The Effect of Different Processing Methods on the Quality of Crude Palm Oil (CPO) in Delta North Agricultural Zone of Delta State, Nigeria

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ABSTRACT

Oil palm is the highest oil producing plant. In 2006, palm oil was the world's most important oil with a production output of 37 million tons, accounting for 25% of the total production of fats and oils. Small scale farmers adopt different methods of oil palm processing which are different from the industrialized methods. This study aims at comparing the quality of crude palm oil (CPO) produced by three different methods of oil palm processing in Delta North Agricultural Zone, which include the scientific method, the semi-scientific method and the traditional method. 18 small /medium scale CPO processing units were surveyed. The CPO collected from these units was compared to CPO collected from NIFOR. Parameters studied to assess quality include free fatty acid (FFA) content, peroxide value and the carotene content. Significant ($P<0.05$) differences were observed in the quality of CPO obtained from the three different methods of processing in NIFOR. There were no significant ($P>0.05$) differences in FFA and carotene content of CPO obtained from NIFOR when compared to CPO obtained from the different processing units. However significant ($P<0.05$) differences were observed in the peroxide value of all the samples investigated.

Keywords: *Crude palm oil, free fatty acid, carotene, peroxide value, oil palm processing methods.*

INTRODUCTION

Oil palm is by far the highest oil producing plant, with an average yield of 3.5 tons of oil/ha/ year (Ngando, Mpondo, Dikotto and Koona, 2011). Extracted from the mesocarp of the fruit, crude palm oil (CPO) represents 95% of the total oil production of the oil palm which also provides palm kernel oil. Palm oil is the richest natural source of carotenoids in terms of retinol (provitamin A) equivalent (Vaughan, 1990; May, 1994) and in some tropical countries like Nigeria and Cameroon, oil palm contributes up to 80% of the total edible oil needs of man and animals (Hirsch, 1999) and the processing of oil palm is mainly carried out by small and medium scale farmers. The quality of CPO produced by such farmers is sometimes below International Standards. For those farmers located in the neighborhood of Industrial oil mills, fresh fruit bunches (FFB) are delivered directly for processing. However in many cases, palm plantations are very far from the industrial oil mills, therefore small and medium scale farmers have to process the FFB themselves. Fruits are usually harvested when the fruits are at optimum ripeness and handled with care to avoid bruising. This is due to the presence of enzymes such as lipase which could cause rapid deterioration

(Ngando, Dhouib, Camiere, Amvam and Arondel, 2006).These enzymes are activated as soon as the bunch is harvested and they act on the pericarp triglycerides hydrolyzing the fatty acids from glycerol, leading to a rapid increase in the amount of free fatty acids, for this reason, the FFB are quickly sterilized, threshed and digested. CPO is extracted from the digested fruits hydraulically or by using a screw press, clarified and dried. There are however some minor differences between oil extraction methods used by small and medium scale farmers and the extraction methods used by industrial oil palm estates. Once harvested, FFB are allowed to ferment over a period of 1 to 6 days at ambient temperature to allow easy separation of the fruits from the bunch. The fruits are then boiled for some hours. In the traditional method, the boiled fruits are pounded into a pulp using a mortar and pestle or trampled underfoot, and the oil is separated by adding water and skimming off.

In most scientific methods, manual or motorized screw presses are used to squeeze out the oil from the boiled fruits. The oil is then heated to remove residual water. CPO from the traditional oil extraction method is highly sought after in local markets due to its better sensory qualities (red colour, taste and aroma) which make it an irreplaceable ingredient of many local recipes. It has been shown by several authors (Coursey, 1966; Broadbent and Kuku, 1977; Aletor, Ikhena and Egharevba, 1990), that CPO samples from the traditional oil extraction methods are of lesser quality compared to the CPO from industrial oil mills. This study compares the quality in terms of carotene content, free fatty acid content and peroxide value of crude palm oil produced by three different processing methods which include, the scientific method carried out by Nigerian Institute for Oil Palm Research, the semi-scientific method which is operated by some medium scale farmers in the Delta North agricultural zone and the traditional method which is practiced by small scale farmers.

MATERIALS AND METHOD

The study was conducted in the research and teaching laboratory of the Animal Science Department, Delta State University Asaba Campus, Delta State, Nigeria ($6^0$14'N and $6^0$49'E). Samples were collected from plantations owned by small scale farms in the nine (9) local government councils of the Delta North Agricultural Zone. A total of 18 crude palm oil processing industries were identified. Four (4) local governments were identified using the fully mechanized or scientific method, nine (9) local governments were identified using the semi-mechanized or semi-scientific method and seven (7) local governments were identified using the traditional method. Samples from the three methods of oil palm processing under consideration in this study were also collected from the Nigerian Institute for Oil Palm Research (NIFOR) Edo State, Nigeria and these samples were used as control.

Chemical analysis: For each sample, free fatty acid (FFA) content, peroxide value and carotene content were assayed. The FFA content was determined by titrating the alcoholic solution of the oils with 0.1N solution of sodium hydroxide using phenolphthalein and alkaline blue as indicators. The FFA content was expressed as a percent of palmitic acid, the major fatty acid in palm oil (AFNOR, 1988). Peroxide value was determined by

titrating chloroform/glacial acetic acid/saturated KI solution of the oil with an aqueous solution of sodium thiosulfate using starch as the indicator (AFNOR, 1988)). The carotene content was determined as â-carotene in milligrams per liter using methods described by Ong, Boey and Ng (1982). The method consists of spectrophotometric measurements of the homogenized and diluted samples measured against a blank solution at an absorbance of 446mm.

Statistical analysis*:* Data collected were subjected to a one-way analysis of variance procedure in a completely randomized design, using the IRRISTAT for windows (version 5.0) computer software. Duncan's multiple range tests (1955) was used to separate the means at 5% level of probability.

RESULTS AND DISCUSSION

The results of the chemical analysis of the crude palm oil samples from different methods of production collected from the Nigerian Institute for Oil Palm Research (NIFOR) are presented on table 1. Results for the carotene content of the crude palm oil samples show significant ($P<0.05$) differences between the means, with the scientific method having the highest values and the traditional method having the lowest values. These results indicate that the method of production of palm oil has a significant ($P<0.05$) effect on the concentration of carotene in the final product. Carotene is a precursor to vitamin A via the action of beta-carotene 15, 15'-monooxygenase (Vaughan, 1990; May, 1994). Red palm oil gets its characteristic red colour from carotenes, such as alpha-carotene, beta-carotene and lycpoene. Recent studies in South Africa (Kruger, Engelbrecht, Esterhuyse, du Toit and van Rooyen, 2007) show consumption of red oil significantly decreased phosphorylation in rat hearts subjected to high cholesterol diets. The results in this present study indicate that oil produced by the scientific methods contains higher proportions of carotenes than the other methods, indicating that the scientific method is a better method for palm oil production in terms of carotene content.

Table 1 also shows the results for the free fatty acid content of the test materials. Significant ($P<0.05$) differences exist between the means; with crude palm oil from the scientific method of production having the lowest values. Free fatty acid content is the most used criterion for determining the quality of palm oil, and must not exceed 5%, expressed as palmitic acid (Codex Alimentarius/FAO/OMS, 2005). Fatty acids are generally present in oils as part of triacylglycerol molecules. The presence of free fatty acid residues in palm oil is an indication of the impairment of oil quality. This process is essentially attributed to an active *lipase* present in the mesocarp of the oil palm fruit and which is responsible for the hydrolysis of triacylglycerols (Henderson and Osborne, 1991; Ngando *et al*., 2006). The *lipase* is usually activated at maturity upon bruising of the fruit (Desassis, 1957). The results in this present study indicate that crude palm oil from the traditional method produces higher concentrations of free fatty acids, this would suggest that fresh fruit bunches are more susceptible to bruising when the traditional method of processing is considered. Results for peroxide value also show significant ($P<0.05$) differences between the means, with crude palm oil from the traditional method of processing having higher

values than the other test materials and the scientific method having the lowest values. The peroxide value gives the initial evidence of rancidity in oils which is usually referred to as lipid peroxidation or oxidative degradation. The peroxide value is also used to assess the stability of fats by measuring the amount of lipid peroxides and hydroperoxides formed during the initial stages of oxidation and thus estimate the extent of spoilage of the oil. Peroxidation makes the oil harmful for consumption by man and animals, as the free radicals generated by this process are proven to be carcinogenic (Rossel, 1999). It has been shown (Ngando *et al.,* 2011) that this value increases with storage, which suggests that, the traditional method of processing produces an oil with a shorter shelf life. Peroxide values of the crude palm oil from the semi scientific and scientific methods are within the ranges according to the Codex Alimentarius/FAO/OMS norms which recommend a maximum peroxide value of 10 ± 1.0 meqO_2/kg. The results of the chemical analysis of the crude palm oil samples from the scientific method of palm oil production from NIFOR compared to the samples obtained from four Local Government Councils in Delta North Agricultural Zone is presented on table 2. The results for carotene and free fatty acids did not show significant ($P>0.05$) differences between the means, however significant ($P<0.05$) differences exists between the peroxide values of the samples from NIFOR and the four local government areas studied. The results of the analysis of the crude palm oil samples obtained from the semi scientific method of oil palm production from NIFOR compared to samples obtained from nine Local Government Councils in Delta North Agricultural Zone is presented on table 3.

Results for carotene values of the crude palm oil samples obtained from the different Local Government Councils in Delta North Agricultural Zone, using the semi scientific method do not show significant ($P>0.05$) differences between the means. The free fatty acid content of all the samples analyzed did not show significant ($P>0.05$) differences between the means. Results however indicate significant ($P<0.05$) differences in the peroxide values between the different LGAs. Comparatively, samples obtained from NIFOR were found to be significantly ($P<0.05$) lower than the samples obtained from the different Local Government Councils except Ika South. The highest values were found in samples obtained from Oshimili North Local Government Area.

The results of the chemical analysis of the crude palm oil samples obtained from the traditional method of oil palm production from NIFOR compared to samples obtained from nine Local Government Councils in Delta North Agricultural Zone is presented on table 4. Significant differences were not detected for carotene content when comparing the traditional method of crude palm oil production in NIFOR and the nine Local Government Councils covered in Delta North Agricultural Zone; neither were there significant differences in the free fatty content of the test materials. Results for the peroxide value of the test materials show significant ($P<0.05$) differences between the means. Samples from Ika South had the lowest values while samples from Aniocha North and Ndokwa West had the highest values. No particular reasons could be given for these differences. However it has been shown (Lewkwowitsch, 1992) that two types of oils are produced by the traditional method, these are the soft oil and the hard oil and production of these two types of oils

depends on the preliminary production steps with a longer fermentation period being used for the production of hard oil.

Table 1: Effect of method of crude palm oil production on the peroxide value, free fatty acid and carotene contents (NIFOR)

Parameter	Traditional method	Semi scientific method	Scientific method
Carotene	491.20[a]	887.20[b]	921.80[c]
Free Fatty acid	15.97[a]	13.70[b]	12.14[c]
Peroxide value	13.40[a]	10.67[b]	7.33[c]

[a b] = Means with different superscripts within rows are significantly (P<0.05) different

Source: Survey, 2012

Table 2: Comparative evaluation of crude palm oil samples from NIFOR and four LGAs in Delta north using the scientific method of palm oil production

Source	Carotene	Free Fatty Acid	Peroxide Value
NIFOR	928.47 [a]	11.27[a]	6.67[b]
Ika South	918.20[a]	12.20[a]	7.00[b]
Ndokwa East	919.57 [a]	12.20[a]	7.00[b]
Aniocha South	920.87[a]	12.50[a]	7.67[ab]
Aniocha North	935.10 [a]	12.53[a]	8.33[a]

[a,b] = means with different superscript within the columns differ significantly (P<0.05)

Source: Survey, 2012

Table 3: Comparative evaluation of crude palm oil samples from NIFOR and nine LGAs in Delta North Agricultural Zone using the semi scientific method of palm oil production

Source	Carotene	Free Fatty Acid	Peroxide Value
NIFOR	906.57	13.20	7.33[a]
Ika N.E.	12.80	12.33[bc]	870.23
Ukwani	836.23	13.63	11.00[abc]
Ika South	865.30	13.40	9.33[ab]
Ndokwa East	893.30	15.40	10.67[abc]
Aniocha North	893.97	13.63	11.00[abc]
Oshimili North	894.63	13.33	13.67[c]
Ndokwa West	902.90	12.87	10.00[abc]
Aniocha South	903.57	13.97	10.33[abc]
Oshimili South	905.57	14.63	11.00[abc]

[abc] = Means with different superscripts within each column differ significantly (P<0.05)

Source: Survey, 2012

Table 4: Comparative evaluation of crude palm oil samples from NIFOR and nine LGAs in Delta North Agricultural Zone using the traditional method of palm oil production

Source	Carotene	Free Fatty Acid	Peroxide Value
NIFOR	582.2	15.2	11.3[ab]
Ika N.E.	466.3	16.3	13.0[ab]
Ukwani	467.2	15.7	14.7[ab]
Ika South	571.6	15.5	10.7[a]
Ndokwa East	466.6	15.1	13.0[ab]
Aniocha North	467.3	16.8	15.0[b]
Oshimili North	473.9	15.9	14.0[ab]
Ndokwa West	470.0	16.4	15.0[b]
Aniocha South	470.6	15.1	14.3[ab]
Oshimili South	475.8	17.6	13.0[ab]

[ab] = Means within different superscripts within columns differ significantly (P<0.05)

Source: Survey, 2012

CONCLUSION

This study has shown that the method of crude palm oil production has a significant effect on the quality of oil produced. The results also indicate that oil produced by the three methods of production in NIFOR is of better quality when compared to the oil produced in the selected Local Government Councils of Delta North Agricultural Zone. These results also indicate that oil produced by the traditional method is of lower quality than that of the semi-scientific and the scientific methods. In this regard, peroxide and free fatty acid values are useful indicators of oil quality and can be used to control dietary oils safety and quality. It is advisable that small scale farmers make efforts to adopt the methods developed by NIFOR; this would go a long way in improving the quality of their CPO by any of the methods used.

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