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Effects of Heating Temperature, Water Volume and Extraction Time on the Oil Yield from Cashew (*Anarcardium Occidentale*) Kernel

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Abstract: Research have revealed that common edible vegetable oils except cashew kernel oil contains cholesterol which couldleads to chest pain, heart attack and bloody stood if not well managed. Despite this fact, there is no much attention on cashew kernel oil for domestic purpose. In this study, the effects of processing parameters affecting the oil yield from cashew kernel were investigated. The extraction analysis of the oil was carried out using a screw press developed in the processing laboratory of Agricultural and Bio-Environmental Engineering Department, AuchiPolytechnic, Auchi. The parameters considered were the heating temperature, added water volume (AWV), and extraction time. Thestudy was considered as a 4×3×3×3 factorial experiment with four levels of heating temperatures (80,90,100 and 110°C), three levels of AWV (7,8, and 9% of the sample) and three levels of extraction time (10, 12 and 15minutes) at each three replications using a Randomized Complete Block Design (RCBD) with water volume as a blocking factor. The data obtained was subjected to statistical analysis using SPSS20.0 software and the study result established that the heating temperature, water volume and extraction time has significant effects on the oil yield rate from cashew kernel and the heating temperature of 100°C produces the optimum oil yield of 42.2% at an average extraction time of 12 minutes and 9% water volume at 0.05 confidence limit.

Keywords: Cashew Kernel, Oil Yield, Heating Temperature, Water Volume, Extraction Time

1. Introduction

Cashew (*Anarcardium Occidentale*) is a native of Brazil and the Lower Amazons. The cashew has been introduced and is a valuable cash crop in the Americas, the West Indies, Madagascar, India and Malaysia (Frankel, 1991). 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 such as soybean, cottonseed, peanuts and sunflower oils; and others such as palm oil, palm kernel oil, coconut oil, castor oil, rapeseed oil and others. They also include the less commonly known oils such as rice bran oil, tiger nut oil, patua oil, ko_me oil, niger seed oil, piririma oil and numerous others. Their yields, different compositions and by extension their physical and chemical properties determine their usefulness in various applications aside edible uses. Also, cottonseed oil was developed over a century ago as a byproduct of the cotton industry (Bennion, 1995).

Abitogun and Borokini (2009) reported that Cashew nut oil is completely neutral when is unprocessed and is the best for human health. It is especially rich in unsaturated fatty acids and is least damaging to heart and arteries. In fact, it constitutes about 47% of the total weight of the nut. Cashew kernel often produces oil half their weight, the oil is referred to as ‘good fat’ and the ratio of saturated to monounsaturated to polyunsaturated fatty acid is 1:2:1 which is ideal for human consumption. According to Achal (2002), the relative abundance of monounsaturated fatty acids in cashew nut oil is conducive to promotion of good health and poses no nutritional risk.

The Cashew Nut Shell Liquid (CNSL) is a versatile industrial raw material with diverse use in friction linings, paints and varnishes, laminating and epoxy resins, foundry chemicals and as an intermediary of chemicals. The innumerable industrial applications of CNSL are based on the fact that it leads itself to polymerization by various means. Simple phenols from petrochemicals have restrictions hence, the range of products obtained from them are few (Achal 2002).

Edible oil can be extracted from cashew nuts but no evidence of its being carried out commercially has been found. Therefore, the objective of this research work is to determine the effects of heating temperature, water volume and extraction time on the oil yield from cashew (*Anarcardium Occidentale*) kernel for potential use for domestic purposes. (Fry, 2001) examined changes in the production and demand for oils and fats in the past quarter century (1976-2000) and made projections for the twenty-first century.

Nuts oils, seed oil and oils of fruit and vegetables are receiving growing interest due to their high concentration of bioactive lipid components, such as polyunsaturated fatty acids and phytosterols, which have shown various health benefits. Fats and oils, and their several lipid components are extensively used in the food and also in cosmetics, pharmaceuticals, oleochemicals and other industries. Cherry seeds are waste product, currently used for the production of biomasses (Sahena *et al*., 2009)

The processing conditions improvement is not the only goals of those who study oilseed extraction, but also the development of new models able to explain the observed phenomena during extraction. From the earlier models reported during 1950's one could observe a constant evolution of the proposed model in order to explain the comportment during extraction of the vegetable materials. The most widely accepted model considers two main mechanisms which occur during extraction a washing process of the oil on the grain surface and a diffusion process from the broken and intact cells that remain after pre-extraction treatments (Sovová *et. al*., 1994)

All extraction processes have three common goals: to obtain undamaged oil; getting oils with a high yield as possible and economically efficient; getting high quality oil residue in order to obtain a high economic value of the extraction process. Rapeseed oils are extracted by several methods. These methods include mechanical, solvent, enzymes and high pressure CO_2 extraction. Solvent extraction is the most efficient method of removing the oil from the seed. It may take place either in batch or continuous process. The solvent extraction most commonly used today is percolation with a countercurrent flow using hexane as solvent. *(*Kartika *et. al.,* 2010).

2. Materials and Methods

2.1. Description of the Machine Used for Study

The pictorial view of the screw press is shown on Figure 1. The screw press consists of the frame, piston, press cage cylinder, collector (tray) and the heater band as its major components for efficient operation. The rigid frame which holds the ram shaft is made of 3 inches angle iron and support the pressure created by the screw. It is well constructed and firmly mounted to the work surface before the pressing operation begins. The frame also comprises of two beams and four columns. The piston is a solid screw, and provides the necessary pressure required for the expression of the oil from the seeds. The press cage is a pipe made of mild steel of 10mm thickness, inner diameter 150mm and outside diameter160mm with the overall height of 210mm, it has an opening through which the oilseed would be admitted in to the cage and also consists of perforations at its lower part for oil drainage. The oil is drained into the oil collector placed blow the cage through the perforations. A heater band is attached to the cage to generate the heat required for the oil expression. The oil collector tray is a mild steel plate of 20mm thickness and 200mm diameter. A galvanized plate of 1mm thickness was wedded round the plate for easy collection of the oil. A circular groove of 10mm deep is made on the flat plate and the grove has the same diameter as the external diameter of the cage with little clearance of 0.05mm in order to allow the easy fixing and removal of the press cage cylinder, The heater band generates the heat required for the oil extraction and the electronic temperature controller regulate the current that flows in to the system and thereby regulate the temperature of the press cage.

Figure 1. *Pictorial view of the screw press during pressing operation.*

2.2. Sample Preparation

The cashew kernel (Figure 2) used for the study was purchased from cashew processing plant located at Ogbodoroko village in Ilorin, Kwara State, Nigeria. 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 2. *Pictorial View of the Sample of Kernels used for the Study.*

2.3. Extraction Procedure

The extraction was carried out using 4× 3 × 3 × 3 factorial experiment i.e. 4 level of temperature (80, 90,100 and 110°C), three level of AWV(7,8 and 9%) and three level of extraction time (10,12 and 15 min) at three replications. 100g of each samples were pressed in a randomized complete block design(RCBD) with moisture content as a blocking factor.

2.4. Measurement and Calculation

Determination of Oil Yield

The oil yield is defined as the amount of oil recovered from a certain kilogram of the seed and it can be expressed mathematically as:

$$\text{OY (\%)}= \frac{W_{OE}}{W_{OE}+W_{CK}} \times 100\% \qquad (1)$$

Where;

OY= Oil yield (%)

W_{OE} = Weight of oil extracted (Kg)

W_{CK} = Weight of cake (Kg)

3. Results and Discussion

3.1. Statistical Analysis

The data generated from the calculated values of the average oil yield at four levels of heating temperature, three levels of extraction time and three levels of water volumeisas represented on Table 1.

Table 1. *Average Value of Oil Yield at Different heating Temperature, Extraction Time and Water Volume.*

Pressing Time (minute)	Moisture Content (%)	Oil Yield (%)			
		Temperature (°C)			
		80	90	100	110
10	7	18.71±2.697	25.25±0.345	26.96±0.394	26.94±0.064
	8	25.14±0.193	29.44±0.550	30.93±0.104	31.24±0.675
	9	31.94±0.551	36.41±4.448	41.51±2.958	39.88±2.518
12	7	20.97±0.068	30.01±0.010	32.05±0.059	30.98±0.038
	8	25.34±0.502	34.81±0.315	36.32±0.497	36.32±1.719
	9	33.17±0.381	41.22±2.748	42.53±3.936	41.03±2.680
15	7	20.99±0.015	30.20±0.352	32.04±0.052	31.06±0.197
	8	25.56±0.499	35.06±0.739	37.18±0.383	35.82±0.834
	9	32.36±0.547	40.19±3.728	42.02±3.488	41.30±2.858

Each value is the mean of triplicate ± standard deviation

3.2. Analysis of Variance (ANOVA)

The data 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, water volume and extraction time while the water volume was considered as the blocking factor.

Table 2. *Analysis of Variance (ANOVA) for the Effect of heating Temperature, Extraction Time and Water Volumeon Oil Yield.*

SOURCE	DF	SUM OF SQUARE	MEANSQUARE	F	SIG.
ET	2	252.243	126.122	40.396	.000*
MC	2	2370.030	1185.015	379.552	.000*
HT	3	1575.430	525.143	168.200	.000*
ET*WV	4	34.481	8.620	2.761	.031*
ET* HT	6	46.308	7.718	2.472	.740^{NS}
WV* HT	6	10.977	1.830	.586	.911^{NS}
ET*WV* HT	12	18.570	1.548	.496	
ERROR	72	224.794	3.122		
TOTAL	108	118828.291			
CORRECTED TOTAL	107	4532.835			

*Significant, ^{NS} Not sign; ET = Extraction Time, WV = Water Volume, HT= Heating Temperature

The analysis of variance for the effect of the heating temperature, water volume and extraction time on oil yield is as shown on the table 2. The Table revealed that the heating temperature, water volume and extraction time and interaction between extraction time and water volume are all significant on oil yield. But, the interaction between the extraction time and heating temperature, water volume and heating temperature are not significant at 0.05 confident limits.

3.3. Effect of Heating Temperature, Extraction Time and Water Volume on Oil Yield

The effect of heating temperature, extraction time and at different water volume is as shown on the figures 3, 4 and 5 below.

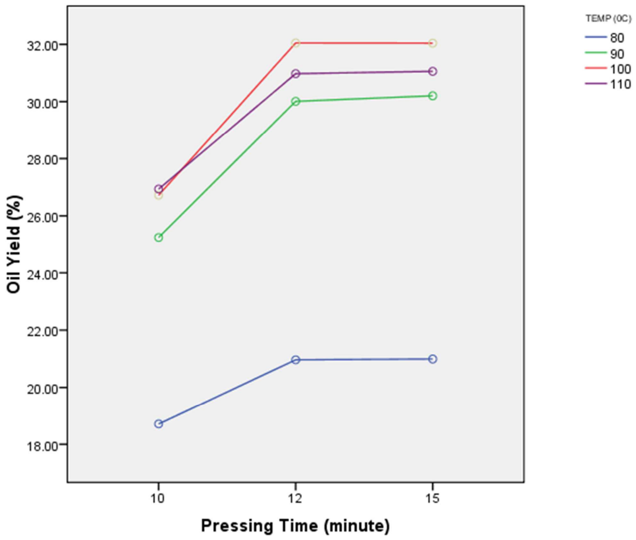

Figure 3. *Effect of Heating Temperature and Extraction Time on Oil Yield at 7% AWV.*

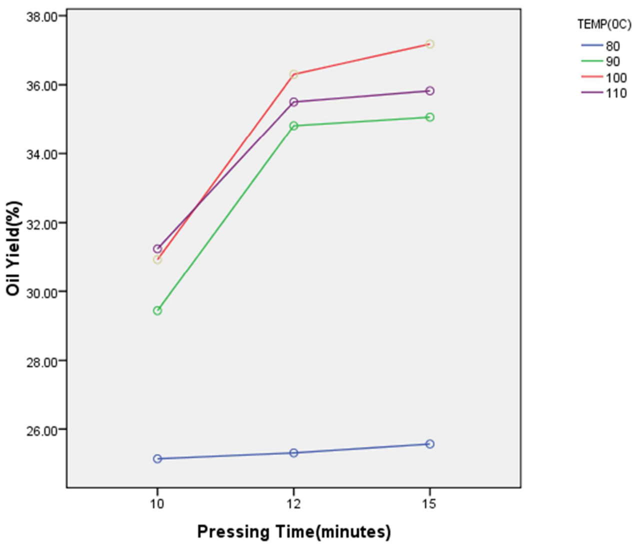

Figure 4. *Effect of Heating Temperature and Extraction Time on Oil Yield at 8% AWV.*

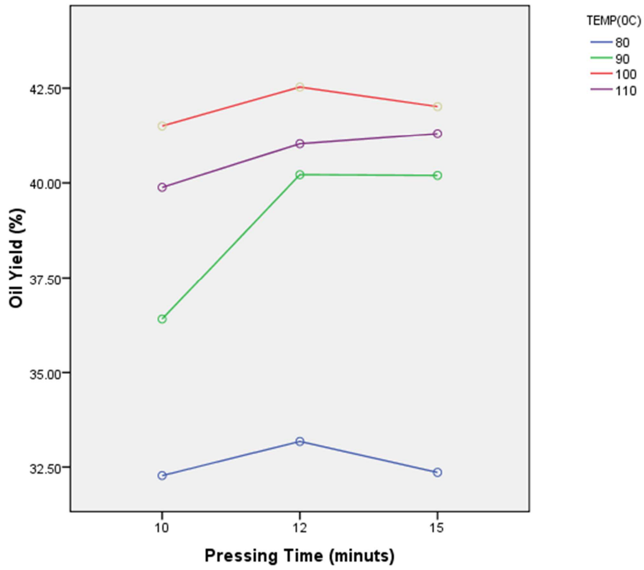

Figure 5. *Effect of Heating Temperature and Extraction Time on Oil Yield at 9% AWV.*

4. Conclusion

The effects of heating temperature, water volume and extraction time on oil yield from cashew kernel was investigated. The study result established that temperature; water volume and extraction time has significant effects on the oil yield from cashew kernel. Oil yield increases with increase in heating temperature but tend to decrease as the temperature rise above 100°C. Also, the more volume of water is added to the sample the more the oil yield from the sample. The extraction temperature of 100°C produces the optimum oil yield of 42.2% at an average extraction time of 12 minute and at 9% water volume.

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