PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

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Pakistan Journal of Nutrition 10 (6): 558-560, 2011
ISSN 1680-5194

The Physical Properties of Pulp and Chemical Characteristics of Edible Oil Extracted from the Pulp of African Pear (*Dacryodes edulis*)

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Abstract: The physical examination of the fruit of African pear (*Dacryodes edulis*) selected from different parent trees was investigated, three-stage modified traditional method was used for the extraction of oil from the pulp and percentage yield was examined. The oil samples were characterized for physico-chemical properties. There was no significant difference ($p<0.05$) detected on some of the physical properties of the fruit and chemical characteristics of the extracted oil samples. The maximum values of physical parameters found were fruit weight 31±0.22 g, fruit length 6.64±0.1 cm, width II 2.86±0.1 cm and 18.9±0.12 g for pulp weight. The percentage oil yield range from 41-47%. The result of chemical properties showed a maximum of acid value 0.46 mgKOH/g, %FFA 0.26, saponification of 189.77 mgKOH/g, peroxide and iodine values of 22.75 mg/g and 37.11 wijs respectively. The oil physical properties discovered melting point of 78°C, smoke point of 185°C and flash point of 278°C. The results obtained in this study further reveal the potentials of oil from pulp of African pear as a substitute for conventional vegetable oil and industrial applications, since most of the values fells within the range of value for the reference standard.

Key words: African pear, edible oil, conventional vegetable oil

INTRODUCTION

African pear is well known plant in West African; the fruit is referred to as the "Ube" in the South-East of Nigeria, "Native pear" in Ghana, or "Safoutier" in Cameroon and "Bush butter" in many other areas of tropical regions of Africa. The tree of Africa pear is an evergreen oleiferous tropical fruit tree which grows in the humid and sub-humid climates of West and Central African Countries (Kengue, 2001). The fruit at maturity becomes bluish-black and more susceptible to injury and heavy losses at the advanced stage of maturity (Kapsue and Kayem, 1998). The fruit pulp and seed of African pear are well known for richness in protein, fat, fiber, mineral and essential amino acids (Kengue, 2001). Domestically, the fruits are gathered for household used such as eaten raw, boiled in hot water or roasted alongside with boiled or roasted corn.

Previous studies have shown the potential of the seed as a good source of vegetable oil with up to 18-70% oil yield (Rao, 1994). However, because of the fewer application of African pear in food processing, observation indicates post-harvest loss range between 40-60% of the total annual yield (Hill and Walter, 1988). In addition, due to high cost of vegetable oils in the market as a result of increase in demand that arise from the population growth, rising standard of living, as well as changes in consumer's preference arising partly from health consideration (Oresanya *et al*., 2000), there is need to source and evaluate many other materials for edible oil production. In current, a lot of interest is being focus on the possibility of exploiting the vast number of less familiar food plant sources existing in the wild (Rao, 1994). However, much has not been done towards utilization the pulp of African pear in food production.

The goals of this research were to investigate the most important physical properties of the fruit of African pear. To extract and examine the chemical characteristics of the oil samples from the pulp of African pear which could affect its utilization in commercial or mechanized oil extraction.

MATERIALS AND METHODS

Sample preparation and physical properties examination: Ripe African pear fruits were harvested from three parent trees from farms within three geopolitical zones of Imo State. The samples were collected in triplicates and labeled accordingly. The fruit was cleaned, sorted to remove spoilt ones. The fruits width I and II was measured using venire caliper, weight and length was determined using electronic beam balance and ruler respectively. The fruit was cut longitudinally to separate the pulp from the seed. Other physical properties of the fruit examined include pulp thickness (skin fold caliper); seed weight; pulp weight and seed/pulp ratio were examined.

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Oil extraction: Three-stage traditional method of oil extraction was developed and used in the processing of edible oil samples. Total weight of 1.2 kg of pulp was further cut into smaller pieces and package in air-tight cellophane bag for 12-24 h in the first stage. The softened pulp was mashed manually with mortar and pestle and transferred to a stainless bowl with subsequent addition 500 ml of boiled water to obtained oil-water emulsion. Cleaned Muslin cloth was used to separate the foaming liquor of oil and water from the mashed pulp in the second stage. While in the third stage, the oil-water emulsion was further separated by distillation process and the oil samples obtained were heated over a GallenKamp hot air oven to remove excess water. 10 ml of 0.2% sodium carbonate was used to degum the extracted oil at 70°C. The physic-chemical characteristics of the oil samples extracted were determined by the standard method of AOAC (2000).

RESULTS AND DISCUSSION

The physical parameters examined were shown in Plate 1 and significant difference ($p>0.05$) was observed in some of the physical properties of the fruits of African pear (*Dacryodes edulis*) selected from different parent trees as shown in Table 1. Fruit samples obtained from different trees varied in fruit weight which range from 16.1±0.1 g to 31.0±0.22 g; the fruit length range from 4.28±0.3 cm to 6.64±0.1 cm; the pulp thickness discovered range from 29±0.2 mm to 40±0.1 mm; the seed weight of the fruits are between 6.28±0.3 g and 13.0±0.1 g. While the pulp weight of the fruits varies from 14.7±0.3 g to 18.9±0.12 g. No significant difference ($p>0.05$) was observed on the width I and width II of the fruit samples (Plate 1) and values range from 2.6±0.2 to 2.84±0.1 cm and 2.6±0.3 to 3.2±0.1 cm for width II respectively. The pear gave consistently different in width (I and II) when measured from opposite sides, width II being higher than width I. This agrees with earlier report by Onuegbu and Ihediohanman (2008) which revealed that the transverse cross-section of African pear is not a perfect circle but oblong in shape with two opposite sides being of the same width. These variations in the physical properties of the fruit samples may be due to difference in the sources of the fruits. The fruit length, width (I and II) and pulp thickness of the fruit are important physical parameters especially in the fabrication of oil extraction unit that can handle the whole fruit. Sanni (1997) reported that value of various physical properties, aerodynamics, hydrodynamics and functional properties are determined and designated at the early stage of research and development. The pulp thickness is a good index for determining pulp yield per hectare of African pear.

There was no significant difference ($p>0.05$) in oil yield and chemical characteristics of the edible oil extracted from the pulp of African pear as presented on Table 2.

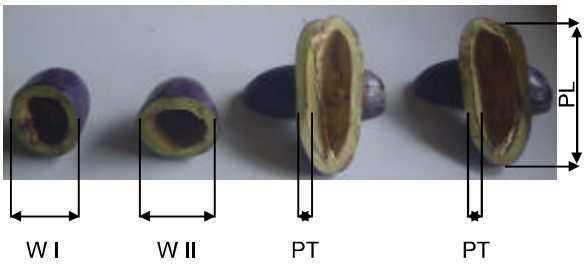

Plate 1: Physical properties of the pulp of African pear. W I = Width I of the pulp of African pear, W II = Width II of the pulp of African pear, PT = Pulp thickness of African Pear, PL = Pulp length of African pear

Table 1: Physical properties of African pear fruit obtained from three parent trees

Physical property	Parent Tree A	Parent Tree B	Parent Tree C
Weight (g)	25.60±0.4^{b}	16.10±0.1^{c}	31.00±0.22^{a}
Length (cm)	6.35±0.2^{a}	4.28±0.3^{b}	6.64±0.1^{a}
Width I (cm)	2.84±0.1^{a}	2.60±0.2^{a}	2.60±0.2^{a}
Width II (cm)	2.86±0.1^{a}	2.60±0.3^{a}	3.20±0.1^{a}
Pulp thickness (mm)	34.00±0.3^{b}	29.00±0.2^{c}	40.00±0.1^{a}
Seed weight (g)	10.90±0.2^{a}	6.28±0.3^{b}	13.00±0.1^{a}
Pulp weight (g)	14.70±0.3^{c}	9.82±0.3^{b}	18.90±0.12^{a}
Seed/pulp ratio	0.74±0.2^{a}	0.63±0.1^{a}	0.70±0.3^{a}

Each value represent mean of ten (10) replicate from each parent tree, ± standard deviation. Any two samples mean with different superscripts on the same row are different ($p<0.05$)

This implies that the variety of the African pear or location of the tree do not have any significant effect on the chemical characteristics of the oil extracted. The oil content of the pulp of the pear selected from different trees varied closely and the value range from 41-47% yield. The quantity discovered in this work agrees with the specification of Codex Alimentarius Commission of 20% content for edible oil (Pearson, 1970) and extracted oil samples were liquid at room temperature. This means that they could be classified as oil. The moisture content of the oil samples was found low and range from 0.46-0.58%. These values fall within the acceptable limit expected of edible oil. Lower moisture content of oils favours their shelf stability during storage Reference. The acid value and the free fatty acids fell within the range of 0.34-0.46 mgKOH/g and 0.17-0.26% palmitic acid respectively. The lower content of free acid in the oil samples could be attributed to the reduced hydrolytic activities and thereby producing oil that is more suitable and appealing for cooking. Champe and Harvey (1994) reported that acid value is a measure of the amount of free fatty acids and the extent to which the glyceride in the oil have been decomposed by lipase action. The low value recorded suggest good post-harvest handling of the raw material used and low level of moisture content in the oil samples. Coenen (1976) reported that abuse of raw material can increase the rate of hydrolysis and therefore lead to high %FFA above 5%.

Table 2: Chemical characteristics of edible oil extracted from the African pear samples

Chemical characteristics	Extracted oil sample A	Extracted oil sample B	Extracted oil sample C	Reference standards
Acid value (mgKOH/g)	0.34[a]	0.41[a]	0.46[a]	≤6.6
FFA as % Palmitic acid	0.17[a]	0.21[a]	0.26[a]	≤5.0
Saponification value (mgKOH/g)	180.89[a]	184.41[a]	189.77[a]	184-196
Peroxide value (mg/g)	12.86[a]	16.71[a]	22.75[a]	10 mg/g
Iodine value (wijs)	32.47[a]	33.62[a]	37.11[a]	75-94
Moisture content (%)	0.46[a]	0.56[a]	0.58[a]	-
Refractive index @ 27.3°C	1.4674[a]	1.4676[a]	1.4667[a]	1.468-
Melting point (°C)	75.00[a]	76.00[a]	78.00[a]	≤100°C
Smoke point (°C)	185.00[a]	185.00[a]	184.00[a]	150-190
Flash point (°C)	274.00[a]	276.00[a]	278.00[a]	≥300°C
Yield (%)	41.00[a]	43.00[a]	47.00[a]	-

Sample means with different superscripts on the same row are different ($p<0.05$)

High saponification value was discovered in the oil samples which range from 180.89-189.77 mgKOH/g. Saponification value is inversely proportional to mean molecular weight of the glyceride in the oil. This attribute is of importance in soap making. The iodine value of the oil samples observed range from 32.47-37.11 (wijs). The values were below the minimum value of 75 (wijs) reference standard of FDA (1974). The low iodine value detected in this work when compared with other oil like cocoa butter, coconut oil and palm oil, means that the oil can be used as plasticizers and lubricants. The African pear pulp may also have potential for hydrogenation because of the moderate Iodine value.

The minimum peroxide value found among the oil samples was 12.86 mg/g. This values are higher than the minimum (10 mg/g) reference standard set by FDA (1974). Therefore, this shown the potential of hydrogenation of the oil samples from the pulp of African pear in the manufacturing of margarine.

In this study, refractive index of the extracted oil samples varies slightly and range from 1.4667-1.4676. Refractive index is temperature dependent, it increases with increasing amount of saturation. Refractive index is a useful parameter to check purity and control of hydrogenation and isomerization processes (Coenen, 1976).

Conclusion: Scientific information and knowledge on less familiar or under-utilized crops such as African pear, encourage the utilization of both nutritional and industrial potential. This study has shown the potential of pulp of African pear for the production of vegetable oil. The width (I and II) property of the pulp is an important parameter in designing of equipment that can handle the fruit in mechanized level, while the pulp thickness of the fruit can be used in determine the yield per hectare. The result of physico-chemical properties further confirmed the quality of the extracted oil for cooking and industrial potentials.

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