Original Research

Volume 5, Issue 2, pp 24-30, September, 2023

ACHIEVERS JOURNAL OF SCIENTIFIC RESEARCH

Opecn Access Publications of Achievers University, Owo

Available Online at *www.achieversjournalofscience.org*

Antioxidative Effects of Sweet Potato *(Ipomoea Batata)* Tuber Peels and Leaves on Crude Groundnut Oil.

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Submitted: July 12, 2023, Revised: August 25, 2023, Accepted: September 02, 2023, Published: September 28, 2023

Abstract

The aim of the research is to examine antioxidative effects of solvent extracts of potato leaves and tuber peels on groundnut oil stored under accelerated conditions. Sweet potato tuber peels (orange specie) and leaves were obtained, washed, dried, ground, and sieved with 40 mm mech and separately extracted with three different solvents (acetone, ethanol, ethyl acetate) for 72 hours. The efficiency of each solvent was determined as percent extractive value. The first two highest solvent extracts for potato peels and leaves were added as additives to the crude groundnut oil (CGO) at varying proportions (200 - 1000 ppm). A sample of oil containing no additives and sample with butylated hydroxyltoluene (BHT 200 ppm) were set aside for comparison. The progression of oxidation was followed by measuring the free fatty acid (FFA), acid value (AV) and peroxide value (PV) of the oils fortnightly for a period of eight weeks. Ethanol had the highest extractive values of 4.1667 ± 0.057 and 6.4667 ± 0.6807 for leaves and peels respectively. The FFA, AV, and PV of the CGO with plant extracts were 1.952, 3.885 and 0.613 while CGO with BHT were 2.14, 4.476, and 0.736 respectively at $P < 0.05$. This study showed that potato tuber peels and leaves had good antioxidant potential and therefore recommended to be utilized in our edible oil industries as an alternative to synthetic antioxidants.

Keywords: Antioxidative, sweet potato, groundnut oil, Free fatty acids.

1.0 Introduction

Edible oils are commonly used in industrial food manufacturing and home cooking worldwide and they are the primary source of unsaturated fats and vitamin E in human diets. However, as with all food products, there is the potential for potentially toxic contaminants to occur in oils (MacMahon *et al*., 2016). Lipid oxidation is the main mechanism of deterioration of vegetable oils, which causes nutritional and sensory losses due to the formation of lipid oxidation products (Echegaray *et al*., 2021). There are various factors responsible for the deterioration of oils. The entrance of oxygen (oxidation) to the oil primarily gets the food (in this case oil) contaminated (rancid). Oxidation may be inhibited by various methods including prevention of oxygen access, use of lower temperature, inactivation of enzymes catalysing oxidation, reduction of oxygen pressure, and the use of suitable packaging. Another method of protection against oxidation is to use specific additives which are called oxidation inhibitors, otherwise known as antioxidants. These antioxidants can be synthetic or natural. And they

represent a class of substances that vary widely in chemical structure, and have diverse mechanisms of action (Nguye *et al*., 2019).

Synthetic antioxidants such as Butylated hydroxytoluene (BHT) and Butylated hydroxylanisole (BHA) exhibits toxic and carcinogenic effects (Frankel and Meyer, 2000). Natural antioxidatives substances from poly phenols of plants and herbs will be safer and will have health benefits compared to synthetic antioxidants. Sweet potatoes have been found by Akyol *et al*. (2016) to contain polyphenols useful in this regard.

Sweet Potato (*Ipomoea batatas*) is large, starchy and sweet-tasting plant that are grown worldwide. The young shoots and leaves are sometimes eaten as greens. They come in a variety of sizes and colours — including orange, white, and purple — and are rich in vitamins, minerals, antioxidants, and fibre. Previous research investigated the agricultural and health benefits of potatoes and related implications, such as antibiotic, anticancer, and antioxidant properties (Brown, 2005).). In particular, the potato peel contains a rich source of phenolic compounds (Akyol *et al*., 2016). Potato peels are a great source of phenolic compounds because almost 50% of phenolics are located in the peel and adjoining tissues. Phenolic compounds are synthetized by the potato plant as a protection response from bacteria, fungi, viruses, and insects. Polyphenols are one of the largest antioxidant groups and are considered the most numerous antioxidants in our diet. They have a diverse structure, molecular weight, physical, biologic and chemical properties. The potatoes are the most important source of polyphenols after apples and oranges, which contain on average–160 mg·100 g−1 of fresh weight (Mystkowka *et al*., 2020).

Groundnut oil is part of the inevitable household consumables. It however get deteriorated (rancid) with time if not well preserved. Food industries make use of synthetic antioxidants in other to retard fat oxidation. Consumers wished to have these additives replaced by natural materials, which were considered to be more acceptable as dietary components. Industrial producers have tried to comply with consumers' wishes, and have moved to increased use of natural antioxidants. Most natural antioxidants are common food components, and have been used in the diet for many thousands of years so that humans have adapted to their consumption (Akyol *et al*., 2016).

Antioxidants rich foods and ingredients are an important component of the food industry and thus reconsidering the health implications of adding antioxidants to foods require unfathomable investigations, which this study aims at unravelling with the use of leaves and tuber peels of sweet potato on groundnut oil using ethanol, ethyl acetate and acetone as the solvents for extraction.

2.0 Material and Methods

2.1 Sources of Materials

Sweet potato tuber (orange specie) and leaves were purchased from Ogbese farm along Akure Express Road, Ondo State. The crude groundnut oil was purchased from groundnut cake (*Kulikuli*) producer being their side product in Akure.

All chemicals used were analytical grade with the highest purity available (99.5%) and procured from Sigma Alderich, USA.

2.2 Preparation and Extraction of Sweet Potato Tuber Peels and Leaves

Potato peels and leaves were washed, cut into smaller pieces for easy air-drying. The dried peels and leaves were ground separately using electric blending machine (Marlex Excella) and sieved with 40mm mesh size. The powdered sample was divided into portion packed in tight containers labelled prior to extraction. Ten (10g) of each sample was extracted separately with 100mL of each solvent (acetone, ethanol, ethyl acetate) for 72hours during which it was intermittently shaken with hand.

The extract was separated from the solvents with the use of filter paper. The extract was put inside petri dish. Each extract was exposed to air and disolventized within 12 hours. The extracts obtained with each solvent were weighed to determine the extractive values of each solvent for leaves and tuber peels of sweet potatoes (Arawande *et al*., 2015).

2.3 Addition of Additives to Edible Oils

Extracts of sweet potatoes peels and leaves at varying concentration (200 ppm to 1000 ppm) were added to 100 g of each of the groundnut oil samples inside transparent glass bottles (heat resistance), these were thoroughly shaken for homogeneity.

The groundnut oil containing synthetic additives 200 ppm butylated hydroxyltoluene (BHT) and a control (groundnut oil without any additives) were set out for comparison.

After the addition of the extracts, the transparent glass bottles of oil were kept in the fume cupboard uncovered, for the period of eight (8) weeks.

2.4 Determination of Peroxide Value

Between 5 to 10 g of groundnut oil sample was weighed into a 250 mL white conical flask. 30 mL of glacial acetic acid and chloroform mixture (3:2) was added into the flask, 0.5 mL saturated potassium iodide was added and it was agitated for one minute, then 10mL of distilled water was added, the resulting solution was titrated with 0.01M of $Na_2Si_2O_3$ and vigorous stirring until the yellow colour precipitate is about disappearing.

Thereafter 0.5 mL of 1% starch solution was added and the titration was continued until the blue black just disappeared. The blank determination was also carried out also. Peroxide value in milli equivalent oxygen per kilogram was calculated from:

$$\text{Peroxide value} = \frac{Titre\ value \times Conc\ KOH \times 100}{Weight\ of\ the\ sample}$$

The peroxide value of the oil sample were determined fortnightly for a period of eight weeks (Arawande *et al*., 2018).

2.5 Determination of Acid Value and Free Fatty Acid

About 25mLof ethanol was put in a conical flask, two drops of phenolphthalein were added and titrated with few drops of potassium hydroxide until faint pink colour appeared. A known weight of sampled oil was added, the mixture was placed on an heated hot plate and it was allowed to boil. Thereafter, it was cooled and two drops of Phenolphtalein indicator was added, and this was titrated with 0.1M potassium hydroxide until it reached pink colour that persisted for 30 seconds.

$$\text{Free fatty acid} = \frac{Titre\ value \times Conc\ of\ KOH \times Z}{Weight\ of\ the\ oil}$$

$$\text{Acid value} = \frac{Titre\ value \times Conc\ of\ KOH \times 56.11}{Weight\ of\ the\ oil}$$

The Free fatty acid and Acid values of the oil sample were determined fortnightly for a period of eight weeks (Arawande *et al.*, 2021).

2.6 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).

3.0 Results and Discussion

The extractive values of the sample extracts were expressed in percentages and is presented in table 3.1. Table 3.1 depicts the extractive value (% yield) of potato peels and leaves. It was clear that different solvents used for the extraction of potato peels and leaf had different abilities to extract bioactive components from both the leaves and peels. Acetone had the lowest yield of 2.4667 ± 0.2309 and 2.500 ± 0.2646 for potato leaves and tuber peels respectively. Ethanol had

the highest extractive values of 4.1667 ± 0.057 and 6.4667 ± 0.6807 for potatao leaves and tuber peels respectively. Ethyl acetate had the extractive value of 4.000 ± 0.2646 and 4.60 ± 0.1732 for potato leaves and tuber peels respectively. From the result obtained above, potato tuber peels gave higher yield than leaves in all the three solvents (Ethyl acetate, Ethanol, Acetone) used.

Table 3.1: Percentage yields and some physical properties of extractions carried out on potato peel and leaf.

Sample	Solvent		
	Ethyl Acetate	**Acetone**	**Ethanol**
Sweet Potato Peels	$4.6000^{b} \pm 0.1732$	$2.5000^{a} \pm 0.2646$	$6.4667^{c} \pm 0.6807$
Sweet Potato Leaves	$4.0000^{b} \pm 0.2646$	$2.4667^{a} \pm 0.2309$	$4.1667^{b} \pm 0.0577$

Note: Within each column, mean values followed by the same superscript are not significantly different at $P < 0.05$ Duncan's New Multiple Range Test (DMRT); Values represent triplicate determination ±standard deviation.

Table 3.2: Mean Value of Free Fatty Acid (FFA) of Groundnut Oil Stored with Varying Concentrations of Plant Extracts and 200 ppm BHT over a Period of Eight Weeks

Additives	Concentrations					
	Results ± Standard Deviation					
	0 ppm	200 ppm	400 ppm	600 ppm	800 ppm	1000 pm
	$2.930^{c} \pm 0.709$	$2.250^{abc} \pm 0.287$				
GLEA	$2.930^{c} \pm 0.709$	$2.146^{ab} \pm 0.141$	$2.029^{a} \pm 0.396$	$1.952^{a} \pm 0.546$	$2.269^{abc} \pm 0.273$	$2.883^{bc} \pm 1.041$
GLE	$2.930^{c} \pm 0.709$	$2.137^{ab} \pm 0.282$	$2.146^{ab} \pm 0.537$	$2.092^{a} \pm 0.314$	$2.190^{ab} \pm 0.521$	$2.134^{ab} \pm 0.465$
GPEA	$2.930^{c} \pm 0.709$	$2.622^{abc} \pm 1.148$	$2.194^{ab} \pm 0.325$	$2.159^{ab} \pm 0.277$	$2.134^{ab} \pm 0.213$	$2.097^{a} \pm 0.361$
GPE	$2.930^{c} \pm 0.709$	$2.128^{ab} \pm 0.379$	$2.144^{ab} \pm 0.281$	$2.266^{abc} \pm 0.253$	$2.207^{ab} \pm 0.509$	$2.143^{ab} \pm 0.272$

NOTE: Within each column, mean values followed by the same superscript are not significantly different at $P < 0.05$ Duncan's New Multiple Range Test (DMRT); Values represent determination ±standard deviation. GBHT – Groundnut Butylaytedhydroxotoluene, GLEA – Groundnut oil Leaf ethyl acetate extract, GLE – Groundnut oil Leaf ethanol extract, GPEA –Groundnut oil Peel ethyl acetate extract, GPE – Groundnut oil Peel ethanol extract

3.1 Effects of Plants Additives on Free Fatty Acid of Crude Groundnut Oil

Table 3.2 demonstrated the trend in FFA of crude groundnut oil stored with varying concentrations (200 ppm - 1000 ppm) of ethyl acetate and ethanol extracts of sweet potato tuber peels and leaves and 200 ppm BHT on fortnight bases for a period of eight weeks.

There was better performance of the plant extracts on the crude groundnut oil than 200 ppm

BHT as shown by the FFA value observed. The best performance was observed at 200 ppm LEA extracts with FFA value of 2.029 $\pm$ 0.39. Likewise values of FFA observed on groundnut oil preserved with peel extracts showed a better performance compared with groundnut oil preserved with BHT. There were significant differences ($P < 5$) at all varying concentrations (200 ppm to 1000 ppm) with PEA extract. The FFA values decreased with an increase in concentrations of PEA extract.

3.2 Effects of Sweet Potato Leaves and Tuber Peels Extract on Acid Value of Crude Groundnut Oil.

Table 3.3 revealed the mean value of acid value of crude groundnut oil stored with varying concentrations of plant extracts and 200 ppm BHT over a period of eight weeks. The leaf extracts had an excellent performance of antioxidant effects on the crude groundnut oil. LEA 400 ppm gave maximum performance in the acid value of crude groundnut oil.

With leaf extracts, there was good performance at 600ppm compared with other concentrations, the acid values obtained here was lower than 200 ppm BHT and 0 ppm (no additives). Potato leaf extracts gave better performance of lower acid value than potato tuber peel extract.

With peel extracts, antioxidants effects was at peak in preventing hydrolytic rancidity in higher concentrations of 1000 ppm compared with 200 ppm concentrations. The performance of plant extracts on the groundnut oil was similar to the effects of Oregano extract and hyssop extract on sunflower oil by Abdalla and Roozen (1999). They reported an acid value lower than both oil control and 200ppm BHT.

Table 3.3: Mean Value of Acid Value (AV) of Groundnut Oil Stored with Varying Concentrations of Plant Extracts and 200 ppm BHT over a Period of Eight Weeks

Additives	Concentrations					
	0 ppm	200 ppm	400 ppm	600 ppm	800 ppm	1000 pm
GBHT	$5.873^{c}\pm1.472$	$4.476^{abc}\pm0.569$				
GLEA	$5.873^{c}\pm1.472$	$4.271^{ab}\pm0.280$	$4.034^{a}\pm0.795$	$3.885^{a}\pm1.086$	$4.520^{abc}\pm0.544$	$5.746^{bc}\pm2.095$
GLE	$5.873^{c}\pm1.472$	$4.173^{a}\pm0.512$	$4.277^{ab}\pm1.057$	$4.178^{a}\pm0.636$	$4.282^{ab}\pm1.005$	$4.247^{ab}\pm0925$
GPEA	$5.873^{c}\pm1.472$	$5.216^{abc}\pm2.284$	$4.366^{ab}\pm0.643$	$4.293^{ab}\pm0.546$	$4.245^{ab}\pm0.424$	$4.174^{a}\pm0.718$
GPE	$5.873^{c}\pm1.472$	$4.258^{ab}\pm0.749$	$4.273^{ab}\pm0.541$	$4.509^{abc}\pm0.503$	$4.390^{ab}\pm0.008$	$4.265^{ab}\pm0.539$

NOTE: Within each column, mean values followed by the same superscript are not significantly different at $P < 0.05$ Duncan's New Multiple Range Test (DMRT); Values represent determination ±standard deviation. GBHT – Butylatedhydroxyltoluene, GLEA – Groundnut oil Leaf Ethyl Acetate, GLE - Groundnut oil Leaf Ethanol, GPEA - Groundnut oil Peel Ethyl Acetate, GPE - Groundnut oil Peel Ethanol.

3.3 Effects of Sweet Potato Leaves and Tuber Peels Extract on Peroxide Value of Crude Groundnut Oil

Table 3.4 revealed the mean value of peroxide value of crude ground nut oil stored with varying concentrations of plant extracts and 200 ppm BHT over a period of eight weeks. It can be seen from the table that the peel extracts was more effective in controlling formation of peroxyl radicals in groundnut oil. Peroxide value from PEA is lower than BHT and 0 ppm (no additives). Maximum performance was obtained with 200 ppm of PEA. Ethyl acetate Peel extracts was the most active on the crude groundnut oil. There was no significant difference in the peroxide values at all concentrations.

There was no significant difference in the peroxide values at all concentrations.

Table 3.4: Mean Value of Peroxide Value (PV) of Groundnut Oil Stored with Varying Concentrations of Plant Extracts and 200 ppm BHT over a Period of Eight Weeks

Additives	Concentrations					
	0 ppm	200 ppm	400 ppm	600 ppm	800 ppm	1000 pm
GBHT	$0.789^{a}\pm0.579$	$0.736^{a}\pm0.597$				
GLEA	$0.789^{a}\pm0.579$	$0.820^{a}\pm0.583$	$0.852^{a}\pm0.606$	$0.992^{a}\pm0.515$	$0.890^{a}\pm0.577$	$0.817^{a}\pm0.617$
GLE	$0.789^{a}\pm0.579$	$0.613^{a}\pm0.672$	$0.844^{a}\pm0.575$	$0.872^{a}\pm0.604$	$0.860^{a}\pm0.635$	$0.846^{a}\pm1.641$
GPEA	$0.789^{a}\pm0.579$	$0.633^{a}\pm0.652$	$0.765^{a}\pm0.620$	$0.708^{a}\pm0.628$	$0.634^{a}\pm0.661$	$0.617^{a}\pm0.667$
GPE	$0.789^{a}\pm0.579$	$0.804^{a}\pm0.591$	$0.805^{a}\pm0.601$	$0.824^{a}\pm0.582$	$0.705^{a}\pm0.638$	$0.926^{a}\pm0.779$

NOTE: Within each column, mean values followed by the same superscript are not significantly different at $P < 0.05$ Duncan's New Multiple Range Test (DMRT); Values represent determination ±standard deviation. BHT – Butylated hydroxyltoluene, GLEA – Groundnut oil Leaf Ethyl Acetate, GLE - Groundnut oil Leaf Ethanol, GPEA - Groundnut oil Peel Ethyl Acetate, GPE - Groundnut oil Peel Ethanol.

4.0 Conclusion and Recommendation

Ethanol, Acetone and Ethyl Acetate were used in this study to extract potato peel and leaf. Ethanol, because of its polarity gave highest yield of 6.47 ± 0.6807 and 4.1667 ± 0.0577 for potato and leaf extract, while Acetone, gave the least yield of 2.5000 ± 0.2646 and 2.4667 ± 2.4667. The yield obtained from potato tuber peels was higher than potato leaves. Ethanol and Ethyl acetate extracts from peels and leaf were only considered for this study and they were effective antioxidants against hydrolytic and oxidative rancidity of crude groundnut oil. The two extracts from peel and leaf contained antioxidants phytochemicals that can scavenge radicals and prevent formation of peroxyl radicals that are responsible for oil rancidity.

The acid value, fatty acid value and peroxide value were determined in varying concentration on groundnut oil at fortnight for eight weeks. The FFA values were greatly low in groundnut oil. Peels extract on groundnut oil proved to be excellent additives against hydrolytic rancidity.

PEA Extracts on groundnut oil are superior at higher concentration (very low PV at 1000 ppm) against peroxides formation. Potato peels extract was more effective in all concentrations than the leaf extract.

In conclusion, this study has been able to add to the body of knowledge with the confirmation of ethanol as an effective solvent in extracting phenolic compounds in sweet potatoes; extension of knowledge on the relevance of sweet potato leaves and tuber peels as antioxidant; potential reduction of waste and pollution with industrial use of potato leaves and peels; and importantly consumption promotion of sweet potato as edible plant potent to reduce stress.

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