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Effect of Additives on the Yield and Quality of Palm Oil

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Abstract. In the study of the effect of additives namely *Manihot esculenta* Crantz, (cassava), *Erythrina senegalensis* (ukwa) and *Oxytenanthera* species (bamboo) leaves, on the yield and quality of traditionally processed palm oil, the raw leaves were found to contain some anti-nutrients like tannins, oxalates, trypsin inhibitors, alkaloids and phytic acid at tolerable levels. The additives increased the yield from 300 ml (of the control) to 450 ml with a standard deviation of 60.6 ml. The peroxide value was in the range of 0.4-1.0 meq/kg, free fatty acid varied between 0.847-1.12 mg KOH/g, iodine value between 51.01-52.54, saponification value between 7.84-93.97 KOH/g of oil and moisture content, between 1.4-1.8%. Analysis of variance (ANOVA) showed significant differences, ($P<0.05$) in the yield, relative density, peroxide value, iodine value and saponification values. However, there were no significant differences ($P>0.05$) in the moisture contents, free fatty acid, specific gravity, smoke point, flash point and fire points. The standard deviation results revealed that the palm oil produced using ukwa leaf differed from the others in terms of smoke, flash, and fire points. Cassava leaves was the best of the studied additives in terms of yield with the physical properties comparing favourably with the control. Chemical properties were similar to the control with the exception of the saponification value.

Keywords: palm oil, additives, yield, *Manihot esculenta*, *Erythrina senezalensis*, *Oxytenathera* sp.

Introduction

Palm oil is an important part of diet of many Nigerian and other West African countries. It is derived from the mesocarp of the fruit of oil palm (*Elaeis guineensis*). The oil is composed of approximately 50% saturated fats (primarily palmitic acid) and 40% unsaturated fats (principally linoleic and oleic acids) (Ihekoronye and Ngoddy, 1985).

The quality of palm oil varies widely depending on the method of processing, quality control measure, and the storage techniques employed. Oil with impaired quality is known for its strong flavour and odour due to formation of free fatty acid (FFA) (Opeke, 1992). The oil palm is now grown as a plantation crop in most countries because of the economic importance of its edible and technical oils (Poku, 1993). Modern processing of oil palm fruit into edible oil is practiced both industrially and traditionally, with traditional processing dominating the market.

Palm oil, sold in both rural and urban areas, is processed by rural women with little professional knowledge of the extraction and refining methods of the oil. Sometimes, extraction imposes a great deal of problems since according to them, the oil refuses to flow from the mesocarp. In such circumstances, they do resort to adding some additives for increasing the extraction rate without impairing the quality of the oil. Such additives include cassava, bamboo, and ukwa leaves. However, the implications of these additives have not been established in the study area, whereas the produced oil is sold beyond the locality. The present study is therefore, aimed at determining the effect of these additives on the yield and physicochemical properties of the oil produced.

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Materials and Methods

The palm fruit used in this study was purchased from Abakpa Main Market, Abakaliki and the additives were acquired from the Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki, Nigeria.

The palm fruit was cleaned to remove dirt and other contaminants and then the lot was divided into four portions of 2 kg each. This was then boiled until the tissue became soft and then pounded into a mash using pestle and mortar together with about 2.0 g of the additives which were previously analysed for antinutrients. The additives used were cassava leaves (CL), ukwa leaves (UL) and bamboo leaves (BL). These were added to three different portions of the palm fruit while the fourth portion was used as control. Palm oil was extracted and refined locally, cooled and the quantity of the extracted palm oil was measured using graduated measuring cylinder. The oils produced were designated as: PCL for the palm oil produced with cassava leaves, PUL for the palm oil produced with ukwa leaves and PBL for the palm oil produced with bamboo leaves and the control. The oils were then packaged in high density plastic containers and stored at ambient temperature, away from the light. These oils were analysed in triplicate for both physical and chemical properties. The analysis, was completed within two weeks of the production. The results are presented as mean of triplicate analysis.

Analysis. The specific gravity and relative density were determined using a pycrometer gravimetric method as described by Pike (2003). The smoke, flash and fire points were determined using Pearson (1976) methods of analysis.

Chemical analysis was carried out using Pearson (1976) methods of analysis. The chemical analyses carried out included determination of peroxide value, free fatty acid, iodine and saponification values of the oil.

Iodine value. About 1 ml of the oil sample was measured into a dry glass-stoppered bottle of about 250 ml capacity. To the test sample was added, 10 ml of carbon tetrachloride and 20 ml of Wij's solution for dissolution. The stopper was moistened with potassium iodide solution and allowed to stand in the dark for 30 min. Thereafter, 15 ml of potassium iodide (10%) and 100 ml distilled water were added, mixed thoroughly and titrated with 0.1 M sodium thiosulphate solution using starch as the indicator. A blank analysis was also carried out in the similar fashion.

Saponification value. About 2 g of the oil sample was weighed into a 250 ml conical flask and 25 ml of alcoholic potassium hydroxide solution was added. It was connected to reflux condenser and heated in boiling water bath (Fisher bath) for 1 h with intermittent shaking. Later it was titrated with 0.5 M hydrochloric acid using 1 ml of phenolphthalein (1%) solution. A blank determination was similarly carried out and the generated results were expressed as mg KOH/g of oil.

Free fatty acid. Equal volumes of diethyl ether and 95% alcohol were mixed and 1 ml of phenolphthalein solution (1%) was added. This was carefully neutralized with 0.1 M sodium hydroxide solution. About 5 g of the oil was dissolved in the neutral solvent and titrated with 0.1 M sodium hydroxide solution shaking constantly until a pink colour occurred which marked the end point of the reaction.

Peroxide value. Equal volumes of chloroform and glacial acetic acid (1:1 vol/vol) were placed in a 250 ml flask and boiled using Bunsen burner. First 1 g of potassium iodide, dissolved in about 1.5 ml distilled water followed by about 1 g of the oil sample were added down the condenser. Then the condenser was turned-off. The mixture was boiled for 4 min and then the flask was removed, rapidly cooled under tap water and 50 ml distilled water was added. The liberated iodine was titrated with 0.01 M sodium thiosulphate solution using starch solution as indicator.

Statistical analysis. The results generated from both physical and chemical analyses were subjected to analysis of variance (ANOVA) at 5% level of significance while Turkey's test was used to compare the means. Standard deviation was used to determine the difference in the results from the mean.

Results and Discussions

The effect of additives on the physical characteristics of the palm oil are reflected in Table 1. The results revealed that the yield of palm oil increased with the addition of the additives, especially with the use of cassava and ukwa leaves. There was 50%, 48%, 38% increase in the yield with cassava, ukwa and bamboo leaves, respectively. The results show a higher yield of oil with the use of additives. Thus additives can extract more oil from the palm fruits than when ordinarily processed without any additive.

Analyses also revealed that there were significant differences ($P<0.05$) among oils. The relative density of palm oil should be in the range of 0.921-0.947. Values higher than the recommended range pose the risk of bursting the barrels in which oil is stored, since increase in temperature diminishes density thereby increasing the volume of the containing vessel (SeaLand, 1991). It, therefore, follows that the produced oils have good relative densities and could be packaged and transported fearlessly. However, PCL and PBL with higher densities could pose problems in selection of packaging material if there is increase in temperature. The values of specific gravity were not significantly different ($P>0.05$); however, values were higher than the recommended standard of 0.898-0.907 of the Standard Organization of Nigeria (SON, 2000).

The smoke, flash and fire points were not significantly different ($P>0.05$), although the standard deviation result revealed that PUL deviated significantly from the mean. Hui (1996) reported that good quality palm oil should have smoke point of 215 °C and above. Low smoke point of cooking and frying oils affect fried foods such as cakes, bean balls and doughnut through exhibition of cracked surfaces, increased tendency to browning and fat absorption (Ihekoronye and Ngoddy, 1985). The high smoke points of oil is indicative of its suitability for use as frying oil.

Table 1. Effect of additives on yield and physical properties of palm oil

Sample	Yield (ml)	Relative density (g/cm^3)	Specific gravity	Smoke point (°C)	Flash point (°C)	Fire point (°C)
PCL	450^a (50%)	0.807^{ab}	0.911^a	200^a	230^a	300^a
PUL	445^{ab} (48%)	0.734^{ac}	0.910^a	240^a	280^a	320^a
PBL	415^c (38%)	0.862^b	0.914^a	220^a	260^a	306^a
Control	300^d	0.688^c	0.909^a	200^a	240^a	290^a
SD	60.67	$6.6x10^{-2}$	$1.8x10^{-3}$	16.58	19.20	10.86

Means in the same column with the same superscripts are not significantly different ($P>0.05$).

Table 2 gives the result of the effect of the additives on the chemical quality of palm oil. There were no significant differences (P>0.05) in the moisture contents of the produced oil. The values obtained were higher than the recommended value of 0.29% for fresh oil (SON, 2000; NIS, 1992). High moisture content of oil facilitates hydrolytic rancidity. Thus the moisture content of the oil must be negligible for longer shelf-life and stability against oxidation.

Table 2. Effect of additives on the chemical properties of palm oil

Sample	Moisture content (mg KOH/g)	Peroxide value (meq/kg)	Free fatty acid %	Iodine value (meq/kg)	Saponification value (mg KOH/g)
PCL	1.8[a]	0.6a[b]	0.98[a]	51.65[a]	77.84[c]
PUL	1.6[a]	0.8a[c]	0.84[a]	52.54[b]	51.19[d]
PBL	1.4[a]	1.0[c]	1.12[a]	51.01[c]	85.55[b]
Control	1.8[a]	0.4[b]	0.951	52.03[ab]	93.97a
SD	$2.7X10^{-1}$	$2.2X10^{-1}$	0.9	$5.4X10^{-1}$	16.02

Means in the same column with the same superscripts are not significantly different (P>0.05).

Free fatty acid (FFA) values were not significantly different (P>0.05). High acid value of oil results in loss of nutritive value, undesirable toughening of tissue and loss of water holding capacity (Ihekoronye and Ngoddy, 1985). Abulude *et al*. (2005) found that high acid value of fats and oils causes oxidative rancidity with resultant flavour impairment of foods. In the present study, free fatty acid values of oils, which show extent of rancidity of the oils, were lower than the maximum free fatty acid content of 3.5 mg KOH/g as specified by SON (2000). This perhaps could be the result of the fact that the oils were analysed immediately after processing.

Iodine value is a measure of unsaturated fatty acids present in the oil. Iodine values were found to be significantly different (P<0.05) from one another. Abulude *et al*. (2005), recommended iodine value for palm oil as 48.22 to 57.95. The iodine values of the oils in the present study were in agreement with Abulude *et al*. (2005) and SON (2000). These values indicate that the oils are highly unsaturated and thus could undergo oxidative rancidity on storage. However, the additives did not affect the degree of unsaturation of the oils.

The peroxide value is usually used as an indicator of deterioration of the oil. According to Son (2000) and NIS (1992), palm oils should have peroxide values in the range of 7.90-8.80 meq/kg. The result shows that primary oxidation resulting from lipid degrading enzymes like peroxidase and lipoxygenase had not set-in. However, there were significant difference (P<0.05) amongst the oils produced.

Saponification value is a measure of the mean molecular weight of fatty acid. In the present study, saponification values were significantly different (P<0.05). This result indicates that the additives affected the molecular weights of the fatty acids with ukwa leaf, having the greatest effect. Generally, the produced oils had low molecular weights. This perhaps could be attributed to the type of palm fruit used since the control had a value less than 100. Low saponification value of palm oil is indicator that the oils are not suitable for soap making.

Conclusion

The result of this study showed that cassava leaves did not affect the quality of the oil. Thus it is better than other additives since it actually increased the yield more and also it is readily available as compared to other additives.

Although ukwa leaves were equally good, it affected the smoke, flash and fire points of the oil produced. However, the additives lowered the saponification value of the oil. The use of these additives facilitates the flow of crude palm oil from the mesocarp of the palm fruit, thereby increasing the revenue accruing from this sector by the rural dwellers of the palm oil-producing areas of Nigeria.

References

Abulude, F.O., Ogunkoya, M.O., Eluyode, O.S. 2005. Effect of storage on the physico-chemical properties of palm oil. *Pakistan Journal of Scientific and Industrial Research* **48:** 110-112.

Hui, Y.H., 1996. Oils and oilseeds. In: *Bailey's Industrial Oil and Fat Products*, p.214, 5th edition, John Wiley and Sons Inc., New York, USA.

Ihekoronye, A.I., Ngoddy, P.O. 1985. *Integrated Food Science and Technology for the Tropics*, pp. 64-85, 1st edition, Macmillan Publishers Ltd., London.

NIS 1992. *Nigerian Industrial Standards*. *Standards for Edible Vegetable Oil*, pp. 5-12.

Opeke, L.K. 1992. Quality of oil extracted from oil palm fruits. In: *Tropical Tree Crops*, pp. 269-270, 1st edition, Spectrum Books Limited, Sunshine House, Ibadan, Nigeria.

Pearson, D. 1976. *The Chemical Analysis of Foods*, pp. 121-150, 7th edition, National College of Food Technology, University of Reading, Weybridge, Surrey, Churchill Living Stone Edinburgh, London, UK.

Pike, O.A. 2003. Fat Characterization. In: *Food Analysis*, S. S. Nielsen (ed.), pp. 227-246, 3rd edition, Kluwer Academic/Plenum Publishers, New York, USA.

Poku, K. 1993. *Innovations in village Based Palm Oil Processing*, Paper presented at the BUROTROP-AFOPDA Seminar on Small and Medium-Scale Oil Palm and Coconut Technologeis, Accra, Ghana.

SeaLand 1991. *Shipping Guide for Perishables*, SeaLand Corporate Marketing, Edison, New Jersy, USA.

SON 2000. *Standards for Edible Refined Palm Oil and its Processed Form*, pp. 2-5, 1st edition, Standard organization of Nigeria.