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Proximate Composition, Energy Content and Physicochemical Properties of Nigerian Edible Fats and Oils

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ABSTRACT: The proximate composition, energy content and physicochemical properties of four Nigerian edible fats and oils were investigated.

Proximate analyses of the samples showed the following composition: moisture 0.29-0.89%, dry matter 99.11-99.71%, ash 0.06-1.44%, crude protein 2.44-5.56%, crude fat 83.10-95.30%, and available carbohydrate 3.73-8.27%.

Apart from the crude fat, all other parameters under proximate composition varied significantly ($P \leq 0.05$) from one sample to another. No significant variation was observed in the dry matter and calorific value of the samples.

The physicochemical results showed a near neutral pH for all the samples. The pH values of the samples did not vary significantly ($P \leq 0.05$) from one another. Significant variations ($P \leq 0.05$) were observed on the melting points of the samples.

The mean colour of the samples varied significantly, except in the case of groundnut oil and palm oil. All the samples, with the exception of palm oil and blue band, had significantly, ($P \leq 0.05$) different mean odour values. The mean texture values of the samples were observed to the significantly ($P \leq 0.05$) different from one another. The free fatty acid, saponification and iodine values of the samples were found to be significantly ($P \leq 0.05$) different.

Key Words: Fats and Oils, Proximate composition, Energy content, Physicochemical properties.

Introduction

There is an abundance of edible fats and oils on the Nigerian market. Presently, Nigeria has imported large quantities of edible vegetable fats and oils to bridge the increasing gap between local production and growing demand for fats and oils.

The most commonly consumed fats and oils in Nigeria include groundnut oil, red palm oil, bleached palm oil, palm kernel oil, margarine, butter oil and the ordinary butter. Most of these are produced locally in Nigeria.

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Edible fats and oils are products of important groups of substances classified as lipids, which act as valuable foods because of their nutritional importance to both humans and animals (1).
They are classified into visible and invisible fats and oils, of which more than one half belong to the invisible category (2). Red palm oil, palm kernel oil, cotton seed oil, soyabean oil, coconut oil, groundnut oil, olive oil, maize oil, sunflower oil, sesame oil and others belong to the invisible category of oils. The visible category includes butter, margarine, lard, shortening and frying fats and oils. Edible fats and oils are concentrated energy sources, producing 37kJ/g compared to 16kJ/g for carbohydrate and 17kJ/g for protein. They also contribute to the palatability of foods as well as good sources of the fat-soluble vitamins, A, D, E and K.

Edible oils rich in polyunsaturated fatty acids (PUFA) have been found to result in a decrease in total cholesterol, triglycerides, low-density lipoprotein cholesterol as well as the very beneficial high density lipoprotein cholesterol (3,4,5).

The physiochemical properties of edible fats and oils are used for identification and to detect the presence of adulteration. The chemical properties really serve to differentiate fats and oils on the basis of the chemical composition of the various triglyceirdes present in the mixture. Typical physiochemical properties include colour, odour/smell, texture, melting point, boiling point, flash point, saponification number, iodine number, free fatty acid (FFA) level, saturated and unsaturated fatty acids, pH, moisture content, protein level, ash content, carbohydrate level, crude fat and calorific values. Others include the fat-soluble vitamins, (A,D, E and K) and the water-soluble vitamins, B and C, and the minerals.

The purpose of this research was to determine the proximate composition, physicochemical properties and the energy content of groundnut oil, red palm oil, blue band margarine and butter, which are major fats and oils consumed in various parts of Nigeria.

Materials and Methods

The samples were bought from the Slaughter Market, Trans-Amadi Industrial Layout, Port Harcourt, Nigeria.

Sample preparation

All the samples were used as purchased with the exception of red palm oil and groundnut oil, which were frozen for easy weighing and accurate quantitative measurements.

Sample Analyses

Proximate analyses were carried out on the samples using AOAC methods, (6). Protein was determined by the micro- Kjeldahl method 960.52 with the nitrogen factor being 6.25 for all samples; fat by method 920.39C, moisture by method 925.09, and ash by method 923.03. Available carbohydrate was determined by the anthrone method, (7). The dry matter content was calculated by difference using the formula: %Dry matter = 100-moisture content. The calorific (energy) content was calculated by multiplying the mean values of crude protein, fat and carbohydrate by Atwater factors of 4, 9 and 4 respectively, summing up the products and expressing the result in kilocalories per 100g sample as reported by Onyeike et al (8).

In physiochemical analyses, pH was measured with a pH meter (Kent EIL 7020), melting point by the AOAC method (9), while mean colour, mean odour/smell and mean texture (sensory evaluation) was determined based on a nine point hedonic scale (10). On this scale 9 was taken as the highest score and 1 the lowest in testing for colour, odour and texture of the edible fats and oils. The extent to which a sample was liked was expressed on a 9 point scale as shown: like extremely (9 points), like very much (8 points), like moderately (7 points), like slightly (6 points), neither like nor dislike (5 points), dislike slightly (4 points), dislike moderately (3 points), dislike very much (2 points) and dislike extremely (1 point). On this scale, like extremely to like slightly constituted good while dislike slightly to dislike extremely denoted poor. Also neither like nor dislike indicated that the product was neither good nor poor. A panel of one hundred randomly selected consumers in Choba community took part in this sensory evaluation. Four groups of judges were involved. Each group had its evaluation sessions alone and independent of the others. The evaluation exercise ran for four days in the biochemistry laboratory II, University of Port

Harcourt, Choba, Nigeria. The individual compartment in which each judge was seated was properly lighted and free from distractions. Each member of the panel evaluated the four samples which were presented in transparent sample bottle through a sliding door in the booth as reported by Nnam (11). The room temperature was constant throughout the testing sessions. The saponification and iodine numbers were determined using the respective methods recommended by AOCS (12). The free fatty acid contents of the samples were determined by the method of Devine and Williams (13).

Statistical Analysis

All results expressed as mean ± standard deviation of triplicate determinations. One way ANOVA was performed using the statistical analysis system (SAS), (14) procedure. Differences were deemed statistically significant at values of 0.05 or less.

Results

Table 1 results show the proximate compositions of groundnut oil, red palm oil, blue band margarine and butter. The moisture contents ranged from 0.29 to 0.89%. Blue-band margarine contained the highest amount of moisture, 0.89%, while groundnut oil had the least value of moisture, 0.29%. The moisture levels of red palm oil and butter were not significantly ($P \leq 0.05$) different from each other, while those of the others varied significantly from one another.

The moisture content of the groundnut oil was found to be significantly ($P \leq 0.05$) lower than those of red palm oil, butter and blue-band margarine. The moisture content in blue-band margarine was also found to be significantly ($P \leq 0.05$) higher than that of butter.

The mean dry matter contents of the samples ranged between 99.11% and 99.71% Blue-band margarine had the least dry matter level of 99.11%, while groundnut oil had the highest dry matter value of 99.71%. Palm oil and butter had similar values of dry matter, 99.23% and 99.24% respectively. These values were thus not significantly ($P \leq 0.05$) different from each other. The dry matter content of blue band margarine was found to be significantly lower ($P \leq 0.05$) than those of palm oil, butter and groundnut oil. Butter and palm oil were found to contain significantly ($P \leq 0.05$)higher levels of dry matter than blue band margarine. Groundnut oil and butter also had dry matter contents that varied significantly ($P \leq 0.05$) from one another.

The ash contents of the samples ranged from 0.06% to 1.44%. Blue band margarine had the highest value of 1.44% and palm oil the lowest values of 0.06%. The ash values varied significantly ($P \leq 0.05$) between all the samples, with the exception of those for palm oil and butter. The values of ash in these two samples did not vary significantly ($P \leq 0.05$) from each other.

The range of mean crude protein in the samples was 2.44% to 5.56%. The highest crude protein concentration was recorded in butter (5.56%). While groundnut oil had the least crude protein value of 2.44%.

The crude protein concentrations in blue band margarine and butter did not vary significantly ($P \leq 0.05$) from each other. However the crude protein concentration in butter and blue-band margarine were significantly ($P \leq 0.05$) higher than those in groundnut oil and palm oil. Palm oil was also found to contain a significantly ($P \leq 0.05$) higher concentration of crude protein than groundnut oil.

The samples had crude fat concentrations ranging from 83.10% to 95.30%. The highest concentration of crude fat was found in groundnut oil (95.30%), while the lowest value was recorded in butter (83.10%). The crude fat concentration in all the samples varied significantly ($P \leq 0.05$) from one another.

The available carbohydrate concentrations in the samples varied from 3.73% in groundnut oil to 8.27% in blue band margarine. All the concentrations of available carbohydrate obtained in this study varied significantly ($P \leq 0.05$) from one another, with the exception of values in the cases of goundnut oil and palm oil.

The calirif values of the samples ranged from 816.631kcal/100g sample in butter to 869.29kcal/100g sample in red palm oil. The calorific values of palm oil and groundnut oil were very similar, 869.29kcal/100g sample and 864.81kcal/100g sample, respectively. The calorific values of the sample did not vary significantly ($P \leq 0.05$) from one another.

Table 1: Proximate Composition (g/100 sample) and energy content (Kcal/100g sample) of four Nigerian edible fats and oils*.

Samples	Moisture	Dry matter	Ash	Crude protein	Crude fat	Available Carbohydrate as % glucose	Energy content
Groundnut oil	0.29±0.00^{c}	99.71±0.00^{c}	0.21±0.00^{c}	2.44±0.06^{c}	93.30±0.00^{c}	3.73±0.04^{c}	864.81±0.00^{a}
Red Palm oil	0.77±0.01^{b}	99.23±0.00^{a}	0.06±0.00^{b}	2.89±0.40^{b}	94.10±0.00^{a}	3.87±0.20^{c}	869.29±0.00^{a}
Blue band margarine	0.89±0.00^{a}	99.11±0.00^{a}	1.44±0.06^{a}	5.38±0.04^{a}	87.24±0.02^{c}	8.27±0.00^{b}	838.83±0.02^{a}
Butter	0.76±0.01^{b}	99.24±0.01^{a}	0.08±0.03^{b}	5.56±0.04^{a}	83.10±0.00^{d}	7.97±0.01^{a}	816.63±0.00^{a}

*Values are means of three independent determination ± standard deviation.
Means not followed by the same letters in the same column are significantly ($P \leq 0.05$) different from each other.

Table 2: Physicochemical Properties of Edible Fats and Oils*

Sample	pH	Physicochemical Properties						
		Melting point (°C)	Mean colour ++	Mean odour (smell) ++	Mean texture ++	FFA as % oleic acid)	Saponification No.	Iodine number
Groundnut oil	7.32±0.3[a]	10.10±0.40[d]	7.33±0.03[c]	6.67±0.41[b]	7.33±0.00[d]	1.22±0.02[b]	193.33±0.00[d]	90.33±0.10[a]
Red palm oil	7.35±0.07[a]	29.00±0.51[b]	7.33±0.02[c]	8.00±0.40[a]	8.00±0.00[b]	4.89±0.04[a]	198.97±0.10[c]	5200±0.21[b]
Blue band margarine	7.40±0.04[a]	25.50±0.30[c]	8.80±0.10[a]	8.00±0.42[a]	8.83±0.10[a]	0.69±0.03[c]	231.67±0.00[a]	18.33±0.00[d]
Butter	7.36±0.04[a]	31.00±0.40[a]	8.33±0.03[b]	5.50±0.41[c]	7.67±0.00[c]	0.27±0.02[d]	223.33±0.20[b]	41.67±0.23[c]

*Values are means of three indepententdetrmination ± standard deviation.
Means followed by the sameletters in the same column are significantly ($P \leq 0.05$) different from each other.
++ Scores are based on a 9-point hedonic scale where scores of

9	Like extremely	6 – Like slightly	3 – Dislike moderately
8	Like very much	5 – Neither like nor dislike	2 – Dislike very much
7	Like moderately	4 – Dislike slightly	1. – Dislike extremely

Table 2 shows the results of the physicochemical analyses of the samples. The pH values ranged from 7.32 to 7.40. Blue band margarine had the highest pH of 7.40, while groundnut oil had the least pH of 7.32. The range of the pH values was sop small that no two samples were significantly ($P \leq 0.05$) from each other.

The melting point values ranged from 10.10°C in groundnut oil to 31.00°C in butter. The melting point values of the samples varied significantly ($P \leq 0.05$) from one another.

The highest mean colour value of 8.80 was found in blue-band margarine, while groundnut oil and palm oil had the least mean colour value of 7.33. All the mean colour values obtained here were significantly ($P \leq 0.05$) different from one another, with the exception of values for groundnut oil and palm oil.

The mean odour values ranged from 5.50 in butter to 8.00 in both palm oil and blue band m,argarine. With the exception of the values for palm oil and blue band margarine, all the other values varied significantly ($P \leq 0.05$) from one another.

The mean texture values ranged from 7.33 in groundnut oil to 8.83 in blue band margarine. Values obtained differed significantly ($P \leq 0.05$) from one another.

The free fatty acid (FFA) contents of the samples ranged from 0.27% to 4.89%. The highest FFA content of 4.89% was found in palm oil, while the least value occurred in butter. Values varied significantly ($P \leq 0.05$) in the sample studied.

The highest saponification number of 231.67 occurred in the band margarine. Groundnut oil had the least saponification number of 193.33. All the saponification numbers obtained for the samples varied significantly ($P \leq 0.05$) from one another.

Blue band margarine had the least iodine number of 18.33, while groundnut oil had the highest value of 90.33%. Values of iodine number for all samples differed significantly ($P \leq 0.05$) from one another.

Discussion

As depicted by the results in Table 1, groundnut oil had the least moisture value showing that it will not support microbial growth and so will not deteriorate very easily. Thus groundnut oil will have a longer shelf life than the other samples. Recent report by Onyeike et al (8) has shown that high moisture level in a sample could lead to food spoilage by enhancing microbial action. However, all the samples were found to contain low moisture (less than 1% in all), meaning that they will all have prolonged shelf life.

A high ash concentration in sample signifies a high mineral content. The high ash level in blue band margarine (1.44%) relative to the other samples is indicative of a high mineral concentration. Thus by this result, it can be inferred that blue band margarine contains a higher mineral content compared to the other samples. This may have been due to some contamination from the metal can or a deliberate addition of some essential minerals in the manufacturing process. The slightly elevated level of ash in the groundnut oil sample may be due to contamination with metal contaminants from the metal cylinder in the pressing machine. However, the generally low ash level in all the samples studied is good as it marks quality and purity of the samples.

The observed relatively high levels of crude protein in both blue band margarine and butter may be due to deliberate fortification in the industry. No fortification with protein is done in the production of groundnut oil and red palm oil.

Higher available carbohydrate concentrations in blue band margarine and other samples may be due to industrial fortification to produce a balanced food. This is not the case for groundnut oil and palm oil production.

All the samples are found to contain high crude fat concentrations, making them the real fatty foods, which they are. A given amount of fat is known to possess more calorific/energy value than a corresponding amount of carbohydrate. Thus the very high crude fat contents of these samples really manifest in the high calorific values seen in Table 1.

The industrial fortification processes involved in the production of the blue band margarine and butter make them good food sources, while the natural fortifications in groundnut oil and palm oil also go to make them good food sources. Blue band margarine and butter are fortified with vitamins A and D, while palm oil and groundnut oil are natural sources of vitamins A and D.

The results in Table 2 show some physiochemical properties of the samples. The pH values for all samples show them to the about neutral.

The melting point of a material is a definite physical property of a pure solid and this is used as a criterion of purity and for the characterization and recognition of pure compounds. Melting point generally decreases with an increasing proportion of unsaturated fatty acid glycerides. From the results it can be deduced that groundnut oil has a higher percentage of unsaturated fatty acid glycerides than red palm oil, blue band margarine and butter. Butter with the highest melting point can be inferred to possess in very high proportion of saturated fatty acid glycerides. It may be noted that the degrees of unsaturation in groundnut oil and palm oil are natural compared to that in the blue band and butter. The slightly higher degree of unsaturation in the band compared to palm oil may be due to industrial fortification with some unsaturated fatty acid glycerides. At ambient temperature, groundnut oil and palm oil are liquids, while blue band margarine and butter are solids. However, blue band margarine is found to be softer in texture compared to butter, presupposing that blue band margarine has a higher degree of unsaturation than butter. This is precisely what the result in terms of the melting point depicts. It has also been posited that the lower the melting point of an oil/fat, the better it is for making oil creams (15). The low melting point of groundnut oil renders it very suitable for cold cream production. The high melting points of palm oil, blue band margarine and butter make them valuable confectionery fats/oils just like coconut oil (16).

In terms of the organoleptic properties, the colours of groundnut oil and palm oil were liked moderately, while the colours of blue band margarine and butter were liked very much. The much appreciated colours of both blue band margarine and butter may have a deliberate industrial strategy to attract customers and consumers to these products.

The odour/smell of groundnut oil was liked slightly, while that of butter was neither liked nor disliked. Palm oil and blue band margarine, however, had odour/smell that was liked very much.

The textures of groundnut oil and butter were liked moderately, while those of palm oil and blue band margarine were liked very much. It is pertinent to point out here that palm oil and blue band margarine are quite popular among consumers in Nigeria.

The very low free fatty acid (FFA) concentrations in the samples render them suitable for soap production. This also confirms the fats/oils as suitable for edible purposes. The maximum permissible limit for FFA in high grave palm oil in Nigeria is 5%, (17). The palm oil used in this experiment contains an acceptable value of FFA, and is thus a high grade palm oil. A high level of FFA in an oil/fats sample depicts lipolysis arising from microbial activities promoted by high moisture concentration. Thus the very low concentration of FFA in all the samples studied show that they have not undergone any form of disintegration or deterioration.

The saponification values obtained in this research for all the samples indicate the possibility of using them for soap and lather shaving creams manufacture (18,19). Groundnut oil, palm oil and butter fat are commonly used in soap manufacture. Saponification value is inversely proportional to the weight of the fatty acid present in the oil. Thus it can be deduced from the result in Table 2 that groundnut oil and palm oil contain glycerides with high molecular weight fatty acids than blue band margarine and butter (19,20).

The mean iodine value obtained in this experiment for palm oil is same as that obtained by Eka in 1989 (19). From the result obtained, it can be postulated that groundnut oil has the highest degree of unsaturation, followed by palm oil, then butter and blue band margarine.

Based on the result for iodine value, it may be stated that blue band margarine has the highest concentration of saturated fatty acids. This may be confirmed by the hydrogenation process involved in the manufacture of margarine. This process leads to the saturation of the polyunsaturated fatty acids that may have been originally present in the raw materials used.

In conclusion, the results of the present study demonstrated the high nutrition value of four edible fats and oils consumed in most Nigerian homes. The high calorific values and a near balanced proximate composition together with some very useful physicochemical properties of the samples were also unfolded.

Based on the results obtained, these fats and oils should be recommended for edible purpose, especially palm oil and groundnut oil which contained higher degrees of unsaturation.

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