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Physicochemical and Fatty Acid Profile Analysis of *Polyalthia longifolia* Seed Oil

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ABSTRACT

Standard analytical methods were used to determine the physicochemical characteristics and fatty acid profile of *Polyalthia longifolia* seed oil with the objective of determining its industrial applications. Physicochemical analysis of the seed oil produced the following results; color (reddish brown); specific gravity (0.875); pH (5.37); viscosity (1.026); acid value (13.46 mg KOH/g Oil); % free fatty acid (7.73); saponification value (120.00 mg KOH/g Oil); ester value (106.54 mg KOH/g Oil); % unsaponifiables (10.60); iodine value (95.0 wij's) and peroxide value (730.0 mg eq/kg Oil). The fatty acids in the oil were determined using a Perkin Elmer Auto sampler XL Gas chromatograph. The results obtained showed that *Polyalthia longifolia* seed oil contained saturated fatty acids (9.04-10.79%), mono unsaturated fatty acids (16.64-20.29%) and poly unsaturated acids (11.55-12.78%). The average fatty acid profiles of the saturated fatty acids showed hexadecanoic acid to be the major saturated fatty acid. The mono unsaturated fatty acids present are C18:1cis (17.07%); C20:1cis (0.29%) C22:1cis (1.26%); cis-9-octadecenoic acid being the most abundant. The polyunsaturated acids included C18:2cis (10.08%) and C18:3cis (2.09%), giving ω6/3 value of 4.82~5. In conclusion *Polyalthia longifolia* seed oil may likely be useful in the Food, Pharmaceutical and Cosmetics industries.

Key words: *Polyalthia longifolia*, seed oil, physicochemical analysis, fatty acid profile, industrial uses

INTRODUCTION

Vegetable matter has been considered the best and renewable source of chemical compounds required on a daily basis in the various chemical industries to ensure the survival of the human race in her quest for materials which will better her living standards and health. According to the World Health Organization, more than 80% of the world's population, mostly in poor and less developed countries, depend on, traditional plant-based medicines for their primary health care needs (WHO, 1993). Most plants that are known and utilized by man for the production of food, clothing and her requirements for health are daily been over-utilized and there is constant search for new materials that will fulfill or meet the same needs (Oyedeji and Oderinde, 2006).

There appears to be readily available a wealth of literature on the antimicrobial activity and the medicinal uses of the leaves, stem and root extracts of *Polyalthia longifolia* (Goyal and Achla, 1987; Nair *et al*., 2007; Faizi *et al*., 2003). The therapeutic efficacy of *P. longifolia* extensively used in Indian System of Medicine has been established through modern testing and evaluation (preclinical and clinical trials) in different disease conditions (Katkar, 2010). These

studies place this indigenous drug as a novel candidate for bio-prospection and drug development for the treatment of diseases, such as cancer, infectious diseases, diabetes and various inflammatory conditions. The medicinal applications of this plant and the countless possibilities for investigation still remain in relatively newer areas of its function. Hence, phyto-chemicals of these plants will enable to exploit its therapeutic use. However not much has been reported on the physicochemical analysis and fatty acid profile of the fixed seed oil of *P. longifolia*.

As a consequence to this, we have in this report presented the results of a study carried out on the physicochemical analysis and fatty acids profile of polyalthia longifolia seed oil.

MATERIALS AND METHODS

Materials/study base: The research study was carried out at the Wood Extraction and Industrial Laboratories of the Department of Chemistry, University of Ibadan, Ibadan, Nigeria during the period from October 2005 to September 2006.

Samples of discarded seeds of *Polyalthia longifolia* were collected over a period of 2 months from October to November 2005. The samples were collected from the garden of a private residence in Orogun Village, Ibadan in Oyo State of Nigeria. The seeds of *Polyalthia longifolia* were separated from the seed coats manually and sun-dried for 1 week. The dried seeds were granulated into coarse particles using a laboratory grinder. Oil was extracted from the granulated seeds using the soxhlet extraction method. All determinations were then carried out in triplicates.

Physicochemical analysis of seed oil: Determination of pH, specific gravity, viscosity, acid value, % free fatty, saponification value, % unsaponifiables, iodine value and peroxide values were carried out using standard analytical methods (IUPAC, 1995).

Determination of fatty acid: The fatty acid profiles of the oils were determined using a Perkin Elmer Auto Sampler XL Gas Chromatograph. The chromatograph had an FID detector with a split injector operating at 220°C. The column used was BPX-70.02, 3.0 m×0.25 mm and 0.25 μmdf. The carrier gas employed was helium at a flow rate of 20 Psi. Kel Fm Fame 5 and GLC-21A standards were used. One microliter of the raw sample was injected using a study period of 27.75 min and sampling rate of 12.50 pts/s.

RESULTS

Physicochemical analysis of the seed oil: The results of physicochemical analysis of the seed oil of *Polyalthia longifolia* are presented on Table 1. The seed oil is reddish brown in color. Its specific gravity is 0.875, pH (5.37); viscosity 1.026 while acid value, % free fatty acid, saponification value, ester value, % unsaponifiables, iodine value and peroxide value are 13.46 (mg KOH/g); 7.73; 120.00 (mg KOH/g); 106.54 (mg KOH/g); 10.60; 95.0 (wij's) and 730.0 (mgeq/kg), respectively.

Fatty acid profile: The fatty acids (Table 2) in the oil were principally cis-9-octa decenoic (17.07%), cis, cis-9, 12-octa decadienoic (10.08%), hexadecanoic (6.45%), octadecanoic (2.22%); cis, cis, cis, 6, 9, 12, -octadecatrienoic acid (2.09), z-docos-13-enoic acid (1.26), docosanoic (0.46), tetracosanoic (0.41), cis-icosaenoic acid (0.29), icosanoic (0.28) and heptadecanoic (0.20) a rare fatty acid in fixed vegetable oil being the least abundant.

Table 1: Physicochemical analysis of *Polyalthia longifolia* seed oil

Property	Values
State at 28°C	Liquid
Colour	Reddish brown
Specific gravity	0.875
pH	5.37
Viscosity	1.026
Acid value (mg KOH/g)	13.46
% free fatty acid	7.73
Saponification value (mg KOH/g)	120.00
Ester value (mg KOH/g)	106.60
% unsaponifiable matter	10.60
Iodine value wij's	95.00
Peroxide value (mg eq/kg)	730.00

Table 2: Fatty acid profiles of crude *Polyalthia longifolia* oil extracted by petroleum ether (40/60)

Fatty acids	Values
Average saturated Fatty Acids (SFA)	
C16:0	6.45±0.10
C17:0	0.20±0.05
C18:0	2.22±0.09
C20:0	0.28±0.02
C22:0	0.46±0.01
C24:0	0.24±0.01
SFA	9.85
Mono unsaturated (MUFA)	
C18:1 cis	17.07±0.01
C20:1cis	0.29±0.01
C22:1 cis	1.26±0.20
MUFA	18.62
Poly unsaturated (PUFA)	
C18:2 cis	10.08±0.05
C18:3 cis	2.09±0.04
PUFA	12.17
PUFA/SFA rate	1.24
ω6/3	4.82~5

DISCUSSION

Seed oil characteristics: The oil obtained from *Polyalthia longifolia* seed is reddish brown. The color of the oil is most likely to be an indication of the presence of carotenoids (vitamin A) and tocopherols and vitamin D all which are easily soluble in fats especially in oleic acid which is the most abundant fatty acid in this oil. According to Ogunbinu *et al.* (2007) terpenoids and diterpenoids are said to be present in the leaves, bark and root of *Polyalthia longifolia*; it is possible that the smell of the oil may be as a result of the presence of these organic compounds. The pH of the seed oil (5.37) is close to that of the acid mantle of the skin (5.50); the oil is therefore expected to be good for formulation of skin compatible emulsions (Schaich and Korting, 1992). This is also confirmed by the presence of cis-9-octadecenoic and cis, cis-9, 12-octadecadienoic acid in the oil which are good skin moisturizers, nourishers and scar removers. This also has great possibilities for the cosmetic and Pharmaceutical industries. The oil is not particularly viscous (1.02) and flows

freely showing that it may not contain too many saturated compounds. This is also confirmed by the gas chromatogram (Table 2) of the oil which shows it to contain principally mono and polyunsaturated fatty acids. The acid value of *Polyalthia longifolia* seed oil (13.46 mg KOH/g) is an indication of the level of biodegradation that has taken place in the oil. The level of free fatty acid also indicates that the oil may not have a palatable taste as the higher the level of fatty acid in an oil, the more unacceptable the taste. This trend is however not unexpected as the seeds were picked from the fruits that have fallen to the ground in the garden and have been exposed to the climate. None of the seeds were obtained from fruits harvested directly from the tree. The saponification value of the oil was slightly high (120.0 mg KOH/g). This indicates the presence of either the hexadecanoic or tetradecanoic acid. The gas chromatogram of the oil shows that it contains hexadecanoic acid (6.45%). The ester value of the oil also indicates the level of oiliness of the oil and contributes to the smell. The % unsaponifiable matter in *Polyalthia longifolia* seed oil is quite high (10.60%). This usually indicates the presence of chemical compounds which are not subject to alkaline hydrolysis. These chemical compounds may be essential oils, hydrocarbons and proteins all of which are important for manufacture of pharmaceuticals and skin care products in the cosmetics industry. Considering the viscosity of the oil, it probably contains hydrocarbon and essential oils and may contain soluble collagens. The unsaponifiable matter in lipids, are known to contain surface active compounds which can act as stabilizers and emulsifiers in various emulsion systems. Soluble collagen is known to be very skin substantive and can help in the reduction of skin wrinkles. The peroxide value of the oil is slightly high indicating the existence of ketones and other oxygenated compounds which may be responsible for the intense odor of the oil. This may be due to the fact that the oil in some of the seed picked was rancid. The iodine value of the oil (95.0 wij's) shows the oil to be in the semi-drying category. This is further confirmed by the fact that the viscosity of the oil increases gradually when it is exposed to air. This is the result of the reactions of the multiple bonds present in the chemical compounds in the oil. This can also be substantiated by the GC of the oil that shows it to contain mono and polyunsaturated fatty acids.

Fatty acid profile: The most abundant fatty acid in *Polyalthia longifolia* seed oil is cis-9-octadecenoic (17.07%) which is a mono unsaturated fatty acid that is essential to human body but technically not an essential fatty acid (http://www.vaxa.com/oleic-acid.cfm) because humans can manufacture a limited amount. cis-9-octadecenoic acid is also known as omega-9 fatty acid. Common sources of cis-9-octadecenoic acid include avocado fruit (50%), macadamia nuts (45%); apricot seeds (35%), almonds (33%) and olive oil (28%) and is also present in canola (62%) and cocoa (34.7%) and soybean (24%) in generous amounts (http:/www.britannica.com/eb/topic-427486/oleic acid). All these sources contain cis-9-octadecenoic acid at a higher level than *Polyalthia longifolia* seed oil in which it is present in higher percent than in safflower oil (12.8%) and matthola oil (13.0%). Cis-9-octadecenoic acid is thought to have a variety of influences when present in a diet or formulation; some positive others negative. In their review Moreno and Mitjavila (2003) stated that, a diet rich in cis-9-octadecenoic acid is thought to decrease risk of atherosclerosis and lower serum cholesterol by diminishing oxidative stress and inflammatory mediators while promoting antioxidant defenses. By implication this means that the oil from the seeds of *Polyalthia longifolia* could be processed by food industries for used as cooking, frying and Table oils. Cis-9-octadecenoic acid is the main ingredient in Lorenzo's oil which may delay onset of adrenoleukodystrophy in young boys. US researchers Menendez *et al.* (2005) stated that cis-9-octadecenoic acid was discovered to help the immune system as it said to sharply cut the level of a

gene her-2/neu thought to trigger breast cancer disease and it also boosted the effectiveness of a breast cancer drug called herceptin. High cis-9-octadecenoic acid diet are said to be as effective in lowering blood levels of total and Lower Density Lipoproteins (LDL) cholesterol (Mattson and Grundy, 1985) and hence is most effective at depressing lipogenesis and cholesterogenesis according to Francesco *et al.* (2007). Lotta *et al.* (2004) in their own research used topical application of cis-9-octadecenoic acid in the treatment of skin papillomas. All of this is an indication that this seed oil could be used as oil for the manufacture of pharmaceutical and cosmetics products for the treatment of the various aforementioned diseases. Cis-9-octadecenoic acid is also used as a drug coloring agent (www.pcl.ox.ac.uk/msds/ol/oleic-acid/html). Cis-9-octadecenoic acid is thought to prevent hypertension and increase absorption of fat soluble vitamins like A, E, D and K (Funari *et al.*, 2003). These vitamins are essentially good for health and may be the reason for the dark color of *Polyalthia longifolia* seed oil. Once again this points to the possible use of the oil in the food industry once its toxicity has been assessed. Davidson *et al.* (2000) (www.iisc.ernet.in/currsci/apr25/article25.htm) found cis-9-octadecenoic acid to be fungistatic against a wide spectrum of saprophytic moulds and yeasts at low concentrations. The application of this property may find great use in food preservation in the food and confectionery industries. As a cosmetic ingredient cis-9-octadecenoic acid seems to be a great moisturizer (Jian *et al.*, 2000). It has a known action as a penetration enhancer and can therefore be used for various purposes such as tanning increaser and in treatment for psoriasis (Martin-Ezquerra *et al.*, 2007). It is also known as a local anti-inflammatory (http//www.naturalemu.com/benefits.htm.). Oiinghung in 2005 used cis-9-octadecenoic acid in the production of polymeric surfactants. Cis-9-octadecenoic acid from cooking oils has been associated with lower insulin resistance in the general population as shown by Pizama Study (Soriguer *et al.*, 2004).

On the other hand a diet rich in cis-9-octadecenoic acid is thought to damage ion transport and promote alveolar oedema (Wang *et al.*, 1994). Patients with acute respiratory distress syndrome are said to have elevated serum levels of cis-9-octadecenoic acid (Quillan *et al.*, 1996). According to Davidson *et al.* (2000), these deleterious effects of oleic acid have been attributed to increase in the permeability of both vascular and alveolar epithelium to solute, caused by changes in membrane fluidity and increases in intracellular calcium concentration. Since this fatty acid is present in *Polyalthia longifolia* seed oil, it can be widely used in pharmaceutical, cosmetic and food industries. The next more abundant fatty acid in *Polyalthia longifolia* is cis, cis-9, 12-octadecadienoic acid (10.08%) which is a polyunsaturated fatty acid and a ω-6-fatty acid. Cis,cis-9, 12-octadecadienoic acid is a plant derived polyunsaturated fatty acid which can be converted to EPA and DHA which are essential to the human body. Khosla and Fungwe (2001) in their research paper stated that cis, cis-9, 12-octadecadienoic acid has potential to decrease risk of cardiovascular disease. It has been shown to reduce body fat in people who are overweight while preserving muscle tissue (Benito *et al.*, 2001). It is found to improve insulin levels for about two thirds of diabetic patients and moderately reduce the blood glucose level and triglyceride levels (Kritchevsky and Czarneski, 2001). It also lowers insulin resistance and reduced food induced allergic reactions (Roche *et al.*, 2001). Cis, cis-9, 12-octadecadienoic acid enhances the immune system (Gnadig *et al.*, 2001). According to Scimeca and Miller (2000), cis,cis-9, 12-octadecadienoic acid is an important fatty acid especially for the growth and development of infants. It has the functional benefits of been moisturizing and nourishing to the skin and hence can be used in the treatment of dry skin.

Hexadecanoic acid is the next more abundant fatty acid in *Polyalthia longifolia* seed oil. Hexadecanoic acid is an important constituent of most vegetable fats and natures most common

long chain fatty acid, derived from animal and vegetation. It is widely used as lubricant and as an additive in industrial preparations. It is used in the manufacture of metallic octadecanoates, pharmaceutical soaps, cosmetics and food packaging. It is also used as a softener, accelerator activator and dispersing agent in rubber. Hexadecanoic acid plays important roles in energy production, hormone production, cellular membranes and used for organic padding. They are used for important signaling and stabilization processes in the body (Enig, 1996). It has also been used in the production of a superior skin barrier enhancing body facing material (Krzysik *et al*., 2003) for use in treatment of skin diseases.

Polyalthia longifolia also contains octadecanoic acid (C18:0) and linolenic acid (C18:3) at lower levels. Octadecanoic acid is useful in making candles, soaps, plastics, oil pastels and cosmetics. Esters of octadecanoic acid with ethylene glycol di-octadecanoate are used to produce a pearly effect in shampoos, soaps and other cosmetic products. It has been shown that octadecanoic acid is less likely to be incorporated into cholesterol esters (Emken, 1994). These findings may imply that octadecanoic acid is less unhealthy than other saturated fatty acids. Octadecanoic acid is used in some plant foods like chocolate and a large percent of octadecanoic acid consumed is converted to cis-9-octadecenoic acid and hence has little effect on blood cholesterol levels (Sundram *et al*., 2007). Gamma linolenic acid is the result of the body's first biochemical step in the transformation of the main essential fatty acid cis, cis-9, 12-octadecadienoic into important prostaglandins which are essential to the proper functioning of each cell. Essential fatty acids formed from GLA are required for each cell's structure. It is important in regulation of inflammation, swelling and pain pressure in the eye, joints or blood vessels. It also effects the proper functioning of secretions from mucus membranes, smooth muscle, autonomic reflexes, gastrointestinal, arterial, ear, heart water retention; it is important in blood clotting ability, allergic response, rheumatoid arthritis, nerve transmission, steroid production and hormone synthesis. Omega -3-fatty acids and GLA work together on the production of beneficial prostaglandins.

The unsaturation index of *Polyalthia longifolia* seed oil (PUFA/SFA value) is 1.24 and its ω6/3 index is 4.82~5 which shows that the oil may be of value as oil for food as this agrees with WHO recommendations that suggest a relationship between w6/3 in the order of 5. It is therefore suggested that the oil may be utilized in the food, cosmetic and pharmaceutical industries.

CONCLUSION

Polyalthia longifolia seed oil could serve as raw materials for the production of cooking, frying and table oils in the food industry and valuable material for preparation of antihypertensive, anticancer, anti-diabetic, antimicrobial, moisturizing, nourishing and scar removing and skin substantive substances. The minor constituents in particular heptadecanoic acid shows that it may likely have antimicrobial properties. Hence it would be of great use in the pharmaceutical industry.

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