The effect of longterm drying on the quality of canary seed oil (*Canarium sp*.) with and without epidermis

Mustamin Anwar Masuku[1*], Angela Wulansari[1] and Erwin Abdul Aziz[2]

1 Lecturers at The Department of Agricultural Processing Products Technology, Faculty of Agriculture, Universitas Khairun
2 The alumni at the Departement of Agricultural Processing Products Technology, Faculty of Agriculture, Universitas Khairun

*E-mail: anwar.masuku@gmail.com

Abstract: Walnut seeds are one of the Indonesian plants that are widely used as food. Walnut kernels are usually eaten fresh, roasted, as a kitchen spice, topping for ice cream, and walnut kernel oil is usually used to cook food. North Maluku has two types of canaries, including the Ifa Tamate and Ifa Wagol canaries. These two types of walnuts have different shapes and sizes of fruit and walnut seeds. Making walnut oil from these two types of walnut kernels has never been done before. Walnut seeds are coated with epidermis which contains carotenoid pigments and is rich in phenolic components. The use of walnut seeds does not only extend to their use as a food ingredient, walnut seeds also have a high fat composition so they have the potential to be a raw material for making vegetable oils, walnut seed oil is produced from extracting walnut kernels using several methods such as mechanical pressing or extraction with organic solvents. This research aims to determine the effect of drying time on the chemical quality characteristics of Ifa Wagol walnut seed oil with and without epidermis made from local North Maluku walnuts. The research method used a Completely Randomized Design (CRD), with an ANOVA test if there was a significant difference ($p<0.05$) then continued with the DMRT test with 6 treatments and 3 replications, so that 18 experimental units were obtained. This treatment uses a temperature of 70^{o}C with different drying times, namely 1 hour without epidermis, 3 hours without epidermis, 5 hours without epidermis, 1 hour with epidermis, 3 hours with epidermis, 5 hours with epidermis. The results of the research were that the drying time and different treatments had a real influence on the water content of dried walnuts between 2.64% - 3.92% and the fat content of dried walnuts 62.49% - 67.83%. The fat content of walnut oil ranges from 98.36% - 99.38%. Caratenoid levels ranged from 555.23 mg/100g - 1107.56 mg/100g. Free fatty acid levels ranged from 0.47% - 1.48%. The value of fresh walnut kernels, water content 4.255%, ash content 3.494%, fat content 61.598%, protein content 14.711%, carbohydrate content 12.319% and crude fiber 3.620%.

Keywords : *walnuts, walnut kernel oil, drying time*

1. Introduction

Walnut seeds are one of the Indonesian plants that are widely used as food. Walnut seeds are usually eaten fresh, roasted, as a kitchen spice, topping for ice cream, and walnut seed oil is usually used to cook food (Wichman, 2012). In Indonesia, there are two species of canary that are often encountered, namely Canarium vulgare and Canarium indicium, (Kennedy and Clarke, 2004). These two species can be found in the Maluku and North Maluku areas. The North Maluku region, especially Makian Island, South Halmahera Regency is one of the centers largest walnut production (Indonesian Health Information Media, 2012).

North Maluku has two types of canaries, including the Ifa Tamate and Ifa Wagol types. These two types of walnuts have different shapes and sizes of fruit and walnut seeds. Making walnut oil from these two types of walnut kernels has never been done before. Walnut seeds are coated with epidermis which

contains carotenoid pigments and is rich in phenolic components (Djasibani et al., 2013). The oil extracted from ripe walnut seeds contains 70% fat, 7% carbohydrates, 12% protein, 22 mg/g tocopherol and also contains phenolic compounds. Dried walnut kernels contain 3.67% water content, 2.82% ash content, 14.89% protein content and 38.29% fat content (Djarkasi et al, 2007). Walnut seeds contain high levels of antioxidants and have bioactive components, especially from the fatty acid group such as oleic acid, linoleic acid, palmitoleic acid, palmitic acid, stearic acid and arachidonic acid (Rahman et al, 2019).

The use of walnut seeds does not only extend to their use as a food ingredient, walnut seeds also have a high fat composition so they have the potential to be a raw material for making vegetable oil (Djarkasi et al, 2011). Walnut seed oil is produced from extracting walnut kernels using several methods such as mechanical pressing or extraction with organic solvents. (Djarkasi, 2017).

One of the stages in making walnut kernel oil is drying and pressing. Drying can reduce the activity of the chemical content in the material and may even be lost, apart from that, the drying time is a factor that influences the components of the oil produced (Wirawati et al., 2020). For this reason, this research will look at the aspect of drying time for walnut seed oil using epidermis and without epidermis, the drying temperature is made according to the best research results from Djakarsi et, al., (2008), namely 70ºC. It is hoped that from this research, the drying time for the extracted walnut seed oil will be obtained to determine the quality of North Maluku walnut oil.

2. Methodology

The tools needed to make walnut kernel oil are a cabinet dryer, filter cloth, electric scale, hydraulic press, and dark bottles. And the tools for analysis are crucibles, desiccators, scales, ovens, furnaces, paper cartridges, soxhlets, boiling stones, Kjeldahl flasks, electric stoves, Erlemeyers, distillation equipment, titration tools, blenders and measuring flasks.

Research Materials Walnut seeds were obtained from walnut farmers on Makian Island, South Halmahera, North Maluku. And the chemicals used are hexane, K2SO4, CuSO4, H2SO4 solution, distilled water, NaOH 40%, H2BO3, BCG-MR, HCI 0.1 N, ethanol 95%, phenophthalein, KOH 0.1 N, and acetone MgCO3.8. This research is experimental research. This research used a completely randomized design (CRD) with one factor, namely the drying time of walnut kernels. Factors for drying time for walnut kernels consist of:

P1 = drying time 1 hour Ifa wagol without epidermis
P2=drying time 1 hour ifa wagol with epidermis
P3=drying time 3 hours ifa wagol without epidermis
P4=drying time 3 hours if wagol with porter
P5 = drying time 5 hours ifa wagol without epidermis
P6 = drying time 5 hours ifa wagol with epidermis

This research was divided into 6 treatments and each treatment was repeated 3 times to obtain 18 experimental units. The raw material for making oil uses large walnuts (Ifa Wagol) which are obtained from walnut farmers on Makian Island, South Halmahera. The walnuts are then pounded to separate the seeds from the fruit. The walnut seeds that have been separated are then peeled again to separate the contents of the seeds from the attached epidermis. The contents of the walnut seeds are what will be made into oil.

2.1. Processing of walnut seed oil

Preparation of walnut seed oil based on the method by Djarkasi et al. (2008) modified. Wet walnut kernels are tested for water content and fat content. The walnut kernels were then dried using a cabinet dryer at 70°C for 1, 3 and 5 hours. The dried walnut kernels were then analyzed for water content and fat content. Dried walnut kernels are wrapped in filter cloth and then pressed using a hydraulic press at a pressure of 200 kg/cm2 for 10 minutes. Pressing is done 2 times to maximize oil extraction. The oil that comes out is then collected and filtered again to clean it of solids that still contaminate the oil. The

oil yield is then measured and stored in a dark bottle. This process was carried out 3 times for each treatment group.

3. Results and Discussions

The analysis parameters for the chemical quality characteristics of walnut oil consist of wet walnut kernels (moisture content, ash content, protein content, fat content and crude fiber content), dry walnut kernels (moisture content and fat content), and walnut oil (moisture content, fat content). fat, free fatty acid levels, and caratenoid levels).

3.1. Wet Walnuts

In this research process, initial data was collected, namely analysis of wet walnut seed samples. This research was then carried out with several analyzes, namely water content, ash content, protein content, fat content, carbohydrates and crude fiber content, before the wet walnut seeds were dried and made into oil. Based on the results of initial research on the analysis of wet canary seeds, it can be seen in the 1th table below.

Table 1. Nutritional components of wet walnuts

Nutritional component	Value (%)
Water	4,2556±0,1313
Ash	3,4945±0,0687
Crude fiber	3,6207±0,1869
Carbohidrate	12,3192±0,4448
Protein	14,7118±0,0634
Lipid	61,5983±0,0846

3.2. Dried Walnut Seeds

Observations on dried walnut seeds include analysis of water content and fat content. Using a drying temperature of 70OC with different drying times and treatments.

a) Water Content

Water content is a parameter used to determine the level of dryness of a material based on wet weight or dry weight. Moisture is also a very important property of food, because water can affect appearance, texture, taste and shelf life. High water content causes the growth and development of bacteria, mold (fungi) and yeast, which can affect the nutritional and antioxidant content of food. The water content of a material varies depending on the water content of the material. The wetter the material, the higher the water content (Khumairoh, 2020). The results of the dry walnut kernel moisture content test are shown in Figure 1th.

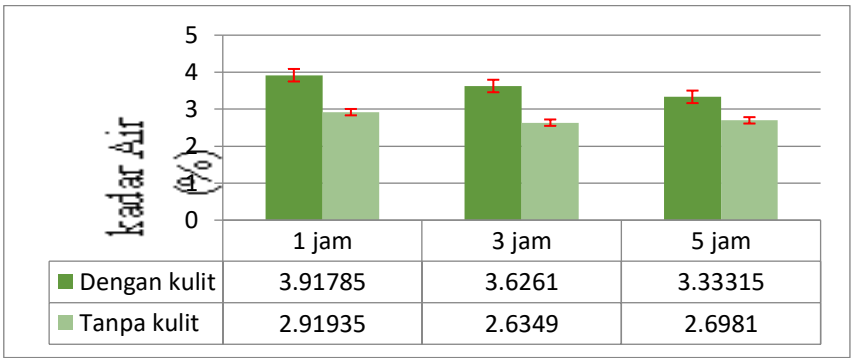

Figure 1. The average value of the effect of drying time on the moisture content (%) of seeds dried walnuts.

Based on proximate analysis with a drying temperature of 70oC, the water content of dried walnut kernels with different drying times was 3.333% - 3.917% with skin, and without skin 2.634% - 2.919%. This is because the water content of dried walnut kernels at the beginning of drying is greater, this changing drying rate is a characteristic of walnut kernels. Judging from the results of proximate analysis, the water content of dried walnut seeds in the treatment with a drying time of 1 hour with epidermis was close to the nutritional component of walnut seeds, namely 3.67% (Lawalata et al, 2004).

The results of the analysis of variance showed that the drying time factor had a very real influence on the water content of the dried walnut seeds produced. This is in accordance with Fitriani's (2008) statement which states that the longer the drying time, the lower the water content, this is caused by the evaporation of more water molecules so that the water content in the material becomes smaller. Evaporation occurs due to the difference in vapor pressure between the water in the material and the water vapor in the air. The water vapor pressure of the material is generally greater than the water vapor pressure in the air, resulting in mass transfer of water from the material to the air.

Based on the results of the DMRT test on the water content of dried walnut kernels by drying using a drying cabinet, it can be seen in the Table of 2nd below.

Table 2. Water Content of Dried Walnut Seeds

The treatments of longterm drying	Averages (%)	P
P1=1 hour with epidermis	3,91785± 0,0969^{d}	0,001
P2=3 hour with epidermis	3,6261± 0,3091^{c}	
P3=5 hour with epidermis	3,33315± 0,1558^{b}	
P4=1 hour with epidermis	2,91935± 0,0541^{a}	
P5=3 hour with epidermis	2,6349± 0,1409^{a}	
P6=5 hour with epidermis	2,6981± 0, 1220^{a}	

Based on the analysis of the DMRT test results, it is known that the water content concentration of dried walnut kernels is very significantly different (p 0.001) for different drying times. The highest water content value for walnut seeds was in treatment P1, namely 3.917 ± 0.096, and the smallest value was found in P5, namely 2.634 ± 0.140.

b) Fat Content

Fat is a food substance that is important for the health of the human body. Apart from that, fat is also found in almost all food ingredients with varying contents (Winarno, 2004).

Based on test results analyzing the fat content of dried walnut kernels at a drying temperature of 70oC, with different drying times, namely with skin 62.490% - 64.367%, and without skin 67.482% - 67.834%. This is due to an increase in drying time, causing the fat to break down and the amount to decrease. The longer the drying is used, the more damage the fat will increase. The process of fat oxidation can cause inactivation of its biological function and can even be toxic. Apart from oxidation, fat is also hydrolyzed (Risnawati and Laming, 2018)

The results of the analysis of variance showed that the drying time factor had a very real influence on the fat content of the dried walnut seeds produced. Generally, after processing food ingredients, there will be damage to the fat contained therein, the level of fat damage varies greatly depending on the temperature used and the length of the processing process. The higher the temperature used, the more intense the damage to the fat, the heat-resistant nature of the fat causes the fat to melt and even evaporate (volatile) to become other components such as flavor (Risnawati and Laming, 2018).

Table.3 Fat content of dried walnut kernels

The treatments of longterm drying	Averages (%)	P
P1=1 hour with epidermis	62,49015± 0.0784[d]	0,000
P2=3 hour with epidermis	63,6542± 0.0098[c]	
P3=5 hour with epidermis	64,36765± 0.1736[b]	
P4=1 hour with epidermis	67,65055± 0.4355[a]	
P5=3 hour with epidermis	67,48255± 0. 1116[a]	
P6=5 hour with epidermis	67,8345± 0. 1513[a]	

Based on the analysis of the DMRT test results, it is known that the fat concentration of dried walnut kernels is very significantly different (p 0.000) for different drying times. The highest value of dried walnut seed fat content was in treatment P6, namely 67.834 ± 0.151, and the smallest value was in P1, namely 62.490 ± 0.078.

3.3. Walnut Oil

Observations on walnut oil include analysis of water content, fat content, free fatty acid content and caratenoids. The method for making walnut oil is that the walnut kernels are dried using a cabinet dryer at a temperature of 70OC with different drying times and treatments. The dried walnut kernels are wrapped in filter cloth and then pressed using a hydraulic press at a pressure of 200 kg for 10 minutes. Pressing is done twice to maximize oil extraction, the oil that comes out is then collected and filtered again to clean it of solids that still contaminate the oil. The oil yield is then weighed and stored in bottles.

1) Water content

Water content plays an important role, except for temperature, water activity has its own place in the spoilage process (Amarudin & Ulum, 2018). Food spoilage is generally a microbiological, chemical, enzymatic process or a combination of the three (Dita et al. 2021).

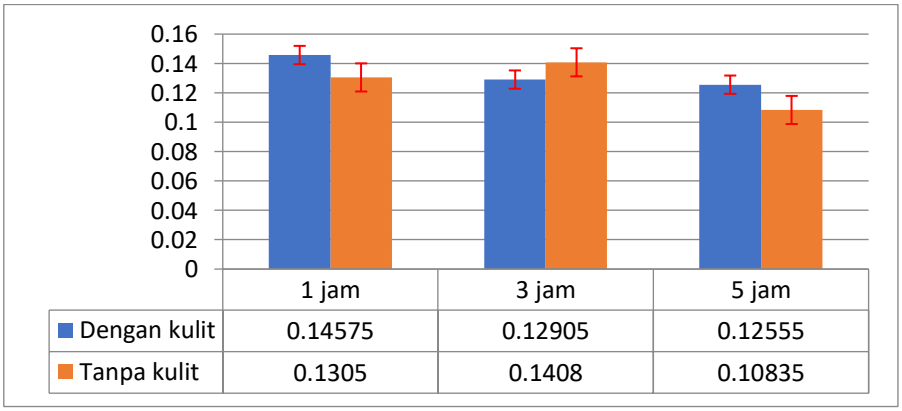

Figure 2. The average value of water content (%) of walnut oil

The water content of walnut oil using the pressing method, namely with the skin, is 0.125% - 0.145%, and without the skin 0.108% - 0.140%. The highest water content of walnut oil was in the P1 treatment with skin, namely 0.145%, and the lowest was in the P3 treatment without skin, namely 0.108%. This is because the water content of dried walnut kernels at the beginning of drying is greater, this changing drying rate is a characteristic of walnut kernels. (Lawalata et al, 2004).

The results of the variance analysis obtained in testing walnut oil showed that the drying time had no significant effect on the water content of walnut oil. Determining the water content in the oil is very important because the amount of water contained in the oil affects the water content of the oil produced. The lower the water content produced, the better the water content of the oil produced.

2) Fat content of walnut oil

The fat content has decreased in value in the material due to the heating process carried out before pressing the material (Apriyanto, 2020). Fat is a substance found in materials that is important for the health of the human body. Apart from that, fat is also found in food with different contents (Winarno, 2004).

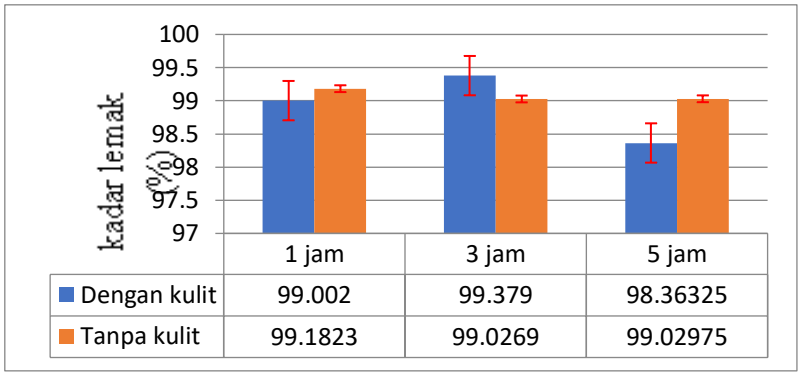

Figure 3. Average value of fat content (%) of walnut oil

The fat content of walnut oil using the pressing method, namely with the skin, is 98.363% - 99.379%, and without the skin 99.026% - 99.182%. The highest fat content of walnut oil was in the P2 treatment with skin, namely 99.379% and the lowest was in the P3 treatment with skin, namely 98.363%. This is because the high fat content in the ingredients is still quite high because the previous fat reduction stage was still less than optimal (Apriyanto, 2019).

The results of the analysis of variance obtained in testing walnut oil were that the fat content had a real influence on the fat content of walnut oil. The higher the temperature used, the faster the fat damage occurred. The decrease in fat content after drying was due to the nature of the fat which is not heat resistant. The level of fat damage varies greatly depending on the temperature used and the length of time of the pressing process. With the heating process the fat becomes liquid and the viscosity of the fat will decrease, making it easier for the fat to flow from the cell matrix of the material (Naik et al., 2012). Based on the results of the DMRT test on the water content of walnut oil cernel.

Based on the analysis of the DMRT test results, it is known that the fat content concentration of walnut oil is very significantly different (p 0.000) to the resulting pressing method. The highest value was found in the P2 treatment with epidermis, namely 99.379 ± 0.045 and the lowest was in the P1 treatment with epidermis, namely 99.002 ± 0.046.

Table 4. Fat content of walnut oil with different drying times

Drying time	Mean (%)	p
P1=1 hour with epidermis	99,0020± 0,0461^{c}	0,000
P2= 3 hour with epidermis	99,3790± 0,0459^{a}	
P3=5 hour with epidermis	98,3633± 0,0238^{d}	
P4=1 hour with epidermis	99,1823± 0,0052^{b}	
P5=3 hour with epidermis	99,0269± 0,0469^{c}	
P6=5 hour with epidermis	99,0298± 0,0224^{c}	

Based on the analysis of the DMRT test results, it is known that the fat content concentration of walnut oil is very significantly different (p 0.000) to the resulting pressing method. The highest value was found in the P2 treatment with epidermis, namely 99.379 ± 0.045 and the lowest was in the P1 treatment with epidermis, namely 99.002 ± 0.046.

3) Walnut Oil Carotenoid Content

Caroteniods are organic pigments that are reddish orange in palm oil and are one of the most important functional compounds that are beneficial for body health. Carotenoids are unsaturated hydrocarbons because they have a double bond between two conjugated carbon atoms and usually undergo transformation (Nokkaew et al., 2019).

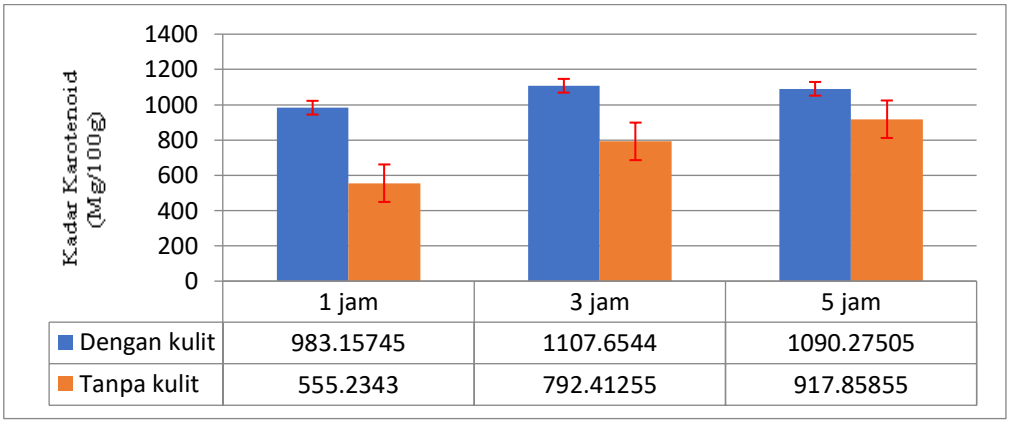

Figure 4. Average value of Mg carotenoid content/100g walnut oil

Based on the graph above, it shows that the carotenoid content value is 983.157 mg/100g – 1107.654 mg/100g with the skin and 555.234 mg/100g – 917.858 mg/100g without the skin. The highest level of carotenoids in walnut oil was in the P2 treatment with skin, namely 1107.654 mg/100g and the lowest was in the P1 treatment without skin, namely 555.234 mg/100g. Belitz et al (2008) said that the stability of caratenoids is related to the presence of double bonds and non-double bonds because they cause them to easily separate due to oxidative degradation by chemicals, enzymes, temperature, oxygen and light. This is due to changes in environmental conditions, such as lighting factors when testing colors using a reader, the intensity of light at the time of collection may be different, differences in light sources (fluorescent lights/sunlight) and differences in the direction of the light angle.

The results of the variance analysis obtained in testing walnut oil, namely that the carotenoid content has a very real influence on the carotenoid content of walnut oil, because carotenoids are insoluble in water, methanol, ethanol and organic solvent solutions such as carbon disulfide, benzane, chloroform, acetone, ether and petroleum. ether (Purnamasari et al., 2013). Based on the results of the DMRT test on the water content of walnut oil using the pressing method, it can be seen in the table of 5th below.

Table 5. Carotenoid content of walnut oil with different drying times

Drying time	Mean Mg/100g	p
P1=1 hour with epidermis	983,1575± 5.4076^{c}	0.000
P2=3 hour with epidermis	1107,654± 5.4320^{a}	
P3=5 hour with epidermis	1090,275± 5.1266^{b}	
P4=1 hour with epidermis	555,2343± 3.0161^{f}	
P5=3 hour with epidermis	792,4126± 5.6012^{e}	
P6=5 hour with epidermis	917,8586± 5.3719^{d}	

Based on the analysis of the DMRT test results, it is known that the concentration of carotenoid levels in walnut oil is very significantly different (p 0.000) to the resulting pressing method. The highest value was in treatment P2 with epidermis, namely 1107.654 mg/100g ± 5.4320 mg/100g and the lowest was in treatment P1 with epidermis, namely 555.234 mg/100g ± 3,016 mg/100g.

Walnut Oil Free Fatty Acid Content

High quality oils have few free fatty acids or low acid numbers. Thanks to the presence of water, triglycerides are hydrolyzed into glycerol and free fatty acids. Free fatty acids are an indicator for determining oil quality. The worse the quality of the oil, the higher the amount of free fatty acids (Eka et al., 2016). The results of the free fatty acid content test in walnut oil are shown in Figure of 5th

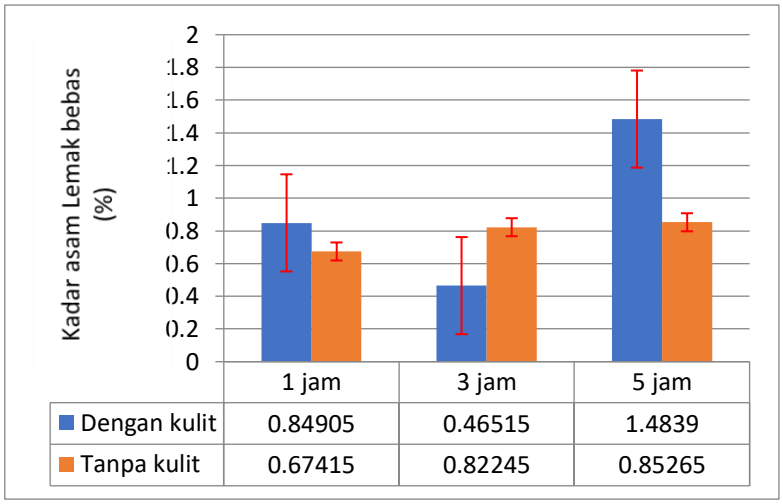

Figure 5. Average value of free fatty acid content (%) of walnut oil

Based on the graph above, it shows the value of free fatty acid levels, namely with the skin, namely 0.465% - 1.483% and without the skin 0.671% - 0.852%. The highest level of free fatty acids in walnut oil was in the P3 treatment with skin, namely 1.483% and the lowest was in the P2 treatment with skin, namely 0.465%. This shows that the amount of free fatty acids exceeds the good limit for oil, because it does not meet the requirements set by SNI, namely 0.30%. The higher the acid number or FFA, the higher the level of oil damage. The high concentration of free fatty acids in the oil is likely caused by hydrolysis reactions. Oils and fats can also be hydrolyzed during pressing (Lempang et al., 2016).

The results of the variance analysis obtained in testing walnut oil are that the free fatty acid content has a very real influence on the free fatty acids of walnut oil. The amount of free fatty acids contained in the oil is a parameter for the quality of the oil, where the higher the free fatty acid content, the lower the quality. Nurhasnawati (2015). The increase in free fatty acid levels is also caused by the length of storage. During storage, oils and fats can experience physical and chemical changes caused by hydrolysis and oxidation. Incorrect storage for a certain period of time can cause the triglyceride bonds in the oil to break and form glycerol and free fatty acids (Nurhasnawati, 2015). Based on the results of the DMRT test on the water content of walnut oil using the pressing method, it can be seen in Table 6.

Table 6. Free Fatty Acid Content of Walnut Oil with different drying times

Drying time	Mean (%)	p
P1=1 hour with epidermis	0,84905± 0,0021^{c}	0,000
P2=3 hour with epidermis	0,46515± 0,0104^{a}	
P3=5 hour with epidermis	1,4839± 0,0137^{d}	
P4=1 hour with epidermis	0,67415± 0,0186^{b}	
P5=3 hour with epidermis	0,82245± 0,0104^{c}	
P6=5 hour with epidermis	0,85265± 0,0172^{c}	

Based on the analysis of the DMRT test results, it is known that the free fatty acid concentration of walnut oil is very significantly different (p 0.000) to the resulting pressing method. The highest value

was found in the P3 treatment with epidermis, namely 1.4839 ± 0.0137 and the lowest was in the P2 treatment with epidermis, namely 0.46515 ± 0.0104.

4) Walnut oil yield

The yield is a comparison of the amount (quantity) of oil produced from plant extracts. The yield uses units of percent (%), the higher the yield value produced indicates the greater the value of the vegetable oil produced (Candra, 2016). The yield test results can be seen in Table 7 below.

Table 7. Walnut Oil Yield with different drying times

No	treatments	Weigth of materials	Volume minyak	Rendemen X 100%	Sig.
1.	1 hour with epidermis	500g	724 ml	0,48±0,006	0.151
2.	3 hour with epidermis	500g	730 ml	0,49±0,035	
3.	5 hour with epidermis	500g	765 ml	0,51±0,026	
4.	1 hour with epidermis	500g	745 ml	0,50±0,010	
5.	3 hour with epidermis	500g	790ml	0,54±0,042	
6.	5 hour with epidermis	500g	750 ml	0,5±0,017	

Based on table 7 above, it can be seen that the average yield of walnut kernel oil ranges from 0.5% - 0.54%. In the treatment of walnut seed oil without epidermis with a drying time of 3 hours, the highest yield was 0.54%, while the lowest yield with a value of 0.5% was found in walnut seed oil without epidermis with a drying time of 5 hours. The yield is a percentage of the raw material. main thing that can be used as a final product or a comparison of the final product with the main raw material.

The higher the yield means the greater the amount of oil produced. The quality of the oil resulting from the extraction process is generally inversely proportional to the yield presentation. From the results obtained it can be concluded that the higher the temperature, the higher the yield will be, taking into account the condition of the seeds used. The resulting lack of yield is greatly influenced by the condition of the pressing tool, such as the age of the tool, and the condition of the hydraulic press on the tool used. The yield of walnut kernel oil is calculated by comparing the overall oil yield obtained from the pressing extraction process to the weight of the material put into the press (Candra, 2016).

Based on the yield results that have been obtained as shown in the table above, the highest yield is in walnuts without shell and with epidermis with 3 and 5 hours of drying, namely 0.51 ± 0.026 - 0.54 ± 0.042. Based on the results of the average analysis On average, the yield of walnut kernel oil produced using the six-treatment pressing method showed no significant effect on the weight of walnut kernel oil. The results of the smallest significant difference test with a level of 5% for the treatment of walnut kernel oil on the yield value are presented in the Table of 7th.

Treatment with longterm drying	Averages (%)	p
P1=1 hour with epidermis	0,84905± 0,0021^{c}	0,000
P2=3 hour with epidermis	0,46515± 0,0104^{a}	
P3=5 hour with epidermis	1,4839± 0,0137^{d}	
P4=1 hour with epidermis	0,67415± 0,0186^{b}	
P5=3 hour with epidermis	0,82245± 0,0104^{c}	
P6=5 hour with epidermis	0,85265± 0,0172^{c}	

4. Conclusion and Recommendations

Based on the results of research research, the following conclusions can be drawn:

1. The value of fresh walnut kernels is 4.255% water content, 3.494% ash content, 61.598% fat content, 14.711% protein content, 12.319% carbohydrate content and 3.620% crude fiber.

2. Drying time has a significant effect on the water content and fat content of dried walnut kernels. The water content of dried walnuts ranges from 2.64% - 3.92% and the fat content of dried walnuts ranges from 62.49% - 67.83%.
3. Drying time has a significant effect on fat, rubberenoid and free fatty acid content. Drying time does not have a significant effect on the water content of walnut oil. The fat content of walnut oil ranges from 98.36% - 99.38%. Caratenoid levels ranged from 555.23 mg/100g - 1107.56 mg/100g. Free fatty acid levels ranged from 0.47% - 1.48%.
4. The drying time does not have a significant effect on the resulting yield value.

Based on the research results, the author suggests continuing this research by extending the drying time so that the water content is obtained in accordance with SNI for oil quality (0.15%).

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