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Effect of Some Processing Parameters on Quality of Palm Oil

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ABSTRACT

An investigation was carried out on the effect of some processing parameters such as delayed time after harvest, sterilization time and digestion time on quality of palm oil. Some physicochemical properties of the oil such as; free fatty acid taste and odour were determined. The palm fruits were cleaned and divided into five batches A, B, C, D and E, and delayed for 0, 5, 10, 15 and 20 days respectively before being processed. 10 Kg sample of palm fruits were sterilized for; 0, 30, 60 and 90 minutesat temperature range of temperature of 95-110°C. The sterilized palm fruits were then digested for; 3, 6, 9 and 12 min and later pressed with screw press. The free fatty acid content of oils produced is significantly different relative to delayed time after harvest variation at $\leq$ 0.05 level of significant.This study suggests that, palm fruits processors need to process their fruits early to avoid build up of free fatty acid in the oil. Also, palm fruits that were processed early at higher sterilization time proved to be the best in terms of odour and taste.

***KEYWORDS*:** Palm oil, Processing, Delayed time and Sterilization time

INTRODUCTION

Palm oil is derived from the fleshy mesocarp of the oil palm fruits, Elaeisguineensis. About 80% of palm oil production is destined for human consumption with balance going to animal feed and to various industries. Harvesting, handling and processing methods usedare known to influence the quality of the palm oil extracted. Palm oil serves as the main cooking oil in Nigeria. Palm oil is consumed as margarine, as a base vegetable fat, as industrial frying oil and several special purpose fats (Olowolarafe*et al*.,2008).

The traditional process of palm fruits to palm oil is simple, but tedious and inefficient. According toOlowolarafe*et al*., (2008)harvesting, handling and processing methods used are known to influence the yield and quality of palm oil extracted. Because of its economic importance as a highly yielding source of edible and technical oils the oil palm is now grown as a plantation crop in most countries with high rainfall (Orji, 2006). Extraction of palm oil from fruits involves field operations and factory/house operations. The field processes include cutting ripe fruit bunches from the palm tree and carrying the fresh fruit bunches (FFBs) and fallen loose fruits to the factory/house by field workers while the factory/house

processes involves digestion of the fruits and squeezing palm oil out of the digested fruit pulp (Orji and Mbata, 2008). Efforts to mechanize and improve traditional manual procedures have been undertaken by research bodies, development agencies, and private engineering companies, but these activities have been piecemeal and uncoordinated. They have generally concentrated on removing the tedium and drudgery from the mashing or pounding stage (digestion), and improving the efficiency of oil extraction. Palm oil processors of all sizes go through these unit operational stages. They differ in the level of mechanization of each unit operation and the interconnecting materials transfer mechanisms that make the system batch or continuous. The scale of operations differs at the level of process and product quality control that may be achieved by the method of mechanization adopted.

The quality of some imported edible vegetable oils and fat were determined, the final physicochemical properties of the investigated edible oils and fat after sixty days of storage changed significantly depending on storage time and also with the mode of storage (Othman and Ngassapa, 2010). The acceptability of palm oil in the international market is largely dependent on the physiochemical properties of the oil at the time of purchase. Some of the properties or parameters usually considered include free fatty acids (FFA), iodine value (IV) peroxide value (PV), moisture, impurities content, colour, taste, aroma, melting point (Edem, 2002). In Nigeria, palm oil is still being produced principally by farmers who adopt different extraction methods that vary from one locality to another (Orji, 2006).

The crude palm oil produced by the small-scale processors in Nigeria is however of poor quality; (high FFA, high Moisture content and impurities because of the low level of technology used in production(NIFOR, 2010). Within the small-scale processing industry, fruits are processed within a period varying from six to twenty days after fruit harvest. The major limiting factor which affects time to fruit processing is fruit removal from the spikelets or bunches which is mainly done by hand and may vary from 3 days to several days depending on availability of labour and quantity of fruits to be processed. This process is time consuming tedious and labour intensive. Although, short delay or fermentation of bunches improves fruits loosening and reduce time devoted to spikelete processing, they may lead to the production of crude palm oil with high free fatty acid content (Taiwo*et al*., 2000). Babatunde*et al*. (1988) reported that processing of fruits without fermentation resulted in the production of high quality crude palm oil of about 2.31% FFA. Poku (2002) reported that, the longer harvested fruits are allowed to stay before they are processed, the higher is the FFA content of the oil extracted from such fruits. The objective of this study was therefore to evaluate the effect of delayed time after harvest on the quality of palm oil produced.

MATERIALS AND METHODS

Materials

The palm fruit bunches (tenera species) were obtained from Agricultural and Bio-Environmental Engineering Plantation Research Farm, Federal Polytechnic, Ado, Ekiti State. In this study, experiments were conducted by varying the following parameters such as delayed time after harvest, sterilization time, and digestion time. Freshly harvested palm fruit bunches were obtained and divided into five batches A, B, C, D and E. Batch A were

debauched and processed immediately within twenty four hours. Batch B, C, D and E were delayed for five, ten, fifteen and twenty days respectively before being processed. 10 kg sample of freshly harvested fruits were used for the experiment. The unsterilized palm fruits were digested thoroughly in a diesel engine-powered digester (8 Horse power) for 3, 6, 9 and 12 min. The other samples were sterilized at different time of 30, 60 and 90 min at thetemperature range of 95-110°C. The sterilized palm fruits were transferred into a digester and digested for 3, 6, 9 and 12 min. The resulting mash was taken into a vertical screw press and subjected to pressure by turning the handle clock wisely. Whereas the extracted oil was dried, cooled, stored in bottle and properly corked to avoid rancidity. The same procedures were repeated for batches B C, D and E of palm fruits delayed for 5, 10, 15 and 20 days respectively.

The quality of the palm oil produced was determined by analyzing the following; free fatty acid (FFA) content, colour and taste.

Free fatty acid (FFA), content of the palm oil samples were also determined using the AOCS official method of analysis.

SENSORY EVALUATION TEST

The sensory evaluation test for taste and odour of fresh palm oil samples produced were carried out. The Hedonic preference rating test method (Peryam and Plyram, 1957) as adopted by (Orji and Mbata, 2008) was used and ten panelists who are conversant with taste and odour of palm oil were chosen. Each panelist was given a sample of the test oil and asked to comment freely on how much he liked or disliked the sample by rating the samples as very good, good, fair, bad and very bad. The following scores were attached to the rating. Very good = 5 points, good = 4 points, fair = 3 points, bad = 2 points, very bad = 1 point. The scores for the samples were analyzed using analysis of variance (ANOVA) in a Split-Split Design (SSD) and the mean evaluation tests of the samples were carried out.

RESULTS AND DISCUSSION

In this study, none of the palm fruits processed after 5^{th} day of harvest had free fatty acid (FFA) content below 5% as required by Codex Alimentarius/FAO/WHO norms (2005). The result shows the relationship between the delayed time after harvest and free fatty acid of oil produced at varying sterilization and digestion time. The lowest free fatty acids were recorded from the palm fruits processed within 24 hours after harvest. Though, there were variations in the values due to processing conditions such as sterilization and digestion time but the values ranged from 1.356 to 1.367 as percentage of Oleic acid. In another development, the free fatty acid content of palm fruits processed after 24 hours continue to increase. Considering the degree of freedom $P< 0.05$, it could be concluded from the Table 1(a-d) that the P value of (1.08E-19 and 0.272793), (1.31E-19 and 0.271549), (1.45E-19 and 0.211066) and (3-5E-29 and 0.039455) respectively are significantly different relative to the variation in delayed time after harvest and are not significantly different relative to variation in sterilization time at 3, 6, 9 and 12 minutes digestion time respectively. The result indicates that, the delayed time after harvest has significant effect on the free fatty acid content of oil

produced and this is line with the result obtained by Poku (2002), who reported that, the longer the harvested palm fruits are allowed to stay before they are processed, the higher is the free fatty acid content of the oil.

Also, the quality of oil obtained from other treatments in terms of odour and taste increasi ngly deteriorated as shown in tables 1 and 2, while the fruits were left for number of days between 0 and 20 days. It could be observed that, the odour and taste best acceptable was that of the palm fruits delayed between 0 and 5 days after harvest. Oil samples which were charact erized by increased sterilization time proved to be the best in terms of odour and taste characte ristics of the palm oil obtained as indicated in the Tables 3 and 4 respectively.In order to check for the relationship between the delayed times after harvest, the sterilization time and the digestion time in relation to the free fatty acid (FFA) generated, regression model was derived using the Microsoft Excel regression analysis. The regression analysis carried out for the FFA is presented in Table 2,the following relationship were generated from the result.

$$\boldsymbol{FFA = 1.041 + 0.083DT + 0Ts + 0Td} \quad \text{.. (1)}$$

Where DT = Delay Time before processing

T_s= Sterilization time
T_d= Digestion time

This leaves the equation as

$$\boldsymbol{FFA = 1.041 + 0.083Td} \quad \text{.. (2)}$$

Since the coefficients of the sterilization time and digestion time are zero in the equation

The model had a R^2 value of 0.757and standard error of 0.33971. The model indicates that the delayed time after harvest of palm fruit has a direct relationship with the FFA generated as this was accounted for by the positive sign; and that the digestion time and sterilization time have no effect on the FFA level of oil processed

CONCLUSION

The results of the investigation of the effect of processing parameters on the quality of oil produced revealed that, delayed time after harvest has effect on the free fatty acid content of oil produced and that sterilization or digestion time has no effect on free fatty acid of the oil. The study also revealed that, palm fruits processed early at higher sterilization time proved to be the best in terms of odour and taste. The study has suggested that palm fruits processors need to process their fruits early to avoid build up of free fatty acid in the oil. Also, deterioration can set in and when processed, oil might come out with unpleasant taste and odour after a period of time.

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Table 1a**: Analysis of variance showing the variation of sterilization and delayed time with free fatty acid of palm fruits digested at 3 minutes.**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Delayed Time	9.032544	4	2.258136	6012.477	1.08E-19	3.259167
ST	0.001653	3	0.000551	1.467394	0.272793	3.490295
Error	0.004507	12	0.000376			
Total	9.038705	19				

Table 1b**: Analysis of variance showing the variation of sterilization and delayed time with free fatty acid of palm fruits digested at 6 minutes.**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Delayed Time	9.072528	4	2.268132	5723.15	1.45E-19	3.259167
ST	0.002075	3	0.000692	1.744896	0.211066	3.490295
Error	0.004756	12	0.000396			
Total	9.079358	19				

Table 1c**: Analysis of variance showing the variation of sterilization and delayed time with free fatty acid of palm fruits digested at 9 minutes.**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Delayed Time	9.043376	4	2.260844	5820.042	1.31E-19	3.259167
ST	0.001716	3	0.000572	1.472273	0.271549	3.490295
Error	0.004661	12	0.000388			
Total	9.049753	19				

Table 1d**: Analysis of variance showing the variation of sterilization and delayed time with free fatty acid of palm fruits digested at 12 minutes.**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Delayed Time	8.994985	4	2.248746	229463.9	3.5E-29	3.259167
ST	0.000112	3	3.74E-05	3.814626	0.039455	3.490295
Error	0.000118	12	9.8E-06			
Total	8.995215	19				

Table 2: **Regression Analysis Output Summary for the Effect of Delay time, Sterilization time and Digestion time on Free fatty acid (FFA), Viscosity and Oil yield**

Regression Statistics	**FFA**
Multiple R	0.870
R Square	0.757
Adjusted R Square	0.748
Standard Error	0.340
Observations	80
Significance F	2.6E-23
Intercept	1.041
Delay time	0.083
Sterilization time	0.000
Digestion time	0.000

Table 3: **Mean Evaluation of Odour**

	0 Day after harvest			5 days after harvest			10 days after harvest			15 days after harvest			20th day after harvest		
	Std. Dev.	**Variance**	**Mini**	**Std.Dev.**	**Variance**	**Min.**	**Std.Dev.**	**Variance**	**Min.**	**Std.Dev.**	**Variance**	**Min.**	**Std.Deviation**	**Variance**	**Mini**
Sample 1	0.516	0.267	FAIR	0.527	0.278	FAIR	0.422	0.178	FAIR	0	0	FAIR	0.516	0.267	BAD
Sample 2	0.516	0.267	FAIR	0.527	0.278	FAIR	0.422	0.178	FAIR	0	0	FAIR	0.516	0.267	BAD
Sample 3	0.516	0.267	FAIR	0.527	0.278	FAIR	0.422	0.178	FAIR	0	0	FAIR	0.516	0.267	BAD
Sample 4	0.422	0.178	GOOD	0.422	0.178	FAIR	0.483	0.233	FAIR	0.483	0.233	FAIR	0.816	0.667	BAD
Sample 5	0.422	0.178	GOOD	0.422	0.178	FAIR	0.441	0.194	FAIR	0.483	0.233	FAIR	0.816	0.667	BAD
Sample 6	0.422	0.178	GOOD	0.568	0.322	FAIR	0.441	0.194	FAIR	0.483	0.233	FAIR	0.816	0.667	BAD
Sample 7	0.316	0.100	GOOD	0.516	0.267	GOOD	0.000	0.000	GOOD	0	0	GOOD	0.516	0.267	FAIR
Sample 8	0.316	0.100	GOOD	0.516	0.267	GOOD	0.000	0.000	GOOD	0	0	GOOD	0.516	0.267	FAIR
Sample 9	0.316	0.100	GOOD	0.516	0.267	GOOD	0.000	0.000	GOOD	0	0	GOOD	0.516	0.267	FAIR
Sample 10	0.316	0.100	GOOD	0.516	0.267	GOOD	0.333	0.111	GOOD	0	0	GOOD	0.516	0.267	FAIR
Sample 11	0.316	0.100	GOOD	0.516	0.267	GOOD	0.333	0.111	GOOD	0	0	GOOD	0.516	0.267	FAIR
Sample 12	0.316	0.100	GOOD	0.516	0.267	GOOD	0.333	0.111	GOOD	0	0	GOOD	0.516	0.267	FAIR

Table 4: **Mean Evaluation of Taste**

	0 Day after harvest			5 day after harvest			10 days after harvest			15 days after harvesting			20 day after harvests		
	Std. Dev	Variance	Min.	Std. Dev.	Variance	Min	Std. Dev	Variance	Min	Std. Dev	Variance	Min	Std. Dev	Variance	Min.
Sample 1	0.568	0.322	BAD	0.316	0.100	FAIR	0.316	0.100	FAIR	0.422	0.178	FAIR	0.483	0.233	BAD
Sample 2	0.667	0.444	BAD	0.422	0.178	FAIR	0.316	0.100	FAIR	0.422	0.178	FAIR	0.483	0.233	BAD
Sample 3	0.667	0.444	BAD	0.422	0.178	FAIR	0.316	0.100	FAIR	0.422	0.178	FAIR	0.483	0.233	BAD
Sample 4	0.675	0.456	FAIR	0.568	0.322	FAIR	0.483	0.233	FAIR	0.516	0.267	FAIR	0.483	0.233	BAD
Sample 5	0.675	0.456	FAIR	0.568	0.322	FAIR	0.483	0.233	FAIR	0.516	0.267	FAIR	0.422	0.178	FAIR
Sample 6	0.675	0.456	FAIR	0.568	0.322	FAIR	0.483	0.233	FAIR	0.516	0.267	FAIR	0.422	0.178	FAIR
Sample 7	0.516	0.267	GOOD	0.516	0.267	GOOD	0.000	0.000	GOOD	0.316	0.100	FAIR	0.422	0.178	FAIR
Sample 8	0.516	0.267	GOOD	0.516	0.267	GOOD	0.000	0.000	GOOD	0.316	0.100	FAIR	0.483	0.233	FAIR
Sample 9	0.516	0.267	GOOD	0.516	0.267	GOOD	0.000	0.000	GOOD	0.316	0.100	FAIR	0.483	0.233	FAIR
Sample 10	0.527	0.278	GOOD	0.516	0.267	GOOD	0.000	0.000	GOOD	0.316	0.100	FAIR	0.483	0.233	FAIR
Sample 11	0.527	0.278	GOOD	0.516	0.267	GOOD	0.000	0.000	GOOD	0.316	0.100	FAIR	0.422	0.178	FAIR
Sample 12	0.527	0.278	GOOD	0.516	0.267	GOOD	0.000	0.000	GOOD	0.316	0.100	FAIR	0.422	0.178	FAIR