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Comparison of antioxidative effects of methanol orange peel extract and butylatedhydroxytoluene on stability of crude peanut oil

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Abstract

The antioxidative effects of methanol orange peel extract (MOPE) and butylatedhydroxytoluene (BHT) on stability of crude peanut oil (CPO) stored for twelve months in white transparent plastic bottles at room temperature (27–33 °C) were investigated. Extract of orange peel was prepared by dissolving 20 g of dried, ground and sieved sweet orange peel into 200 ml of methanol for three days. The methanol orange peel extract (MOPE) was added at varying concentrations (200–1000 ppm) to CPO. Another set of CPO which contained 200 ppm BHT as well as CPO that contained no additive was also set up. The colour and refractive indices of oil samples were immediately determined while free fatty acid (FFA), acid value (AV) and peroxide value (PV) of CPO samples were determined monthly using standard methods. The colour of CPO containing additives (MOPE and BHT) and that which contained no additive (0 ppm) was 30.0 units in 1/2″ cell. The refractive index of CPO containing varying concentrations of MOPE ranged between 1.464 and 1.465 while CPO containing no additive (0 ppm) and 200 ppm BHT was 1.463. There was no significant difference at $P < 0.05$ in FFA, AV and PV of CPO containing MOPE, BHT and CPO containing no additive. The FFA, AV and PV of CPO containing additive (MOPE and BHT) were lower than that of CPO containing no additive. BHT was better in stabilizing hydrolytic rancidity of CPO while MOPE was superior to BHT in stabilizing CPO against oxidative rancidity.

Keywords: Stability; Methanol orange peel extract; BHT; Crude peanut oil and quality parameters

1. Introduction

Peanut oil is edible oil obtained from groundnut seeds (*Arachis hypogaea Linn*). It is also called groundnut oil or Arachis oil (Aluyor et al., 2009).The oil is commonly and majorly consumed in the northern part of Nigeria among the Hausa and Fulani tribes. Peanut seeds contain about 45–50% oil (Bernardini, 1973). The seeds are predominately cultivated among the Hausas in Kaduna, Kebbi, Kastina, Kano, Borno, Sokoto and Plaetue states in Nigeria and the seeds very cheap and affordable in these localities. The common and most effective processes involved in getting the crude oil from peanut seeds entails a mechanical method which includes nut pretreatment, expelling (screw pressing) and oil clarification (Bernardini, 1973; Ihekoronye and Ngoddy, 1985). The residue after obtaining the oil is used to make local cake popularly known as "Kulikuli". At times the seeds are industrially processed by solvent extraction method to obtain crude oil and meal (Nkafamiya et al., 2007). The crude oil is further processed industrially to obtain refined vegetale oil while the meal is used to feed pigs or use to formulate feeds for chichen, broilers etc. However, the low income Nigerians can easily afford to purchase the crude peanut oil rather than the refined peanut oil because it is cheaper. The crude peanut oil is commonly kept by the oil producers for several months or bought and stored in larger quantities by mearchants when it is abundantly available due to its low price. The oil is later sold when the price increase approximately six months after peak harvest. During storage of peanut oil,several chemical changes occur resulting in deterioration in safety and organoleptic

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properties (John, 1990). There is therefore need to find ways for prevent oil rancidity, possibly by addition of antioxidants (Amir et al., 2005; Ihekoronye and Ngoddy, 1985).

Therefore, in the edible oil processing industry, there is growing interest in finding suitable natural alternatives to synthetic antioxidants such as butylatedhydroxytoluene (BHT), butylatedhydroxyanisole (BHA), propylgallate (PG), tertiary butylatedhydroquinone (TBHQ) and citric acid currently in use to prevent lipid deterioration, but are reported not safe for human consumption (Ullah et al., 2003; Ruger et al., 2002; Gunstone and Norris, 1983). The effectiveness of antioxidants of phenolic compounds from some plant sources in retarding lipid deterioration have been reported (Arawande and Ogunyemi, 2012; Rehab, 2010; Arawande and Komolafe, 2010; Arawande and Abitogun, 2009; El-Anany, 2007; Farag et al., 2006; Shaker, 2006; Farag et al., 2003; Wanasundara and Shahidi, 1998; Tian and White, 1994). Owing to carcinogenicity of synthetic antioxidants, the exploration for safer natural sources of antioxidants continues to gather momentum. Sweet orange fruit peel has a lot of health importance and it is very rich in antioxidants (vitamin A & C, flavonoids) that helps to fight illness, and helps in reducing cholesterol, promotes healthy skin, aids digestion, good source of vitamin-packed flavouring (Anonymous, 2011). The focus of this work is to obtain methanol extract of sweet orange peel and to investigate its antioxidant potential on crude peanut oil stored for twelve months by determining some physical and chemical quality characteristics of the oil as well as to compare its antioxidant performance with that of butylatedhydroxytoluene (BHT).

2. Materials and methods

2.1. Sources of materials

Sweet Orange fruits that were matured and ripe were purchased from a local farmer at Utelu camp, Iyere, Owo, Ondo-State, Nigeria. The crude peanut oil was obtained from a local producer at Ore, Ondo-State, Nigeria.

2.2. Preparation and extraction of orange peel

Orange fruits were peeled with hands and knife, rinsed with water, chopped into smaller pieces for easy sun drying. The dried peel was ground using electric blending machine and it was sieved with 40 mm mesh size. The sample was packed into a black polythene bag prior to extraction.

Twenty gram of the sample was weighed into a cleaned and dried reagent bottle; and 200 ml of methanol was added and left for 72 h during which it was intermittently shaken on a shaking orbit machine. The mixture was filtered through a 0.45 μm Nylon membrane filter. The extract was evaporated to dryness under reduced pressure at 40 °C by a rotary evaporator (Amir et al., 2005; Arawande and Komolafe, 2010).

2.3. Addition of additives to crude peanut oil

Methanol extract of orange peel at concentrations of 200 ppm (0.02 g per 100 ml oil) to 1000 ppm (0.10 g per 100 ml oil) was added to Crude peanut oil (CPO) contained in white transparent plastic bottles of equal capacity and they were thoroughly shaken for proper mixing. CPO containing 200 ppm BHT (0.02 g per 100 ml oil) and that which contained no additive (0 ppm (control)) were also set-up. Each container was appropriately labelled and stored in an open place at room temperature ranging from 27 °C to 33 °C.

2.4. Physical and chemical analysis

The colour of the oil sample was determined as described by AOCS, 2004 using Lovibond Tintometer (Model 520). The refractive index was also determined using Abbe's Refractometer at 40 °C (AOCS, 2004). Thereafter, the free fatty acid (FFA), acid value (AV) and peroxide value (PV) of each oil sample were monitored monthly using standard method of analysis (AOCS, 2004) for a period of twelve months.

2.5. Statistical analysis

The results were compared by one-way analysis of variance (one-way ANOVA) to test for significant difference. Means of the group were compared using Duncan multiple range test (DMRT) (SAS, 2002).

3. Results and discussion

Table 1 shows changes in colour and refractive index of crude peanut oil stored with varying concentrations of methanol orange peel extract and 200 ppm BHT. Oil to which orange peel extract was added the colour with that of control. Colour of edible oils is an important physical quality factor that influences consumer decision of acceptance or otherwise (Ihekoronye and Ngoddy, 1985). The most acceptable colour of edible oils is golden yellow and the lower the colour unit, the more acceptable and attractive the oil becomes. The colour

Table 1
Changes in colour and refractive index of crude peanut oil stored with varying concentrations of methanol orange peel extract and 200 ppm BHT.

Concentration of additive	Colour (units) in 1/2″ cell	Refractive index at 40 °C
0 ppm (no additive)	2R+20Y=30.0[a]	1.463[a]
200 ppm MOPE	2R+20Y=30.0[a]	1.464[b]
400 ppm MOPE	2R+20Y=30.0[a]	1.464[b]
600 ppm MOPE	2R+20Y=30.0[a]	1.465[b]
800 ppm MOPE	2R+20Y=30.0[a]	1.465[b]
1000 ppm MOPE	2R+20Y=30.0[a]	1.465[b]
200 ppm BHT	2R+20Y=30.0[a]	1.463[a]

Within column, mean values followed by the same superscript are not significantly different at $P < 0.05$ level according to Duncan multiple range test (DMRT); MOPE=methanol orange peel extract; BHT=butylated hydroxytoluene, R=red slide; Y=yellow slide.

unit is measured as red and yellow slides by using Lovibond Tintometer in 1/2″ cell. Addition of additives (methanol orange peel extract (MOPE) and BHT) did not lead to any change in colour of crude peanut oil (CPO). CPO containing 200–1000 ppm MOPE ad 200 ppm BHT had colour of 30.0 units. The colour measurements for oil treated with MOPE and BHT were similar and not significantly different from the measurement of CPO which contained no additive (0 ppm (control)). Refractive index of CPO containing additives was measured at 40 °C. The methanol extract of orange peel slightly increased the refractive index of CPO by 0.001 and 0.002. The oil which contained 200 ppm BHT as well as the oil which contained no additive had refractive index of 1.463 while CGNO which contained 200–1000 ppm MOPE had refractive index of 1.464–1.465. Refractive index of edible oil is a measure of the extent of oil adulteration or purity (Cocks and Rede, 1966) hence the addition of MOPE to CPO did not reflect that the oil was adulterated and it had almost the same refractive index with CPO containing 200 ppm BHT.

Fig. 1 depicts free fatty acid (FFA) of CPO stored with MOP extract and BHT for twelve months. It was observed that CPO containing 200–1000 ppm MOP extract as well as 200 ppm BHT had six months of induction period during which there were only very slight increase in the FFA of the oil samples. In the last five months of storage, there was steady and gradual increase in the FFA of the oil samples. And there was also no remarkable difference in FFA trend of CPO containing additives (MOP and BHT) and CPO which contained no additive.

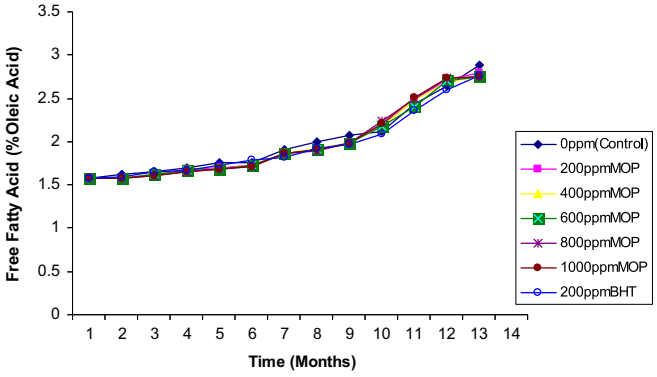

Fig. 1. Free fatty acid of crude peanut oil stored with methanol orange peel (MOP) extract and BHT for twelve months.

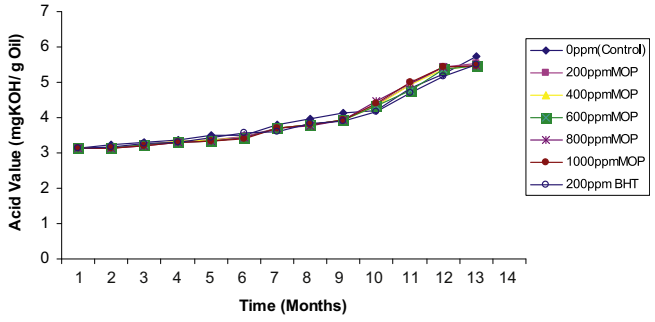

Fig. 2. Acid value of crude peanut oil stored with methanol orange peel (MOP) extract and BHT for twelve months.

Fig. 2 shows acid value (AV) of CPO stored with MOP extract and BHT for twelve months. It was observed that CPO containing 200–1000 ppm MOP extract as well as 200 ppm BHT had six months of induction period during which there were only very slight increase in the AV of the oil samples. In the last five months of storage, there was steady and gradual increase in the AV of the oil samples. There was no remarkable difference in the AV trend of CPO containing additives and CPO which contained no additive. In Figs. 1 and 2, there was similar trend in the plots; the only difference was that the values obtained for acid value were higher than values obtained for free fatty acid for each treatment in each of the month. Figs. 1 and 2 contained data that were very close to each other hence the differences in treatment were better explained in Table 2 below.

Fig. 3 reveals the peroxide value of crude peanut oil stored with methanol orange peel (MOP) extract and BHT for twelve months. There was slight increase in the peroxide value of CPO in the first three to four months of storage. The trend observed in the plots was in agreement with the observation reported by Amir et al., 2005. All the additives lowered peroxide value of CPO at varying degrees. The rate of peroxide value increase was slightly lower among treated samples compared to the control. The peroxide value of CPO decreased gradually as the concentration of MOP extract increased from 200 ppm to 1000 ppm. The methanol extract at all varying concentrations were more effective in combating lipid peroxidation of CPO than 200 ppm BHT.

Table 2 shows the mean value of FFA, AV and PV of crude peanut oil stored with varying concentrations of methanol orange peel extract and 200 ppm BHT for a period of twelve months. The FFA, AV and PV of CPO containing additives

Table 2
Mean values of some selected quality properties of crude peanut oil stored with varying concentrations of methanol orange peel extract and 200 ppm BHT.

Concentration of additive	[a]Free fatty acid (FFA) (% oleic acid)	[a]Acid value (AV) (mgKOH/g Oil)	[a]Peroxide value (PV) (meqO_2/Kg oil)
0 ppm (no additive)	$2.007^a \pm 0.413$	$3.995^a \pm 0.822$	$14.956^a \pm 8.150$
200 ppm MOPE	$1.987^a \pm 0.429$	$3.954^a \pm 0.854$	$14.107^a \pm 7.777$
400 ppm MOPE	$1.978^a \pm 0.419$	$3.937^a \pm 0.835$	$13.884^a \pm 7.494$
600 ppm MOPE	$1.971^a \pm 0.414$	$3.922^a \pm 0.823$	$13.457^a \pm 7.266$
800 ppm MOPE	$1.983^a \pm 0.432$	$3.946^a \pm 0.859$	$13.069^a \pm 7.192$
1000 ppm MOPE	$1.983^a \pm 0.432$	$3.946^a \pm 0.860$	$12.863^a \pm 7.981$
200 ppm BHT	$1.962^a \pm 0.388$	$3.903^a \pm 0.772$	$14.524^a \pm 7.982$

Note: Within each column, mean values followed by the same superscript are not significantly different at $P < 0.05$ level according to Duncan multiple range test (DMRT).
MOPE = methanol orange peel extract; BHT = butylated hydroxytoluene.
[a]Mean value of quality properties ± standard deviation.

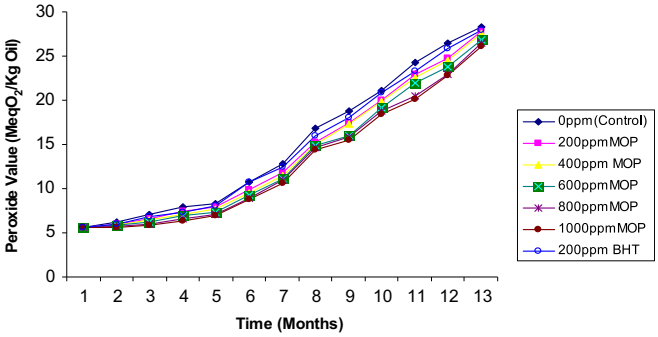

Fig. 3. Peroxide value of crude peanut oil stored with methanol orange peel (MOP) extract and BHT for twelve months.

(MOPE and 200 ppm BHT) were slightly lower than the control over the twelve months of storage. This implies that the additives are effective in combating both hydrolytic and oxidative rancidity of CPO.

Free Fatty Acid and Acid Value of any lipid are indicative of hydrolytic rancidity (Amir et al., 2005; Ihekoronye and Ngoddy, 1985). The higher the value of FFA and AV of any lipid the higher the degree of hydrolytic rancidity that set-in (Arawande and Amoo, 2009). The FFA and AV of CPO were not significantly different at $P < 0.05$ in all the storage conditions. CPO containing 200 ppm BHT had lower FFA and AV than CPO containing MOPE. Thus, 200 ppm BHT proved superior to MOPE in combating hydrolytic rancidity of CPO. The optimal concentration at which the lowest value of FFA and AV was observed in CPO was 600 ppm for MOPE. The peroxide values of CPO containing methanol orange peel extract at all varying concentrations were relatively lower in value than CPO that contained 200 ppm BHT. There was no significant difference at $P < 0.05$ of PV of CPO in all the storage conditions. The peroxide value of oil samples decreased progressively in value as the concentration of additives increased. Peroxide value is a measure of oxidative rancidity of oil and the lower the PV value the better is the oil quality (Amir et al., 2005; Ihekoronye and Ngoddy, 1985). Methanol orange peel extract (MOPE) is more effective in combating oxidative rancidity of CPO than 200 ppm BHT.

4. Conclusion

Methanol orange peel extract had little antioxidant activity against both hydrolytic and oxidative rancidity of crude peanut oil stored in white transparent plastic bottles. The antioxidant activity of methanol orange peel extract against oxidative rancidity of crude peanut oil was better than that of 200 ppm BHT while the antioxidant activity of 200 ppm BHT against hydrolytic rancidity of crude peanut oil was better than methanol extract of orange peel. Further studies can be done using this extract on other edible oils store in tin and glass containers.

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