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Effectiveness of adding ginger extract in preserving crude peanut oil.

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Abstract

Water ginger extract (WGE) and ethanol ginger extract (EGE) were obtained by grinding dried ginger and soaking it in water and ethanol for 72 hours, and thereafter the solvents were removed using rotary evaporator. Crude peanut oil (CPO) was stored with varying concentration (200 ppm–1000 ppm) of WGE, EGE and 200 ppm butylatedhydroxyltoluene (BHT) in a plastic bottle for five months. The refractive index (RI), free fatty acid (FFA), acid value (AV) and peroxide value (PV) were determined monthly for a period of five months. The mean values of these parameters were used to compare the effectiveness of the extracts and BHT against hydrolytic and oxidative rancidity of CPO. The RI of CPO containing EGE ranged between 1.4633 ± 0.0012 and 1.4640 ± 0.0008 while CPO containing WGE ranged between 1.4636 ± 0.0012 and 1.4641 ± 0.0006 and the RI of CPO containing no additive 0 ppm and 200 ppm, BHT were 1.4631 ± 0.0011 and 1.4629 ± 0.0013 respectively. The FFA of CPO with ginger extract was within 0.8356 ± 0.1279 and 0.9139 ± 0.2082% oleic acid while the FFA of CPO without additive and 200 ppm BHT were 0.9400 ± 0.1981 and 1.1228 ± 0.2509% oleic acid respectively. CPO containing EGE and WGE had AV ranged between 1.6106 ± 0.3064 and 1.9223 ± 0.4994 mg KOH/g oil; and that of CPO without additive and 200 ppm BHT were 1.9742 ± 0.4693 and 2.2340 ± 0.4994 mg KOH/g oil. The PV of CPO with EGE and WGE was within 16.3519 ± 12.8410 and 20.7037 ± 15.7827 mEq O2/Kg oil while CPO that contained no additive and 200 ppm BHT were 22.9259 ± 20.2676 and 17.8888 ± 11.1092 mEq O2/Kg oil respectively. Both EGE and WGE are more effective than 200 ppm BHT in combating hydrolytic rancidity of CPO. EGE and WGE at 400 ppm had better antioxidant potential than 200 ppm BHT against oxidative rancidity of crude peanut oil.

Keywords: Crude peanut oil, Ginger extract, Rancidity, Antioxidant, Solvents.

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Introduction

Hydrolytic and oxidative rancidity has been the major problem associated with edible oil storage. The most frequently occurring cause of oil quality deterioration during processing and storage is autoxidation [1]. The breakdown products of the autoxidation of unsaturated fatty acid are the major source of off-flavours and odours in the oil. The second most frequently cause of deterioration of fats and oil is hydrolysis, which occurs when a triglyceride reacts with water and the fatty acids are split off from the glyceride backbone [1,2]. Hydrolysis reduces the final yield of finished product as well as increasing the susceptibility to oxidation [2]. These problems have been successfully prevented or delayed in occurring in vegetable oils by using synthetic antioxidants such as butylatedhyroxyltoluene (BHT), propyl gallate (PG), butylatedhydroxylanisole (BHA) etc [3-5]. However, the use of these chemicals has been discouraged in international market because they have been found to be carcinogenic, mutagenic, toxic and expensive [6-8]. Consequently, there have been keen interests in sourcing for cheaper and safer mean of combating rancidity in edible oil by use of additives extracted from plants. A lot of research work has been documented in the effeteness of using plant extracts obtained from grape, pomposia, orange peel, oat, cabbage, banana and plantain peels to delay the onset of deterioration on different edible oils [6,9-13].

Crude peanut oil is popularly known as crude groundnut oil which is commonly found in northern part of Nigeria among the Hausa tribe. Peanut seeds contain about 45-50% oil [14]; and the oil is extracted from the seeds by mechanical method [14,15]. The meal or cake obtained after extracting the oil is used for making local cake popularly known as "Kulikuli" [11]. Sometimes the seeds are industrially processed using solvent extraction method to obtain crude oil and meal [16]. This meal/cake is sometimes used to feed pigs or to formulate feeds for chicken, fishes etc. In Nigeria, the low income earners 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 properties [11]. There is therefore need to find ways for prevent oil rancidity, possibly by addition of antioxidants [12-14,17].

Ginger or ginger root is the rhizome of *Zingiber officinale* plant and it is cultivated in the tropics and it requires warm and humid climate flourishing in a well-drained friable soil, though it can also be grown in a light soil rich in humus. It is used as food

and therapeutic purposes in lowering the cholesterol level, pain relief from arthritis, digestive issue, expectorant and gesture-intestinal stimulation [18]. Ginger root has characteristics odour and flavour of ginger is caused by a mixture of zingerone, shogaol and gingerol [19,20]. It was found that ginger contained 1.5%-3% essential oil, 2-12% fixed oil, 40-70% starch, 6-20% protein, 3-8% fibre, 8% ash 9-12% water, pungent principles, other saccharides, cellulose, colouring matter and trace minerals [21]. Ginger is called different names in different parts of the world and such names are *Zingiberis rhizoma*, Shen jiany, Cochin, Asia ginger, Africa ginger and Jamaican ginger [18-22].

The aim of this research is to obtain extracts from ginger root using ethanol and water; investigating the antioxidative potential of the extracts at varying concentrations (200 ppm-1000 ppm) on crude peanut oil; determining the effect of the extracts on refractive index of the oil as well as comparing the antioxidant activities of the extracts with that of butylatedhydroxytoluene (200 ppmBHT) by monthly monitoring their free fatty acid (FFA), acid value (AV) and peroxide value (PV) for five months.

Materials and Methods

Source and preparation of plant materials

Fresh rhizomes of ginger were collected from local farms located at Utelu, Iyere Owo, Ondo State, Nigeria. The plant material was taxonomically identified and authenticated in the Environmental Biology laboratory at the Department of Science Laboratory Technology, Rufus Giwa Polytechnic, Owo, Nigeria. The rhizomes were shade dried until all the water molecules evaporated and the rhizomes became dried for grinding. The foreskin of the rhizomes were removed and it was later ground using electrical laboratory blender into a very fine powder and kept in an airtight container with proper labelling prior to analysis. The crude peanut oil was purchased from a local producer in Ore, Ondo State, Nigeria.

Preparation of plant extracts

The method described by Amir et al. [17] and modified by Arawande et al. [23] was used. Ten gram of the powdery sample was weighed into each of the five cleaned and dried 250 mL reagent bottles and 100 mL of each solvent (ethanol and water) was separately added to each of the bottle 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 extracts were evaporated to dryness under reduced pressure at 40˚C by a rotary evaporator.

Addition of additives to crude peanut oil (CPO)

Ethanol and water extracts of ginger at concentrations of 200 ppm (0.02 g per 100 ml oil) to 1000 ppm (0.10 g per 100 ml oil) were separately 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)) was also set-up. Each container was appropriately labelled and stored in an open place at room temperature ranging from 29˚C to 35˚C.

Physical and chemical analysis

As soon as the set-up was done, the refractive index, free fatty acid (FFA), acid value (AV), and peroxide value (PV) of oil samples were determined; and thereafter these parameters were monitored monthly using standard method of analysis [24] for a period of five months.

Statistical analysis

The results (except colour and refractive index) 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) [25].

Results and Discussion

Table 1 presents the mean value of refractive index (at 40˚C) of crude peanut oil containing ethanol and water ginger extracts, 200 ppm BHT and the control which contained no additive (0 ppm) that was stored for five months in transparent bottles.

Table 1 shows the mean value of refractive index of crude peanut oil stored with varying concentration of ethanol and water ginger extract and 200 ppm BHT for five months. The refractive indices of crude peanut oil stored with no additive (control (0 ppm)) and 200 ppm BHT was 1.4631 ± 0.0011 and 1.4629 ± 0.0013 respectively and there was no significant difference ($P<0.05$) in the two of them. Crude peanut oil stored with ethanol ginger extract (EGE) had refractive index ranged from 1.4633 ± 0.0012 and 1.4640 ± 0.0008 while oil stored with water ginger extract (WGE) had refractive index ranged from 1.4636 ± 0.0012 and 1.4641 ± 0.0006. At $P<0.05$, there was no significant difference in refractive indices of crude peanut oil stored with 400 ppm and 600 ppm EGE;800 ppm EGE, 200 ppm, 600 ppm and 1000 ppm WGE; and 1000 ppm EGE and 800 ppm WGE. The mean values obtained for crude peanut oil with and without additives were within the quality standards specified and approved by governing council of Standards Organisation of Nigeria [26]. Refractive index of edible oil is used to identify adulteration and it is an identity characteristic parameter. Since the mean value of crude peanut

Table 1. *Mean value of refractive index of crude peanut oil stored with varying concentration of ethanol and water ginger extract and 200 ppm BHT for five months.*

Concentration of additive	Refractive index at 40°C
0 ppm (No additive)	$1.4631^{a} \pm 0.0011$
200 ppm EGE	$1.4640^{e} \pm 0.0008$
400 ppm EGE	$1.4634^{b} \pm 0.0010$
600 ppm EGE	$1.4633^{b} \pm 0.0012$
800 ppm EGE	$1.4638^{cd} \pm 0.0008$
1000 ppm EGE	$1.4636^{c} \pm 0.0008$
200 ppm WGE	$1.4639^{cd} \pm 0.0010$
400 ppm WGE	$1.4641^{d} \pm 0.0006$
600 ppm WGE	$1.4638^{cd} \pm 0.0008$
800 ppm WGE	$1.4636^{c} \pm 0.0012$
1000 ppm WGE	$1.4639^{cd} \pm 0.0008$
200 ppm BHT	$1.4629^{a} \pm 0.0013$

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); *Mean value of refractive index for five months Standard Deviation. EGE: Ethanol Ginger Extract; WGE: Water Ginger Extract, BHT: Butylated Hydroxyl Toluene.

oil was within the acceptable standard at the level of additive used, it means that the addition of the additives does not adulterate the oil.

Table 2 depicts the free fatty, acid value and peroxide value of crude peanut oil stored with ginger extracts and BHT for five months. The table shows the value for each month as well as the mean values with its standard deviation. Table 2.1 shows free fatty acid of crude peanut oil store with ginger extracts and BHT for five months. Table 2.2 indicates acid values of crude peanut oil store with ginger extracts and BHT for five months. Table 2.3 presents peroxide values of crude peanut oil store with ginger extracts and BHT for five months. The average values of FFA, AV and PV for each treatment were presented clearly in Table 3 for discussion to assess the overview of the effect of the additives on the crude peanut oil.

Table 2. *Free fatty acid, acid value and peroxide values of crude peanut oil store with ginger extracts and BHT for five months.*

(2.1) Free fatty acid (% oleic acid) of crude peanut oil store with ginger extracts and BHT for five months.

Months	0	1	2	3	4	5	Mean	Standard Deviation
Control (0 ppm)	0.6267	0.9400	0.9400	0.9400	0.9400	1.2533	0.9400	0.1982
200 ppm EGE	0.6267	0.7833	0.7833	0.9400	0.9400	0.9400	0.8356	0.1279
400 ppm EGE	0.6267	0.7833	0.9400	0.9400	0.9400	0.9400	0.8617	0.1311
600 ppm EGE	0.6267	0.7833	0.9400	0.9400	0.9400	0.9400	0.8617	0.1311
800 ppm EGE	0.6267	0.7833	0.9400	0.9400	0.9400	0.9400	0.8617	0.1311
1000 ppm EGE	0.6267	0.9400	0.9400	0.9400	0.9400	0.9400	0.8878	0.1279
200 ppm WGE	0.6267	0.7833	0.9400	0.9400	0.9400	1.2533	0.9139	0.2082
400 ppm WGE	0.6267	0.9400	0.9400	0.9400	0.9400	0.9400	0.8878	0.1279
600 ppm WGE	0.6267	0.9400	0.9400	0.9400	0.9400	0.9400	0.8878	0.1279
800 ppm WGE	0.6267	0.7833	0.9400	0.9400	0.9400	1.2533	0.9139	0.2082
1000 ppm WGE	0.6267	0.7833	0.9400	0.9400	0.9400	0.9400	0.8617	0.1311
200 ppm BHT	0.6267	1.0967	1.2533	1.2533	1.2533	1.2533	1.1228	0.2510

NOTE: EGE: Ethanol Ginger Extract; WGE: Water Ginger Extract, BHT: Butylated Hydroxyl Toluene.

(2.2) Acid value (mg KOH/g oil) of crude peanut oil store with ginger extracts and BHT for five months.

Months	0	1	2	3	4	5	Mean	Standard Deviation
Control (0 ppm)	1.2469	1.8703	1.8703	1.8703	2.4938	2.4938	1.9742	0.4693
200 ppm EGE	1.2469	1.2469	1.5586	1.8703	1.8703	1.8703	1.6106	0.3065
400 ppm EGE	1.2469	1.5586	1.8703	1.8703	1.8703	1.8703	1.7145	0.2608
600 ppm EGE	1.2469	1.5586	1.8703	1.8703	1.8703	1.8703	1.7145	0.2608
800 ppm EGE	1.2469	1.5586	1.8703	1.8703	1.8703	1.8703	1.7145	0.2608
1000 ppm EGE	1.2469	1.8703	1.8703	1.8703	1.8703	1.8703	1.7664	0.2545
200 ppm WGE	1.2469	1.5586	1.8703	1.8703	2.4938	2.4938	1.9223	0.4994
400 ppm WGE	1.2469	1.2469	1.8703	1.8703	1.8703	1.8703	1.6625	0.3219
600 ppm WGE	1.2469	1.8703	1.8703	1.8703	1.8703	1.8703	1.7664	0.2545
800 ppm WGE	1.2469	1.5586	1.8703	1.8703	1.8703	2.4937	1.8184	0.4143
1000 ppm WGE	1.2469	1.5586	1.8703	1.8703	1.8703	1.8703	1.7145	0.2608
200 ppm BHT	1.2469	2.1821	2.4938	2.4938	2.4938	2.4938	2.2340	0.4994

NOTE: EGE: Ethanol Ginger Extract; WGE: Water Ginger Extract, BHT: Butylated Hydroxyl Toluene.

(2.3) Peroxide values (meqO_2/Kg oil) of crude peanut oil store with ginger extracts and BHT for five months.

Months	0	1	2	3	4	5	Mean	Standard Deviation
Control (0 ppm)	5.3333	8.8889	16.6667	17.7778	27.7778	61.1111	22.9259	20.2676
200 ppm EGE	5.3333	10.5556	13.3333	22.2222	27.7778	33.3333	18.7593	10.7956
400 ppm EGE	5.3333	6.1111	8.8889	16.6667	22.2222	38.8889	16.3519	12.8410
600 ppm EGE	5.3333	5.5556	15.5556	16.6667	22.2222	33.3333	16.4445	10.5970
800 ppm EGE	5.3333	6.1111	13.3333	16.6667	38.8889	38.8889	19.8704	15.3431
1000 ppm EGE	5.3333	9.4444	27.7778	27.7778	31.1111	33.3333	22.4630	11.9362
200 ppm WGE	5.3333	7.2222	11.1111	22.2222	22.2222	50.0000	19.6852	16.5329
400 ppm WGE	5.3333	5.5556	15.5556	16.6667	27.7778	27.7778	16.4445	9.99754
600 ppm WGE	5.3333	5.5556	13.3333	22.2222	33.3333	44.4444	20.7037	15.7827
800 ppm WGE	5.3333	5.3333	11.1111	13.3333	33.3333	38.8887	17.8888	14.5705
1000 ppm WGE	5.3333	8.3333	8.8889	16.6667	27.7778	55.5556	20.4259	19.0231
200 ppm BHT	5.3333	5.3333	16.6667	22.2222	24.4444	33.3333	17.8889	11.1091

NOTE: EGE: Ethanol Ginger Extract; WGE: Water Ginger Extract, BHT: Butylated Hydroxyl Toluene.

Table 3. *Mean values of some selected quality properties of crude peanut oil stored with varying concentration of ethanol and water ginger extract and 200 ppm BHT for a period of five months.*

Concentration of Additive	*Free Fatty Acid (FFA) (% Oleic acid)	*Acid Value (AV) (mg KOH/g Oil)	*Peroxide Value (PV) (meqO_2/Kg Oil)
No additive (0 ppm)	0.9400^{d} ± 0.1982	1.9742^{d} ± 0.4693	22.9259^{e} ± 20.2676
200 ppm EGE	0.8356^{a} ± 0.1279	1.6106^{a} ± 0.3064	18.7593^{b} ± 10.7956
400 ppm EGE	0.8617^{b} ± 0.1311	1.7145^{b} ± 0.2608	16.3519^{a} ± 12.8410
600 ppm EGE	0.8617^{b} ± 0.1311	1.7145^{b} ± 0.2608	16.4445^{a} ± 10.5970
800 ppm EGE	0.8617^{b} ± 0.1311	1.7145^{b} ± 0.2608	19.8704^{c} ± 15.3431
1000 ppm EGE	0.8878^{bc} ± 0.1279	1.7664^{bc} ± 0.2545	22.4630^{e} ± 11.9362
200 ppm WGE	0.9139^{c} ± 0.2082	1.9223^{c} ± 0.4994	19.6852^{c} ± 16.5329
400 ppm WGE	0.8878^{bc} ± 0.1279	1.6625^{bc} ± 0.3219	16.4445^{a} ± 9.9975
600 ppm WGE	0.8878^{bc} ± 0.1279	1.7664^{bc} ± 0.2545	20.7037^{d} ± 15.7827
800 ppm WGE	0.9139^{c} ± 0.2082	1.8184^{c} ± 0.4143	17.8888^{ab} ± 14.5705
1000 ppm WGE	0.8617^{b} ± 0.1311	1.7145^{b} ± 0.2608	20.4259^{d} ± 19.0231
200 ppm BHT	1.1228^{e} ± 0.2509	2.2340^{e} ± 0.4994	17.8888^{ab} ± 11.1092

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);*Mean value of quality properties for five months ± Standard Deviation. EGE: Ethanol Ginger Extract; WGE: Water Ginger Extract, BHT: Butylated Hydroxyl Toluene.

Mean values of some selected quality properties of crude peanut oil stored with varying concentration of ethanol and water ginger extract and 200 ppm BHT for a period of five months is presented in Table 3. The three selected quality parameters are free fatty acid (FFA), acid value (AV) and peroxide value (PV) and these parameters are indices of hydrolytic and oxidative rancidity of edible oils. The FFA and AV measures the hydrolytic rancidity; and high values of these parameters in edible oils result in loss of nutritive value, undesirable toughening of tissue and loss of water holding capacity [15] while the PV measures the oxidative rancidity of vegetable oils which is an indication of the presence of hydroperoxides that are the primary products of lipid peroxidation [15,17,27]. The FFA of crude peanut oil stored without additive (control (0 ppm)) and with 200 ppm BHT is 0.9400 ± 0.1982 and 1.1228 ± 0.2509% oleic acid accordingly and these values are significantly different at P<0.05. Crude peanut oil stored with EGE and WGE had FFA ranges from 0.83555 ± 0.1279 to 0.8878 ± 0.1279% oleic acid; and 0.8617 ± 0.1311 to 0.9139 ± 0.2082% oleic acid respectively. There was no significant difference at P<0.05 for FFA of oil stored with 400 ppm, 600 ppm and 800 ppm EGE and 1000 ppm WGE; 1000 ppm EGE, 400 ppm and 600 ppm WGE; and 200 ppm and 800 ppm WGE. Crude peanut oil containing ginger extract had lower FFA values than that which contained no additive (control) and 200 ppm BHT. The AV of crude peanut oil stored without additive (control (0 ppm)) and with 200 ppm BHT is 1.9742 ± 0.4693 and 2.2340 ± 0.4994 mg KOH/g oil accordingly and these values are significantly different at P<0.05. Crude peanut oil stored with EGE and WGE had AV ranges from 1.61606 ± 0.3064 to 1.7664 ± 0.2545 mg KOH/g oil; and 1.7145 ± 0.2608 to 1.8184 ± 0.4143 mg KOH/g oil respectively. There was no significant difference at P<0.05 for AV of oil stored with 400 ppm, 600 ppm and 800 ppm EGE and 1000 ppm WGE; 1000 ppm EGE, 400 ppm and 600 ppm WGE; and 200 ppm and 800 ppm WGE. Crude peanut oil containing ginger extract had lower AV than that which contained no additive (control) and 200 ppm BHT. It is noted that EGE is superior to WTE against hydrolytic rancidity of crude peanut oil.

The PV of crude peanut oil containing no additive and 200 ppm BHT are 22.9259 ± 20.2676 and 17. 8888 ± 11.1092 mEq O_2/Kg oil while oil sample containing varying concentrations of EGE had PV ranged from 16.3519 ± 12.8410 to 22. 4630 ± 11.9362 mEq O_2/Kg oil. And 16.4445 ± 9.9975 to 20.7037 ± 15.7827 mEq O_2/Kg oil were the range of PV of crude peanut oil containing varying concentrations of WTE. There was no significant difference at P<0.05 for PV of oil stored with 400 ppm and 600 ppm EGE and 400 ppm WGE; 800 ppm WTE and 200 ppm BHT; 800 ppm EGE and 200 ppm WGE; and 600 ppm and 1000 ppm WGE. Oil samples containing EGE and WTE had lower PV than the control while oil samples containing 400 ppm, 600 ppm EGE and 400 ppm WTE had lower PV that oil sample containing 200 ppm BHT. Edible oils with lower PV are safer for consumption because it is more oxidatively stable hence little or no hydroperoxides have been formed in such oils. It is observed that crude peanut oil containing water ginger extract had lower PV than those containing ethanol ginger extract for the five months of storage. Therefore, water ginger extract is more effective in combating oxidative rancidity of crude peanut oil than ethanol ginger extract.

Conclusion

Water and ethanol extracts of ginger are effective in preventing both hydrolytic and oxidative rancidity of crude peanut oil. And these extracts are more effective than 200 ppm BHT in combating hydrolytic rancidity. Ginger extracts at 400 ppm served as better antioxidants than 200 ppm BHT against oxidative rancidity of crude peanut oil. Water ginger extract is more effective than ethanol ginger extract against hydrolytic rancidity of crude peanut oil while the latter was more effective than the former against oxidative rancidity of the oil. In furtherance of this research, it is therefore suggested that the antioxidant potential of ginger extracts can be investigated on other crude and refined edible oils and the duration of storage can also be extended to one year. Antioxidant and phytochemical characterization of these extracts may be probed into in order to ascertain the active ingredients in them which enhance their performance in preserving crude peanut oil against hydrolytic and oxidative rancidity.

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