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Comparative Evaluation of the Mineral Content of Cakes Produced using different Oil Sources for Socio-Economic Transformation

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ABSTRACT

Cake is a bakery product that is mostly consumed by people globally. Cakes are convenient food products and are usually sweet and often baked using flour, sugar, shortening (butter), baking powder, egg, and essence as principal ingredients. This study was aimed at comparing the mineral content of cakes produced by replacing butter with different oil sources for socioeconomic transformation in Nigeria. The result of this study showed that the calcium content of the cake ranged from 15.77 to 37.92mg/100g with soybean oil and simas butter having the highest and lowest values respectively. The magnesium content ranged from 35.63 to 67.90mg/100g with coconut oil and palm olein oil having the highest and the lowest values respectively. The potassium content ranged from 119.61 to 193.50 with coconut oil and palm kernel oil having the highest and the lowest values respectively. While the phosphorus content ranged from 117.97 to 147.60 with soybean oil and palm kernel oil having the highest and the lowest values respectively. All samples analyzed were significantly different ($p<0.05$). The result of this work establishes that soybean oil, coconut oil and palm olein oil can be used as excellent replacer of butter in cake production and should be adopted for large scale production.

Keywords: cake, coconut oil, palm olein oil, palm kernel oil, soybean oil

1. INTRODUCTION

Cakes are convenient food products which are sweet and often baked, usually prepared from wheat flour, sugar, shortening, baking powder and egg as principal ingredients [1]. Consumption of various bakery and confectionary products is the demand of time due to change in food habit of the people. Fat replacement in food systems poses a complex problem because fat contributes to sensory and physiological characteristics such as flavor, mouth feel, taste, odor and texture [2]. While public demand for better-tasting reduced-fat food products remains high, recent research has focused on utilization of fat replacers to make these low-fat foods more acceptable. Commercial fat replacers like polydextrose [3][4] Oatrim and Z-trim [5][6][7], Trim Choice-5 [8], as well as natural fat replacers like okra

gum [9], apple sauce, prune paste, pureed white beans [10], mung bean paste [11] and pawpaw puree [12] have all been used with some degree of success in baked products.

1.1. Palm Olein

Palm olein is the liquid fraction obtained during fractionation of palm oil. This involves crystallization under controlled temperature and removal of crystals by filtration. Palm olein contains higher amounts of oleic acid (39–45%) and linoleic acid (10–13%) compared to palm oil [13]. It has a melting point of 18–20°C and therefore is a liquid at room temperature (25°C) [13]. There are different grades of palm olein based on the iodine value with potential for specific end-use applications. A more unsaturated fraction called super olein is obtained by further fractionation of olein. It contains 43–49% oleic and 10–15% linoleic acids [14]. Super olein has an iodine value of 60 or above. Therefore, super olein has better clarity, stability, and lower tendency to turn cloudy compared to normal olein [14]. The clarity of palm olein is significantly affected by its diacylglycerol (DAG) content, which has a preference to separate into the olein phase during fractionation [13].

1.2. Coconut Oil

Coconut oil is edible oil derived from the wick, meat, and milk of the coconut palm fruit [15]. Coconut oil is a white solid fat; in warmer climates during the summer months, it is clear thin liquid oil, melting at warmer room temperatures of around 25 °C (78 °F). Coconut oil is 99% fat, composed mainly of saturated fats (82% of total). In a 100 gram reference amount, coconut oil supplies 890 calories. Coconut oil is composed of the fatty acids, caprylic acid C -8:0 (8%), capric acid, C-10:0,(7%), lauric acid C-12:0, (49%), myristic acid C-14:0(8%), palmitic acid C-16:0 (8%), stearic acid C-18:0 (2%), oleic acid C-18:1 (6%) and 2% of C-18:2 linoleic acid.

Half of the saturated fat content of coconut oil is lauric acid (41.8 grams per 100 grams of total composition), while other significant saturated fats are myristic acid (16.7 g), palmitic acid (8.6 g), and caprylic acid (6.8 g) [16]. Monounsaturated fats are 6% of total composition, and polyunsaturated fats are 2%. Coconut oil contains phytosterols, whereas there are no micronutrients in significant content.

As an oil relatively recently introduced to Western countries, coconut oil is commonly used in baked goods, pastries, and sautés, having a nut-like quality with some sweetness [17] It is sometimes used by movie theatre chains to pop popcorn.

Other culinary uses include replacing solid fats produced through hydrogenation in baked and confectionery goods [18].

DebMandal and Mandal [19] reported that coconut oil is rich in medium chain saturated fatty acids (lauric acid) which allows them to be directly absorbed from the intestine and sent straight to the liver to be rapidly used for energy production.

1.3. Soybean oil

Soybean oil is a kind of cooking oil derived from soybean seeds and has been described as one of the most widely and commonly consumed vegetable oils. Its fatty acid composition is its selling point as it contains a high proportion of unsaturated fatty acids, comprising of alpha-linolenic acid, C-18:3 (7–10%), linoleic acid, C-18:2 (51%) and oleic acid, C-18:1 (23%) [20]. It also includes the following saturated fats: 4% stearic acid (C-18:0) and 10% palmitic acid (C-16:0). Although the high level of linolenic acid, a polyunsaturated fatty acid (PUFA), in soybean oil is

desirable, it is highly prone to oxidation and therefore unpleasant for some uses such as cooking and frying at high temperatures.

1.4. Palm Kernel Oil

Palm kernel oil is an edible plant oil derived from the kernel of the oil palm tree (Elaeis guineensis) [21]. Palm kernel oil, which is semi-solid at room temperature, is more saturated than palm oil and comparable to coconut oil [22]. Palm kernel oil is high in lauric acid, which has been shown to raise blood cholesterol levels, both as LDL-C (cholesterol contained in low-density lipoprotein) and HDL-C (cholesterol contained in high-density lipoprotein) [23]. However, the raise in total cholesterol concentration is partly due to more HDL-C than LDL-C [24] Palm kernel oil does not contain cholesterol or trans fatty acids.

Palm kernel oil is commonly used in commercial cooking because it is lower in cost than other oils and remains stable at high cooking temperatures. The oil can also be stored longer than other vegetable oils [25]. Palm kernel oil contains primarily trigylcerides with short chain fatty acids. Nearly 64% consist of lauric (C12) and myristic (C14) acids. The melting profile of palm kernel oil is very steep and sharply melting. As such, foods containing palm kernel oil give a pleasant cooling sensation on the tongue. Biscuits with cream fillings, whipped cream, and some confections benefit from this effect. PKO also has the unique property of forming eutectic mixtures with palm oil in margarine formulations. Palm kernel oil is used as a replacement for butterfat [26].

2. METHOD AND MATERIALS

2.1. Source of Raw Materials

The study was conducted in the laboratories of the Department of Food Technology, Federal Polytechnic Oko, Anambra State, Nigeria. Wheat Flour (Golden Penny, Nigeria Flour Mills Plc), soybean oil, coconut oil, palm olein (kings oil), palm kernel oil and other cake ingredients such as eggs, vanilla flavour and baking powder were purchased from Eke Ekwulobia market in Orumba North Local Government Area of Anambra State, Nigeria.

2.2. Production of Cake

The method described by Ceserani and Kinton [27] was adopted for the cake production with slight modification. Cakes were prepared by mixing the following ingredients 250 g of flour, 250ml of each of the oil sample, sugar (100g), baking powder (5mls), eggs (200g), and vanilla flavor (5ml). The granulated sugar was creamed with each of the oil sample for 30 min and egg albumin was added. The other ingredients

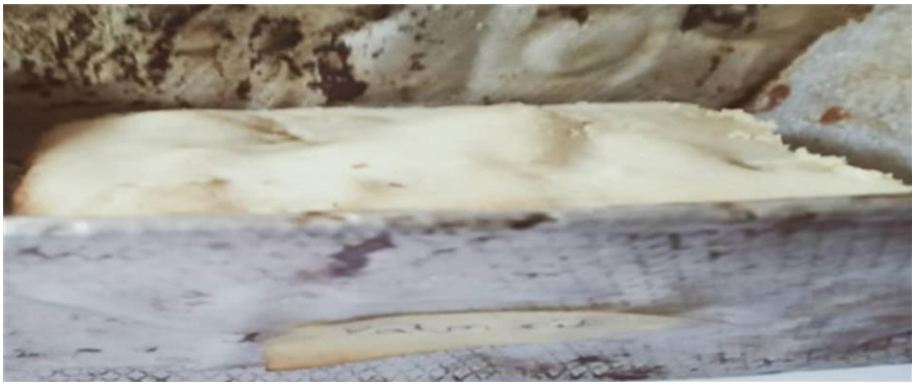

Fig 1. Result Karatedo Coaching Behaviors in Terms of Practical

Fig 2. Cake made with butter (Control)

Fig 3. Cake made with palm kernel oil

were added and mixed. Each of the batter was poured into an 8 inch baking pan and baked at 150^{o}C for 45 min.

2.3. Mineral Evaluation: Procedure for Mineral Element Analysis (AOAC 2010) [28]

2.3.1. Digestion of sample

The mineral contents of the test samples were determined by the dry ash extraction method following each specific mineral element as described by AOAC (2005) [29]. Twenty (20) grams of the samples were digested with 8ml mixture of HNO_3 and $HCLO_4$ in the volume 4:1 at room temperature overnight and then heated at 130^{0}C for 1 hour till a clear solution was obtained (about 2ml). The solution was subsequently transferred to 25ml volumetric flask with distilled water after cooling down. Then, the minerals were checked using AOAC standard [29]. The mineral elements like potassium, and phosphorus were determined using atomic absorption spectrophotometer.

2.3.2. Calcium Determination

Calcium contents of the test samples were determined by the EDTA complex isometric titration. Twenty (20) ml of each extract was dispersed into a conical flask and panels of the masking agents, hydroxytannin, hydrochlorate, and potassium cyanide were added followed by 20ml of ammonia buffer (pH 10.0). A pinch of the indicator-Ferrochrome black was added and the mixture was shaken very well. It was then titrated against 0.02N EDTA solution. A permanent blue colour was observed and the reading taken. The calcium contents was calculated using the formulae below.

$$\text{Calcium (mg/100g)} = \frac{Tv \times 0.4008 \times 1000}{Volume\ of\ sample}$$

Fig 4. Cake made with coconut oil

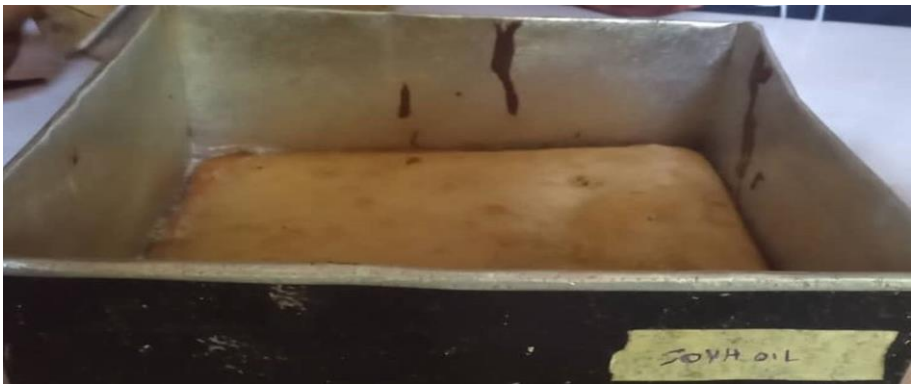

Fig 5. Cake made with soybean oil

2.3.3. Determination of Magnesium

Exactly 10ml of the sample filtrate was pipetted into 250ml conical flask after which 25ml of ammonia buffer solution was added into the conical flask and the mixture was properly mixed. Then a pinch of Erichrome black T indicator was added and titrated with 0.02N of EDTA until the colour of the solution changed from wine-red to blue colour.

$$\text{Magnessium (mg/100g)} = \frac{Tv \times 0.2432 \times 1000}{Volume\ of\ sample\ used}$$

2.3.4. Potassium Determination

The concentration of potassium (ppm) was analysed using UV-spectrophotometer at a wavelength of 766.5nm, and the concentration in mg/100g was calculated thus:

$$\text{Potassium (mg/100g)} = \frac{Concentration(ppm) \times Dilution factor \times 1000}{Volume\ of\ sample\ used}$$

3. RESULT AND DISCUSSION

The calcium content of the cake samples ranged from 15.77-37.92 mg/100g with CON having the least value and SBO having the highest value. The calcium content in some of the cake samples were lower than the one recorded by Akubor and Ishiwu [30] for plain cake who reported 29.0mg/100g with the exception of soybean oil cake. The high calcium content in cake produced using soybean oil can be attributed to high amount of calcium in soybean oil. Calcium functions as a constituent of bones and teeth, regulation of nerve and muscle function. In blood coagulation, calcium activates the conversion of prothrombin to thrombin and also takes part in milk clotting. It plays a vital role in enzyme activation. Calcium activates large number of enzymes such as adenosine triphosphatase (ATPase), succinic

Table 1. Result of the Mineral Evaluation of cakes produced using different oil samples

Samples	Calcium	Magnesium	Potassium	Phosphorus
CON	15.77^{e}±0.01	37.05^{d}±0.05	128.80^{d}±0.00	119.60^{d}±0.20
COC	25.75^{b}±0.02	67.90^{a}±0.00	193.50^{a}±0.01	124.60^{c}±0.01
UPO	19.84^{c}±0.05	43.53^{c}±0.03	119.61^{e}±0.02	117.97^{e}±0.01
RPO	15.85^{d}±0.05	35.63^{e}±0.01	145.50^{c}±0.10	127.00^{b}±0.00
SBO	37.92^{a}±0.03	54.84^{b}±0.04	190.00^{b}±0.00	147.60^{a}±0.10

COC= cake produced from coconut oil
UPO= cake produced from palm kernel oil
RPO= Cake produced from palm olein
SBO= cake produced from soybean oil

dehydrogenase, lipase etc. It is also required for membrane permeability, involved in muscle contraction, normal transmission of nerve impulses and in neuromuscular excitability. A reduced extracellular blood calcium increases the irritability of nerve tissue, and very low levels may cause spontaneous discharges of nerve impulses leading to tetany and convulsions [31].

The magnesium content of the cake ranged from 35.63-67.90mg/100g with RPO and COC cake having the least and the highest values respectively. The values obtained were lower than that mentioned by Akubor and Ishiwu [30] (140mg/100g) in plain cake made with butter.

Magnesium is an active component of several enzyme systems in which thymine pyrophosphate is a cofactor. Oxidative phosphorylation is greatly reduced in the absence of magnesium. Magnesium is also an essential activator for the phosphate-transferring enzymes myokinase, diphophopyridinenucleotide kinase, and creatine kinase. It also activates pyruvic acid carboxylase, pyruvic acid oxidase, and the condensing enzyme for the reactions in the citric acid cycle. It is also a constituent of bones, teeth, enzyme cofactor, (kinases, etc.) [32]. The health status of the digestive system and the kidneys significantly influence magnesium status. Magnesium is absorbed in the intestines and then transported through the blood to cells and tissues.

The values obtained for the potassium content ranged from 119.60-193.50mg/100g with UPO and COC having the least and the highest values respectively. This result was lower than that obtained by Akubor and Ishiwu [30] who reported a potassium content of 315mg/100g. This result suggests that coconut oil is richer in potassium than other oils analyzed. Potassium is the principal cation in intracellular fluid and functions in acid-base balance, regulation of osmotic pressure, conduction of nerve impulse, muscle contraction particularly the cardiac muscle, cell membrane function and Na^{+} /K^{+}-ATPase. Potassium is also required during glycogenesis. It also helps in the transfer of phosphate from ATP to pyruvic acid and probably has a role in many other basic cellular enzymatic reactions. Its metabolism is regulated by aldosterone. Hyperkalaemia is increased level in serum potassium and this occurs in Addisons disease, advanced chronic renal failure, shock and dehydration [32].

The phosphorus content of the cake samples ranged from 117.97-147.60mg/100g with UPO and SBO having the least and highest values respectively. These values

are lower than that obtained by Akubor and Ishiwu [30]. Phosphorus is a component of nucleic acids, phospholipids, adenosine triphosphate (ATP), several coenzymes. Phosphorus is located in every cell of the body and is vitally concerned with many metabolic processes, including those involving the buffers in body fluids [31]. It serves as buffering action, that is, phosphate buffers, functions in the formation of high energy compounds, that is, adenosine triphosphate (ATP) and is involved in the synthesis of phospholipids and phosphoproteins. Practically, every form of energy exchange inside living cells involve the forming or breaking of high-energy bonds that link oxides of phosphorus to carbon or to carbon-nitrogen compounds [32].

4. CONCLUSION

Cakes produced with the different oil analyzed produced a consumer acceptable cake with high nutritive quality. Snacks based on the use of these oil sources either singly or in combination with margarine would provide a healthy snack as well as reduce total dependence on margarine for baking. It is however, recommendable for use in bakery industries.

5. ACKNOWLEDGEMENT

NA

6. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

7. SOURCE/S OF FUNDING

NA

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