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Research Article

Physicochemical Properties of Palm Kernel Oil

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Abstract: Physicochemical analyses were carried out on palm kernel oil (Adin) and the following results were obtained: Saponification value; 280.5±56.1 mgKOH/g, acid value; 2.7±0.3 mg KOH/g, Free Fatty Acid (FFA); 1.35±0.15 KOH/g, ester value; 277.8±56.4 mgKOH/g, peroxide value; 14.3±0.8 mEq/kg; iodine value; 15.86±4.02 mgKOH/g, Specific Gravity (S.G) value; 0.904, refractive index; 1.412 and inorganic materials; 1.05%. Its odour and colour were heavy burnt smell and burnt brown, respectively. These values were compared with those obtained for groundnut and coconut oils. It was found that the physico-chemical properties of palm kernel oil are comparable to those of groundnut and coconut oils except for the peroxide value (i.e., 14.3±0.8 mEq) which was not detectable in groundnut and coconut oils. Also the odour of both groundnut and coconut oils were pleasant while that of the palm kernel oil was not as pleasant (i.e., heavy burnt smell).

Keywords: Acid value, ester value, free fatty acid, iodine value, inorganic materials, refractive index, saponification value

INTRODUCTION

Lipids are heterogeneous group of substances which occur ubiquitously in biological materials. Fats and oil belong to these groups of compounds known as lipids which are found in living tissues e.g., tissues of plants and animals (Free Mantle, 1993). They may be categorized as a group by their extractability in non-polar solvent such as chloroform, carbon tetrachloride, benzene ether, carbon disulphide and petroleum ether. The term lipid is a general one that is used to describe a large group of naturally fat-like substance. They are organic compounds which all contain carbon, hydrogen and small amount of oxygen (Fox and Cameron, 1992).

At room temperature, lipids can be oils or fat depending on the degree of unsaturation of the fatty acid components. Those with a high percentage of saturated fatty acids are solid at room temperature while those with a high percentage of unsaturation are oils (i.e., liquids at room temperature). Lipids serve as food, which is being used when calories demand exceeds calories supply, they are used up when there is deficiency in other sources of energy.

Oil palm trees are grown for their clusters of fruits which can weigh 40-50 kg. Upon harvest, the drupe, pericarp and seeds (kernels) are used for production of soap and edible vegetable oil. Different grades of oil quality are obtained from the pericarp and kernel with the pericarp oil used mainly for cooking and the kernel oil used in processed foods (Osanyinbgemi, 1995).

For each hectare of oil palm which is harvested year round the annual production averages 10 tonnes of fruit, which yield 3,000 kg of pericarp oil and 750 kg of seed kernels which in turn yield 250 kg of high quality palm kernel oil as well as 500 kg of kernel meal. Some varieties have even higher productivities which had led to their consideration for producing the vegetable oil needed for biodiesel (Faessler, 2004). The world's largest producer and exporter of oil palms today is Malaysia producing about 47% of the world's total supply. Indonesia is the second largest world's producers of oil palm producing approximately 36% of the world oil palm volume. Other oil palm producing countries include the west lands of West Africa and South Benin which already hosts many palm plantations. Colombia who are the largest palm oil producer in the Americas and 35% of which is expended as biofuel (Malaysian Oil Palm Board, 2005).

Physicochemical properties of oils are determined to know the quality, purity and identification. Characteristic properties are properties that depend on the nature of the oil. These are used to characterize oil, irrespective of location or sources of origin. Example of these properties are iodine value and saponification value. While the variable properties change with location, examples are peroxide value, free fatty acid value, acid value and density (Shorunke, 1986). Iodine value is a measure of the degree of unsaturation or double bonds among the fatty acid present in the oil therefore it does not tell precisely the fatty acids composition of any oil. Iodine value or number is useful

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as a guide to check adulteration of oil and also as a process control of oil.

Peroxide value is used in determining the degree of spoilage. The standard peroxide value for edible oils which have not undergone rancidity must be well below 10 meq/kg (Pearson, 1976).

Free fatty acid value is often used as general indication of the condition and edibility of oils (Pearson, 1976). Saponification value is a rough index of the molecular weight of the fat or oil. The smaller the saponification value the higher the molecular weight. It also indicates the quantity of alkali required for conservation of a definite amount of fat or oil into soap. It is used to check the adulteration of fat and oils (Theodore, 1983).

Esterification value is the difference between the saponification value and the free fatty acid value of the fats and oils.

Refractive index is the degree of refraction of a beam of light that occurs when it passes from one transparent medium to another. The refractive index of an oil can be estimated with the aid of a refractometer in degrees, at 20°C usually. The value obtained is unique for a particular oil and can therefore be used to check adulteration and purity of oil (Pearson, 1981).

Specific gravity is determined and calculated at temperature 20°C as a ratio of mass in air of a given volume of the oil or fat to that of the same volume of at 20°C (Theodore, 1983). It can reveal the extent of adulteration and may be used as a means of acceptance of oils as raw materials as well as determination of size of pumps and piping in plant installation. The relative density of most oil range between 0.89 and 0.92 at 20°C (Theodore, 1983).

Other variable properties of oil include solubility, freezing point, colour, odour and boiling point.

Oil spoilage can be prevented through exclusion of air, addition of antioxidants, addition of chelation agents and hydrogenation (Furniss, 1978).

Palm kernel oil (called Adin in Southwestern part of Nigeria) has various important uses, though used by majority in the rural parts of West Africa. It is used as drug being given to a child suffering from convulsion, it is used as a hair ointment in the treatment of dandruff. It is also used as a moisturizer mostly for new born children to prevent cold and lowering bodily temperature in a sick child and also for the prevention of scaly skin.

In this study, the physicochemical properties of palm kernel oil were obtained as well as those of groundnut and coconut oil for contemporary comparison for the purpose of inferring the suitability or otherwise of palm kernel oil for cooking and/or frying.

MATERIALS AND METHODS

The palm kernel oil (Adin), groundnut oil and coconut oil, used were sourced from Erinfun market, Ado Ekiti, Ekiti State, Nigeria. Saponification values of the three types of oil were determined using reflux boiling and titration methods (Pearson, 1976). Determination of acid value of the oils was accomplished by boiling and titrimetric methods (Onwuka, 2005). The specific gravity values of the oils were determined by volumetric and gravimetric methods (Pearson, 1976). Free fatty acid values of the oils were determined by calculation (Pearson, 1976). The determination of peroxide values were accomplished with titration (Onwuka, 2005). Iodine value determination was accomplished by gravimetric and titrimetric methods (Wijs method) (Pearson, 1976). Refractive indices were measured by the use of refractometer (Onwuka, 2005). Determination of inorganic materials was accomplished by gravimetric method (AOAC International, 2005). The colour and odour characteristics of the oils were determined by sighting and smelling respectively. Petroleum ester was used on the non-polar solvent for all the oil samples.

RESULTS AND DISCUSION

From the results obtained as presented in Table 1 the saponification value of palm kernel oil (280.5±56.1 mg KOH/g) is higher than those obtained for coconut oil (257.5±6.5 mg KOH/g) and groundnut oil

Table 1: Physicochemical properties of palm kernel oil, coconut oil and groundnut oil

Physicochemical properties	Kernel oil	Coconut oil	Groundnut oil
Saponification value (mgKOH/g)	280.5±56.1	257.5±6.5	191.5±3.5
Acid value (mgKOH/g)	2.7±0.3	5.5±0.5	9.0±0.5
Free fatty (FFA) (mgKOH/g)	1.35±0.15	2.75±4.5	4.5±0.25
Ester value (mgKOH/g)	277.8±56.4	252±6.5	182.5±3.0
Peroxide value (mEq/kg)	14.3±0.8	-	-
Iodine value (mgKOH/g)	15.86±4.02	8.5±1.5	9.4±1.2
Specific Gravity value (S.G)	0.904	0.91±0.003	0.9155±0.0055
Refractive index	1.412°	1.449±0.001	1.47±0.001
Inorganic materials (%)	1.05%	-	-
Odour	Burnt smell	Pleasant	Pleasant
Colour	Burnt brown	Pale yellow	Very pale brown
Solubility	Soluble in non-polar solvent	Soluble in non -polar solvent	Soluble in non-polar solvent

(191.5±3.5 mg KOH/g) and since the higher the saponification value, the higher the unsaturated level of the oil, it can thus be inferred that palm kernel oil possess more unsaturated fatty acids than groundnut and coconut oils. It also indicates that the molecular weight of palm kernel oil is less than those of groundnut and coconut oils (Theredore, 1983). The iodine value obtained for palm kernel oil (i.e., 15.86±4.02 mgKOH/g) is also higher than those obtained for coconut and groundnut oils (8.5±1.5 mgKOH/g) and 9.4±1.2 mgKOH/g) depicting a higher level of unsaturated (Pearson, 1976).

The peroxide value of palm kernel oil (i.e., 14.3±0.8 mEq/kg) is considerably much higher than those obtained for coconut and groundnut oils which are negligible. This is an indication of the degree of spoilage of palm kernel oil which probably is more liable to rancidity more than the coconut and groundnut oils. This is not unexpected as a result of the inferred higher level of unsaturation. Rancidity begins to be noticeable when the peroxide value is well above 10 mEq/kg (Pearson, 1976).

Furniss (1978) indicated that the lower the molecular weight of an oil, the higher is its unsaturation. The result showed that palm kernel oil has specific gravity of 0.904 compared to those of coconut oil (0.91±0.03) and groundnut oil (i.e., 0.915 ±0.0055) indicating that the molecular weight of palm kernel oil is lower than those of coconut and groundnut oils.

The acid value obtained for palm kernel oil (i.e., 2.7±0.3 mgKOH/g) is lower than those obtained for coconut and groundnut oils (i.e. 5.5±0.5 mg KOH/g and 9.0±0.5 mg/KOH/g, respectively) indicating the lower level to which the glycerides in the oil had been decomposed by lipase action (Pearson, 1975). Therefore palm kernel oil is still in good condition and probably edible since its acid value is less than the values obtained for coconut and groundnut oils.

Palm kernel oil contains some inorganic materials which are probably the residual grinded nuts during milling process (1.05%). The presence of this component, especially as fibre, in the oil plays a very important nutritional role in human nutrition; it helps in easy bowel movement during digestion process. Fibre has also been associated with beneficial role in diverticular disease by diluting out potential carcinogens and spreading their transit through the colon and also believed to play a role in reducing the risk of colon cancer. Hence the beneficial role of the fibre content of palm kernel oil (Devlin, 1997).

Palm kernel oil has a very heavy brunt smell that more or less persist although the shelf life of the oil. It is a dark-brownish oil that is insoluble in water but rapidly dissolved in non-polar solvents.

CONCLUSION

This study has established that palm kernel oil, like most contemporary edible oils, also contain high amount of unsaturated fatty acids required by human body as essential fatty acids (i.e., fatty acids that cannot be synthesized by the human body), hence the desirability of palm kernel oil in human diet. Additionally, its higher content of inorganic materials make it stand head and shoulders high above its contemporary cooking oils such as coconut and groundnut oils.

It is however recommended that further research be undertaken to improve the organoleptic properties of palm kernel oil.

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