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Microbial Quality of Palm Oil Sold in Amassoma, Bayelsa State, Nigeria

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Abstract

Palm oil is an active ingredient in diets in many families in Nigeria. Palm oil production is majorly carried out by smallholder processors that use local equipment for processing. This study evaluated the microbial quality of palm oil sold in Amassoma, Bayelsa state, Nigeria. Triplicate samples of palm oil were purchased from six palm oil retailers in Amassoma. Microbiological techniques were applied in the analysis. Results revealed that the total heterotrophic bacteria and total fungi ranged from 0.68-14.40 × 10^4 cfu/ml and 1.23-12.60 × 10^2 cfu/ml, respectively. There were significant differences ($P<0.05$) in the total heterotrophic bacteria and total fungi population in most of the locations. The microbial isolates that were identified included *Staphylococcus aureus, Escherichia coli, Bacillus, Pseudomonas, Micrococcus* species (bacteria), and *Aspergillus niger, Aspergililus flavus, Rhizopus, Mucor and Penicillium* species (fungi). The similarity interaction between the various locations with respect to microbial diversity (bacteria and fungi) ranged from 50.00-92.31%. The microbial interactions of the samples from the different locations were above the similarity critical level of significance=50%. The mean microbial density were within the limits for palm oil used as food, while the diversity of microbial species in the palm oil samples exceeded the specified limit by Nigerian Agency for Food and Drug Administration Control (NAFDAC). As such, there is the need for improved handling processes of palm oil by both processors and retailers/marketers.

Keywords: Contaminants; Food; Microorganisms; Palm oil; Public Health

Introduction

Agriculture is the main stay of Nigerian economy before the discovery of crude oil [1]. During the period (before 1960), Nigeria is a major exporter of cocoa, rubber, oil palm. According to Ugbah and Nwawe [2], Nigeria is the leading exporter of palm oil. Probably due to the discovery of crude oil, there was neglect in the agricultural sector; hence Malaysia became the leading producer of palm oil between1962-1969 [2]. Due to intense effort from some Asian nations including Indonesia, Thailand and Malaysia, Nigeria position in global palm oil production was affected. As such Nigeria is the fifth largest producer of palm oil within the last 6 or more years [3-21].

The processing oil palm to produce useful products such as palm oil and palm kernel oil is a major source of livelihood for several families in southern Nigeria where palm oil in produced in the wild and plantation [3,20-24]. In many areas in Nigeria, oil palm processing and marketing of its products is a major source of employments.

Oil palm start bearing fruits after 3-5 years of planting, with optimum yield being achieved after about 10 year of planting depending on the variety. The fruit of oil palm is light yellow to orange-red/orange in colour when ripe and it contain nut [3,8,25]. Palm oil is used as active ingredients in diets by several families. This could be probably due to its carotenoids [26] and vitamin content [22], and other minerals. In addition, palm oil has been severally reported to anti-cancer and antioxidant activities, cholesterol lowering effects [3,27].

In Nigeria, palm oil is predominantly produced by smallholders that accounts for about 80% of total domestic output [9,10,18,19]. Palm oil is produced by smallholder processers under poor hygienic status [1,3]. As such the essential and health benefits of palm oil could be altered by environmental contaminants such as microorganisms. Okechalu et al. [27], Izah and Ohimain [3] reported the microorganism in palm oil could lead to rancidity, acidity, bitterness, soapiness and other off flavours.

Microorganisms are known to cause deterioration of food products which may lead pathological effects when the pathogenic ones are ingested. During cooking palm oil is subjected to varying form of heat effects, but some people still consumes it raw [1,3,27,28]. When they are consumed raw, it could transfer the microbial contaminants to human. Depending on the species of microbes, it could cause disease conditions especially in immune-compromised individuals [3]. Several studies have been carried out with regard to the microbial quality of palm oil in Nigeria. Some of these studies were carried out in some markets in Jos metropolis, Plateau state [27], smallholder processing mills in Elele, Rivers state [28], semi-mechanized mill in Bayelsa state [17], major markets of Yenagoa metropolis, Bayelsa state [29]. Therefore, this study aimed at assessing the microbial quality of palm oil sold in Amassoma, Bayelsa state, Nigeria.

Materials and Methods

Study area

Amassoma is the host communities of Niger Delta University in Bayelsa state, Nigeria. The region lies in the sedimentary basin and fishing is a major occupation of the indigene of the area. Amassoma has a link with river Nun. The area is characterized by river flooding that usually occur around September and October every year and affecting many resident close to the river bank. The population of the area have increased probably due to the presence of higher institution of learning. The climatic condition with regard to temperature and relative humidity is similar to other region of the Niger Delta that has been widely described by authors [30-34].

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Field sampling

Triplicate sample of palm oil were purchased from six different vendors at different location in Amassoma. As such a total of 18 samples were obtained. The samples were analyzed <6 hours after sample collection.

Enumeration bacteria counts

The bacteria density in the various samples was enumerated using pour plate method previously described by Pepper and Gerba [35], Benson [36]. Nutrient agar and Potatoes dextrose agar was used to enumerate total heterotrophic bacteria and total fungi, respectively. The serially diluted samples were plated in sterile agar. Then after the prepared media was added, and the agar plates were allowed to solidify before being incubated inverted at room temperature. The agar containing nutrient agar and potatoes dextrose agar was incubated for 1-2 days and 3-5 days respectively. The resultant colonies were counted and expressed as colony forming unit per milliliter of the palm oil samples.

Tentative identification of the bacteria isolates

The samples were streaked in different media including MacConkey agar, blood agar, mannitol salt agar. The colonies that grew on the MacConkey agar were further streaked in Levine's eosin methylene blue (EMB) Agar and incubated at 37°C for 24 hours. The occurrence of small nucleated colonies with greenish metallic sheen indicates *E. coli* [36]. Furthermore, yellow pigment growth on mannitol salt agar is an indication of *Staphylococcus aureus*. Biochemical test including gram reaction, citrate, catalase, oxidase, Indole, coagulase, motility, methyl red were carried out using the scheme of cheesbrough [37], Benson [36]. The resultant microbial species from biochemical test was compared with those of known taxa using scheme of Cheesbrough [37] and Bergey's Manual of Determinative Bacteriology by Holt et al. [38].

Fungi identification

Microscopic and macroscopic approach was used for the identification of mould. The Colonia characteristics of the mould were compared with guide provided by Benson [36], while the microscopic morphology was determined using Lactophenol cotton blue stain as described by Pepper and Gerba [35], Benson [36]. The resultant microscopic characteristics were compared with the scheme of Ellis et al. [39], Benson [36].

Statistical analysis

Statistical Package for Social Sciences software version 20 was used to carry out the statistical analysis. Data were expressed as mean and standard error. One-way analysis of variance was carried out at P=0.05 and Tukey HSD Test was used for mean separation. Sorenson qualitative index was used to determine the bacteria diversity similarity between samples from the different locations at critical level of significance=50% [40]. The similarity chart was plotted using Microsoft excel.

Results and Discussions

Table 1 presents the microbial population of palm oil sold in Amassoma, Bayelsa state, Nigeria. The total heterotrophic bacteria ranged from 0.68-14.40 × 10^4 cfu/ml, being significantly different (P<0.05) among most of the locations. Total fungi ranged from 1.23-12.60 × 10^2 cfu/ml. Basically, there was significant differences (P<0.05) among most of the different locations.

The significant variation in the microbial counts of some of the locations could be due to handling process by the retailers, processing hygiene of the producers and period of storage prior to sales. While the no significant variation between the means in some of the location could be attributed to the fact that the palm oil sold by the different vendors may have comes from same source preferably nearby states such as delta and rivers [22]. The palm oil is packaged in empty ragolis/mineral/la cacera bottles. As such some of the microbial impurity in the palm oil may have comes from the packaging container. Based on the permissible level of microbial load in the palm oil, the average value were within the range of minimum microbial density (10^4 cfu/ml) recommended by the Nigerian Agency for Food and Drug Administration (NAFDAC) as reported by Okechalu et al. [27].

The microbial density is this study had some similarity with the level previously reported in palm oil. For instance, Ohimain and Izah [29] reported total heterotrophic bacteria and total fungi in palm oil sold in major markets in Yenagoa metropolis, Bayelsa state in the range of 3.802-4.858 Log cfu/ml and 2.287-3.792 Log cfu/ml, respectively. Ohimain et al. [17] reported total heterotrophic bacteria and total fungi in palm oil from semi-mechanized palm oil mill in Elebele, Bayelsa state as 7.2 × 10^3 cfu/ml and 1.3 × 10^2 cfu/ml, respectively. Okechalu et al. [27] reported microbial density of palm oil sold in Jos metropolis, Plateau state, Nigeria in the range of 9.4-1.61 × 10^4 cfu/ml. Izah and Ohimain [28] reported total heterotrophic bacteria and total fungi in palm oil from smallholder processor in Elele, Rivers state, Nigeria in the range of 3.6-9.2 × 10^4 cfu/ml and 1.3-8.7 × 10^3 cfu/ml, respectively. The storage, handing and processing pattern could be the possible source of variation between the different studies.

The microbial isolate from the palm oil samples sold in Amassoma, Bayelsa state is presented in Table 2. The isolates include *Staphylococcus aureus*, *Escherichia coli, Bacillus, Pseudomonas, Micrococcus* species (bacteria) and *Aspergillus niger, Aspergililus flavus, Rhizopus, Mucor*

Locations	THB × 10^4 cfu/ml	TF × 10^2 cfu/ml
A	4.90 ± 0.78bc	6.87 ± 0.98b
B	8.30 ± 0.70c	7.17 ± 0.73bc
C	2.55 ± 0.68ab	7.77 ± 0.78bc
D	0.68 ± 0.11a	1.23 ± 0.12a
E	4.73 ± 0.64bc	4.89 ± 2.26ab
F	14.40 ± 1.36d	12.60 ± 0.89c
Average (n=18)	5.93 ± 1.11	6.75 ± 0.92
NAFDAC Limit	10^4	10^4
Each value is expressed as mean ± standard error (n=3). Different letters in each column indicate significant differences at P<0.05 according to the Tukey Honestly significance difference statistics		

Table 1: Microbial population of palm oil sold in Amassoma, Bayelsa state, Nigeria.

Microbial isolates	Locations					
	A	B	C	D	E	F
Escherichia coli	+	+	+	+	+	+
Bacillus species	+	+	+	-	-	+
Staphylococcus aureus	+	+	+	+	+	+
Micrococcus species	-	+	-	+	-	-
Pseuodmonas species	-	-	+	-	-	+
Aspergililus niger	+	+	+	+	+	+
Aspergililus flavus	+	-	-	-	+	+
Rhizopus species	-	+	-	+	-	-
Mucor species	-	-	+	+	-	+
Penicillium species	+	-	-	-	+	-

Table 2: Tentative microbial isolates from palm oil sold in Amassoma, Bayelsa state, Nigeria.

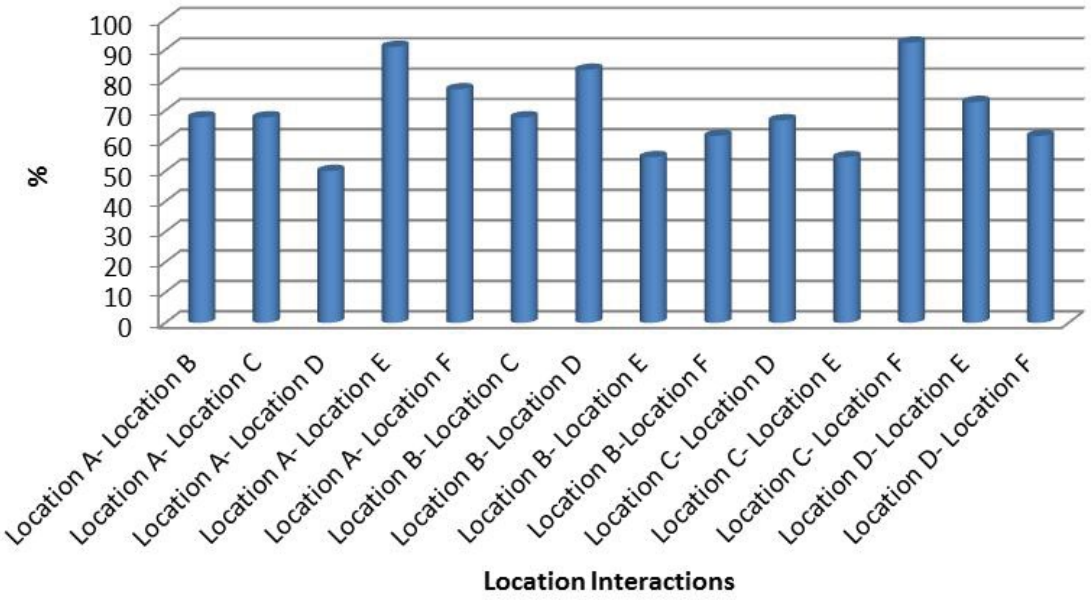

Figure 1: Similarity index of microbial diversity found in palm oil samples sold in Amassoma, Bayelsa state, Nigeria between each of the location.

and *Penicillium* species (fungi). Figure 1 presents the microbial diversity similarity between locations based on Sorenson qualitative index. The similarity interaction between the various locations with respect to microbial diversity (bacteria and fungi) ranged from 50.00-92.31%. The microbial interactions of the samples from the different locations were above the similarity critical level of significance=50%.

Palm oil processed by smallholder in Nigeria is basically carried out in unhygienic conditions [1,3]. The microbial quality including diversity and density could be altered at different processing and handling processes including mills, packaging container, marketing activities etc. The microbial density found in this study had some similarity with the work of previous authors. Previous studies have identified *Enterobacter, Bacillus, Proteus, Micrococcus, Staphylococcus, Trichphyton schoenleinii*, *Microsporium canis, Aspergillus, Candida, Mucor* and *Penicillium* species as microbes found in palm oil [3,17,27-30,41]. Furthermore, the diversity also exceeded the minimum number of species specified by NAFDAC in oil.

Palm oil is predominantly used for cooking as such there is some form of heating before consumption. But some individuals still consumes it raw. It is also used in some traditional medicine [22]. These microbes are known to cause disease conditions among individuals with their immune system compromised probably due to their opportunistic nature [3,29].

Conclusion

Palm oil is an active ingredient in meals. It's usually consumed by several families in Nigeria. This study investigated the microbial quality of palm oil sold in Amassoma, Bayelsa state, Nigeria. The study found that the mean microbial counts $\times 10^4$ and while the number of diversity exceeded 2 isolates specified by NAFDAC. Significant variation ($P<0.05$) also exists among the various locations. This is an indication of variation in processing, handling and packaging processes. Based on the finding of this study, there is the need for improved handling and packaging of processor of palm oil so as to minimize the microbial impurity.

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