}} \times 100\% \quad (1)$$

The acid number is determined by titrating 0.5 grams of oil sample using 0.1 N standard NaOH solution with the help of phenolphthalein indicator and the addition of 5 ml of hot neutral 96% ethanol. The calculation of the acid number uses Formula 2.

$$\text{Bilangan asam NaOH/gr} = \frac{\text{ml NaOH} \times \text{n NaOH} \times 40}{\text{Berat sampel (gr)}} \quad (2)$$

The peroxide number is determined by titrating 0.5 grams of oil sample using 0.01 N Na₂S₂O₃ solution added with 5 ml of acetic acid solution with a ratio of 3:2 (v/v) and 0.2 ml of saturated KI and 5 ml of distilled water. Titration is carried out until the yellow color is no longer visible. A total of 0.2 ml of starch indicator is added and the sample is titrated again until the color of the starch indicator disappears. Formula 3 for calculating the peroxide number is:

$$\text{Bilangan Peroksida (meq O}_2\text{/kg)} = \frac{V \times N \times 1000}{W} \quad (3)$$

Information:

V : Volume Na₂S₂O₃ 0.01 N during titration (ml)
 N : Normality of 0.01 N Na₂S₂O₃ standard solution
 W : oil sample weight (kg)

The saponification number is determined by saponifying 0.5 grams of oil sample using 0.5 N KOH/alcohol solution. Furthermore, 0.5 HCl is used to titrate the sample with the addition of 1 ml of phenolphthalein indicator. Titration of the blank solution is carried out in the same way without using an oil sample. The following is the calculation of the saponification number formula (Formula 4).

$$\text{Bilangan penyabunan (KOH/gr)} = \frac{(B-S) \times (N)}{W} \times 56.1 \quad (4)$$

Information:

B : Volume of HCl for blank titration (ml)
 S : Volume HCl for sample titration (ml)
 N : Normality of HCl
 W : Heavy sample (gr)

Water content

Water content is determined by weighing a porcelain cup containing 1 gram of oil sample that has been previously weighed initially. Furthermore, the cup containing the oil is ovened for 2 hours at a temperature of 100-105°C until the water content in the oil evaporates. The final weight of the cup is re-weighed

after the cup is cooled in a desiccator. Water content calculation uses the formula (Formula 5).

$$\text{Kadar air (\%)} = \frac{(A-B)}{C} \times 100\% \quad (5)$$

Information:

A: weight of cup + weight of sample before heating (gr)
 B: weight of cup + weight of sample after heating (gr)
 C : Sample weight before heating (gr)

Antioxidant activity testing using the DPPH method

Testing Antioxidant activity was carried out according to the method Abdillah et al. (2018). A total of 30 gr DPPH was weighed and dissolved in 100 ml ethanol as a stock solution (30 ppm). A 10 mg oil sample was extracted in 100 ml of 95% ethanol for 48 hours to an assumed concentration of 100 ppm (w/v). The IC₅₀ dilution curve was made by diluting the sample with concentrations of 20 ppm, 40 ppm, 60 ppm, and 80 ppm. Each concentration was taken as much as 2 ml, added with 3 ml of DPPH 30 ppm, then shaken and left for 30 minutes at room temperature in a dark room. Absorption measurements were carried out using UV spectrophotometry at a maximum absorption wavelength of λ 526 nm. Ethanol was used as a blank and vitamin C was used as a standard solution. All measurements were carried out in triplicate. The IC₅₀ value of the antioxidant activity of pumpkin seed oil which can inhibit DPPH radical activity (from a concentration of 50% of the sample) was compared with the IC₅₀ antioxidant of the standard vitamin C solution.

Data analysis

Data analyzed using the Analysis of Variance (ANOVA) method then DMRT with a confidence level of 95%.

Results and Discussion

Respiration fruit during post-harvest storage will affect the primary metabolic pathway, such as starch metabolism, glycolysis, and the citric acid cycle which will have an impact on changes in the nutritional content of the fruit. Interactions between hormones are also involved in the ripening and aging process of post-harvest fruit. During the ripening and aging process of this fruit, there will be a decrease in water (Pott et al. 2020). Lack of water will affect the seed ripening process which will affect the quality of the oil. Furthermore De Vitis et al. (2020) mentioned that effective storage is very important to maintain seed viability. The characteristics of *C. moschata* seed oil at various fruit storage times are presented in Table 1.

Table 1. Results of Seed Oil Characteristics Test on Variations in Fruit Storage Duration

Parameter	Shelf life (DAH)		
	10	20	30
Oil yield (%)	28.66±1.37a	31.59±1.00b	34.01±1.21c
Acid number (NaOH/g)	29.26±1.00a	18.66±0.72b	3.56±0.09c
Peroxide number (meq O ₂ /kg)	ttd*	ttd*	ttd*
Saponification number (KOH/g)	25.83±0.31a	19.34±0.06b	12.73±0.31c
Water content (%)	2.23±0.20	1.73±0.23	1.46±0.98

Note:* not detected, different letters indicate significant differences

Oil yield

Vegetable oil is an important source of nutrients for health. Vegetable oil sources are obtained from various plants, including *C. moschata* seeds. *C. moschata* seeds have a high fat content (Akintade et al. 2019), so it can be used as an alternative choice of vegetable oil. The storage time of the fruit will also affect the oil yield (Ruswanto et al. 2020). Table 1. shows that there is a significant difference between the oil yields in fruit storage at 10 DAH, 20 DAH, and 30 DAH. In addition, there was an increase in seed oil yield along with the length of fruit storage up to 30 days after the fruit was harvested, which was $34.01 \pm 1.21\%$. These results are comparable to research Kabutey et al. (2024) namely with an oil yield of 34.00%, but this result is lower than the results Soetjipto et al. (2018) which is 36.65%. Several factors that affect the production of seed oil include plant type, environmental conditions, harvest time, plant cultivation, processing, and storage (Kafkaletou et al. 2021; Zhou et al. 2020).

Petkova and Antova (2015) stated that the oil content of *C. moschata* seeds increased in the final phase of fruit ripening, namely 90 days from the flowering phase. This is in line with Nguyen et al. (2015) mentioned that the yield of *Coriandrum sativum* L. seed oil increased from the flowering phase to the maturity phase of the plant. Seed maturity and harvest time are two different things. Fruit maturity is a process that culminates in physiological maturity, while harvesting is based on economic and technological parameters related to seed quality (Bareke 2018). However, for economic purposes, usually the fruit will be harvested when it reaches maturity because harvesting too early can result in low oil yields. In addition, after harvesting the fruit or seeds must be stored carefully to avoid damage, so that the risk of contamination by microorganisms can be minimized (Zhou et al. 2020).

Acid Number

Based on Table 1. shows that there is a significant difference in acid number in different fruit storage variations. The results of the acid number obtained based on the storage time of 10 DAH; 20 DAH; 30 DAH respectively are 29.26±1.00; 18.66±0.72; 3.56±0.09 mg NaOH/g. The smaller the acid number, the better the

quality of the oil (Julianty et al. 2021). A high acid number indicates a high level of free fatty acids, either as a result of hydrolysis due to oxidation and other rancidity processes or as free fatty acids that tend to be easily oxidized (Abdillah et al. 2014). Based on the results obtained, it can be seen that the storage period of 30 DAH showed a small acid number, it can be concluded that the longer the storage period after harvest will produce good quality pumpkin seed oil.

Saponification Number

The saponification number results showed significant differences in each variation of fruit storage time. The results obtained based on storage time of 10 DAH; 20 DAH; 30 DAH respectively were 25.83±0.31; 19.34±0.06; 12.73±0.31 mg KOH/g. The saponification number is influenced by the molecular weight and chain length formed inversely proportional to the molecular weight of lipids (Soetjipto et al. 2018). The smaller the saponification number, the better the quality of the oil, this indicates the higher the molecular weight (Julianty et al. 2021). Based on the results obtained, it can be seen that the storage period of 30 DAH showed a small saponification number, it can be concluded that the longer the storage period after harvest will produce good quality pumpkin seed oil.

Peroxide Number

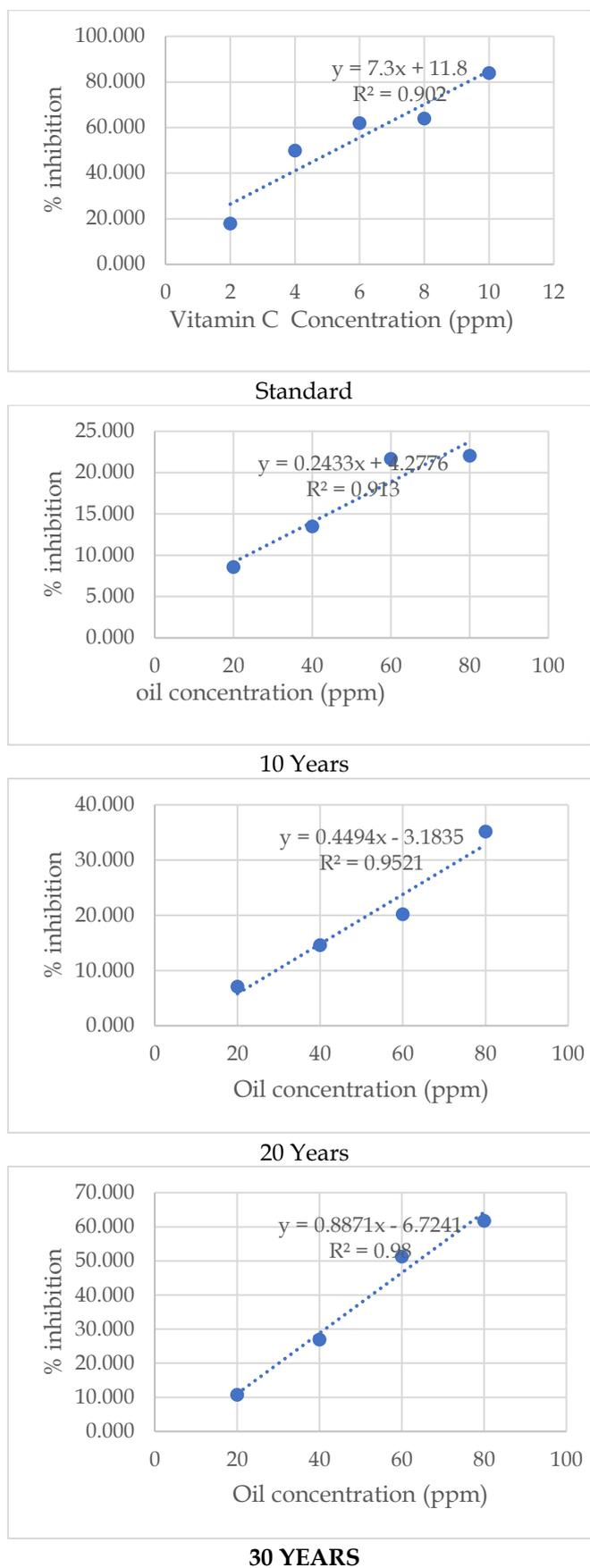
The peroxide number is used to see the quality of oil. Oil with a high oxidation number indicates a decrease in oil quality because the higher the oxidation level of the oil (Slamet et al. 2023). Based on Table 1. the peroxide number in each sample cannot be detected. This indicates that the *C. moschata* seed oil sample has good quality and has not been damaged (Dewi et al. 2019). Soetjipto et al. (2018) stated that the use of n-hexane solvent will reduce the peroxide number. The results of the study are not in line with the research Julianty et al. (2021) that the peroxide value of *C. moschata* seed oil is 50 meq O₂/kg due to heat extraction which causes oxidation. Other factors that affect the peroxide number of oil such as the length of oil storage, repeated use, and the use of bioadsorbents (Khoirunnisa et al. 2020; Muqasyifah et al. 2020; Sari et al. 2019).

Water content

According to Zhou et al. (2020) the water content in the seeds affects the storage time of the oil and the quality of the oil. High water content in oil can speed up the oil becoming rancid (Lempang, Fatimawali, and Pelealu 2016). Based on Table 1. the water content in the fruit storage variations did not show significant differences. However, the water content in *C. moschata* seed oil tended to decrease along with the length of fruit storage time. The results of the water content from various fruit storage times were lower than the results of the study Soetjipto et al. (2018), which is 3.86. According to Sari et al. (2019)) water is naturally present in oil. Water is also formed due to the reaction of caustic soda with free fatty acids. The higher the water content, the higher the acid number or free fatty acid content in the oil due to the hydrolysis reaction in the oil. Hydrolysis in oil occurs because the presence of water in the oil causes the formation of free fatty acids (Musafira et al. 2020). Gupta et al. (2019) explained that the water content in oil can be reduced by the seed drying method. In addition to the drying method, the difference in water content in *C.moschata* seed oil produced from different fruit storage is due to the water content in the seeds decreasing from the flowering phase to the ripening phase (Nguyen et al. 2015). The water content in seeds decreases significantly at the end of the ripening phase because in the seeds there are changes in the structure of the cell membrane and an increase in the activity of enzymes responsible for germination (Bareke 2018).

Antioxidant Activity

The higher the sample concentration, the higher the percentage of inhibition (Figure 1.). This inhibition value will be used to calculate the IC50 value. The IC50 (Inhibition concentration) value is the sample concentration needed to inhibit 50% of DPPH radicals. The smaller the IC50 value, the higher the antioxidant activity (Maryam 2015). When compared with the IC50 value of vitamin C, which is 5.23 µg/ml, the antioxidant activity of *C. moschata* seed oil is lower with a range of values 63.94±0.28 µg/ml to 187.92±0.39 µg/ml depending on the length of fruit storage. This antioxidant activity is higher than the research Boujemaa et al. (2020) with the same solvent and method produced an IC50 value of *C. moschata* seed oil of 396.95 ± 12.73 µg/ml. Although the results of the antioxidant activity of *C. moschata* seed oil were lower than the standard, the study Bakeer et al. (2021) stated that *C. moschata* seed oil has antioxidant activity that can capture free radicals produced during gametogenesis.



30 YEARS
Figure 1. Standard inhibition percentage and variation of fruit storage time

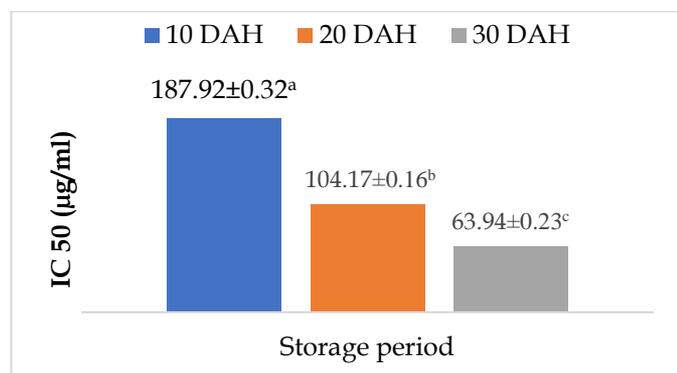


Figure 2. IC₅₀ values of *C. moschata* seed oil in different fruit storage variations

Based on the results of the study, the antioxidant activity of *C. moschata* seed oil in different variations showed significant differences (Figure 2). The antioxidant activity of *C. moschata* seed oil can increase along with the length of fruit storage. This is because the fruit ripening phase will affect the physiological characteristics of the seeds (Ramos et al. 2021). Basu and Groot (2023) suggested that the aging and post-harvest phases result in the accumulation of food reserves in seeds. Seeds will accumulate antioxidants during seed maturation to protect against oxidative damage that cannot be repaired by enzyme activity. In addition, antioxidant activity increases with seed germination time (Li et al. 2019).

Conclusion

The characteristics and antioxidant activity of *C. moschata* seed oil at 30 DAH storage time produced better oil quality compared to 10 and 20 DAH storage times.

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Author Contributions

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Conflict of Interest

The authors declare no conflict of interest.

References

- Abdillah, M. N., Musfiroh, I., & Indriyanti, W. (2014). Karakterisasi Minyak Biji Labu Kuning (*Cucurbita pepo* L.) Hasil Ekstraksi dengan Alat Soxhlet. *Jurnal Farmasi Galenika*, 1(1), 1-7.
- Acacio, F. N., Francisco, A. C. A., Jucilayne, F. V., & Maraisa, F. da S. (2015). Physiological maturity of pumpkin seeds. *African Journal of Agricultural Research*, 10(27), 2662-2667. <https://doi.org/10.5897/ajar2015.9522>
- Akhtari, R., & Rosalina, L. (2023). Kelayakan Masker Biji Labu Kuning (*Cucurbita Moschata*) Untuk Perawatan Kulit Wajah Menua (Anti Aging). *Jurnal Pendidikan Tambusai*, 7, 16754-16761. <https://doi.org/https://doi.org/10.31004/jptam.v7i2.9029>
- Akintade, AO Awolu, OO Ifesan, B. (2019). *Nutritional Evaluation Of Fermented, Germinated And Roasted Pumpkin (Cucurbita Maxima) Seed Flour - Research Paper - Adeyanmola Oluwaseyi Akintade *, Olugbenga Olufemi Awolu ***,
- Beatrice Olawumi (2020) *Food Science and Technology Department, Ondo State Uni.* XXIII (2), 179-186.
- Ariyanti, M. (2021). Teknologi Budidaya Labu Madu Dan Pemanfaatannya Sebagai Pangan Alternatif Di Desa Pasigaran, Sumedang, Jawa Barat. *Dharmakarya*, 10(2), 159. <https://doi.org/10.24198/dharmakarya.v10i2.32340>
- Arumsari, D. P., Susanto, W. H., & Wijayanti, N. (2017). Pengaruh Lama Penyimpanan Buah dan Proporsi Gula:Slurry terhadap Karakteristik Lempok Labu Kuning (*Cucurbita sp.*). *Jurnal Pangan Dan Agroindustri*, 5(4), 9-19.
- Bakeer, M. R., Saleh, S. Y., Gazia, N., Abdelrahman, H. A., Elolimy, A., & Abdelatty, A. M. (2021). Effect of dietary pumpkin (*Cucurbita moschata*) seed oil supplementation on reproductive performance and serum antioxidant capacity in male and nulliparous female V-Line rabbits. *Italian Journal of Animal Science*, 20(1), 419-425. <https://doi.org/10.1080/1828051X.2021.1889406>
- Bareke, T. (2018). Biology of Seed Development and Germination Physiology. *Advances in Plants & Agriculture Research*, 8(4). <https://doi.org/10.15406/apar.2018.08.00336>
- Basu, Su., & Groot, S. P. C. (2023). Seed Science and Technology: Biology, Production, Quality. In M. Dadlani & D. K. Yadava (Eds.), *Seed Science and Technology: Biology, Production, Quality*. Springer Nature Singapore. <https://doi.org/10.1007/978-981-19-5888-5>
- Bieżanowska-Kopeć, R., Ambroszczyk, A. M., Piatkowska, E., & Leszczyńska, T. (2022).

- Nutritional Value and Antioxidant Activity of Fresh Pumpkin Flowers (*Cucurbita* sp.) Grown in Poland. *Applied Sciences (Switzerland)*, 12(13). <https://doi.org/10.3390/app12136673>
- Boujemaa, I., El Bernoussi, S., Harhar, H., & Tabyaoui, M. (2020). The influence of the species on the quality, chemical composition and antioxidant activity of pumpkin seed oil. *OCL - Oilseeds and Fats, Crops and Lipids*, 27. <https://doi.org/10.1051/ocl/2020031>
- Cao, J., Chen, W., Zhang, Y., Zhang, Y., & Zhao, X. (2010). Content of selected flavonoids in 100 edible vegetables and fruits. *Food Science and Technology Research*, 16(5), 395–402. <https://doi.org/10.3136/fstr.16.395>
- Colombari, L. F., Chamma, L., da Silva, G. F., Zanetti, W. A. L., Putti, F. F., & Cardoso, A. I. I. (2022). Maturation and Post-Harvest Resting of Fruits Affect the Macronutrients and Protein Content in Sweet Pepper Seeds. *Plants*, 11(16), 1–10. <https://doi.org/10.3390/plants11162084>
- De Vitis, M., Hay, F. R., Dickie, J. B., Trivedi, C., Choi, J., & Fiegenger, R. (2020). Seed storage: maintaining seed viability and vigor for restoration use. *Restoration Ecology*, 28(S3), S249–S255. <https://doi.org/10.1111/rec.13174>
- Dewi, N. P. P. M. S., Bogoriani, N. W., & Suaniti, N. M. (2019). Identifikasi Dan Karakterisasi Profil Asam Lemak Virgin Coconut Oil Dengan Penambahan Ekstrak Etanol Kunyit Putih (*Curcuma zedoaria* Rosc.). *Chimica et Natura Acta*, 8(3), 125–131.
- Enneb, S., Drine, S., Bagues, M., Triki, T., Boussora, F., Guasmi, F., Nagaz, K., & Ferchichi, A. (2020). Phytochemical profiles and nutritional composition of squash (*Cucurbita moschata* D.) from Tunisia. *South African Journal of Botany*, 130, 165–171. <https://doi.org/10.1016/j.sajb.2019.12.011>
- Farhat, Naima Hussain, Shabbir Syed, Shahzada Khurram Amjad, Muhammad Javed, Mohsin Iqbal, Muhammad Hussain, Mazhar Haroon, Shah Muhammad Raza, Hamid Butt, Shumaila Zulfiqar Kirain, Rabia Riaz, S. (2020). Dietary Phenolic Compounds In Plants: Their Antioxidant And Pharmacological Potential. *Postępy Biologii Komórki*, 47(3), 307–320.
- Gholipouri, A., & Nazarnejad, H. (2007). The effect of stem pruning and nitrogen levels of on some physico-chemical characteristics of pumpkin seed (*Cucurbita pepo* L.). In *Pakistan Journal of Biological Sciences* (Vol. 10, Issue 20, pp. 3726–3729). <https://doi.org/10.3923/pjbs.2007.3726.3729>
- Gupta, A., Sharma, R., Sharma, S., & Singh, B. (2019). Oilseed as Potential Food Ingredient. In *Trends and Prospects in Foods Technology, Processing and Preservation* (Issue November). Today and Tomorrow's Printers and Publisher. Hesari, Z., Sharifdini, M., Sharifi-Yazdi, M. K., Ghafari, S., Ghasemi, S., Mahmoudi, S., Mohebbali, M., & Nikmanesh, B. (2020). In vitro effects of pumpkin (*Cucurbita moschata*) seed extracts on *echinococcus granulosus* protoscoleces. *Iranian Journal of Parasitology*, 15(1), 76–83. <https://doi.org/10.18502/ijpa.v15i1.2529>
- Indrianingsih, A. W., Rosyida, V. T., Apriyana, W., Nur Hayati, S., Nisa, K., Darsih, C., Kusumaningrum, A., Ratih, D., & Indirayati, N. (2019). Comparisons of antioxidant activities of two varieties of pumpkin (*Cucurbita moschata* and *Cucurbita maxima*) extracts. *IOP Conference Series: Earth and Environmental Science*, 251(1), 7–13. <https://doi.org/10.1088/1755-1315/251/1/012021>
- Julianty, R., Kurniasih, E., & Sami, M. (2021). Pemanfaatan Biji Labu Kuning (*Cucurbita Moschata*) Sebagai Sumber Minyak Nabati Menggunakan Metode Ekstraksi Soxhletasi. *Jurnal Teknologi*, 1(2), 46–51.
- Kabutey, A., Mizera, & Herák, D. (2024). Evaluation of percentage oil yield, energy requirement and mechanical properties of selected bulk oilseeds under compression loading. *Journal of Food Engineering*, 360(July 2023). <https://doi.org/10.1016/j.jfoodeng.2023.111719>
- Kafkaletou, M., Ouzounidou, G., & Tsantili, E. (2021). Fruit ripening, antioxidants and oil composition in koroneiki olives (*Olea europea* L.) at different maturity indices. *Agronomy*, 11(1), 1–13. <https://doi.org/10.3390/agronomy11010122>
- Khoirunnisa, Z., Wardana, A. S., & Rauf, R. (2020). Angka Asam Dan Peroksida Minyak Jelantah Dari Penggorengan Lele Secara Berulang. *Jurnal Kesehatan*, 12(2), 81–90. <https://doi.org/10.23917/jk.v12i2.9764>
- Kim, N. R., Kim, H. Y., Kim, M. H., Kim, H. M., & Jeong, H. J. (2016). Improvement of depressive behavior by Sweetme Sweet Pumpkin™ and its active compound, β -carotene. *Life Sciences*, 147, 39–45. <https://doi.org/10.1016/j.lfs.2016.01.036>
- Lempang, I., Fatimawali, & Pelealu, N. (2016). Uji Kualitas Minyak Goreng Curah Dan Minyak Goreng Kemasan Di Manado. *Pharmacon Jurnal Ilmiah Farmasi*, 5(4).
- Li, X., Li, J., Dong, S., Li, Y., Wei, L., Zhao, C., Li, J., Liu, X., & Wang, Y. (2019). Effects of germination on tocopherol, secoisolaricresinol diglucoside, cyanogenic glycosides and antioxidant activities in flaxseed (*Linum usitatissimum* L.). *International Journal of Food Science & Technology*, 54(7), 2346–2354. <https://doi.org/https://doi.org/10.1111/ijfs.14098>

- Majid, A. K., Ahmed, Z., & Khan, R. (2020). Effect of pumpkin seed oil on cholesterol fractions and systolic/diastolic blood pressure. *Food Science and Technology (Brazil)*, 40(3), 769-777. <https://doi.org/10.1590/fst.03720>
- Martínez, C., Valenzuela, J. L., & Jamilena, M. (2021). Genetic and pre-and postharvest factors influencing the content of antioxidants in cucurbit crops. *Antioxidants*, 10(6). <https://doi.org/10.3390/antiox10060894>
- Maryam, S. (2015). Kadar antioksidan dan IC50 tempe kacang merah (*Phaseolus vulgaris* L.) yang difermentasi dengan lama fermentasi berbeda. *Proceedings Seminar Nasional FMIPA UNDIKSHA V*, 347-352.
- Men, X., Choi, S. Il, Han, X., Kwon, H. Y., Jang, G. W., Choi, Y. E., Park, S. M., & Lee, O. H. (2021). Physicochemical, nutritional and functional properties of *Cucurbita moschata*. *Food Science and Biotechnology*, 30(2), 171-183. <https://doi.org/10.1007/s10068-020-00835-2>
- Muqasyifah, Nurhaeni, Syamsuddin, & Khairuddin. (2020). Perubahan Bilangan Peroksida pada Blending VCO-Ekstrak Likopen Buah Tomat Berdasarkan Perbandingan Rasio dan Lama Penyimpanan. *KOVALEN: Jurnal Riset Kimia*, 6(2), 112-117. <https://doi.org/10.22487/kovalen.2020.v6.i2.13132>
- Musafira, Dzulkifli, Fardinah, N. (2020). *The Influence of Water Content and Free Fatty Acid Content on Mandar Coconut Oil Shelf Life*. *Riset Kimia*, 6(November), 224-229.
- Nadjiba, C. M., Nassima, B., Amel, M., & Soumeia, F. (2018). Anti-Inflammatory And Anti-Microbial Activity Of Fatty Oils Of Pumpkin Seeds (*Cucurbita moschata*) Harvested In Bouira (Algeria). *International Multidisciplinary Scientific GeoConference:SGEM*, 725-732.
- Nguyen, Q. H., Talou, T., Cerny, M., Evon, P., & Merah, O. (2015). Oil and fatty acid accumulation during coriander (*Coriandrum sativum* L.) fruit ripening under organic cultivation. *Crop Journal*, 3(4), 366-369. <https://doi.org/10.1016/j.cj.2015.05.002>
- Oloyede, F. M., Obisesan, I. O., Agbaje, G. O., & Obuotor, E. M. (2012). Effect of NPK fertilizer on chemical composition of pumpkin (*Cucurbita pepo* Linn.) seeds. *The Scientific World Journal*, 2012. <https://doi.org/10.1100/2012/808196>
- Petkova, Z. Y., & Antova, G. A. (2015). Changes in the composition of pumpkin seeds (*Cucurbita moschata*) during development and maturation. *Grasas y Aceites*, 66(1), 1-9. <https://doi.org/10.3989/gya.0706142>
- Pott, D. M., Vallarino, J. G., & Osorio, S. (2020). Metabolite changes during postharvest storage: Effects on fruit quality traits. *Metabolites*, 10(5). <https://doi.org/10.3390/metabo10050187>
- Prommaban, A., Kuanchoom, R., Seepuan, N., & Chaiyana, W. (2021). Evaluation of fatty acid compositions, antioxidant, and pharmacological activities of pumpkin (*Cucurbita moschata*) seed oil from aqueous enzymatic extraction. *Plants*, 10(8). <https://doi.org/10.3390/plants10081582>
- Ramos, C. A. da S., Soares, T. L., Barroso, N. S., & Pelacani, C. R. (2021). Influence of maturity stage on physical and chemical characteristics of fruit and physiological quality of seeds of *Physalis angulata* L. *Scientia Horticulturae*, 284(January). <https://doi.org/10.1016/j.scienta.2021.110124>
- Rosales, R., Photchanachai, S., Khanobdee, C., Boonyarittongchai, P., & Wongs-Aree, C. (2023). Store or not to store: A comparative study on the physicochemical properties of pumpkin. *IOP Conference Series: Earth and Environmental Science*, 1182(1). <https://doi.org/10.1088/1755-1315/1182/1/012070>
- Ruswanto, A., Ramelan, A. H., Praseptianga, D., & Partha, I. B. B. (2020). Palm oil yield potency on different level of ripening and storage time based on fruits percentage and fresh fruit bunches. *IOP Conference Series: Earth and Environmental Science*, 443(1). <https://doi.org/10.1088/1755-1315/443/1/012005>
- Sari, M., Ritonga, Y., & Saragih, S. W. (2019). Pengaruh Kadar Air Pada Proses Pemucatan Minyak Kelapa Sawit. *Talenta Conference Series: Science and Technology (ST)*, 2(1), 79-83. <https://doi.org/10.32734/st.v2i1.317>
- Sari, N. P., & Putri, W. D. R. (2018). Pengaruh Lama Penyimpanan Dan Metode Pemasakan Terhadap Karakteristik Fisikokimia Labu Kuning (*Cucurbita moschata*). *Jurnal Pangan Dan Agroindustri*, 6(1), 17-27. <https://doi.org/10.21776/ub.jpa.2018.006.01.3>
- Singh, A., & Kumar, V. (2023). Phyto-chemical and bioactive compounds of pumpkin seed oil as affected by different extraction methods. *Food Chemistry Advances*, 2(February), 100211. <https://doi.org/10.1016/j.focha.2023.100211>
- Slamet, N., Yusuf, G., Husain, F., Mohamad, F., Wicita, P., Zulfiayu, & Yunus, F. (2023). Suplementasi Sari Daun Kelor (*Moringa oleifera* L.) Menurunkan Bilangan Peroksida Dan Asam Lemak Bebas VCO. *Jurnal Katalisator*, 8(1), 111-122.
- Soetjipto, H., Anggreini, T., & Cahyanti, M. N. (2018). Profil Asam Lemak Dan Karakterisasi Minyak Biji Labu Kuning (*Cucurbita moschata* D.). *Jurnal Kimia Dan Kemasan*, 40(2), 79. <https://doi.org/10.24817/jkk.v40i2.3797>

- Suranto, S., Hidayati, N. R., Furqan, M., Mahadjoeno, E., & Sajidan, S. (2023). Flavonoid compound of Cucurbita moschata at three different altitudes. *Biodiversitas Journal of Biological Diversity*, 24(3), 1853–1860.
<https://doi.org/10.13057/biodiv/d240361>
- Suwannapong, A., Talubmook, C., & Promprom, W. (2023). Evaluation of Antidiabetic and Antioxidant Activities of Fruit Pulp Extracts of Cucurbita moschata Duchesne and Cucurbita maxima Duchesne. *Scientific World Journal*, 2023.
<https://doi.org/10.1155/2023/1124606>
- Tjiptowibisono, S., Tediando, T., Purwanto, E., & Sety, P. (2015). The Relationship Between Altitudes And The Contents Of Protein, Carbohydrates, Lipids Of Pumpkin (Cucurbita moschata). *AGRIVITA Journal of Agricultural Science*, 37(1), 59–66.
<https://doi.org/10.17503/Agrivita-2015-37-1-p059-066>
- Villaverde, P., Lajous, M., MacDonald, C. J., Fagherazzi, G., Bonnet, F., & Boutron-Ruault, M. C. (2019). High dietary total antioxidant capacity is associated with a reduced risk of hypertension in French women. *Nutrition Journal*, 18(1), 1–10.
<https://doi.org/10.1186/s12937-019-0456-0>
- Vinod, K., Tomar, B. S., Kaddi, G., & Kumar, S. (2014). Effect of stage of harvest and post harvest ripening on hybrid seed yield and quality in bottle gourd. *Indian Journal of Horticulture*, 71(3), 428–432.
- Zhou, Y., Zhao, W., Lai, Y., Zhang, B., & Zhang, D. (2020). Edible Plant Oil: Global Status, Health Issues, and Perspectives. *Frontiers in Plant Science*, 11(August), 1–16.
<https://doi.org/10.3389/fpls.2020.0131>