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Improving the Frying Stability of Peanut oil through blending with Palm kernel Oil

Otu Okogeri[1]

[1] Department of Food Science and Technology, Ebonyi State University, P.M.B. 053, Abakaliki, Nigeria

Correspondence: Otu Okogeri, Department of Food Science and Technology, Ebonyi State University, P.M.B. 053, Abakaliki, Nigeria. Tel: 234-703-722-8100. E-mail: doc.otu@gmail.com

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Abstract

The present work explores the possibility of improving the frying stability of peanut oil, by decreasing its level of unsaturation using tropical oil. Blends comprising of 35.92-46.63% oleic acid, 17.74-25.41% linoleic acid, and less than 0.01% linolenic acid were studied. The fatty acid compositions were attained by blending peanut oil (PNO) and palm kernel oil (PKO) at 90:10; 80:20; 70:30; and 60:40 ratios respectively. The blends were used to fry sliced yam and subsequently subjected to chemical analyses while the fried yam slices were subjected to sensory evaluation. Pure peanut oil was also used to fry sliced yam, and served as control. Findings from this study indicate that the blends recorded lower values of total polar compounds (7.90-14.60%) than the control (15.40%); and lower values of FFA (0.90-1.45% vs. 1.09% for the control) with the exception of the 60:40 blend which recorded FFA value of 1.45%. In terms of acceptability of taste, flavour and overall acceptability, yam slices fried in the control oil were generally preferred over those fried in blends; however among the blends, slices fried in 90:10 and 80:20 blends recorded the highest scores for overall acceptability and were preferred by the panelists more than those fried in the 70:30 and 60:40 blends. In terms of acceptability of appearance no significant difference was obtained for slices fried in the different blends. Findings from this work further suggest that peanut oil for frying purpose can be substituted with PNO/PKO blends of up to 80:20 ratio.

Keywords: fried yam, frying stability, oil blend, peanut oil, palm kernel oil

1. Introduction

Peanut oil (PNO) is derived from the seed of *Arachis hypogea*, commonly known as groundnut. Its major unsaturated fatty acids are oleic (36–67%), and linoleic (14–44%) along with 0.7–1.7% of gadoleic, and only trace (<0.1%) of linolenic (Gunstone, 2005). PNO is the preferred frying oil by many Nigerian households who use the oil in preparing popular snacks like fried plantain and yam slices. However, due to its fatty acid composition, the oil is prone to rapid thermal breakdown and development of rancid and off flavours (Ryan, Mestrallet, Nepote, Conci, & Grosso, 2008). The effect of fatty acid composition on oxidative stability of oils has been reported by many authors (Liu & White, 1992; O'Keefe, Wiley, & Knauft, 1993). It is also well documented that the oxidative stability and heat performance of oils are greatly dependent on temperature and the level of total polyunsaturated fatty acids. Hydroperoxides of linolenate for instance, decompose more readily and at lower temperatures than hydroperoxides of linoleate, which in turn decompose more rapidly than hydroperoxides of oleate (Su and White, 2004; Li, Fan, Li, Tang, Hu, & Deng, 2013). Reducing the level of unsaturation of PNO is therefore expected to reduce the rate of formation of oxidized products and increase the frying life of the oil.

Mixing of oils and fats to produce blends with improved nutritional and physicochemical properties has a long history, and appears to be the most common method applied in stabilizing frying oils. Several studies have indicated that reducing the contents of linolenic and linoleic acids in frying oil increases its oxidative stability (Warner & Kwowlton, 1997; Xu, Tran, Palmer, White, & Salisbury, 1999). The flavor and oxidative stability of linolenate-containing oils were substantially improved by blending them with different levels of high-oleic oils to lower the linolenic content (Frankel & Huang, 1994; De Marco, Savarese, Parisini, Battimo, Falco, & Sacchia, 2007). Likewise, blending different proportions of peanut oil with highly saturated oil such as palm kernel oil (PKO) may also provide an effective method for improving the frying stability of PNO.

Palm kernel oil, a lauric oil obtained from the kernel of the oil palm (*Elaeis guineensis*), is solid at room temperature but melts sharply and completely at body temperature; as a result, foods processed in the oil do not have waxy taste. In addition, PKO has good oxidative stability contributed by its predominantly saturated fatty acid composition, and due to the same high level of saturates, the development of polymerized or oxidized products during thermal processing is very low (Young, 1983).

The objective of this work was to improve the frying stability of peanut oil, by decreasing its level of unsaturation using palm kernel oil, readily available and less expensive oil; without imparting objectionable organoleptic properties to foods fried in the oil.

2. Materials and Method

2.1 Base Oils and Blends

Peanut oil (PNO) was obtained from a local grocery store while palm kernel oil was obtained from a local commercial processor. The above base oils were blended in the following weight ratios (PNO/PKO): 100:0; 90:10; 80:20; 70:30; and 60:40. The blends were obtained by weighing base oils into a 200-mL plastic bottle and mixing in a LabQuake shaker (Barnstead International, USA) set at moderate agitation speed at room temperature for 30 minutes. The 100:0 ratio (pure peanut oil) served as control.

2.2 Frying Protocol

Yam (*Dioscorea rotundata*) tubers were purchased from a local grocery store and were peeled, cut into slices of 0.3 cm thickness (8 x 6 cm), washed, wiped and then pan-fried in uncovered frying pan (26.5 x 4.5 cm; diameter x depth) at 180^{0}C until a crisp light brown colour was attained (3 minutes on average), using a temperature regulated hot plate as heat source. The frying operation was carried out for each of the blends and for peanut oil (control), using 500 g of yam slices and 0.35 L of oil. This yam/oil ratio was chosen to mimic a typical domestic yam-frying operation. At the end of each frying operation, oil samples were collected, filtered into amber glass vials, and stored in the freezer until analysed, while the fried yam slices were immediately subjected to sensory analysis.

2.3 Analysis of Samples

Free fatty acid, Peroxide value and Iodine value, were determined according to AOCS Official Methods Ca 5a-40, Cd 8b-90, and Cd 1d-92 respectively (AOCS, 2004). Polar Compounds were analysed by AOCS Method Cd 20-91 (AOCS, 2004) using 12mL SPE silica tubes (Supelco DSC-Si, 2g sorbent) and following the modifications reported by Sebedio, Septler, and Grandgirard (1986). The fatty acid profiles of base oils and blends were evaluated by GC analysis of methylated samples according to AOCS Official Method Ce 1h-05 (AOCS, 2004). FAMEs were analyzed on a HP 6890 GC system from Hewlett Packard, using a DB-23 capillary column (60m x 0.32mm x 0.25µm film thickness) from Agilent Technologies. All reagents were of analytical grade and purchased from Merck (Darmstadt, Germany).

2.4 Sensory Evaluation

Fifteen panelists were selected from students of the Department of Food Science and Technology, Ebonyi State University, Abakaliki. The panelists were screened using the triangle test (Nobel, 2006) and selected based on their ability to consistently discriminate between yam slices fried in PNO and slices fried in PKO. Fried slices were evaluated by rating on a 9-point hedonic scale, where 1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely, according to acceptability of appearance, taste, flavour and overall acceptability. Evaluation of sensory attributes of samples was carried out based on the recommendations described by Malcolmson (2005). Each panelist received hot yam slice from each of the frying oil, evaluated it, and took a 2-min break before evaluating another slice from different oil. For evaluation of taste, panelists were asked to cleanse their palates with warm water after each tasting.

2.5 Statistical Analysis

Data from chemical analyses and sensory evaluation were processed using regression analysis (Microsoft Excel 2007).

3. Results and Discussion

3.1 Initial Oil Quality

Considering that the rate of oxidation of oil is directly related to its degree of unsaturation (Gunston, 2005), peanut oil (PNO), highly unsaturated oil, was blended at varying ratios with palm kernel oil (PKO), highly saturated oil, in an attempt to decrease the level of unsaturation of PNO, thereby increasing its oxidative stability as common frying oil. Table 1 shows the quality indices and fatty acid profiles of the starting oils and their blends.

Table 1. Initial characteristics of the starting oils and their blends before frying

Parameter[a]	PNO	PKO	PNO/PKO 90:10	PNO/PKO 80:20	PNO/PKO 70:30	PNO/PKO 60:40
FFA (%)	0.13	0.37	0.15	0.18	0.20	0.23
PV (meq/kg)	2.20	3.68	2.35	2.50	2.64	2.82
TPC (%)	1.19	2.80	1.75	2.15	2.46	2.60
IV (g I_2/100g oil)	92.40	17.60	85.30	77.50	69.40	62.50
Fatty Acid Profile (%)						
8:0	<0.1	3.24	0.32	0.66	0.98	1.28
10:0	<0.1	3.82	0.39	0.76	1.14	1.52
12:0	<0.1	47.80	4.86	9.60	14.35	19.10
14:0	<0.1	15.86	1.69	3.24	4.81	6.36
16:0	10.33	8.00	10.11	9.85	9.93	9.40
16:1	0.15	nd	0.10	0.10	0.10	0.10
18:0	3.71	2.20	3.56	3.42	3.27	3.11
18:1	50.20	14.60	46.63	43.06	39.49	35.92
18:2	27.97	2.40	25.41	22.86	20.30	17.74
18:3	<0.1	nd	nd	nd	nd	nd
20:0	0.13	0.60	0.17	0.22	0.26	0.31
20:1	1.33	nd	1.20	1.06	0.91	0.79
22:0	3.34	nd	3.00	2.67	2.33	2.00
24:0	1.57	nd	1.41	1.26	1.03	0.95

[a]Values are means of duplicate analysis. PNO = peanut oil; PKO = palm kernel oil; FFA = free fatty acid; PV = peroxide value; TPC = total polar compounds; IV = Iodine value; nd = not detected.

Oleic (18:1), Linoleic (18:2), palmitic (16:0) and stearic (18:0) were the major acids found in PNO, while PKO was composed majorly of lauric (12:0), myristic (14:0), oleic (18:1), and palmitic (16:0). Table 1 also indicates that the oleic and linoleic content of the fresh blends ranged from 35.92-46.63%, and 17.74-25.41% respectively, while total saturates ranged from 25.51-44.03%. As expected, linolenic acid (18:3) was not detected in the blends. Higher values of peroxides (2.82 meq/kg) and total polar compounds (2.60%) were recorded for PNO/PKO 60:40, and can be attributed to the increased amount (40%) of PKO in this blend (Table 1). Iodine value, a measure of the degree of unsaturation, ranged from 61.10-83.10 g/100g for the blends and as expected, decreased with decreasing levels of 18:1 and 18:2; while FFA of blends ranged from 0.15-0.23% and followed similar pattern as PV and TPC.

3.2 Frying Oil Quality

Oil quality has long been identified as the most important factor that determines the quality of fried foods. The quality of blends after frying of yam slices was assessed by subjecting the blends (and control) to measurement of free fatty acid (FFA), total polar compounds (TPC) and iodine values (IV) (Table 2). The FFA values of blends ranged from 0.90-1.45% and were less than that of the control (1.09%), with the exception of PNO/PKO 60:40 which recorded FFA value of 1.45%. During frying, FFAs are formed by hydrolytic cleavage of triglycerides, promoted by the presence of food moisture (Fritsch, 1981). Values of FFA before (Table 1) and after frying of yam (Table 2) indicate that hydrolysis was more intense in the 60:40 blend during the course of frying.

Table 2. Quality indices of blends after frying of yam slices[a]

Sample	FFA (%)	TPC (%)	IV (g I_2/100g oil)
PNO (control)	1.09	15.40	89.70
PNO/PKO 90:10	1.05	11.80	83.10
PNO/PKO 80:20	0.90	8.83	76.30
PNO/PKO 70:30	1.05	7.90	68.10
PNO/PKO 60:40	1.45	14.60	61.10

[a] Values are means of duplicate analysis.

TPC in frying oil are composed of breakdown products, nonvolatile oxidized derivatives produced during frying, and oil soluble substances from the food (Tompkins & Perkins, 2000). TPC of all blends increased significantly during frying, recording values in the range of 8.83-14.60%. However these values were below that recorded for the control with TPC of 15.40% (Table 2) and indicate that addition of palm kernel oil led to substantial decrease in the formation of polar materials during frying of yam slices. Iodine value on the other hand, decreased during frying with the highest decrease occurring in PNO (control) which decreased from initial IV of 92.40 to 89.70 g/100g; followed by PNO/PKO 90:10 which decreased from 83.1 to 81.30 g/100g. Decreases in IV for PNO/PKO 80:20, 70:30, and 60:40 blends were similar but lower than those observed for the control and the 90:10 blend. Decrease in IV of blends appeared to correspond to increase in TPC with the exception of the 60:40 blend which recorded the lowest decrease in IV (from 62.50 to 61.10 g/100g) but highest increase in TPC (from 2.60 to 14.60). Considering that total polar compounds include products of thermal breakdown as well as products of hydrolysis, the high increase observed in the TPC of PNO/PKO 60:40 (and the low decrease in its IV) may be due to the presence of compounds mainly from hydrolytic breakdown (which are not evaluated by the iodine value). This is also supported by the relatively high value of FFA recorded by this sample, since FFAs are also produced during hydrolysis.

3.3 Sensory Evaluation

Sensory evaluation results are shown in Figures 1a to 1d. Yam slices fried in the blends showed similar mean scores for appearance acceptability as those fried in the control (Figure 1a), indicating that blending of PNO with PKO at the ratios studied, had no significant impact on the characteristic light brown colour of fried yam. The mean scores for acceptability of taste and flavour were significantly higher for PNO (control) than for the blends (Figures 1b and 1c). Among the blends, slices fried in PNO/PKO 90:10 had the highest rating for acceptability of taste and 80:20 the highest rating for flavor acceptability, while the 70:30 and 60:40 blends had the lowest rating for taste and flavour acceptability. Some panelists described the flavour of slices fried in these blends (70:30 and 60:40) as ‘’soapy’’ and ‘’rancid’’. This is believed to have been brought about by the higher amount of PKO in these blends, since the short chain fatty acids of PKO triglycerides are known to hydrolyse easily, resulting in unpleasant soapy off-flavor (Young, 1983). The rating for overall acceptability (Figure 1d) indicates that the panelists generally preferred slices fried in the control to those fried in PNO/PKO blends. Overall acceptability scores were also correlated with those for taste acceptability (r = 0.9216) and flavour acceptability (r = 0.8388).

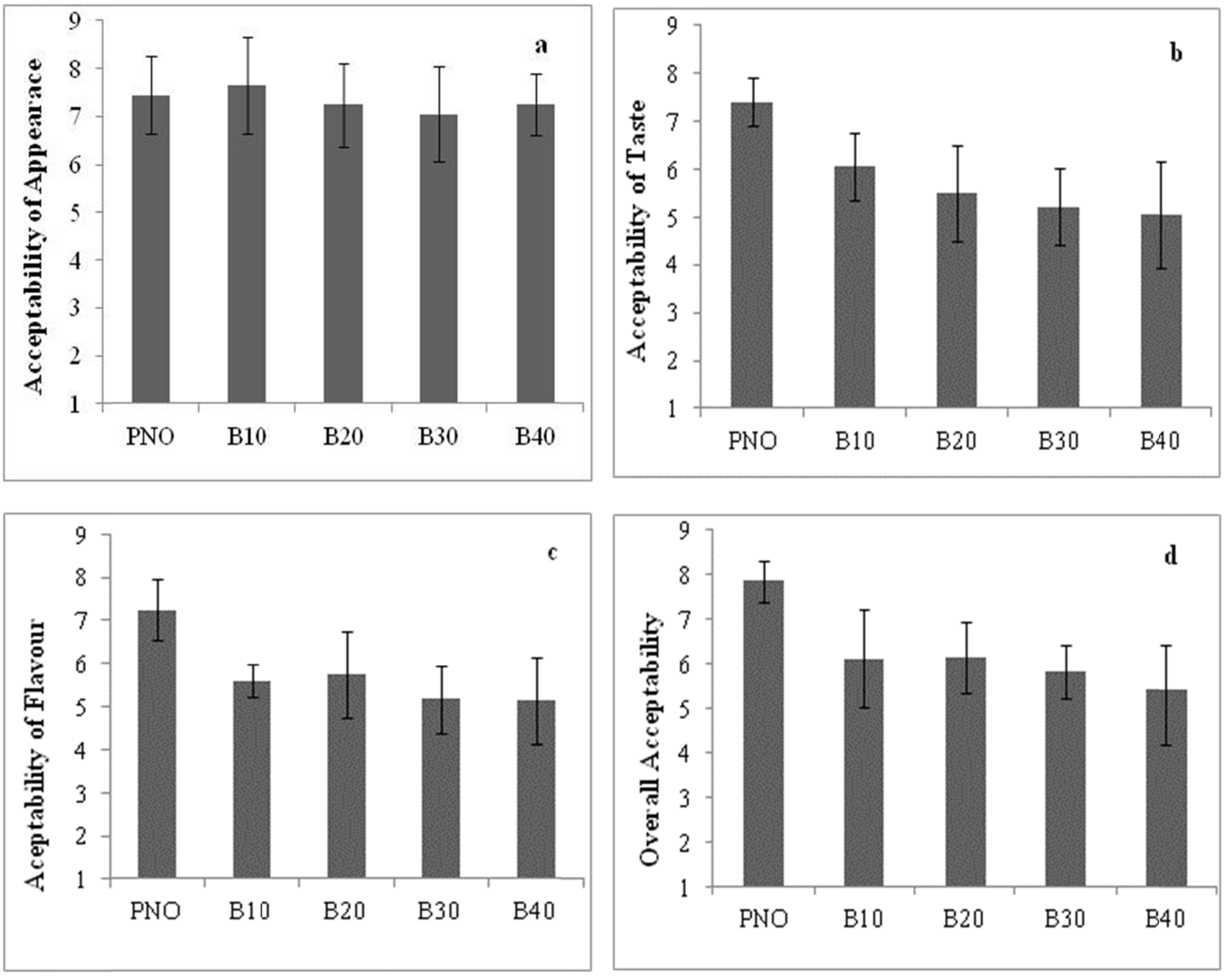

Figure 1. Mean scores (n=15) for acceptability of Appearance (a), Taste (b), Flavour (c), and Overall acceptability (d) of yam slices fried in blends and control. PNO = peanut oil (control); B10, B20, B30 and B40 = PNO blended with 10, 20, 30 and 40% palm kernel oil respectively

4. Conclusions

Blending peanut oil with palm kernel oil appears to be an effective means through which the frying stability of peanut oil can be improved; and blending of PNO with PKO up to the ratio of 80:20 appears to be effective. In terms of TPC, the 90:10 and 80:20 blends recorded significantly lower values than the control, suggesting that the formation of oxidized and polymerized products were significantly reduced; and further suggesting that these blends can be used longer than PNO as frying oil, with less frequent replacement, making them more economical. The above samples also recorded lower FFA values than the control, suggesting that hydrolytic breakdown was also reduced. The panelists accepted the taste and flavour of the 90:10 and 80:20 ratios but appeared to neither accept nor reject the taste and flavour of the 70:30 and 60:40 blends. Blending at the ratios studied did not alter the appearance of the fried yam. Findings from this work therefore suggest that blending peanut oil with up to 20% palm kernel oil could be an effective and economical means by which the frying stability of peanut oil can be improved.

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