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Research Article

NUTRITIONAL QUALITY OF PALM OILS SOLD AT THE CENTRAL MARKET OF KISANGANI

Lusamaki M F¹., Solomo E²., Borive A³., Posho I⁴., Kayembe T⁵., Batina A⁵., Losimba LJ⁴
and Kayisu K A⁶

¹Department of Human Nutrition Faculty of Medicine and Pharmacie(FMP) of the University of Kisangani(UNIKIS)

²Department of Biotechnological Sciences of the Faculty of Sciences of the UNIKIS,

³Department of pharmacie of The faculty of Medicine and Pharmacie of the University of Kisangani

⁴Department of Public Health of the FMP of the UNIKIS,

⁵Department of Internal Medicine, Faculty of Medecine and Pharmacie of the UNIKIS

⁶Department of chemistry and food Industries of the Institute of the Agronomic Sciences of Yangambi(IFA YANGAMBI)

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ABSTRACT

Introduction: The quality of oil depends on its chemical composition as well as the conditions of manufacture or preservation. Palm oil is a food consumed by a large part of the population of Kisangani. The objective of our study is to determine the nutritional quality of palm oils sold at the central market of Kisangani, analyzing their content of free fatty acids and provitamin A.

Methods: The free fatty acid and beta-carotene assays were performed at the chemistry laboratory of the Faculty of Sciences of the University of Kisangani (UNIKIS). The provitaminA assay was performed according to the method described by WELCHER and that of free fatty acids by the method described by Lion. Five samples were taken for each quality; the arithmetic mean was calculated using Excel 2007 software. The statistical test T was calculated by the SPSS 20 software to compare the provitaminA content and the loss rate for a threshold of Meaning of 0.05.

Results: The fresh oil we prepared showed 9788 µg of beta-carotene per 100 grams and the third-grade oil showed only 4592 µg, a loss of 53.1% compared to the standard. Regarding the acidity index (Ia), the fresh oil showed an average of 4 ± 0.38 SD, the first-grade oils, the average of 4 ± 0.38 , the first-grade oils, the average of 5.823 ± 1.40 , for the second quality, 13.206 ± 1.89 and for third grade oils, 14.435 ± 1.92

Conclusion: it emerges from this work that the second and third quality palm oil sold at the central market in Kisangani are not of good nutritional quality. They have low levels of beta-carotene and an acidity index greater than 10, which does not comply with the standards of codex alimentarius.

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INTRODUCTION

Palm oil is the plant product richest in beta-carotene, which gives it the orange-yellow color according to carotenoid concentration; it is also rich in vitamin E (1). It is mainly used in the agri-food sector (80%), up to 19% in oleo chemistry and about 1% for biodiesel (2).

It is an ingredient most used in culinary preparation in several households of Kisangani. It provides more energy and fat-soluble vitamins in the diet (3). About 50% of its fatty acids are saturated, 40% of which are palmitic acids (1).

Some studies have shown that consumption of palm oil contributes to saturated fatty acid intakes and their excessive intake has been associated with an increased risk of cardiovascular disease (4,5). On the other hand, Siri-Tarino (6) did not find significant evidence to conclude this increase. However, it is necessary to limit their intake on the basis of Recommended Dietary Allowances (ANC) in the order of 1 to 2% of the Recommended Energy Intake (EAR) (7).

The oil quality depends essentially on its chemical composition as well as the conditions of manufacture or preservation. Its deterioration is often accomplished by hydrolysis and oxidation. In both cases, it becomes unfit for human

*Corresponding author: Lusamaki M F

Department of Human Nutrition Faculty of Medicine and Pharmacie(FMP) of the University of Kisangani(UNIKIS)

consumption (8). The degree of oxidation of lipids depends on its unsaturated fatty acid content, the oxygen scattering coefficient in the lipids, the temperature and the presence of light (9). Thus, the peroxide index which makes it possible to evaluate the degree of oxidation of an oil and the acid number which determines the free fatty acids resulting from the hydrolytic reaction of the triglycerides are two quality criteria making it possible to assess the state of preservation of an oil (3.8).

Palm oil sold at the central market of Kisangani is exposed to direct sunlight, sometimes in open containers, making it vulnerable to possible alteration. The objective of our study is to determine the nutritional quality of palm oils sold at the central market of Kisangani, analyzing their content of free fatty acids and provitamin A.

MATERIALS AND METHODS

Our study took place in the town of Kisangani, Province of Tshopo, located in the Northeast of the Democratic Republic of Congo (DRC), precisely at the central market of Kisangani. The determination of free fatty acids and beta-carotene was carried out at the chemistry laboratory of the Faculty of Sciences of the University of Kisangani (UNIKIS).

Materials

Our study was carried out on different qualities of palm oil sold at the central market of Kisangani. We analyzed four different oil qualities:

- Fresh red palm oil prepared from palm fruits four days after harvest
- "First quality" palm oil: stored in a tightly closed container protected from light and sunlight and is liquid at room temperature.
- "Second quality" palm oil: kept in an open container, exposed to the sun and in the open air; It is semi-liquid at room temperature.
- "Third quality" palm oil: kept in an open container, exposed to the sun and in the open air; It is solid at room temperature. It requires a source of heat to make it semi-liquid or liquid in order to allow its sale.

Let us mention that we prepared the fresh palm oil and that the other three qualities were bought at the central market of Kisangani. This cross-sectional study was conducted from February 20 to June 25, 2014.

During our analyzes we used a few materials including the spectrophotometer, the glass test tubes, the centrifuge (HETTICH mark), the precision balance (KERN EW mark), the empty 30 ml flask, the 500 ml flask, 30 ml Erlenmeyer, 20 ml pipette and some reagents, namely 0.1N NaOH, 0.1% phenolphthalein, 70% ethanol solution, benzene solution and petroleum ether solution.

Methods

Preparation of the samples the fresh red palm oil was obtained by the traditional method of extraction from a mature ripe palm fruits. After the extraction process, about 100 ml were collected in a clean, hermetically sealed jar and was used for direct laboratory analysis. This oil was used as a standard (reference value) with regard to the other qualities of oil for their content

of provitamin A and the acid number. The other three grades of oil were purchased from the market on an occasional basis among salespeople. These are artisanally produced oils and are sold at different prices depending on the quality. After purchase, each sample was immediately brought to the laboratory for analysis of free fatty acids and provitamin A.

Determination of provitamin A

The provitamin A assay was carried out according to the method described by WELCHER (10) as follows: Put 5 g of the sample into a centrifuge tube, add 5 ml of 70% ethanol solution and then 12 ml of petroleum ether. Stir for 10 minutes, centrifuge and then take the ether phase, ie 10 ml of supernatant liquid and place in the colorimeter flask, read the result at 490 nm against petroleum ether. As a standard, take 0.02% potassium dichromate (K₂Cr₂O₇) which gives a yellow coloration similar to a solution of β -carotene containing 1.12 mg / ml, (ie 1.12 g / l). 88 mg of β -carotene is equivalent to 84.1 units of vitamin A (WELCHER, 1963).

The concentration of β -carotene in the sample was determined by the following formula:

$$C.I = \frac{CS \times DOI}{Dost}$$

Where CI: Concentration of the unknown, CS: Concentration of standard, DOI: Optical density of the unknown, Dost: optical density standard

Determination of the acidity index

The determination of free fatty acids was done by the method described by Lion (11) as follow:

weigh 0.5 grams of the fat, dissolve it in 20 ml of 70% ethanol, then stir. Put the same amount of solvent in a control flask. Add in each container 3 drops of phenolphthalein 0.1% and titrate each test with exactly prepared 0.1N sodium hydroxide (NaOH) solution.

The acidity index of the sample was obtained as follows:

$$AI = (V_1 - V_0) Mm.N$$

Where V₁ = Volume of NaOH used to neutralize the free acids of the fat

AI: acidity index

V₀ = volume of NaOH used for the control

Mm = Molar mass of NaOH

N: normality of the sodium hydroxide solution

M = mass of the test sample (0.5g)

For each oil quality, we analyzed 5 different samples, then we calculated the average and standard deviation of observed values (free fatty acid) using Excel 2007 software. The single sample T statistical test was calculated by the SPSS software to compare the content of provitamin A and free fatty acids in the different oil grades for a significance level of 0.05. The loss rate of provitamin A was obtained by differentiating between the provitamin A content of the standard and that observed in other samples. It should be noted that an oil is considered to be of good nutritional quality in terms of acid number, if this index is less than 10 according to the standards of the codex alimentarius.

RESULTS

The results obtained in our study are presented in the tables which follow.

Provitamin A content Table I shows the different grades of oils analyzed according to their provitamin A content and the rate of loss compared to the standard.

Table I Provitamin A content of the various Samples as well as the rate of loss

Echantillon	β -Carotene ($\mu\text{g}/100\text{g}$)(mean \pm S.D)	Rate to standard	Loss rate
Palm oil Freshly prepared (standard)	9788 \pm 3,63	100	0
Liquid Palm oil (1st quality)	7616 \pm 4,62	77,8	22,2
Semi- Liquid palm oil(2 nd quality)	4816 \pm 13,43	49,2	50,8
Semi-liquid heated palm oil (3 rd quality)	4592 \pm 23,51	46,9	53,1

Single T-test for a confidence interval of 95% difference P val = 0.012

It appears from this table that the fresh oil we prepared contains 9788 \pm 3.63 μg of beta-carotene per hundred grams and was considered as reference oil to calculate the rate of loss. The third grade oil contains 4592 \pm 23.51 μg of beta-carotene per hundred grams with a loss of 53.1% compared to the standard.

Free fatty acid content

Acidity in different samples of analyzed oils

Table II presents the acidity indices of the various grades of oils analyzed.

Table II Average free fatty acid content in oils

Echantillon	Sample Acid levels (Ia) (Mean \pm S.D)
Palm oil Freshly prepared	4 \pm 0,38
Palm oil First quality	5,823 \pm 1,40
Palm oil (2nd quality)	13,206 \pm 1,89
Palm oil (3rd quality)	14,435 \pm 1,92

It appears from this table that the average acidity index (Ia) of oil that we have prepared is 4 with a standard deviation of 0,38. For premium oils, the average is 5,823 and the standard deviation is 1.40. For the second quality, the average is 13,206 and a standard deviation of 1,89. For the third quality oil the average is 14,435 and a standard deviation of 1,92

DISCUSSION

Provitamin A content Tables I show that the fresh oil we prepared contains 9788 micrograms of beta-carotene per 100g, palm oil of the first quality 7616 μg showing a loss of 22,2% compared with freshly prepared oil, the second quality oil 4816 μg that is a loss of 50.8% and that of third quality 4592 μg of beta-carotene that is a loss of 53,1%. According to the National Program of Nutrition (PRONANUT) (12), red palm oil contains more than 13 000 μg of carotene in 100 g of oil. Its density varies from 0,889 to 0,900. The observed difference between our results and that of PRONANUT is due to the method of preparation and conservation but also to the method of analysis, because the results of PRONANUT give the value of all the carotenoids while ours concern only beta-carotene.

Red palm oil (unrefined and untreated) is considered to be the richest natural food in β -carotene: it contains about 15 times more than the carrot. It is also the second oil richest in vitamin E (tocopherol) after wheat germ oil. This level of vitamin

decreases very strongly after refining, heating and cooking (13). The loss rate of provitamin A increased dramatically with the way of preparation, preservation and manner of exposure during sale ($p < 0.05$). Indeed, exposure to the open air of this commodity exposes it to intense oxidation which dramatically lowers the beta-carotene content. The heating of this oil during the preparation of foods, suggests that the diet of a large part of the population of Kisangani would be deficient in this vitamin. Because several households buy second and third quality oil (which costs less than the first quality), which has already lost more than half of this micronutrient.

In 1998, the results of a survey carried out by the Ministry of Public Health showed that 61% of 6-36 months old children had hypovitaminosis A, however it is this oil that is most used in culinary preparation in many households. Deficiency of this vitamin decreases immunity, increases the risk of infectious diseases, and increases the mortality rate due to diarrhea, measles, malaria and pneumonia in young children by 23%. Faced with this situation, the DRC had decided to supplement all children under five with vitamin A (14). In the study by Arkadiusz Szterk (9) on the chemical stability of the lipid phase of concentrated emulsions of β -Carotenes it was shown that the oxidation rate of lipids in the emulsions was strongly dependent on the chemical composition of the lipid fraction (type of oil used). The presence of carotenoid increased the rate of oxidation.

The acid number

As far as it is concerned, it appears that the oil which we have prepared has on average an acid number of 4, the oil of first quality has an average of 5.823, that of 2nd quality an average of 13,206 and for the oil of 3rd quality the average of 14,435

A good quality oil must have zero or low acidity, an acid number of about 4 mg of potassium hydroxide / g (8) can not be tolerated. According to Alfred (15), the content of free fatty acids in palm oil should vary between 3 and 5%. The codex alimentarius says that a good quality oil must have a low or zero acidity (16). When an oil is not subjected to good preservation conditions, its quality can deteriorate in various ways, but most often by hydrolysis or by oxidation. In this case, it becomes unfit for consumption.

The peroxide value, which makes it possible to evaluate the degree of oxidation of the oil, and the acid number which measures the amount of free fatty acids resulting from the hydrolytic reactions of the triglycerides are two quality criteria making it possible to assess the state of preservation of an oil. Ndéya (8) found an acidity rate of 29.17, a result that is different from ours. However, for our study, no sample analyzed showed zero acidity, but the results obtained with the oil we prepared as well as that of first quality remain in accordance with the standards of the codex (Ia < 10). On the other hand, the second and third quality oils have a high acidity index with respect to the standards of the codex alimentarius. The strong acidity of this oil can be explained by a bad conservation, but also because the pulp of the fruit contains a very active lipase, which causes a rapid acidification of the oil during shelling (17). Palm oil, whether hydrogenated or not, is composed of too much saturated fatty acids (18). Associated with a high acid number, several studies have shown a significant relationship between increased palm oil

consumption and higher mortality rates related to cardiovascular accidents and ischemic heart disease as saturated fatty acids increase the rate of Bad blood cholesterol (18,19). In addition, excess intake of saturated fatty acids (AGS) is associated with an increased risk of obesity, cardiovascular disease and certain cancers as reported by numerous epidemiological studies (4). According to recommended nutrient intakes (ANC), consumption should be limited to approximately 8% of total energy intake (EAT), ie 19.5 g / d in man and 16 g / d in the woman, for an energy intake of 2,200 and 1800 kcal / d respectively. The foods in question are products of animal origin: meat, sausages, and dairy products (20).

CONCLUSION

This work, which focused on the nutritional qualities of palm oils sold at the central market in Kisangani, led to the conclusion that these oils lose their nutritional values according to the manner of preservation and the manner of exposure to light during the sale. The fresh oil we prepared as well as the high-quality oil showed higher values of beta-carotene and an acid number of less than 10 according to the standards of codex alimentarius. However, the second and third-grade oil showed low levels of beta- carotene and an acid number higher than 10, which does not comply with the standards of codex alimentarius.

We therefore recommend that the population of Kisangani no longer consume second and third quality oils. To the government of the DRC through its control office to take appropriate measures to limit the marketing of these oils; To the sellers of palm oils to preserve and expose this commodity under conditions which spare it from any alteration.

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