MYCOLOGICAL DETERIORATION OF STORED PALM KERNELS RECOVERED FROM OIL PALM MILL

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Abstract

Palm kernels obtained from Pioneer Oil Mill Ltd. were stored for eight (8) weeks and examined for their microbiological quality and proximate composition. Seven (7) different fungal species were isolated by serial dilution plate technique. The fungal species included *Aspergillus flavus* Link; *A nidulans* Eidem; *A niger* Vantiegham; *Fusarium oxysporium* Schlect; *Penicillium fellatanium* Biohrge; *Rhizopus anhizus* Fischer *and R. stolonofer* Engrenneng. The percentage internal mouldiness was quite high throughout the storage period, which ranged from 25 to 52. The average moisture content of 8.04% was found to be above the 5.7% acceptable for safe storage, but a little below 9% acceptable value at grading at the end of the study. Both the moisture content and the free fatty acid (FFA) increase with the length of the storage period, while the oil content decreased gradually. Fungal isolates played a significant role in the deterioration of palm kernel and hence, they pose a health risk, in addition to reduced economic value and possible industrial applications for quality products.

Keywords: Palm kernels, deterioration, microbial activity, quality, storage, mouldiness.

1. Introduction

Palm kernel is the seed of oil palm (*Elaies guinensis* Jaerq.) that constitute the main source of vegetable oil. It is widely grown in the Coastal regions of Latin America and tropical rainforest of West Africa (Cook, 1942; Rees, 1965; Opeke, 1982; Jaradat and Zaid, 2004). West Africa countries are the major producers and exporters of palm kernels, led by Nigeria. The native applications and usefulness of oil palm especially to the people of the rain forest zone of Nigeria the world have been reported (Nwoko, 1988; Goh and Berhad, 2002).

The palm kernel is an important export crop, although the overseas demand is not as high as that of cocoa and groundnut (Kuku, 1979), but there are future potentials for its worldwide demand. Interestingly, the oil obtained from palm kernel fruits is useful in the production of edible oils, fats, soap and margarine. Palm kernel cake (PKC), which is cheaper than other feeds, is useful and economical to supplement other animal feeds. An analysis of the composition show that it contains a favourable calcium to phosphorus ratio; hence it makes valuable contributions to protein build up of a compound animal feeds (Kuku, 1976; 1977). Lauric acid which has been found to be the major component of palm kernel oil has since found its usefulness in confectioneries and the bakery trade, in the preparation of ice cream and manufacture of toilet soaps, soap powders and detergents. The oil is also used for plating hair as hair oil and can be mixed with kerosene as fuel oil. The oil is also known to be taken orally as a palliative therapy for stomach upset and other intestinal pains. These are in addition on the skin against skin rashes and inflamed surfaces, while the leaves are used to feed ruminant animals. Odosi and Akanranta (1986) reported the usefulness of palm kernels shells in the preparation of activated carbons suitable for decolourizing aqueous solutions, wood pulps and removal of pigments.

Microbial infestation and deterioration of stored products including palm kernel have been a major problem especially in the third world countries. However, representatives of the various microbes implicated for this occurrence at various depots in Nigeria for exports have been reported (Kuku, 1979; Atanda, 1997). This work is undertaken to investigate fungi species involved in the deterioration of palm kernels recovered from oil palm mill and to determine quality characteristics under controlled atmosphere.

2. Materials and Methods

Source of samples: Shelled palm kernels were obtained from Pioneer Oil (former Okitipupa Oil Palm Plc., Ondo State, Nigeria). The samples were stored in the kilner jar at laboratory temperature of 27±2 °C and relative humidity of 78±2% in the

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Microbiology Research Laboratory of the Federal University of Technology Akure, Nigeria. Sub-samples were taken at two week interval for analysis over a period of eight (8) weeks. The analysis involved mould isolation and identification, determination of moisture content, oil content and free fatty acid (FFA).

Isolation and identification of associated moulds: Palm kernels were surface-sterilized by sub-merging them in 70% ethanol shaking for 2-5 minutes and then allowing it to stand for 2 minutes interval for two subsequent exercises. The kernels were then rinsed in several changes of sterile distilled water, blotted dry between oven dried sterile 7 mm diameter *Whatman* filter paper. Some of the kernels were plated whole as control, while the triplicate experimental plates were prepared by cutting open the kernel with a flamed sterilized nut cracker. Potato dextrose agar (oxoid) incorporated with 1% lactic acid to suppress the growth of possible bacteria was used for the isolation of associated moulds. The control and triplicate experimental plates were incubated at 27±2 °C for 3-5 days. Subcultures were made from the mixed cultures to obtained pure cultures. The pure isolates were identified using the texts of Barnnet and Hunter (1972), Onions *et al.* (1981).

Determination of Internal Mouldiness (%): One hundred palm kernels were randomly picked in three different sets from the kilner jar containing the stored palm kernels. After surface sterilization, each kernel was cut open with a sterilized nut cracker and then examined under a dissecting microscope. The numbers of the moldy kernels were expressed as a percentage of the total and the average recorded.

Determination of moisture content (%): This was done using a modification of the BSM (1976) method. Five grams of finely ground palm kernels was transferred into a previously weighed crucible and lid and dry in an oven set at 104 °C for 4 hours. Repeated drying and weighing was carried out until a constant weight was achieved. The moisture content was computed by calculating the weight difference and expressed as percentage of the weight of the sample.

Determination of crude fat content (oil content): The methods of Josyln (1970) and BSM (1976) using the gravimetric method were used for this determination and expressed as percentage of weight of extracted oil of sample.

Determination of free fatty acid (FFA): This was done using the titrimetric method of AOAC (1990). The percentage free fatty acid (FFA) was expressed in lauric acid as a result of being the dominant fatty acid in palm kernels.

3. Results and Discussion

A total of seven (7) different moulds were isolated from the stored palm kernel samples. They included *Aspergillus flavus; A. nidulans; A. niger; Fusarium oxysporium; Pencillium fellatanium; Rhizopus anhizus and R. stolonifer* (Table 1). The ability of these moulds to grow in palm kernels clearly indicated that the kernels contain nutrients that can be utilized by the isolates. This may be in addition to the favourable storage conditions of 27±2 °C and 78±2% Rh. Interestingly, the level of infestation increased throughout the period of storage. *A flavus, A. nidulans, Fusarium oxysparum and Rhizopus stolonifer* were the predominant species of moulds (Table 1). This finding conformed to the report of Atanda *et al.* (1997). These dominant moulds may be categorized as the first invaders and possibly predisposed the kernels to other secondary invaders such as *A. niger, penicillum fellutanum* and *R. anhizus* to further deteriorate the kernels.

However, the occurrence of moulds in any produce is undesirable, as it affects the appearance and the market value of the produce (Kuku and Adeniji, 1976). The processing and handling techniques should be carefully done to reduce the degree of contamination and occurrence of these undesirable moulds.

The percentage internal mouldiness increased from the initial 25% to 52% at the end of the storage period (Table 2). This may be attributed to the hydrophilic nature of the isolated moulds. Hence, the high occurrence of internal mouldiness attributed to the description of Copeland (1976) as the inability of oil seeds to hold moisture more tightly such that the moisture absorbed becomes quickly excessive leading to rapid deterioration. Suffice to say that the short drying period do not really have any significant effects on the internal mouldiness. The moisture content increased corresponding from 6.7% to 8.9% during the period of storage (Table 2). The observed trend showed a moisture re-absorption and the hygroscopic nature of palm kernels that is typical of most stored products. The samples had an average moisture content of 8.04% below 9%, the maximum level acceptable at grading (Kuku, 1979) but higher than 5.7%, the recommended safe moisture level (Hall, 1963). There is no doubt as to the critical role of the moisture content with the ease of infection of crops by microorganisms being a primary precondition for microbial activity. An observed progressive decrease in the oil content from 52.72% to 50.0%, the major constituent of the palm kernels may not be unconnected with the action of lipolytic enzymes produced by some isolates The average percentage of oil content of 51.24 was fairly above the acceptable 49% for commercial purposes (Table

Table 1: Moulds isolated from kernels in storage.

Moulds	Storage Period (weeks)				
	0	2	4	6	8
Aspergillus flavus	+	+	+	+	+
Aspergillus nidulans	+	+	+	+	+
Aspergillus niger	-	+	+	+	+
Fusarium oxysporium	+	+	+	+	+
Penicillium fellutanum	-	+	+	+	+
Rhizopus anhizus	-	-	+	+	+
Rhizopus stolonifer	+	+	+	+	+

Key: + = Present; - =Absent

Table 2: Proximate Analysis of Palm Kernels in Storage

Proximate Analysis	Storage Period (weeks)				
	0	2	4	6	8
Internal Mouldiness (%)	25	34	38	47	52
Moisture Content (%)	6.7	7.6	8.2	8.8	8.9
Oil Content (%)	52.72	52.61	51.60	50.2	50.0
Free Fatty Acid (FFA)	6.86	7.20	7.43	8.1	8.6

2) thus requiring additional cost of re-drying. The free fatty acid (FFA) ranged from 6.86% to 8.60%, which was above the acceptable value at grading right from the beginning of the experiment (Table 2). Moisture content re-absorption and high mouldiness may be responsible or accountable for this observation. Lipolysis, which was responsible for the free fatty acid development, is usually of dual origin, namely biological and chemical in origin (Akano, 1989). In this study, the isolated moulds constitute the source.

These parameters no doubt determine the desirability of the quality standard of the palm kernels, which ultimately affect its economic and industrial value. Most of the moulds are toxigenic and then growths are highly favoured by the available moisture content. The humid surrounding of the oil palm mill could also be a source for moisture re-absorption during storage. Therefore, strict adherence to the standard will guarantee the exporters' maximum returns on produce (ROP) through the exploitation of the various incentives created by the Nigeria Export Promotion Council. This will ultimately translate into increase in foreign exchange earnings in the face of the dwindling naira.

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