

Influence of Margarine and/or Coconut Oil on Quality of Bread Prepared from Wheat Flour

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ABSTRACT

Unrefined coconut oil was obtained from mature kernel of coconut by cold press method. The oil was substituted for margarine at 0, 25, 50, 75 and 100% levels (w/w) in bread production. The effects of added unrefined coconut oil on chemical, physical and sensorial qualities of bread were evaluated. The bread samples had moisture (28.15- 28.80%), protein (9.0-9.2%), ash (1.13-1.27%), fiber (1.29-1.45%), fat (3.6-4.6%), carbohydrate (55.6-56.9%) and energy (295.3-300.3 kcal/g). The mineral elements were in a range of calcium (52.22-63.21 mg/kg), magnesium (311.91-347.99 mg/kg), potassium (1149.50-1630.20 mg/kg), sodium (2363.6-2453.6mg/kg) and iron (68.12-82.45 mg/kg). Physical properties showed increased loaf weight but less loaf volume and specific volume with increased unrefined coconut oil replacement. There was significant difference between the bread samples in terms of crust colour and crumb appearance. Bread samples with inclusion levels up to 75% (w/w) unrefined coconut oil were acceptable to the consumer sensory panel. However, there is tendency for some consumers to prefer lower levels of inclusion; it is pragmatic therefore to recommend inclusion of 25-75% unrefined coconut oil to replace margarine in commercial bread.

Keywords: Unrefined coconut oil, Margarine, Functional bread, Chemical composition, Sensory attributes

INTRODUCTION

Coconut (*Cocos nucifera* Linn.) belongs to the family Arecaceae. The palm is grown about 90 countries around the globe with a total production of 62 million tonnes annually [1]. It is not indigenous to Nigeria but had acquired agro-climatic adaptation due to long period of cultivation and this may be attributed to its low genetic base in the country [2]. The cultivation of coconut is in scattered holdings and mostly in groves in the rain forest zones of Nigeria. The area under cultivation was estimated at about 36,000 ha found mostly in Lagos and Rivers states [3]. Every part of coconut is used by man, hence, it is known as 'Tree of Life'. One of the primary natural products produced from the dry fruit (copra) of coconut is coconut oil which has been used from time immemorial as food ingredient.

Coconut oil is commonly used in cooking, especially for frying. It is a colourless to pale brownish yellow oil with a melting point ranging from 23°C to 26°C [4]. It possesses a unique liquefying property that contributes to mouth-feel of the food of which it is component. The oil has highest content of glycerol (13.5% to 15.0%) but contains lowest amount of cholesterol (5-24 parts per million) compared to palm kernel oil, sunflower oil, palm oil, soy oil, cottonseed oil, rapeseed oil and corn oil [5]. It is also rich in saturated fatty acids found mostly in tropical oils. The use of coconut oil for baking was advertised in the United States at the end of 19th century [6]. The oil could be used in two main ways for baking: as a natural non-sticking agent, and as a baking fat. The innovation was quite a relief to the people who have allergies to dairy products such as butter for baking. Though margarine and other vegetable shortenings are available to use as a substitute, but there may be formation of trans fat in such hydrogenated products which are strongly associated with an increased risk of heart disease [7].

Coconut oil in its unrefined form could displace the use of hydrogenated and processed vegetable oils in baking. The

oil is obtained from the fresh, mature kernel of the coconut by mechanical or natural means, with or without the use of heat, without undergoing chemical refining, bleaching or deodorizing and which does not lead to alteration of the nature of the oil [8]. It is however imperative to note that previous researches confirmed that high saturated fats cause hypercholesterolemia and coronary heart disease, hence, coconut oil being rich in saturated fatty acids was once believed to be cholesterogenic [9]. However, animal studies that showed these harmful effects were flawed because of their use of hydrogenated coconut oil as reported by Cecille dela Paz et al. [9]. Hydrogenation of coconut oil saturates the small amount of the essential fatty acid linoleic acid that makes hydrogenated coconut oil cholesterogenic [10].

Over the years, numerous studies clearly demonstrated that unrefined coconut oil has a neutral effect on cholesterol levels [11-13]. Coconut oil provides a source of antimicrobial lipid for individuals with compromised immune systems and is a non-promoting fat with respect to chemical carcinogenesis [6]. The oil has also gained popularity as a nutraceutical, hence promoted as a dietary supplement designed to optimize health through improved nutrition as reported by Cecille dela Paz et al. [9]. In addition to the potential health benefits, absorption of calcium and magnesium and also amino acids has been found to increase when infants are fed with diet containing unrefined coconut oil [14]. These health promoting attributes should be of great interest to producing countries for dietary intervention especially for the health minded consumer of today.

It is expected that the use of unrefined coconut oil in bread production will reveal or open up a new research besides what it has already been known. Therefore, the objectives of this study were to formulate and develop functional breads by substitution of margarine with unrefined coconut oil, and to evaluate the products' baking properties, nutritional and sensorial characteristics.

MATERIALS

Raw materials

Unrefined coconut oil was obtained from fresh mature kernel of coconut by cold press method as indicated in Figure 1. Other ingredients such as hard wheat flour, sugar, margarine (Pratima TBK foods, Indonesia), yeast (STK, Germany) and salt were purchased from a local market in Osun state, Nigeria.

Preparation of bread with different levels of coconut oil inclusion

Margarine was substituted with unrefined coconut oil at 0, 25, 50, 75 and 100%. Bread samples were produced using the recipe on Table 1. The ingredients were mixed for 5 min in a mixer (Kitchen Aid-KSM 900, USA). This was followed by a rest period of about 15 min in order to relieve residual stress that occurred during mixing. The dough was divided into portions using a Parry dough divider. The dough was proofed in pre-oiled baking pans

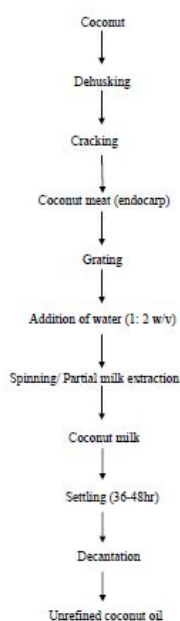


Figure 1: Process flow for the production of unrefined coconut oil

Table 1. Recipe for bread (EDC - Dough developer)

Ingredients	A	B	C	D	E
Wheat flour (g)	250	250	250	250	250
Water (ml)	140	140	140	140	140
Sugar (g)	30	30	30	30	30
Yeast (g)	1.5	1.5	1.5	1.5	1.5
Salt (g)	3	3	3	3	3
Margarine (g)	10	7.5	5	2.5	-
Unrefined coconut oil (g)	-	2.5	5	7.5	10
Improver (g)	0.5	0.5	0.5	0.5	0.5
Preservative(g)	1.0	1.0	1.0	1.0	1.0
EDC (g)	0.5	0.5	0.5	0.5	0.5

(dimensions=length 13.5 cm, width 7 cm and height 7 cm) for 45 min at 35°C and RH, 85% and then introduced into the oven after it had attained and maintained baking temperature (about 265°C) for 45 min according to the method described by Oladunmoye et al. [15]. The loaves were allowed to cool after baking, placed in zip-lock bags and stored at a temperature of -18°C for subsequent analysis.

METHODS

Chemical composition

The proximate composition (moisture, protein, fat, ash and fibre) of bread samples were determined using standard procedures [16]. Carbohydrate content was determined by difference. Energy content was calculated by multiplying protein, fat and carbohydrate contents by factors of 4, 9 and 4, respectively. For each type of bread, two loaves frozen in home freezer were thawed out in pre-heated oven at 175°C for 40 min. The bread loaves were ground into a coarse powder (60 mesh size) before analysis. All analyses were carried out in triplicate.

Analysis of potassium content of the samples was carried out using flame photometry. The other elemental contents (Ca, Mg, Fe and Na) were determined, after wet digestion of sample ash with an Atomic Absorption Spectrophotometer (AAS, Hitachi Z6100, Tokyo, Japan). All the determinations were carried out in triplicates.

Physical characteristics

Physical characteristics of bread samples such as oven spring, loaf weight, loaf volume, specific loaf volume and colour were evaluated.

Oven spring: Oven spring was estimated from the difference in height of dough before and after baking.

Loaf weight: Loaf weight was measured 30 min after the loaves were removed from the oven using a laboratory scale (CE- 410I, Camry Emperors, China) and the readings recorded in grams (g).

Loaf volume: Loaf volume was determined by rapeseed displacement method [17].

Specific volume: The specific loaf volume was determined by dividing the loaf volume by its corresponding loaf weight (cm³/g).

Colour measurement

Crust and crumb colour were measured using Konica Minolta Spectrophotometer CR-410 (Japan). Samples were cut into cubes of 2 × 2 × 2 cm and placed in the colorimeter. L* defines lightness, a* denotes the red/green value and b* the yellow/blue value. The L* axis has the following boundaries: L=100 (white or total reflection) and L=0 (black or total absorption). Along the a* axis, a colour measurement movement in the -a direction depicts a shift toward green; +a movement depicts a shift toward red. Along the b* axis, -b movement represents a shift towards blue; +b shows a shift towards yellow. Three measurements were taken from each sample.

Sensory evaluation

Loaves of bread produced from various treatments were subjected to sensory evaluation. The 25-member panel comprised a broad cross section of adult population (students and staff) of the Bowen University, with panelists spread across a wide range of age, education and income groups. Loaves of bread were prepared a day ahead of sensory evaluation and stored at room temperature. The bread samples were presented in random order and panelists were asked to evaluate each loaf for colour, aroma, taste, texture, sweetness and overall acceptability. Sensory property

was evaluated using standard evaluation score card (9 hedonic scales) where 1=dislike extremely to 9=like extremely.

Statistical analysis

All data were subjected to Analysis of Variance (ANOVA) with the SPSS version 15.00 Software. The means of the results were compared using Turkey's test and the statistical significance was defined as $P \leq 0.05$.

RESULTS AND DISCUSSION

Chemical composition

The proximate composition of bread samples are as given in Table 2. The moisture content ranged from 28.15 to 28.80%. The slight variations in the moisture content of sample A (control) and other samples could have resulted from the use of unrefined coconut oil with lower moisture than margarine. Margarine is essentially an emulsion of edible oils and fats with water. However, high moisture content has been associated with short shelf life of bread as it encourages microbial proliferation [18]. The protein content of sample E (8.98%) was significantly different from other samples. The difference could have arisen from the processing conditions as reported by Oomah and Mazza [19]. The fat content of the bread samples ranged from 3.6 to 4.6%. The fat content increased with increased coconut oil substitution. This could be explained by the fact that coconut oil consist basically oil while margarine consist a minimum 80% fat substance, the rest consisting of liquid phase that includes emulsifiers, antioxidants, artificial flavor, etc. Most importantly unrefined coconut oil is characterized by particular type of saturated fats called "medium chain triglycerides" (MCTs), which are easily digested and readily burned for energy but without the spike in blood sugar, hence those people with diabetes would greatly benefit by adding coconut oil to daily diet [20]. Another bonus of MCFAs in unrefined coconut oil is the effect on metabolism, specifically their ability to promote weight loss as they do not circulate in blood stream like other fats. They are absorbed readily and carried to the liver where they undergo rapid oxidation to release energy. Consequently, they are deposited less into adipose tissue and do not cause obesity as reported by Cecille dela Paz et al. [9].

The total dietary fiber of the bread samples ranged from 1.29 to 1.45%. Consumption of food containing fiber is considered beneficial to human due to its ability to reduce the risk of certain medical conditions like obesity, type 2 diabetics and cardiovascular related diseases. However, it is imperative to note that very high intakes of fiber (i.e., above 50 to 60 g/day) can result in hard, dry stools that are painful to eliminate [21]. The ash content of the bread samples showed an increase in the range of 1.13 to 1.27% as margarine was substituted with unrefined coconut oil. This could be attributed to the appreciable mineral concentration in unrefined coconut oil. The carbohydrate content of the bread samples ranged between 55.63 to 56.86% indicating that the substitution with unrefined coconut oil has no major effect on the carbohydrate content of the resulting products. The bread samples contained energy values in the range of 293.74 to 300.18 kcal/g. It was observed that samples containing unrefined coconut oil had significantly higher energy values.

The mineral composition of the bread samples is as given in Table 3. The profile showed a range; calcium (52.22-63.21

Table 2. Proximate composition of bread samples (%). A: Bread made with 100% margarine; B: Bread made with 75% margarine and 25% coconut oil; C: Bread made with 50% margarine and 50% coconut oil; D: Bread made with 25% margarine and 75% coconut oil; E: Bread made with 100% coconut oil). Data are mean values of triplicate determination \pm standard deviation. Values in the same row with different superscript are significantly different ($p \leq 0.05$)

Sample	Moisture	Protein	Fat	Fiber	Ash	Carbohydrate	Energy Kcal/g
A	28.80 \pm 0.17 ^d	9.19 \pm 0.04 ^b	3.62 \pm 0.03 ^a	1.41 \pm 0.01 ^c	1.13 \pm 0.04 ^a	55.85 \pm 0.23 ^b	293.74 ^a
B	28.42 \pm 0.03 ^{bc}	9.21 \pm 0.02 ^b	3.89 \pm 0.04 ^b	1.45 \pm 0.01 ^c	1.17 \pm 0.01 ^b	55.86 \pm 0.03 ^b	295.29 ^b
C	28.28 \pm 0.05 ^b	9.18 \pm 0.03 ^b	4.18 \pm 0.05 ^c	1.33 \pm 0.02 ^b	1.19 \pm 0.01 ^c	55.84 \pm 0.26 ^b	297.70 ^c
D	28.20 \pm 0.26 ^a	9.23 \pm 0.03 ^b	4.38 \pm 0.03 ^d	1.29 \pm 0.01 ^a	1.27 \pm 0.03 ^d	55.63 \pm 0.12 ^a	298.86 ^d
E	28.15 \pm 0.13 ^a	8.98 \pm 0.12 ^a	4.62 \pm 0.06 ^e	1.42 \pm 0.03 ^c	1.16 \pm 0.01 ^{ab}	55.67 \pm 0.65 ^a	300.18 ^e

Table 3. Mineral composition of bread samples (mg/kg). Data are mean values of triplicate determination \pm standard deviation. Values in the same row with different superscript are significantly different ($p \leq 0.05$)

Sample	Calcium	Magnesium	Potassium	Sodium	Iron
A	52.22 \pm 0.09 ^a	347.99 \pm 0.03 ^e	1149.50 \pm 0.46 ^a	2363.60 \pm 0.08 ^b	82.45 \pm 0.05 ^d
B	57.95 \pm 0.05 ^b	321.15 \pm 0.30 ^b	1269.80 \pm 0.21 ^b	2410.70 \pm 0.05 ^a	82.39 \pm 0.03 ^d
C	59.98 \pm 0.03 ^c	322.72 \pm 0.17 ^d	1323.82 \pm 0.05 ^c	2424.61 \pm 0.07 ^b	68.12 \pm 0.04 ^a
D	62.23 \pm 0.08 ^d	311.91 \pm 0.42 ^a	1546.50 \pm 0.14 ^d	2440.03 \pm 0.05 ^c	70.56 \pm 0.04 ^b
E	63.21 \pm 0.03 ^e	321.49 \pm 0.09 ^c	1630.20 \pm 0.05 ^e	2453.60 \pm 0.06 ^d	70.95 \pm 0.03 ^c

mg/kg), magnesium (311.91-347.99 mg/kg), potassium (1149.50-1630.20 mg/kg) and sodium (2410.75-2453.60 mg/kg). Basically, coconut oil substituted bread samples had significantly higher concentrations of mineral elements. Coconut oil has been reported to contain an appreciable amount of mineral elements [22].

Physical characteristics

Physical characteristics of bread samples with different inclusion levels of unrefined coconut oil are presented in Table 4 and Figures 2 and 3. There was no significant difference in the oven spring of the control and coconut oil substituted samples (Table 4). The loaf weight of cooled bread samples ranged from 230.06 to 238.21g. The observed increase in loaf weight as the level of coconut oil substitution increases is desirable quality attribute as consumers are often attracted to bread with high weight with a notion that it has more substance for the same price [23]. The loaf volume of bread samples ranged from 600.75 to 613.03 cm³. It was observed that the loaf volume decreases as level of substitution with coconut oil increases. Similarly, the specific volume of the bread samples decreased significantly with increase in the percentage of coconut oil substituted in the products.

The measured colour attributes of bread samples are given in Table 5. The lightness (L*), redness (a*) and yellowness (b*) values of crumb colour of bread samples showed a range of 65.23 to 62.75, 2.35 to 2.12 and 17.93 to 17.03, respectively. Sample B had the highest L* value but was not significantly different from sample A. Sample C, D and E had lower values indicating that they were darker than samples A and B. It implies that the substitution with unrefined coconut oil above 25% leads to a darker crumb colour. In terms of a* value, there was no significant difference between samples A, B, C and E while sample D had the lower value. Sample B had the highest b* value though not significantly different from sample A, while lowest value was observed in sample C. The difference in colour characteristics may be attributed to coloured pigments in the different combinations of margarine and unrefined coconut oil.

The crust colour showed a significant decrease ($p \leq 0.05$) in L* value of unrefined coconut oil substituted bread samples compared to the control (sample A). However, redness (a*) and yellowness (b*) values increased as the level

Table 4. Physical properties of bread samples. Data are mean values of triplicate determination \pm standard deviation. Values in the same row with different superscript are significantly different ($p \leq 0.05$)

Sample	Oven spring (g)	Loaf weight (g)	Loaf volume (cm ³)	Specific volume (cm ³ /g)
A	0.42 \pm 0.01 ^a	230.06 \pm 0.04 ^a	613.03 \pm 0.06 ^e	2.67 ^e
B	0.40 \pm 0.01 ^a	232.10 \pm 0.03 ^b	611.45 \pm 0.03 ^d	2.64 ^b
C	0.42 \pm 0.02 ^a	233.50 \pm 0.11 ^c	609.63 \pm 0.05 ^c	2.61 ^c
D	0.41 \pm 0.02 ^a	236.40 \pm 0.09 ^d	605.76 \pm 0.07 ^b	2.56 ^b
E	0.40 \pm 0.01 ^a	238.21 \pm 0.05 ^e	600.75 \pm 0.06 ^a	2.52 ^a



Figure 2: Bread samples made with margarine and/or unrefined coconut oil. (A: Bread made with 100% margarine; B: Bread made with 75% margarine and 25% coconut oil; C: Bread made with 50% margarine and 50% coconut oil; D: Bread made with 25% margarine and 75% coconut oil; E: Bread made with 100% coconut oil)

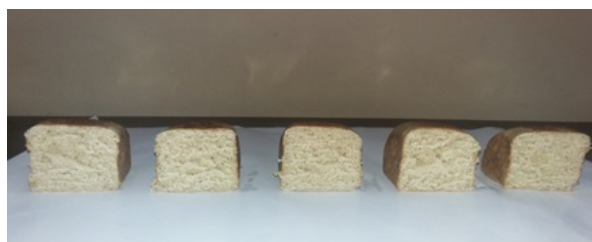


Figure 3: Transverse section of bread samples made with margarine and/or unrefined coconut oil. (A: Bread made with 100% margarine; B: Bread made with 75% margarine and 25% coconut oil; C: Bread made with 50% margarine and 50% coconut oil; D: Bread made with 25% margarine and 75% coconut oil; E: Bread made with 100% coconut oil)

of substitution increases. The colour gradually changed from light-brown in the control sample to darker brown as indicated in samples B, C, D and E. The only factor responsible for darker crust colour of bread samples prepared from unrefined coconut oil was the high content of glycerol in the oil. Glycerol is a carbohydrate with chemical composition similar to that of simple sugar hence loaves containing additional glycerol had a darker crust. Generally, surface colour depends both on the physico-chemical characteristics of the raw dough (i.e., water content, pH, reducing sugars and amino acid content) and on the operating conditions applied during baking such as temperature, air speed, relative humidity and mode of heat transfer as reported by Zanoni *et al.* [24].

Sensory properties

Figure 4 shows the sensory characteristics of bread samples containing different levels of unrefined coconut oil. It could be inferred from the result that the colour of the bread samples was fairly good. It was observed that panellists most preferred bread prepared from the 25% margarine and 75% unrefined coconut oil (sample D) with a mean value of 6.16 closely followed by sample B and sample C respectively. In terms of taste, panellists accepted inclusion of unrefined coconut oil up to 75% substitution as bread sample containing 100% unrefined coconut oil was unacceptable. Unrefined coconut oil possesses a light coconut taste, however the product's quality mostly depends on the freshness of the coconut used and the processing conditions. Based on aroma, sample B with 25% unrefined coconut oil ranked highest with a mean value of 5.84. This was very close to 75% (sample D) and 100% (sample E) substitutions with value of 5.58 and 5.60, respectively. Aroma is a determining factor in consumers' acceptance of bread; hence it can be deduced that bread sample is accepted up to 75% substitution with unrefined coconut oil. This could be due to the flavour compounds in unrefined coconut oil. As expected, unrefined coconut oil will have a stronger flavour than a refined version; however such higher threshold possesses a slight undertone that is non-aggressive.

There was significant difference ($P \leq 0.05$) among the products regarding texture. The bread sample containing 100% margarine (sample A) was more preferred compared to samples containing different levels of coconut oil. Higher bread density (decreased specific loaf volume) as observed in bread samples containing coconut oil has been correlated to a more pronounced firmness during storage [25]. In terms of sweetness, there was significant difference ($P \leq 0.05$)

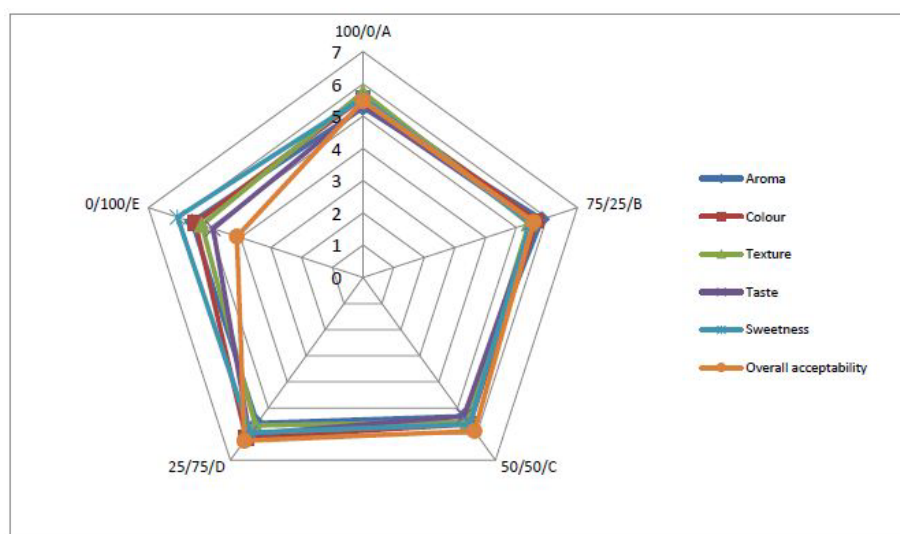


Figure 4: Sensory mean scores of bread samples containing varying levels of coconut oil

Table 5 Crust and crumb colour of bread samples. Data are mean values of triplicate determination \pm standard deviation. Values in the same row with different superscript are significantly different ($p \leq 0.05$)

Sample	Crumb colour			Crust colour		
	L*	a*	b*	L*	a*	b*
A	64.08 \pm 0.98 ^b	2.31 \pm 0.09 ^b	17.75 \pm 0.27 ^b	56.90 \pm 0.35 ^e	6.05 \pm 0.19 ^a	19.36 \pm 0.30 ^a
B	65.23 \pm 0.92 ^b	2.35 \pm 0.07 ^b	17.93 \pm 0.25 ^b	56.20 \pm 0.08 ^d	6.21 \pm 0.06 ^b	19.47 \pm 0.06 ^b
C	62.75 \pm 0.48 ^a	2.32 \pm 0.06 ^b	17.03 \pm 0.13 ^a	55.75 \pm 0.01 ^c	6.92 \pm 0.02 ^c	19.55 \pm 0.04 ^c
D	63.83 \pm 0.49 ^a	2.12 \pm 0.03 ^a	17.16 \pm 0.13 ^a	55.42 \pm 0.30 ^b	7.31 \pm 0.04 ^d	19.63 \pm 0.06 ^d
E	62.88 \pm 0.48 ^a	2.30 \pm 0.04 ^b	17.16 \pm 0.14 ^a	54.88 \pm 0.03 ^a	7.66 \pm 0.01 ^e	19.84 \pm 0.01 ^e

between the bread samples with a range of 5.57 to 6.05. Bread samples containing 100% unrefined coconut oil (sample E) was most preferred by the panelists followed by samples D, C and B, respectively. The control (sample A) was least preferred. Preference for bread samples containing unrefined coconut oil over control sample could be as a result of high glycerol noted with the oil. With regards to overall acceptability, there were significant differences ($P \leq 0.05$) among bread samples evaluated. The overall acceptability scores of the bread samples ranged from 4.11 to 6.26 which were in the “dislike slightly” to “like slightly” category on the 9-point hedonic scale employed. In general, bread made with 75% inclusion of unrefined coconut oil (sample D) was most preferred with a mean score rating of 6.26.

CONCLUSION

Results showed the substitution of margarine with unrefined coconut oil in bread production had physical and nutritional benefits. Fat and mineral concentrations increased significantly with increased levels of coconut oil in the products. Lauric acids were the main fatty acids in the oil possessing numerous health benefits. Therefore, bread containing unrefined coconut oil might also be considered a functional food.

REFERENCES

- [1] FAOSTAT. Food and agriculture organization of the United Nations. Coconuts, Production/Crops. *Statistical Division (FAOSTAT)*, **2013**.
- [2] Akpan EEJ. Coconut breeding in past, present and future. Nigeria Institute for Oil Palm Research (NIFOR) Seminar Report, **1985**.
- [3] NIFOR. Nigerian Institute for Oil Palm Research. In house review, **2008**, 109-144.
- [4] Carandang EV. Health benefits of virgin coconut oil. Philippine Coconut Research and Development Foundation, Inc. (PCRDF), 3F PCRDF Bldg., Pearl Drive, Ortigas Center, Pasing City, 1605 Philippines, **1998**, 8-12.
- [5] Clement G, Clement J, Bezard J. Effect of human pancreatic lipase on mixed, symmetrical, synthetic triglycerides made up of long-chain fatty acids and of butyric acid. *Arch Sci Physiol (Paris)*, **1962**, 16: 213–225.
- [6] Enig MG. Health and nutritional benefits from coconut oil: An important functional food for the 21st century. A paper presented at the avoc lauric oils symposium, Ho Chi Min City, Vietnam, **1996**.
- [7] Willet WC, Stampfer MJ, Manson JE, Colditz GA, Speizer FE, et al. Intake of trans- fatty acids and risk of coronary heart disease among women. *Lancet*, **1993**, 8845: 341, 581-585.
- [8] PNS. *The Philippine National Standard*. Virgin coconut oil (VCO). Bureau of Products Standards, **2004**, 1-4.
- [9] Cecille dela Paz MD, Cecilia Jimeno MD, Rody Sy MD, Eduardo F, Punzalan MD, et al. The effect of virgin coconut oil on lipid profile and fasting blood sugar: A phase I clinical trial. *Philipp J Intern Med*, **2010**, 48: 1-6.
- [10] Dayrit CS. Coconut oil: Atherogenic or not? *Philippine Journal of Cardiology*, **2003**, 31: 3, 97-104.
- [11] Geliebter A, Torbay N, Bracco EF, Hashim SA, Van Itallie TB. Overfeeding with medium-chain triglyceride diet results in diminished deposition of fat. *Am J Clin Nutr*, **1983**, 37: 1-4.
- [12] Dayrit FM, Buenafe OE, Chainani ET, DeVera IM (2008). Analysis of monoglycerides, diglycerides, sterols and free fatty acids in coconut (*Cocos nucifera* L.) oil by 31P NMR spectroscopy. *Agric Food Chem*, **2008**, 56: 5765-5769.
- [13] Heli JR. Health effects of coconut oil. Pennington biomedical research center. Louisiana State University. **2013**, 94.
- [14] Hassan MA. Modification of a coconut oil extractor. B.Sc. Thesis. Department of Agricultural Engineering, College of Engineering, University of Agriculture Abeokuta, Ogun State, Nigeria, **2011**.
- [15] Oladunmoye OO, Akinoso R, Olapade AA. Evaluation of some physical-chemical properties of wheat, cassava, maize and cowpea flours for bread making. *J Food Qual*, **2010**, 33: 693-708.
- [16] AOAC. *Official Methods of Analysis*. 19th ed. Association of official analytical chemists, Washington, DC., USA, **2005**.
- [17] AACC. Approved methods of the American association of cereal chemists. 10th ed. St. Paul, MN, **2000**.
- [18] Ezeama CF. Food microbiology: Fundamentals and applications. Natural Prints Limited, Lagos. **2007**.

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- [19] Oomah BD, Mazza G. Flaxseed proteins. *Food Chem*, **1993**, 48: 109-114.
- [20] Garfinkel M, Lee S, Opara EC, Akwari OE. Insulinotropic potency of lauric acid: A metabolic rationale for medium chain fatty acids (MCF) in TPN formulation. *J Surg Res*, **1992**, 62:328-333.
- [21] Byrd-Bredbenner C, Moe G, Beshgetoor D, Berning J. Wardlaw's perspectives in nutrition. 9th ed. McGraw-Hill International Edition, 2013.
- [22] Sani I, Owoade C, Abdulhamid A, Isah MF, Bello F. Evaluation of physicochemical properties, phyto-chemicals and mineral composition of *Cocos nucifera* L. (Coconut) kernel oil. *Int J Adv Res Chem Sci*, **2014**, 1: 22-30.
- [23] Shittu TA, Raji AO, Sanni IO. Bread from composite cassava-wheat flour: effect of baking time and temperature on some physical properties of bread loaf. *Food Res Int*, **2007**, 40: 280-290.
- [24] Zanoni B, Peri C, Bruno D. Modelling of browning kinetics of bread crust during baking. *Lebensm Wiss Technol*, **1995**, 28: 604-609.
- [25] Axford DWE, Colwell KH, Cornford SJ, Elton GAH. Effect of loaf specific volume on the rate and extent of staling in bread. *J Sci Food Agric*, **1968**, 19: 95-101.