African Journal of Biochemistry Research Vol.2 (9), pp. 192-196, September, 2008
Available online at http://www.academicjournals.org/AJBR
ISSN 1996-0778 © 2008 Academic Journals

Full Length Research Paper

Effect of extraction methods on the quality and spoilage of Nigerian palm oil

Michael U. Orji and Theodore I. Mbata*

Department of Applied Microbiology and Brewing, Nnamdi Azikiwe University, Awka, Nigeria.

Accepted 26 August 2008

The methods of palm oil extraction in Nigeria were evaluated for their effect on properties and storability of the extraction oil. Three principal extraction methods were identified and included mainly traditional small scale, semi-mechanized and mechanized methods. Traditional methods were found to be classifiable into extraction by fermentation, wet extraction and extraction by frying. The oil extracted through the mechanized method had lower free fatty acid (ffa), moisture and impurities than that extracted by the other methods. Oil extracted by the traditional methods especially those produced by the fermentation method had the poorest quality. There were no differences in taste and aroma of fresh palm oil extracted through the different methods but sharp differences exist among them in taste and aroma after storage for eight months. All methods produced low quality palm oil in terms of ffa, moisture and impurities when compared with international standards for export quality palm oil.

Key words: Palm oil, extraction method, oil quality, storage.

INTRODUCTION

Palm oil which is orange-red to brownish or yellowish-red in colour is extracted from the mesocarp of fruits of oil palm tree (*Elaeis guineensis Jacq).* The fruit, a drupe, prolate spheroid in shape varies between 20 to 50 mm in length and could be as large as 25 mm in diameter, is found in bunches that are attached to the crown of the tree through a stalk[1,2,]. The fruit pulp from where the oil is obtained surrounds a nut, the shell of which encloses the palm kernel from which another oil, the palm kernel oil is obtained (Hartley, 1988; Purseglove, 1995).

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 (NIFOR, 1975; Badmus, 1990).

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, tocophenol and tocotrienol contents (Cornelius, 1977; Johansson and Pehlergard, 1977; Hartley, 1988; Purseglove, 1995; 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 objective of this study was to identify the various methods of palm oil extraction in Nigeria and evaluate the effect of extraction methods on the quality and storability of the extracted oil.

MATERIALS AND METHODS

Palm oil producing communities, including private and government owned palm oil mills in Nigeria were visited to understudy the various method of producing palm oil. Information about palm oil extraction methods in each of the communities visited was obtained through oral interview, questionnaire, discussion with the villagers and on-the-spot observation of the extraction process both in the communities and at the palm oil mills (Figure 1). One hundred and twenty communities and thirty five palm oil mills in nine palm oil pro-

*Corresponding author. E-mail; theoiyke@yahoo.com. Tel; 2348032618922

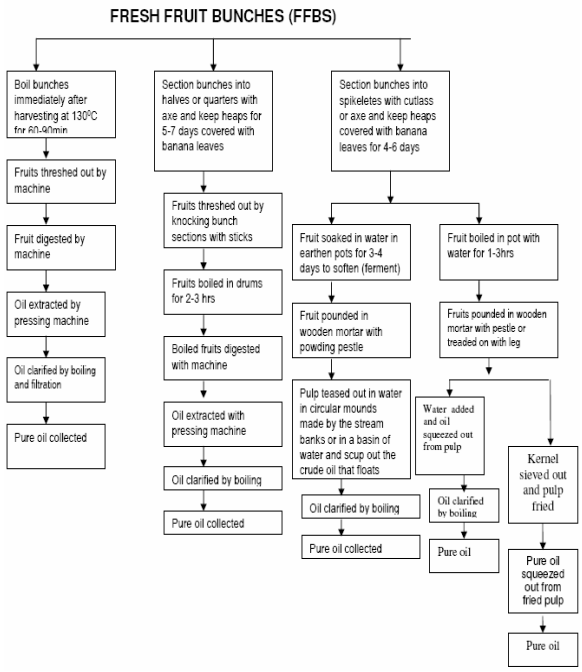

Figure 1. Flow diagram of palm oil extraction methods in Nigeria. **Mm,** Mechanized method; **Sm,** Semi-mechanized method; **T**, Traditional method; **TF,** Traditional fermentation method; **TW,** Traditional wet extraction; **TFr,** Traditional frying method.

ducing states of the federation were visited. Oil samples col-lected in sterile sample bottles from any community that has a unique extraction method. Samples were also collected from different palm oil mills. Oil samples were also purchased from sellers in different Nigerian markets.

Extract of palm oil in the laboratory

In addition, palm oil was also extracted in the laboratory according to the method adopted by Orji (2006). Two ripe fresh fruit bunches (ffbs) of 10 kg each were sectioned into spikelets with a cutlass and the heap formed was steam heated in batches in an autoclave at 121°C for 60 min. The fruits were stripped with forceps and digested with hot water rinsed digester. Oil was squeezed out of the digested pulp mass with hot water rinsed palm oil presser. The oil obtained was clarified by boiling and filtration using Whatman No. 1 filter paper. The filtered oil was thereafter boiled for 30 min at 70°C.

Determination of physiocochemical properties

The physicochemical properties of each of the oil samples produced using different extraction method including the samples produced in the laboratory and the ones bought from the market were determined. The peroxide value (pv) free fatty acid (ffa) iodine value (iv) and moisture content of the palm oil samples were determined using the AOCS official method of analysis (AOCS, 1997). The impurities/dirt content was determined using the method described by PORIM (PORIM 1995). The colour was determined by the Lovibond comparative method, (AOCS1997). The microbial count was determined by the pour and spread plate methods (Frey et al., 1981; Collee and Miles, 1989)

Determination of organoleptic properties

The sensory evaluation test for taste and odour of fresh palm oil samples produced through different methods including those produced in the laboratory was carried out The test was also carried out on the samples after keeping them for eight months at room temperature (30 ± 2°C).

The Hedonic preference rating test method (Peryam and Plgram, 1957) 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 completely randomized design using the method of Cochran and Cox (1950).

Effect of production methods on keeping quality

Fresh palm oil samples produced through different methods including those produced in the laboratory and those bought from the market were each introduced into sterile sample bottle in duplicate and kept at room temperature (30 ± 2°C) for eight months. The ffa, pv, moisture, impurities, microbial count, taste and aroma of the samples were determined after the storage period.

RESULTS

Three principal palm oil extraction methods were identified from the study and they included traditional small scale method, semi-mechanized and mechanized methods. Several traditional methods were identified and they included extraction by fermentation, wet extraction and extraction by frying. The steps involved in the various extraction methods are presented in Figure 1. The physiocochemical properties of the oil samples produced through several extraction methods including those produced in the laboratory and the ones bought from the markets are presented in Table 1. Results show that the moisture, impurities, free fatty acids (ffa) and microbial counts of all the oil samples examined varied greatly from one extraction method to the other and their values except the ones produced in the laboratory were higher than the international standards for edible palm oil. The samples obtained through the traditional extraction methods, especially those obtained through the fermentation methods had the poorest quality.

The effect of storage on the peroxide value (pv), ffa, odour, taste and microbial count of palm oil extracted through different methods is presented in Table 2. Results indicate that there a remarkable increase in ffa and microbial counts and a mild increase in pv of all the samples throughout the storage period. However, there was no microbial growth or increase in ffa of oil sample

Table 1. Physicochemical properties of palm oil extracted through different methods.

Source of oil	Moisture (%)	Impurities (%)	Pv (meq/kg)	Ffa (%)	Iodine value) iv (gI_2/100kg)	Colour (Lovibond 5¼)in	Microbial count (Logcfu/ml)
MM	0.26	0.10	3.40	5.33	49.52	19R1.0y	3.7
SM	0.72	0.41	7.00	8.0	49.44	20.R0.4y	6.3
TW	0.77	0.40	6.00	7.5	48.69	19R9.5y	6.0
TF	0.53	0.37	5.80	9.20	48.35	18R1.0y	7.2
TFr	0.26	0.20	6.80	7.0	49.42	25R0.5y	5.3
LB	0.1	0.01	2.40	1.0	49.32	30R0.2y	00
Mkt	0.90	0.4	8.6	8.80	49.62	22R0.4y	7.6

MM = palm oil produced by mechanized method
SM = palm oil produced by semi mechanized method
TW = palm oil produced by traditional wet extraction method
LB = palm oil produced in the laboratory
MKT = palm oil bought from the open markets
TF = Palm oil produced by the traditional fermentation method
TFr = palm oil produced by the frying method.

Table 2. The effect of storage on PV, ffa, taste, odour and microbial counts of palm oil extracted through different methods

Source of oil	Pv (meq/kg)		Ffa (%)		Taste		Odour*		Microbial count Log cfu/m	
	b	a	b	a	b	a	b	a	b	A
MM	3.40	4.0	5.33	6.20	50	40	50	40	3.7	4.6
SM	7.00	7.6	8.00	9.10	49	21	50	36	6.3	7.6
TW	6.00	6.8	7.50	8.2	48	22	49	34	6.0	7.0
TF	5.80	6.20	8.20	9.5	48	19	48	30	7.2	8.2
TFR	6.80	7.0	7.00	8.2	50	39	50	40	5.3	6.8
LB	2.40	2.6	1.0	1.0	50	48	50	48	-	-

a = values after storage

* 50 is the maximum additive score from the 10 tasters
b = values before storage

produced in the laboratory after storage. The organoleptic test result and the effect of storage on the taste and odour of the palm oil samples are shown in Table 2.There were significant difference in taste and odour of fresh palm oil produced by the different methods but difference exist among them after storage.

DISCUSSION

Three principal palm oil extraction methods were identified and they include traditional small scale semi-mechanized and mechanized methods. The points of difference that exist among these extraction methods, include, the extent to which machines were involved in the extraction process, how bonds holding the fruits are weakened before they are threshed out from the fresh fruit bunches (ffbs) and how the fruits are softened before they are digested to squeeze out the oil (Figure 1).

Badmus (1987) noted that stripping of palm fruits from the bunch is dependent on weakening the strength of attachment (bond) of the fruits to the bunch. Whereas in mechanized method, the weakening of the attachment bonds is achieved by boiling the bunches. The weakening of attachment bond is achieved in semi-mechanized and traditional methods by sectioning bunches and heaping them for several days which have been found to contain higher free fatty acids (ffa) contents after the extraction of palm oil as observed by Orji (2006). This may partly explain why all the oil samples from the semi-mechanized palm oil mills and palm oil obtained from local producers have higher ffa values than the sample from the mechanized palm oil mills.

Orji (2006) noted that the longer the harvested fruits were allowed to stay before they were processed, the

higher is the ffa of the oil extracted from such fruits. This assertion is not surprising since ripe palm oil fruits have been reported to contain autolipolytic enzyme which starts to split the fruit oil to fatty acid and glycerol once the fruit is bruised (Bek-Nielsen, 1977; Esechie, 1978; Hartley, 1988). This may also explain why the oil samples extracted through the traditional method that employs fermentation has higher ffa than all the other oil samples since the fruits were never boiled in any of the processing steps (Figure 1). Although the ffa of palm oil extracted through the mechanized method was lower than the oil extracted through semi-mechanized and traditional methods, the value of the ffa (5.33%) (Table 1) is very high from an expected value than 1%. It is however not surprising that values ffa as high as 5.33% were obtained from oil samples from the mechanized mills because the mills always have several heaps of unprocessed fresh fruit bunches (ffbs) against the ideal practice of boiling the bunches immediately on receipt from the field operators to inactivate the lipases. Mechanized palm oil mills is capital intensive and this may be one of the reasons why very few mechanized palm oil mills exist in Nigeria and the people that appear to have interest in palm oil extraction business are the farmers (Orji, 2006). The ones that are existing have maintenance problems and either they close down and start again very frequently or they compromise certain basic standards like sterilizing the fresh fruit bunches immediately on arrival to the mill with the result that the palm oil obtained from them have ffa level very close to those produced through the traditional and semi-mechanized methods.

The moisture and impurities levels of all the oil samples except those produced in the laboratory were higher than the international standard for edible palm oil (Table 1). It has been variously stated that moisture and impurities level of palm oil depend directly on the efficiency of the final oil extraction and clarification processes (Wolves Perges, 1969; Johansson and Pehlergard, 1977; Orji, 2006). Hartley (1988) noted that moisture is removed from the oil by boiling at elevated temperature while the impurities/dirt is removed by filtration. The high values of moisture and impurities of the oil produced through the traditional and semi-mechanized methods (Table 1) may be due to the fact that the local producers do not boil the pure oil to allow much moisture to evaporate nor do they filter the oil to remove the dirt. The peroxide values (pv) of the oil samples irrespective of the extraction method except the sample produced in the laboratory were relatively high. Oxidation, especially the formation of peroxides has been noted to be entirely a man-made feature of palm oil often resulting from processing methods by which hot oil absorbs oxygen from the atmosphere and the process is catalyzed by the presence of certain metals (e.g. iron) and steam (Wolves Perges, 1969; Chin and Tan, 1977) Purvis (1977) remarked that not until the collapse of the Eastern Nigerian, Palm oil Marketing Board around 1966, the Nigerian small scale palm oil producers responsible for the production of the bulk of palm oil in Nigeria were permitted to market palm oil containing as much as 0.4% moisture. In Zaire, 0.13% dirt content and 3.5% ffa where as most palm oil mills achieved in the same period, moisture content of 0.1% or below, dirt content as low as 0.005% and ffa 2.5% in their palm oil.

This permission may have been the root of the apparent lack of quality initiative among the palm oil producers in Nigeria. This fact is highlighted by the fact that all the palm oil producers using the traditional and semi-mechanized methods interviewed showed ignorance of the standard required for edible palm oil.

Oil samples with high microbial load, high moisture and impurities contents deteriorate faster in storage in terms of increases in ffa content (Orji 2006). This may explain why there were little or no changes in ffa content of oil sample produced in the laboratory while there was higher ffa contents in oil samples produced by the traditional and semi-mechanized methods after storage. The increase in ffa during storage may explain the differences in taste of the different oil samples after storage (Table 2).

REFERENCES

AOCS. (1997). Sampling and Analysis of Commercial Fats and oils American Oil Chemists Society Official Methods (Cd 8-53, Cg 50-40, CC 13, eg2, Cd 1-25, ba 21-38 (AOCS.) Press, Champaign, Illinois, USA.

Badmus GA (1987). An Assessment of the Performance of a Palm fruits bunch threshing machine. Nig. J .Palms and Seeds 3:78-90.

Badmus GA (1990). Factors affecting the design of a fruit bunch harvesting system of tall oil palm trees in plantations. Nig. J. Palms and Seeds 11; 102-1114.

Edem DO (2002). Palm oil Biochemical, Physiological, nutritional, hematological and toxicological aspects. A review. Plant Foods Hum Nutr 57:319-341

Bek-Nielsen B (1977). Quality Preservation and Testing of Malaysian palm oil from fresh fruit bunches to the oil refinery. In International Society of Planters, Kuala Lampur, Malaysia. pp. 159-168

Chin AGH, Tan BK (1977). The Quality of Solvent Extracted palm oil. International development in palm oil, Earp, D. A. and Newall, W. (Eds) pp.169-186.

Cochran WG. Cox GM (1950). Statistical Analysis of Results, Experimental Designs. John Wiley and Sons Inc. New York, pp 50-57

Collee JG, Miles RS (1989). Tests for Identification of Bacteria. In Practical Medical Microbiology. 3rd (ed) Vol. 2, Collee, JG.; Hunguid JP, Fraser AG, Marmion BP (Eds). Churchill Livingstone, Edinburgh, London. pp. 141-160.

Cornelius JA (1977). Progress towards International Standards for crude palm oil. In Symposium on oil palm processing and marketing, Kuala Lumpur, 1976.

Esechie H A (1978). Mesocarp oil and free fatty acid accumulation in oil palm fruits during ripening. Nig. Agri. J .15:114-129.

Frey O, Oldfield RJ, Bridger RC (1981). A Colour atlas of pathogenic fungi. Wolfe Medical Publications Ltd, Holland.

Hartley CWS (1988). The oil palm. 3rd (ed) Longman Publishers Ltd. Singapore. pp. 1-256, 340-780.

Johansson G, Pehlergard PO (1977). Aspect on quality of palm oil. In International developments in palm oil. Earp, DA. and Newall, W. (Eds). Society of planters, Malaysia p. 203-220.

NIFOR (1975). A manual on oil palm production. Nigeria Institute for Oil Palm Research (NIFOR) 3rd (ed). pp. 39-41.
Peryam DR, Pilgrin FJ (1957). Hedonic Scale Method of Measuring Food Preference. Food Technol. 11 (9): 22-36
PORIM (1995). Methods of Test for Palm Oil and Palm Oil Products. Palm oil Research Institute Malaysia (PORIM) Ministry of Primary Industries. Bandar Baru Bange Malaysia. pp. 72-75.
Purseglove JW (1995). Tropical Crops Monocotyledons Vol. 1 and 2, Longman Group Ltd. pp. 479-509
Purvis MJ (1977). Annual Yield Variation in oil palm marketing Board Purchases in Eastern Nigeria, 1955-1966. J. Nig Insti Oil Palm Res. 5 (18): 59-67.
Orji MU (2006). Microbiological and Chemical Studies on Nigerian palm oil with particular reference to the effect of extraction methods on oil quality. PhD dissertation, Nnamdi Azikiwe University, Awka, Nigeria.
Wolves Perges A (1969). Factors affecting the quality of palm oil. In: the quality and marketing of palm products Turner, P. (Ed). The Society of Planters, Malaysia. Pp. 42-57.