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Effects of Processing Parameters on the Quality Characteristics of Oil Extracted from Cashew (*Anarcardium Occidentale*) Kernel

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Abstract: Cashew kernel oil (CKO) is one of the most important edible vegetable oils because of its low cholesterol and monosaccharide nature. In this study, the effects of processing parameter affecting quality of cashew kernel oil were investigated. The extraction analysis was carried out using a laboratory screw press in the Department of Agricultural and Bio-Environmental Engineering, Auchi Polytechnic, Auchi and the quality analysis of CKO extracted was carried out in the chemistry laboratory of the University of Ilorin, Ilorin Nigeria. The study investigated the effects of heating temperature, moisture content, and Pressing time on the iodine value, acid value, peroxide value and free fatty acid of the CKO. The study was considered as a 4×3×3×3 factorial experiment with four levels of heating temperature (80, 90,100 and 110°C), three level of moisture content (7,8 and 9% wb) and three level of pressing time (10, 12 and 15minutes) and in three replication using a Randomized Complete Block Design (RCBD) with moisture content as a blocking factor. The data obtained was subjected to statistical analysis using SPSS20.0 software. The study result established that the heating temperature, moisture content and pressing time have significant effects on the iodine value, acid value, peroxide value and free fatty acid of the CKO at 0.05 confidence limit.

Keywords: CKO, Quality Characteristics, Heating Temperature, Moisture Content, Pressing Time

1. Introduction

Vegetable oils are obtained from oil containing seeds, fruits, or nuts by different pressing methods, solvent extraction or a combination of these (Bennion, 1995). Crude oils obtained are subjected to a number of refining processes, both physical and chemical. These are detailed in various texts and articles (Bennion, 1995), there are numerous vegetable oils derived from various sources. These include the popular vegetable oils: the foremost oilseed oils - soybean, cottonseed, peanuts and sunflower oils; and others such as palm oil, palm kernel oil, coconut oil, castor oil, rapeseed oil and others. The most important product of the cashew tree is the nut, which is used as confectionery. Cashew shell nut liquid (CNSL), which is of great industrial importance is obtained from the seed pericarp by steam distillation or extraction with solvents. When unprocessed or improperly roasted, the cashew nut is very astringent (Abitogun and Borokini, 2009).

Cashew nut is a high value edible nut. It yields two "Oils" one of these found, between the seed coat (or pericarp) and the nuts, is called the Cashew Nut Shell Liquid (CNSL).It is not a triglyceride and contains a high proportion of phenolic compound. It is used in industry as a raw material for brake lining compounds, as a water proofing agent, a preservative and in the manufacturing of paints and plastics. It is toxic and corrosive to the skin. Cashew apples are sometimes made locally into fruit drinks, wines and pickles. In some countries they are also Osmo-Sol dried to produce a date- like caramel. (Akinhanmi and Akintokun, 2008).

Oil can be extracted from many raw materials, but not all contain edible oil. Some contain poisons and unpleasant flavors (Frank, 1998). Edible oils are derived from animals and plants (Sagha *et.al.,* 2004). Oils from plants are classified as vegetable oils. The largest sources of vegetable oils are annual plants, which include soybeans, corn, cottonseed, groundnut, sunflower, rapeseed, melon and sesame seed (Frank, 1998; O'Brien 1998). Other sources are oil bearing

perennial plants such as olive, coconut, shear, cashew and palm (Atiku *et. al*., 2004).

There is a universal demand for vegetable oil due to its increasing domestic and industrial uses. Moisture content of the seeds is one of the most important factors that affect the quality of the oil. According to fuel norms, the water content in the oil should be below 0.08%. High moisture content might increase the formation of FFA during storage. Hull content of the seeds and pressure is another factor Lower hull fraction in the seeds leads to lower pressures and higher pressure leads to higher temperature and more solid particles in the crude oil.

Above certain temperatures during extraction process phosphor is formed, which leads to carbon deposits on fuel injectors and combustion chambers for rape seed for example the maximum temperature of the oil during process is 55 – 60^0c. For Jatropha the exact temperature at which Phosphor start to dissolve in the oil has not yet been determined. (Jatropha hand book)

Palmoil,oliveoil,cottonseedoil,peanutoil,andsunfloweroi lamongstothersareclassedasOleic – Palm oil, olive oil, cottonseed oil, peanut oil, and sunflower oil amongst others are classed as Oleic – Linoleic acid oils seeing that they contain a relatively high proportion of unsaturated fatty acids, such as the monounsaturated oleic acid and the polyunsaturated linoleic acid (Dunn, 2005 as reported by Abitogun and Borokini, 2009). They are characterized by a high ratio of polyunsaturated fatty acids to saturated fatty acids. As a consequence of this, they have relatively low melting points and are liquid at room temperature. Iodine values, saponification values, specific compositions and melting points in addition to other physical properties have been determined and are widely available in the literature (Abitogun and Borokini, 2009).

Edible oil can be extracted from cashew nuts but hitherto, there is no evidence of it being carried out commercially. Despite the fact that Nigeria is one of the major cashew producers in the world, it is worthy of note that the utilization of the fruit is still very low. The nut, most times, is discarded, after the consumption of the edible cashew apple, despite its richness in oil. Again, even though it has been discovered that edible oil can be extracted from cashew nut, a thorough characterization of the oil has not be carried out. Cashew nut contains oil of economic importance and due to the efforts of Nigerian government to improve the production of the crop; it is of economic interest to characterize and to improve the oil extracted from the abundant cashew nuts for possible consumption as vegetable oil (Idah, *et.al*, 2014).

Cashew kernels are of high nutritive value. It contains 21 percent of protein, fat (47%), moisture (5.9 %), carbohydrates (22%), phosphorus (0.45%), calcium (0.05%), iron (5%) for every 100 gm and other mineral elements. Cashew kernel contains 47 percent fat but 82 percent of this is unsaturated fatty acid, which lowers the cholesterol level in blood. The most prominent vitamins in cashew are Vitamin A, D and E, which help to assimilate fats and increase the immunity level. (Yahaya, *et.al*, 2012).

2. Materials and Methods

2.1. Sample Preparation

The cashew kernel (Figure 1) used for the study was purchased from cashew processing plant located at Ogbodoroko in Ilorin Kwara State. The initial moisture content of the sample was determined to be 8.5%wb before it was sundried to a moisture content below 7% which Is the minimum moisture content required for the experiment. The sample was then grinded to a uniform granular size using attraction mill before conditioning and pressing operation.

Figure 1. *Pictorial View of the Sample of Kernel used for the Study.*

2.2. Extraction Procedure

The extraction of the CKO was carried out using 4× 3 × 3 × 3 factorial experiment i.e. 4 level of temperature (80, 90 ,100 and 110℃), three level of moisture content(7,8 and 9%wb) and three level of extraction time (10,12 and 15 min) at three replications. 100g of each sample is pressed in a randomized Complete Block Design (RCBD) with moisture content as a blocking factor. A total of 108 extracted oil samples were subjected to quality analysis for the determination of acid value, free fatty acid (FFA), peroxide value and iodine value.

2.3. Measurement and Calculation

2.3.1. Determination of Acid Value

25 cm^3 diethyl ether was mixed with 25cm^3 ethanol in a conical flask 1$cm^3$of 1% phenolphthalein indicator solution was added. The mixture was neutralized with 0.1M potassium hydroxide solution then 1g of oil was added to the neutralized solvent mixture. This was then titrated with 0.1M potassium hydroxide solution. It was then shaken constantly until a pink color which persists for 115 seconds was obtained. (Ronald, 1991).

$$\text{Acid value} = \frac{(V_b - V_a)cm^3 \times 5.61}{Weightofssampleused}(mgKOH/g) \quad (1)$$

$$V_a = \text{sample titre value}$$

V_b = blank titre value

2.3.2. Determination of Percentage of Free Fatty Acid (FFA)

One gram of oil sample was accurately weighed into a conical flask. This was followed by the addition 10 cm^3 of neutralized 95% ethanol and phenolphthalein. This was then titrated with 0.1M NaOH, with constant shaking until a pink colour persisted for 30s. The percentage was calculated from the equation reported by AOAC, 1990.

$$FreeFattyAcid\ (FFA) = \frac{V \times M \times 2.82mg}{sampleweight(g)} \quad (2)$$

Where:
V = Volume of NaOH
M = Molarity of NaOH
2.82 = conversion factor of oleic acid
V = Volume of NaOH
M = Molarity of NaOH
2.82 = conversion factor of oleic acid

2.3.3. Determination of Peroxide Value

One gram of the oil was weighed in to a clean dry boiling tube,1g of powered potassium iodide and 10 cm^3 of the solvent mixture where added. The mixture was allowed to boil vigorously for 30 seconds. The tube was washed twice with 25 cm^3 portion of water and the washings where added to the titration flask. This was then titrated with 0.002M sodium thiosulphate using starch indicator. The relationship for peroxide value is given by Ranken, 1988.

$$Peroxidevalue = \frac{(V_b - V_a)cm3 \times molarityoftitrant}{weightofoil} \times 100(meqKOH/g) \quad (3)$$

2.3.4. Determination of Iodine Value

0.2g of the oil was weighed into a 250 cm^3 glass stopper flat, 10 cm^3 of carbon tetrachloride was added to the oil and dissolved. Twenty cm^3 wijs' solution was equally added to the mixture and the content was corked with a stopper that was initially moistened with potassium iodide solution. The mixture was titrated with 0.1M standard sodium thiosulphate solution using starch as an indicator just before the end point. The relationship for peroxide value is given by AOAC, 1990.

$$Iodinevalue = \frac{(V_b - V_a)cm^3 \times 1.269}{weightofoil(g)} gl_2/10 \quad (4)$$

3. Result and Discussion

3.1. Statistical Analysis

The data generated from the calculated values of the average Iodine value, Acid value, peroxide value and Free Fatty Acid (FFA) at four levels of temperature, three levels of pressing time and at three levels of moisture content are represented on the tables 1, 2, 3 and 4 respectively.

Table 1. *Average Iodine Value at Different Temperature, Moisture Content and Pressing Time.*

Pressing Time (minute)	Moisture Content (%)	Iodine value			
		Temperature (°C)			
		80	90	100	110
10	7	65.37±0.163	63.79±0.036	62.32±0.020	60.89±0.015
	8	59.69±0.026	57.91±0.036	55.98±0.010	53.77±0.021
	9	52.93±0.015	50.98±0.015	48.82±0.026	53.88±0.021
12	7	65.79±0.015	63.98±0.020	62.21±0.025	60.46±0.025
	8	59.55±0.040	57.69±0.026	55.74±0.021	53.53±0.011
	9	52.70±0.025	50.82±0.020	48.72±0.020	57.97±0.010
15	7	65.63±0.015	63.29±0.021	62.09±0.067	60.53±0.026
	8	59.43±0.020	57.51±0.026	55.55±0.040	53.38±0.015
	9	52.41±0.021	50.57±0.074	48.53±0.021	57.77±0.102

Each value is the mean of triplicate ± standard deviation

Table 2. *Average Acid Value at Different Temperature, Moisture Content and Pressing Time.*

Pressing Time (minute)	Moisture Content (%)	Acid value			
		Temperature (°C)			
		80	90	100	110
10	7	30.95±0.015	31.44±0.020	33.48±0.015	60.88±0.017
	8	39.45±0.055	41.53±0.021	42.12±0.036	44.20±0.025
	9	45.47±0.025	47.42±0.060	47.24±0.029	49.69±0.021
12	7	30.83±0.025	31.33±0.020	33.29±0.015	35.80±0.021
	8	39.29±0.021	41.38±0.025	42.06±0.035	44.09±0.031
	9	45.32±0.025	47.33±0.020	48.61±0.021	49.53±0.015
15	7	30.78±0.032	31.20±0.025	33.20±0.025	35.73±0.015
	8	39.08±0.015	41.24±0.025	42.02±0.025	44.08±0.026
	9	45.21±0.021	47.22±0.025	48.32±0.021	49.42±0.025

Each value is the mean of triplicate ± standarddeviation

Table 3. *Average Peroxide Value at Different Temperature, Moisture Content and Pressing Time.*

Pressing Time (minute)	Moisture Content (%)	Peroxide value			
		Temperature(°C)			
		80	90	100	110
10	7	3.83±0.081	3.34±0.025	3.72±1.702	3.55±0.020
	8	3.64±0.030	3.57±0.026	3.72±0.021	3.75±0.026
	9	3.88±0.015	3.87±0.015	3.82±0.025	3.95±0.031
12	7	3.73±0.127	3.63±0.025	3.66±0.015	3.55±0.020
	8	3.62±0.015	3.53±0.025	3.73±0.015	3.75±0.025
	9	3.85±0.032	3.85±0.015	3.80±0.015	3.92±0.025
15	7	3.71±0.021	3.61±0.030	6.33±0.020	3.55±0.036
	8	3.60±0.025	3.53±0.030	3.69±0.025	3.75±0.012
	9	3.84±0.025	3.83±0.025	3.83±0.025	3.92±0.020

Each value is the mean of triplicate ± standard deviation

Table 4. *Average Value of Free Fatty Acid at Different Temperature, Moisture Content and Pressing Time.*

Pressing Time(minute)	Moisture Content (%)	Freefattyacid			
		Temperature(°C)			
		80	90	100	110
10	7	15.45±0.049	15.12±0.015	16.74±0.021	17.94±0.015
	8	19.73±0.015	20.75±0.021	21.07±0.012	22.10±0.010
	9	22.71±0.021	23.72±0.120	24.33±0.031	24.84±0.021
12	7	15.41±0.020	15.69±0.021	16.64±0.015	17.91±0.020
	8	19.62±0.200	20.68±0.015	21.05±0.015	22.05±0.025
	9	22.68±0.015	23.66±0.025	24.23±0.020	24.87±0.020
15	7	15.39±0.015	15.61±0.055	16.59±0.052	17.84±0.015
	8	19.55±0.015	20.64±0.026	21.03±0.025	22.04±00015
	9	22.69±0.020	23.64±0.025	24.17±0.015	24.73±0.020

Each value is the mean of triplicate ± standard deviation

3.2. Analysis of Variance (ANOVA)

The data obtained were subjected to statistical analysis using SPSS 20.0 software by considering the experiment as a factorial design with three factors being investigated i.e. the heating temperature, moisture content and pressing time while the moisture content was considered as the blocking factor. The ANOVA of the result is as shown on Table 5.

Table 5. *Analysis of Variance (ANOVA) for the Effect of Heating Temperature, Moisture Content and Pressing Time on Oil Qualities.*

SOURCE	DF	SUMOFSQUARE	MEANSQUARE	F	SIG
Iodine Value					
PT	2	4.201	2.100	2.277	.110^{NS}
MC	3	214.216	71.405	77.420	.000*
TEMP	2	2096.215	1048.108	1.136E3	.000*
PT*MC	6	14.233	2.372	2.572	.026*
PT*TEMP	4	19.335	4.834	5.241	.001*
MC*TEMP	6	392.969	65.495	71.012	.000*
PT*MC*TEMP	12	62.278	5.190	5.627	.000*
ERROR	72	66.406	.922		
TOTAL	108	355453.368			
CORRECTEDTOTAL	107	2869.855			
Acid Value					
PT	2	110.293	55.146	8.508E4	.000*
MC	3	839.011	279.670	4.315E5	.000*
TEMP	2	2888.980	1444.490	2.229E6	.000*
PT*MC	6	322.628	53.771	8.296E4	.000*
PT*TEMP	4	220.222	55.056	8.494E4	.000*
MC*TEMP	6	404.860	67.477	1.041E5	.000*
PT*MC*TEMP	12	612.432	51.036	7.874E4	.000*
ERROR	72	.047	.001		
TOTAL	108	190464.756			
CORRECTEDTOTAL	107	5398.474			
Peroxide Value					
PT	2	1.302	.651	693.349	.000*
MC	3	2.540	.847	901.946	.000*
TEMP	2	1.188	.594	632.879	.000*

SOURCE	DF	SUMOFSQUARE	MEANSQUARE	F	SIG
PT*MC	6	4.494	.749	797.690	.000*
PT*TEMP	4	2.846	.712	757.905	.000*
MC*TEMP	6	5.056	.843	897.562	.000*
PT*MC*TEMP	12	8.771	.731	778.481	.000*
ERROR	72	.068	.001		
TOTAL	108	1591.262			
CORRECTEDTOTAL	107	26.266			
Free Fatty Acid					
PT	2	.199	.099	173.202	.000*
MC	2	1008.718	504.359	8.800E5	.000*
TEMP	3	80.638	26.879	4.690E4	.000*
PT*MC	4	.005	.001	2.168	.081^{NS}
PT*TEMP	6	.009	.002	2.731	.019*
MC*TEMP	6	3.638	.606	1.058E3	.000*
PT*MC*TEMP	12	.039	.003	5.646	.000*
ERROR	72	.041	.001		
TOTAL	108	45912.990			
CORRECTEDTOTAL	107	1093.287			

*Significant, NS: Not significant; PT=Pressing-time, MC=Moisture Content, TEMP=Temperature

3.2.1. Effect of Heating Temperature and Pressing Time on Iodine Value

The effect of heating temperature and pressing time on Iodine value is as shown on Figure 2.

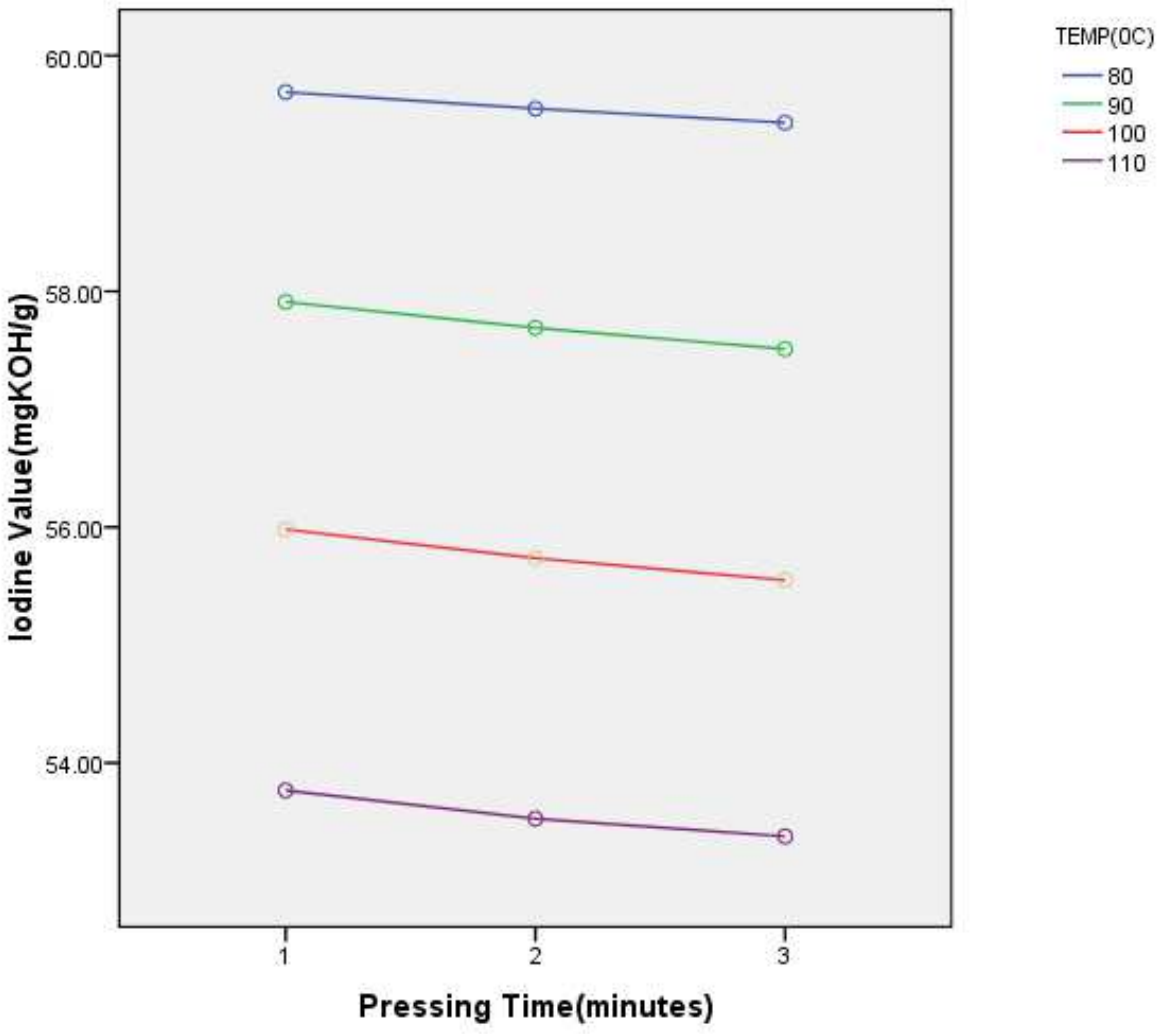

Figure 2. *Effect of Heating Temperature and Pressing Time on Iodine value at 8% Moisture Content.*

3.2.2. Effect of Heating Temperature, Moisture Content and Pressing Time on Acid Value

The effect of heating temperature and pressing time on Acid value is as shown on the Figure 3.

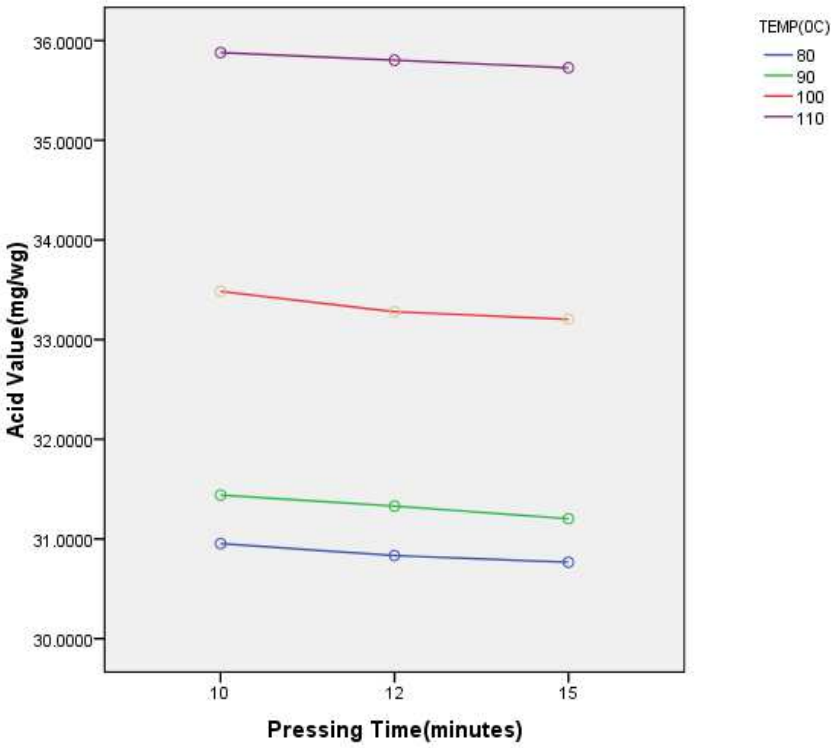

Figure 3. *Effect of Heating Temperature and Pressing Time on Acid value.*

3.2.3. Effect of Heating Temperature, Moisture Content and Pressing Time on Peroxide Value

The effect heating temperature and pressing time at different moisture content on peroxide value is as shown on the figures 4.

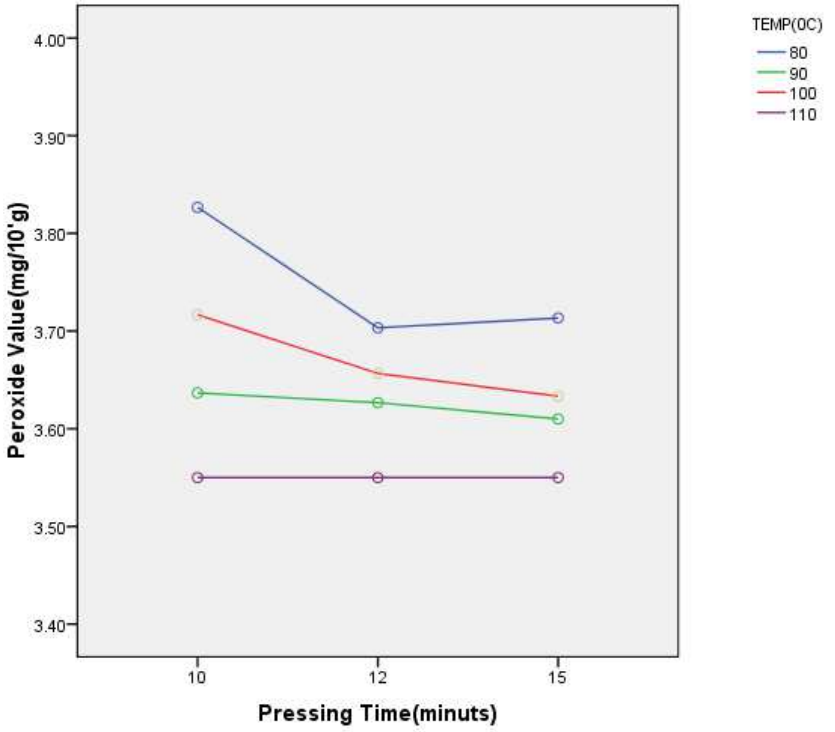

Figure 4. *Effect of Heating Temperature and Pressing Time on peroxide value.*

3.2.4. Effect of Heating Temperature and Pressing Time on Free Fatty Acid

The effect of heating temperature and pressing time at different moisture content on Free Fatty Acid is as shown on figures 5.

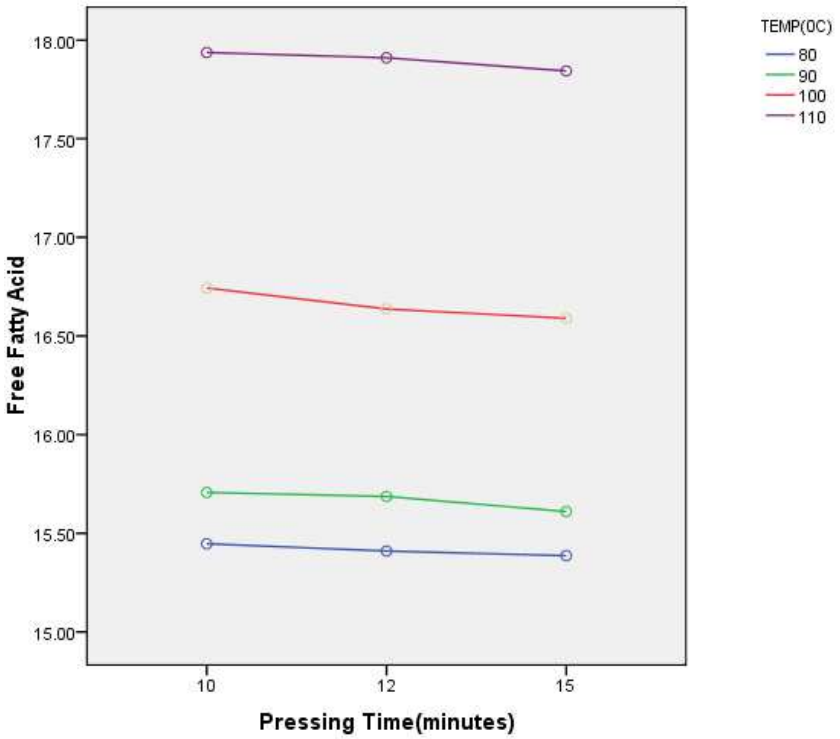

Figure 5. *Effect of Heating Temperature and Pressing Time on Free Fatty Acid.*

4. Con clusion

The research was carried out to determine the effects of processing parameters on the quality characteristics of cashew kernel oil. The study result established that temperature, moisture content and pressing time has a significant effect on the quality of oil extracted from cashew kernel. It is revealed that all the processing parameters (temperature, moisture content and pressing time) considered has significant effects on the peroxide value, acid value, free fatty acid, and iodine value of the oil extracted. The statistical analysis of the result obtained also validate effects of processing parameters on the iodine value, peroxide value, free fatty acid and the acid value of the cashew kernel oil extracted at 0.05 confidence limit.

References

[1] Atiku, A.; Aviara N.; and Haque, M. (2004). "Performance Evaluation of a Bambara Groundnut Sheller". Agricultural Engineering: the CIGR Journal of ScientificResearch and Development Manuscript PM 04 002 Vol. VI.

[2] Abitogun, A. S., and borokini, F. B. (2009). Physicochemical Parameter and Fatty Acid Composition of Cashew Nut (anacardiumoccidentale) Oil. Journal of research national development.

[3] Jatropha Handbook. (2009). Oil Pressing and Purification. 2nd Edition, pp1-23.

[4] Sangha, M.; Gupta, P.; Thapar, V. and Verma, S. (2004). Storage Studies on Plant Oils and their Methyl Esters. Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Manuscript EE 03 005. Vol. VI.

[5] AOAC (Association of Analytical Chemist): Official Method of Analysis 13th Edition. (1990). William Horwitz. Ed. Washington. DC, Association of Official Analytical Chemists, 7:.

[6] Ranken, M. D. (1988): Food industries manual, 2nd Edition, Published by AVI van Nostrand Reinhold Company, New York.

[7] Ronald, S. K. and Ronald, S. (1991): Composition and analysis of foods. 5th edition, Longman New York.

[8] Idah P. A, Simeon M. I and Mohammed M. A. (2014). Extraction and Characterization of Cashew Nut (Anacardium Occidentale) Oil and Cashew Shell Liquid Oil. Academic Research International Vol. 5(3). Pp1-5.

[9] Yahaya A. T, Taiwo O., Shittu T. R, Yahaya L. E and Jayeola C. O (2012). Investment in Cashew Kernel Oil Production: Cost and Return Analysis of Three Processing Methods. American Journal of Economics 2012, 2(3): 45-49.

[10] Akinhanmi, T. F and Akintokun, P. O (2008). Chemical Composition and Physicochemical Properties Of Cashew nut (Anacardium occidentale) Oil and Cashew nut Shell Liquid. Journal of agricultural, food and environmental science. Volume 2, Issue 1. Pp1-10.