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Fats, Oils and Oil Fruits Processing Evaluation of the Physico-Chemical Characteristics and Oxidative/Hydrolytic Stabilities of Oils of African Pear (*Dacryodes edulis*) and Bullet Pear (*Canarium schweinfurthi*) Fruits

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ABSTRACT

The physic-chemical characteristics and Oxidative/Hydrolytic stabilities of oils of African pear and Bullet peat fruits were studied. African pear fruit (APF) and Bullet pear fruit (BPF) oils were greenish yellow in colour. The saponification, unsaponifiable matter and specific gravity values of APF oil were greater than those of BPF oil. APF oil has more saturated fatty acids as its iodine value (49.40mg/100g) was smaller than that of BPF oil (75.12mg/100g). The exposure of the oils to atmospheric condition for nine weeks changed the free fatty acid values of APF and BPF oils, respectively from 0.06 and 0.09mg/g in the first week to 5.87 and 4.06mg/g in the ninth week. At the same period of exposure to atmospheric condition, the APF oil showed faster rate of deterioration than BPF oil as the peroxide values were found to change from 0.60 – 18.50mg/kg for APF oil and 0.20 – 12.50mg/kg for BPF oil. The oxidative/hycholytic changes at accelerated condition (at the condition where the oils were heated at one hour intervals for total period of five hours) showed that the peroxide values changes from 0.90 – 7.10mg/kg for APF oil and 1.00 – 9.30mg/kg for BPF oil.

Keywords: African pear fruit oil, Bullet pear fruit oil, physico-chemical characteristics

INTRODUCTION

The African pear (*Dacryodes edulis*) and Bullet pear (*Canarium Schweinfurti*) are tropical forest trees which belong to the family of Burseraceae. They are widespread and are found in the forest and sometimes planted (Burkill, 1994). African and bullet pears are well known indigenous fruit trees of the tropical rainforest found in some Western and Central African countries (Nwanekezi and Onyeagba, 2007a; Burkill, 1994).

African pear is known in Nigeria by several tribal names such as 'Ube' (Igbo), 'Elemi' (Yoruba) and 'Oronu' (Bini). The Igbo name for bullet pear is 'Ube Ngba' and Ugandans calls it 'Muwafu'. The trade name for this pear is African Canarium or White Mahagony (Emebiri and Nwufor, 1990; Burkill, 1994).

The fruits of African pear are purplish-blue or purlish black in colour while that of bullet pear fruits is purplish. Both tree yield resinous aromatic gum from their cut barks. The fruits are characterized by central core surrounded by edible fleshy layers. The seeds of African pear fruits (APFs) are covered by leathering material, while the core of the bullet pear (BP) has no seed but a hard flutted object with sharp points at the apex (Onyeka *et al;* 2005; Ajiwe *et al*; 1997).

The principal value of African pear and bullet pear fruits lies in their acidic pulpy mesocarp which is softened by dipping in hot water. The African pear fruit is also softened in hot ash or grilled in oven. The dominant nutrient of African and bullet pear fruits is fat/oil, with African pear pulp containing about 33.5% fat (Onyeka *et al,*2005; Omoti and Okiy, 1987) and bullet pear 38.0% (Lilian, 1982).

African pear fruit like most fruits is highly perishable. Inspite of its low moisture content of 9 – 11% it has a short shelf life of 3 – 5days (Nwanekezie and Onyeagba, 2007a). Bullet pear with a moisture content of 21.3% is also highly perishable (Ajiwe *et al*; 1997).

Large quantities of both fruits are harvested between July and September, the fruits pulps are consumed but their seeds are thrown away and wasted, as they are more or less considered to have no recognized food and economic values. However, African pear seeds have been found to contain oil and protein and can be used as livestock feed in some places (Omoti and Okiy, 1987; Kapseu and Tchiengany, 1996).
African and bullet pear fruits having large percentage of oil could be used as sources of future industrial and edible oils. Most studies on the oils of APF and BPF were focused on their physical and

biochemical properties. Not much has been reported on the oxidative and hydrolytic stabilities of APF and BPF oils. Therefore this study was designed to assess and evaluate the physic-chemical characteristics as well as the hycholytic/oxidative stabilities of the two oils.

MATERIALS AND METHODS

Sample Collection

The fruits of *Canarium Schweinfurti* and *Dacryodes edulis* were purchased from Eke-Atta market in Ikeduru L.G.A of Imo –State Nigeria. The fruits, were fully ripped, fresh and wholesome, and were of different shapes and sizes.

Sample preparation/Extraction of oil

The bullet pear fruits and African pear fruits were separately sorted and cleaned to remove dirty and spoilt ones. The edible parts of the fruit were disloged from the seeds with a kitchen knife. These edible parts (or mesocarp) were pulped using Corona hand grinder (Molino Victoria brand). Oil extraction was carried out by solvent extraction using the method described by AOCs (2000). The solvent used was petroleum ether. During the extraction the pulped mesocarp of each fruit type was thoroughly mixed with petroleum ether in a bowl, covered and stored overnight. Muslin cloth was used to squeeze out the oil solution more extraction of oil was carried out on the cake using fresh petroleum ether. The pear oil was separated from petroleum ether by distillation which allowed the evaporating petroleum ether to be condensed and collected for reuse. The extracted oil was filled with little or no headspace into amber coloured bottles and tightly covered. The two fruit oils were subsequently subjected to various physical and chemical analysis.

Oxidation and Hydrolysis of Oil

Two 280ml reagent bottles containing 150g of each type were stoppered and covered with 100ml beakers. They were left outdoors (under ambient weather) on the balcony of a two storey building laboratory complex, whose temperature varied between 28°c – 38°c for 9 (nine) weeks.

The contents were opened every morning to admit air and at the same time water vapour. They were stirred once daily. On the 4th day of each week, samples were withdrawn from each of the bottles after stirring and used for analysis of free fatty acids and peroxide values using the method described by Pearson (1987). Each analysis were carried out in triplicate.

Accelerated Oxidation of Oil

Oxidation of the samples under accelerated oxidative condition was achieved by heating the samples at 100 ± 5°C in the atmosphere. Forty (40) grammes of each oil sample was accurately weighed into 50ml beaker and heated on a hot plate at 100 ± 5°C while stirring with a rod. At every one (1) hour interval during boiling, fraction (3mls) of the oil was taken to determine the peroxide value. The analysis was carried out at this hourly interval for a total period of 5hours. The hourly peroxide measurements for each sample were carried out in triplicate.

Physico-chemical Evaluations

The specific gravity, saponification value and iodine value were determined as described in standard methods of analysis (AOAC 2000). The unsaponifiable matters were determined as prescribed by Pearson (1987).

RESULTS AND DISCUSSION

The physico-chemical properties of African pear and bullet pear fruit oil are presented in table 1.

The saponification values of 198.03mg/g and 195.4mg/g were obtained respectively for African pear and bullet pear fruit oils. There saponification values are within the range of edible fats and oils as specified by NIS (1992). According to Charles and Guy (1999), oils with saponification values less than 190mg/g contain long chain fatty acids (high molecular weight acids) while those with saponification value above 200mg/g contain short chain fatty acids. The African pear and bullet pear fruits oils could be regarded as possessing short chain fatty acids as their saponification values are higher than 190mg/g and nearer to 200mg/g, and such oils are known for quick supply of dietary energy especially under emergency condition (Gurr, 1991).

The unsaponifiable matter for African pear fruit oil is 1.91% and that for bullet pear fruit oil is 1.83%. The two oils could be regarded as normally pure. Hoffman (1989) had earlier stated that most oils of normal purity contain less than 2% unsaponifiable matters. High values of unsaponifiable matter may indicate contamination and adulteration of the oils.

Therefore, lower values of unsaponifiable matters in the two pear fruit oils show that the oil will be good for producing high quality soap (NIS, 1992).The iodine value of bullet pear (BPF) oil is 75.12mg/100g and is higher than that of African pear fruit (APF) oil which is 49.40mg/100g. The iodine value recorded for BPF oil is in agreement with the range of (71.1 – 94.9mg/100g) obtained for the oil by Abeyah *et al;* (1991). The iodine value of 49.40mg/100g obtained for APF oil is similar to 49.53mg/100g value reported by Onyeka *et al;* (2005) for APF oil. Alternatively, oils with iodine value range of 25-50mg/100g are regarded as saturated, as they have low (few) numbers of double bonds (Philips, 2003). The iodine value of APF oil falls within this range. APF oil is therefore more saturated and may have higher melting point than BPF oil.

The specific gravity of oils extracted from African pears and bullet pear fruit were 0.928 and 0.921 respectively. The specific gravity of the two oils fall within specific gravity range of 0.921 – 0.947 as stated by AOCS (2000). Since specific gravity is useful in assessing oil purity; the two oil samples could be regarded as pure. The colour of the APF and BPF oils on extraction was greenish yellow, but after storage for few weeks, the APF oil changed to dark greenish yellow while that of BPF turned to light greenish brown.

The oxidative/hydrolytic changes occurring in the samples during nine (9) weeks of exposure to sunlight and oxygen are shown in table 2. The free fatty acid content of bullet pear oil in the first week of storage was 0.9mg/g and thus 15 times higher than 0.06mg/g recorded for African pear fruit oil. This could be due to long post-harvest storage of bullet pear before processing (extraction), unlike African pear fruits that are processed immediately after harvesting to avoid spoilage. The oxidative and hydrolytic reactions of APF and BPF oils were found to increase as the time of storage increased. These were confirmed by the increase in free fatty acid values of APF and BPF oil, which increased respectively from 0.06mg/g and 0.90mg/g in the first week to 5.89mg/g and 4.06mg/g in the ninth week of storage. The steady increase in free fatty acid contents of both oils showed that the oils were deteriorating in quality with increase in time of storage. Since the rate increase in free fatty acid values of fats/oils is a measure of the rate of increase in oxidative/hydrolytic rancidity, the result showed that oxidative/hydrolytic deterioration in APF oil was higher than that in BPF oil. Therefore BPF oil is more stable than APF oil when exposed to atmospheric or ambient condition.

The rate at which oxidative rancidity developed in APF oil was more than the rate it was found to develop in BPF oil within the nine weeks of storage of both oils. Even though APF oil was found to be less unsaturated than BPF oil, it recorded higher peroxide values compared to BPF oil. This was confirmed by the increase in peroxide values of APF and BPF oils which increased respectively from 0.60mg/kg and 0.20mg/kg in the first week to 18.50mg/kg and 12.50mg/kg in the ninth weeks of storage (Table 2). According to Lilian (1982) bullet pear contains 294mg/100g vitamin C, the antioxidant could extend the shelf life of pure unrefined vegetable oils for months (Badifu and Abbah, 1998). The faster rate of deterioration recorded for APF oil in storage (exposed) could have been promoted by heat, light, ionizing radiation, catalysts or enzymes (hpoxygenases) alone or in combination. BPF oil despite its higher unsaturation level was more stable probably because of the natural antioxidants it contains.

The results obtained for the samples under accelerated oxidative conditions are presented in table 3. The peroxide value of APF oil was 0.90mg/kg and that of BPF oil was 1.00mg/kg after one hour of heating the oils. It increase to 7.10mg/kg and 9.30mg/kg respectively after the oils had been subjected to 5hours of heating (oxidation). These results suggest that under any oxidizing conditions BPF oil is less stable than APF oil to lipoperoxidation process.

According to Ihekoronye and Ngoddy (1985), the rate of oxidation of fat/oil is greatly dependent upon the degree of unsaturation and high temperature is one of the accelerating factor, the BPF oil being more unsaturated was more susceptible to oxidation at higher temperature and this could have resulted to formation of more hydroperoxides as primary products than in heated APF oil.

CONCLUSION

African pear and bullet pear oils are suitable as both edible and industrial oils. Hydrolytic/oxidative process occurs faster in African pear fruit oil than bullet pear fruit oil at ambient condition. At accelerated oxidation, rancidity is faster in bullet pear fruit oil than African pear fruit oil.

Table 1: Physico-chemical properties of African pear fruit oil and Bullet pear fruit oil

Parameters	APF oil	BPF oil
Saponification value mg/g	198.03	195.4
Unsaponifiable matter (%)	1.91	1.83
Iodine value mg/100g	49.40	75.12
Specific gravity	0.928	0.921
Colour (oil)	Greenish yellow	Greenish yellow

Table 2: Oxidative/Hydrolytic Changes in APF and BPF Oils Exposed to Sunlight and Oxygen over a Period of Nine Weeks

Time of Storage (Weeks)	FFA(mg/g)APF Oil	FFA(mg/g)BPF Oil	Peroxide Value (mg/kg) APF Oil	Peroxide Value (mg/kg) BPF Oil
1.	0.06 ± 0.008[f]	0.90 ± 0.082[e]	0.60 ± 0.082[g]	0.20 ± 0.008[h]
2.	0.17 ± 0.014[f]	1.46 ± 0.058[de]	1.40 ± 0.082[f]	0.50 ± 0.008[gh]
3.	0.28 ± 0.022[e]	1.52 ± 0.016[de]	2.00 ± 0.356[e]	0.60 ± 0.025[g]
4.	0.85 ± 0.036[d]	1.63 ± 0.008[de]	2.70 ± 0.082[d]	1.40 ± 0.016[f]
5.	0.96 ± 0.028[d]	1.80 ±s 0.082[cd]	2.80 ± 0.082[d]	2.30 ± 0.082[e]
6.	2.54 ± 0.036[c]	2.25 ± 0.016[cd]	6.20 ± 0.082[c]	2.90 ± 0.041[d]
7.	2.59 ± 0.057[c]	2.59 ± 0.008[bc]	6.60 ± 0.082[c]	4.50 ± 0.071[c]
8.	4.06 ± 0.065[b]	3.38 ± 0.008[ab]	9.70 ± 0.082[b]	7.00 ± 0.216[b]
9.	5.87 ± 0.080[a]	4.06 ± 0.022[a]	18.50 ± 0.163[a]	12.50 ± 0.163[a]
LSD (P < 0.05)	**0.129**	**0.869**	**0.376**	**0.279**

Table 3: Changes in Peroxide Value of APF and BPF Oils Heated at 100° ± 5°C

Time (hours)	Peroxide Value (mg / kg)	
	APF oil	BPF oil
1.	0.90 ± 0.022[d]	1.00 ± 0.071[e]
2.	1.10 ± 0.071[d]	2.00 ± 0.036[d]
3.	1.90 ± 0.036[c]	3.10 ± 0.071[c]
4.	4.20 ± 0.071[b]	6.20 ± 0.057[b]
5.	7.10 ± 0.082[a]	9.30 ± 0.082[a]
LSD (P < 0.05)	**0.194**	**0.0202**

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