



## Microbiological quality and chemical characteristics of palm oil sold within Jos Metropolis, Plateau State, Nigeria

Juliet Ngume Okechalu<sup>\*1</sup>, Michael Macvren Dashen<sup>1</sup>, Patricia Manko Lar<sup>1</sup>, Brains Okechalu<sup>2</sup> and Tongriyang Gushop<sup>1</sup>

<sup>1</sup>Dept. of Microbiology, Faculty of Natural Sciences, University of Jos, Jos, Nigeria

<sup>2</sup>Dept. of Plant Science & Technology, Faculty of Natural Sciences, University of Jos, Jos, Nigeria

### ABSTRACT

The study was carried out to assess the microbiological and chemical characteristics of palm oil sold in three markets (Terminus, Kwararafa and Angwan Rukuba) within Jos metropolis. A total of 60 samples; 20 each were collected from the three different markets in sterile bottles. The bacterial load was determined. Bacteria and fungi were isolated and identified based on their cultural, morphological and biochemical characteristics. The free fatty acids (FFA), peroxide value (PV), moisture content (MC) and iodine value (IV) were determined. The mean bacterial load ranged from  $1.61 \times 10^4$  cfu/ml to  $9.4 \times 10^4$  cfu/ml with samples obtained from Kwararafa market having the highest mean bacterial load ( $9.4 \times 10^4$  cfu/ml), while samples obtained from Angwan Rukuba market had the least mean bacterial ( $1.61 \times 10^4$  cfu/ml). The microbial contaminants isolated were *Enterobacter* sp, *Bacillus* sp, *Proteus* sp, *Micrococcus* sp, *Staphylococcus aureus*, *Aspergillus niger*, *A. flavus*, *A. fumigatus*, *Candida* sp, *Mucor* sp, and *Penicillium* sp. *Penicillium* sp. had the highest frequency of occurrence of 26.67% followed by *Aspergillus niger* (16.67%), while *Enterobacter* sp had the lowest (3.33%) frequency of occurrence. The bacterial load of palm oil samples from each of the markets fall within the minimum acceptable range stipulated by NAFDAC for oil. However, the peroxidase value, free fatty acids and moisture content were found to be high compared to standards.

**Keywords:** Microbiological Quality, Chemical Characteristics, Palm oil, Jos metropolis.

### INTRODUCTION

“Oils” is collective term for more or less viscous, generally organic chemical liquids. Palm oil which is orange-red to brownish or yellowish-red in colour is extracted from the fleshy mesocarp of the fruit of oil palm tree [18]. Oil palm fruit is a monocotyledon belonging to the genus *Elaeis*. It is a tree crop and the highest oil producing plant. It produces two types of oils; these are palm kernel oil and palm oil. Palm kernel oil is obtained from the endocarp while palm oil is obtained from the fleshy mesocarp [10]. It is rich in Vitamin E (tocopherols and tocotrienols), carotenoids,

and phytosterols [21].

Palm oils rich content of saturated and monounsaturated fatty acids has actually been turned into an asset in view of current dietary recommendations. The use of palm oil in combination with other oils and fats facilitates development of a new generation of fat products that can be tailored to meet most current dietary recommendations [21]. Palm Vitamin E (30% tocopherols and 70% tocotrienols) has been extensively studied for its nutritional and health properties, including antioxidant activities, cholesterol lowering, anti-cancer effects and protection against atherosclerosis. A relatively new out-put from the oil palm fruit is the water soluble phenolic-flavonoid rich antioxidant complex, which has potent antioxidant properties coupled with beneficial effects against skin, breast and other cancer. Its water solubility is being currently tested for use as nutraceutical and in cosmetics with potential benefits against skin aging [21].

Microorganisms are known to cause chemical changes in palm oil that lead to deterioration in the quality of their chemical compositions [16]. The lipolytic activity of fungi on the triglycerides of oils and fats used in baking formulations may cause rancidity, acidity, bitterness, soapiness and other off flavours. Such activities may occur in seeds or other plant parts from which oils are derived [14].

Traditional methods of production are employed for the extraction of palm oil by individuals who have little or no knowledge neither of modern aseptic production techniques nor of the microbiological implication of poor sanitation and storage methods. Therefore, palm oil is prone to contamination by microorganisms found in the environment, raw materials and equipments used for the processing, as well as those used for storage and distribution [14].

Frying and cooking of the oil can reduce the microbial load to the minimum level, but the fact that some individuals consume this product raw is of concern as this may result in health problems in such individuals when the microbial load is high. It is against this background that this research was carried out with the aim of determining the microbial quality of palm oil sold in different markets within Jos as well as their chemical characteristics.

## **MATERIALS AND METHODS**

### **Sampling Area**

Samples of palm oil were collected from three different markets in Jos Metropolis. The markets are; Terminus, Angwan Rukuba market and Kwararafa market. A total number of thirty (60) samples, twenty (20) from each market were collected.

### **Collection of Samples**

The samples were collected in sterile universal bottles. Care was taken not to contaminate the bottles before and during collection of the samples. The samples were then transported to the laboratory for microbiological and chemical analysis.

### **Aerobic Plate Count of the Samples**

A stock solution of each of the samples was made by dissolving ten millilitre (10ml) of each sample in ninety millilitre (90ml) of sterile Tween 80. Six – fold serial dilution was made from each stock solution. Aliquots of the last two dilutions of each sample were inoculated on Plate Count agar (PCA) in duplicates using the pour plate method. All the plates were incubated at 35<sup>0</sup>C for 24 hours. Colonies were counted after 24 hours and results expressed as colony forming units per millilitre.

### Identification of Bacterial Isolates

All bacterial isolates on the PCA plates were identified based on biochemical characteristics as described by Cheesbrough, [4] and U.S.FDA manual online [22], [23].

### Isolation and Identification of Fungal Isolates

Each of the Palm oil sample was inoculated on Sabouraud's Dextrose Agar (SDA) and incubated at room temperature for 3 – 7 days. All fungal isolates were identified based on their macroscopic and microscopic appearance with reference to manual of Barnett and Hunter, [3], Larone [13] and Mycology online of Ellis [11].

### Determination of Chemical Characteristics of the palm oil samples

The peroxidase value (PV), free fatty acids (FFA) content, moisture content (MC) and iodine value (IV) of the palm oil were determined as described by Aurand *et al.* [2], FAO, [12] and Siew, [20].

**Statistical Analysis:** The data obtained were analysed using analysis of variance (ANOVA).

## RESULTS

The aerobic plate count of the samples ranged from  $9.4 \times 10^4$  cfu/ml to  $1.61 \times 10^4$  cfu/ml with samples obtained from Kwararafa market having the highest bacterial load while samples from Angwan Rukuba market had the least contamination. However, there is no significant difference in the mean bacterial load of samples from the three markets. ( $P > 0.05$ ). (Table 1).

Table 2 shows the microorganisms isolated from the oil samples obtained from the three (3) markets and their frequency of occurrence. The organisms isolated include *Enterobacter* sp, *Bacillus* sp, *Proteus* sp, *Micrococcus* sp, *Staphylococcus aureus*, *Aspergillus niger*, *A. flavus*, *A. fumigatus*, *Candida* sp, *Mucor* sp and *Penicillium* sp. *Penicillium* sp had the highest frequency of occurrence while *Enterobacter* sp and *Staphylococcus aureus* had the lowest frequency of occurrence.

The chemical characteristics of Palm oil sold in the three (3) markets are as shown in Table 3. The mean free fatty acid (FFA) ranged from 2.67% to 4.20%. While the mean Peroxide value (PV), Iodine value (IV) and moisture content (MC) ranged from 32.4Eq/kg to 35.5mEq/kg, 0.69 to 1.27 and 0.69% to 1.27% respectively.

**Table 1: Mean Aerobic Plate Count of Palm Oil Sold in the Various Markets**

Markets	No of Samples	Mean Total Plate Count (CFU/ml x10 <sup>4</sup> )
Kwararafa	20	9.4
Terminus	20	3.0
Angwan Rukuba	20	1.61
Total	60 Mean Total	4.67

**TABLE 2: Frequency of Occurrence of Microbial Isolates in Palm Oil samples from the different Markets**

Organisms	Markets			No of times isolated	% frequency of occurrence
	A	B	C		
<i>Enterobacter</i> sp	+	-	-	1	3.33
<i>Bacillus</i> sp	+	-	+	3	10.00
<i>Proteus</i> sp	+	+	+	4	13.33
<i>Micrococcus</i> sp	+	+	+	3	10.00
<i>Staphylococcus aureus</i>	-	-	+	1	3.33
<i>Aspergillus flavus</i>	+	+	+	4	13.33
<i>Aspergillus niger</i>	+	+	+	5	16.67
<i>Aspergillus fumigatus</i>	+	-	+	2	6.67
<i>Candida</i> sp	+	+	+	4	13.33
<i>Mucor</i> sp	+	+	+	6	20.00
<i>Penicillium</i> sp	-	+	+	8	26.67

A = Kwararafa Market

B = Terminus Market

C = Angwan rukuba market

+ = Positive

- = Negative

**TABLE 3: Chemical Characteristics of Palm oil sold in the different Markets**

Sampling Sites	Mean value			
	FFA (%)	PV (mEq/kg)	IV	MC (%)
Kwararafa	3.06	32.4	46.74	1.09
Terminus	2.67	23.2	52.65	0.69
Angwan Rukuba	4.20	35.5	63.59	1.27

FFA = Free fatty acid

PV = Peroxide value

MC = Moisture content

IV = Iodine value

## DISCUSSION

The bacterial load of the palm oil samples obtained from the three (3) markets fall within the minimum acceptable microbiological level required by the Nigerian Agency for Food and Drug Administration (NAFDAC), which stipulated that the maximum allowable number of organisms in a sample unit of oil should not be more than 2 with acceptable microbiological level of  $10^4$ /ml. The microbial load obtained agrees with the finding of Ekwenye, [9].

The presence of *Enterobacter* sp. could be indicative of fecal contamination. Some *Bacillus* sp. are pathogenic and can cause food poisoning, bacteremia and endocarditis, their presence in some of the palm oil samples may be because some of the palm oil samples are sold openly in the market exposed to the spores of the organism which are dormant and are highly resistant to the lethal effects of heat drying and ultraviolet radiation [5]. *Enterobacter* sp. can be found in the environment and water, their presence in the palm oil samples might be due to contamination from the environment or water. Some strains of *Enterobacter* sp. are opportunistic pathogens and are involved in respiratory tract infection and occasionally cause septicaemia and meningitis. *Proteus* sp. has been implicated in urinary tract infection. *Staphylococcus aureus* is capable of producing enterotoxin and is noted to survive for extended periods in hostile environments [5]. It could cause gastroenteritis in the individuals if the oil is consumed raw. Its isolation could be an indication of unhygienic handling of the oil by the sellers [7].

*Aspergillus niger* and *Mucor* sp. have been noted for their ability to survive in oil by producing the enzyme lipase [1]. The ability of these fungi to produce spores helped them to survive the anaerobic nature of the oil, and the spores are resistant to heat. *Aspergillus flavus* is of health significance because of its ability to produce aflatoxin which is capable of inducing toxic syndromes especially cancer [17,19].

The result of the free acids (FFA) obtained from this study is comparable with those of Egan *et al.*, [6], Ekpa and Ekpe [8], Ekwenye [9] and Orji and Mbata, [18]. The high FFA values obtained may be due to the fact that the oil samples obtained were exposed to normal room temperature conditions at the market stores [9]. It may also be due to decomposition of glycerides by the fungi and may have been accelerated by the exposure of the palm oil to heat and sunlight. Egan *et al.* [6] stated that glycerides in oil can be decomposed by lipase or other actions and that decomposition may be accelerated by light heat.

The peroxide value (PV) determines the degree of oxidation of oil as well as gives an indication of the level of deterioration of oils and fats [15]. The PV of the palm oil samples obtained from this study agrees with the results of Ekpa and Ekpe [8] who stated that rancidity often begins to be noticeable when peroxide value is between 20 and 40mEq/kg,. Rancidity is an indication of deterioration of fats and oils. The peroxide values of the oil samples indicate that the oils sold within Jos metropolis may be rancid.

The Iodine Value (IV) is a useful index of detecting adulteration of palm oil with any other vegetable or animal fat. The iodine value obtained also tallies with that of Ekwenye, [9] who reported that the greater the degree of unsaturated fats (High iodine value), the more readily the oil or fat becomes rancid. It also agrees with the findings of Nwanekezi and Onyeagba [15] who reported that the higher the iodine value, the greater the degree of unsaturated fats that exist in the oils. Orji and Mbata [18] also reported iodine values that are comparable with those of this study. The high iodine value obtained in this study may as well explain the rancidity noticed in the oil samples surveyed.

The moisture content (MC) of all the oil samples was higher than the international standard for edible palm oil. The moisture content obtained from this study is similar to those obtained by Orji and Mbata [18] who reported that the high values of moisture of the oil produced through traditional methods may be due to the fact that the local producers do not boil the pure oil to reduce the moisture content.

## CONCLUSION

In conclusion, some of the palm oil samples do not meet the NAFDAC standards for food and international standard for edible food, due to the fact that the PV, FFA, and MC were found to be high compared to standards. Some of the microorganisms isolated, even though their microbial load is not high can cause health problems in individuals who consume the product without heat processing. Some are food spoilage organisms and may accelerate the deterioration of palm oil. The high PV and FFA indicate that some of the palm oil samples have undergone some level of deterioration.

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