PHYSICOCHEMICAL AND NUTRITIVE CHARACTERIZATION OF HIGH VALUE NON-CONVENTIONAL OIL FROM SEEDS OF *AMARANTHUS HYBRIDUS* LINN

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Abstract

This work was carried out to investigate the physicochemical and nutritional properties of oil extracted from seeds of *Amaranthus hybridus*, an important leafy vegetable of Côte d'Ivoire. The oil yield of *Amaranthus hybridus* seeds was 9.76 ± 0.74%. Physicochemical properties of extracted oil were as follow: specific gravity (0.92 ± 0.01), refractive index (1.47 ± 0.00), colour lovibond (20.2 ± 0.00), viscosity at 20°C (52.05 ± 0.15 mPas), cloud point (- 2.1 ± 0.00°C) acid value (2.81 ± 0.00 mg KOH/g), peroxide value (5.67 ± 0.58 meq O_2/kg), iodine value (119.85 ± 1.22 g I_2/100g), saponification value (160.82 ± 3.24 mg KOH/g). Biochemical and nutritive analysis have revealed the following assets: impurities (0.014 ± 0.00%), unsaponifiable matter (2.57 ± 0.21%), phosphorus (0.098 ± 0.01 mg/g), vitamin A (0.44 ± 0.01 mg/g) and vitamin E (0.25 ± 0.01 mg/g). Fatty acids profile of *Amaranthus hybridus* seed oil highlighted oleic and linoleic acids as major fatty acids with amounts of 36.45 and 33.16 ± 0.01%, respectively. All these interesting characteristics should arouse attention for the usage of *Amaranthus hybridus* seed oil in food and pharmaceutical industries.

Keywords: Amaranthus hybridus, seed oil, vitamin A, vitamin E, linoleic acid.

Introduction

Vegetable oils extracted from seeds and fruits are the main lipid source in a healthy human diet (Flickinger and Huth, 2004). These oils mainly consisted of triacylglycerols (95-98%) which act as a solvent for sterols, fat soluble vitamins (mainly tocopherols/tocotrienols), pigments

including chlorophylls and carotenoids, phenolics compounds, phospholipids, free fatty acids, mono- and diacylglycerols (Kamal-Eldin, 2006). More than 75% of the world vegetable lipid production consists of liquid oils, which are currently used for food application such as salad and cooking oils, frying fats, liquid and solid shortening, spreads and ingredients in bakery products (Gunstone, 2002). Vegetable oils are also used to a lesser extent in other products such as soaps, cosmetics and skin care products (Kamal-Eldin, 2006).

There are numerous vegetable oils derived from various sources. The most popular vegetable oils are: palm, olive, cottonseed, sunflower and soybean oils (Bennion, 1995). Palm, olive, cottonseed and sunflower oils are categorized as oleic-linoleic acid oils seeing that they contain a relatively high proportion of monounsaturated oleic acid and the polyunsaturated linoleic acid. Soybean oil is important with numerous increasing applications in the modern day world. It is classed as linolenic acid oil since it contains the more highly polyunsaturated linolenic acid (Aluyor and Ori-Jesu, 2008). Linoleic and linolenic acids are essential fatty acids (EFA) for the human nutrition because, they are unable to be physiologically synthesized. In this respect, diet must cover organism needs (Naudet *et al*., 1992). Indeed, linoleic acid is metabolized to arachidonic acid (AA) while α-linolenic acid is metabolized to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These active metabolic products are used for the synthesis of biologically compounds such as steroid hormones, prostaglandins and leukotrienes (Singh, 2005).

To meet the increasing demand for oils, improvements are being made, with conventional crops in the one hand and great interest in newer sources of non-conventional edible oils has recently grown in other hand. Indeed, no oil from a single source has been found to be suitable for all purposes because oils from different sources generally differ in their composition (Aluyor *et al*., 2009). Therefore, appropriate knowledge about the composition and the quality parameters of various vegetable oils is necessary. It is from this perspective that a number of non-conventional oilseeds from several plants of sub-Saharan Africa have been investigated (Badifu, 1993; Kapseu *et al*., 2005). These studies have revealed the indisputable potentialities of most of these underexploited oils for food, pharmaceutical or cosmetic applications. Therefore, to contribute to non-conventional oils promotion, we have focused our attention on oil extracted from seeds of *Amaranthus hybridus*, a tropical leafy vegetable plant.

Amaranthus hybridus is annual herbaceous plant which belongs to the family *Amaranthaceae*. In most countries of tropical Africa and particularly in Côte d'Ivoire, leaves of these plants are widely consumed as green vegetables due to their richness in polysaccharides, vitamins and minerals

(Grubben, 1993). Roughly studies showed that seeds of *Amaranthus hybridus* contain about 6% fat and this lipid fraction is mainly composed of three fatty acids (palmitic, oleic, linoleic) and significant amount (7.3%) of squalene (Guil-Guerrero, 2000; He, 2003). For this study, the mature seeds of *Amaranthus hybridus* grown in Côte d'Ivoire were collected and the physicochemical characteristics of oil extracted were investigated in order to deduce the potentially uses in food and pharmaceutical industries.

Materials and Methods

Chemicals

Analytical HPLC grade solvents, standards and reagents were used to perform analysis. Solvents (n-hexane, chloroform, acetic acid, diethyl-ether, ethanol, methanol and n-heptane) were provided from Merck (Germany). Standards such as fatty acids (palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid), retinol palmitate (vitamin A), α-tocopherol acetate (vitamin E) and erucic acid were purchased from Sigma-Aldrich (Germany). Wijs reagent was from Prolabo (France).

Plant materials

Mature *Amaranthus hybridus* seeds were collected from market gardening of Abidjan district (Côte d'Ivoire) in June 2013. The plant was identified and authenticated by the Botany Department of Félix Houphouët Boigny University – Abidjan. Voucher specimen (No AMPT02) of the plant was kept in the herbarium of National Center of Agronomic Research (CNRA) of Côte d'Ivoire. Seeds were rinsed thoroughly with distilled water to remove dirt and dried at 40 °C for 24 h in an electric oven (Memmert, Germany) (Ali *et al*., 2008).

Oil extraction

Oil was extracted from 50 g crushed seeds with 300 mL of n-hexane (40-60 °C) in a Soxhlet extractor. Then the solvent was removed (vacuum-packed) at 40°C with a rotary evaporator (Heidolph, Germany). The extracted lipid was weighed to determine the oil content of the seed. Crude oils were stored at 4 °C in air tight brown sterile glass bottles until further use (Ejikeme *et al*., 2010).

Physicochemical parameters

Specific gravity at 20°C, refractive index at 20°C and specific extinction (232 nm and 270 nm) were carried out following the IUPAC (1979) methods. Color and cloud point were determined according to the MPOB (2005) methods by using a Lovibond colorimeter (Lico, France) and a thermometric system (Metller Toledo, Switzerland) respectively. Viscosity

was determined at different temperatures (20 – 80°C) by using a viscometer apparatus (Anton Paar Gmbh, Austria) equipped with a syringe filled with 1 mL of oilseed sample. Values of viscosities were automatically recorded after temperature programming. Visible and Near infrared spectrum (NIR) was determined by reading absorbance of oil sample in the range (400-2500 nm) using an infrared spectrophotometer (Foss, Denmark) equipped with a software (NIR Vision Spectral Analysis, Model 6500) for data acquisition. pH value of oil sample was determined at 25°C according to Afane *et al*. (1997). Acid, peroxide, iodine and saponification values were determined by the AOAC (1997) methods.

Biochemical characteristics

Moisture, impurities, total fatty matter and total saponifiable matter contents were determined according to the MPOB (2005) test methods. Unsaponifiable matter content of oil samples was determined following the IUPAC (1979) method.

Nutritive characteristics

Phosphorus content

Phosphorus content of oil sample was determined following the IUPAC (1979) colorimetric method. The test oil portion (5 g) was burned to ashes in the presence of magnesium oxide. The ashes obtained were dissolved in diluted nitric acid solution (65%). Absorbance was then measured at 460 nm using a spectrophotometer (PG Instruments, England) after adding an aqueous ammonium vanadate solution. A standard curve of phosphorus (1 mg/mL) was used as reference.

Vitamin A and vitamin E contents

Oilseed sample was previously prepared as described by Gimeno *et al*. (2000). Oil sample (1 g) was diluted in 10 mL of hexane. Thereafter, 200 µL of this mixture was transferred into a screw-capped tube where 800 µL of methanol were added. After being vortex-mixed and centrifuged (3000 rpm for 5 min), the samples were filtered through a 0.45 µm pore size filter and the overlay was used for high performance liquid chromatography (HPLC) analysis. Separation by HPLC was carried out using a liquid chromatography system (Acquity Waters, USA) equipped with an optical detector TUV system and a BEH C_{18} column (150 X 0.25 mm i.d., 1.7 µm particle size). The injection volume was 10 µL. The mobile phase was methanol-water (98:2, v/v) and the elution was performed at a flow rate of 2 mL/min. The analytical column was kept at 45°C. Vitamin A of oil sample was detected at 325 nm and identified by comparing its retention time with this of authentic standard. Quantification of vitamin A identified in oil sample was done by

using a standard curve (concentration versus peak area) of retinol palmitate. For vitamin E, detection was done at 292 nm and identification was carried out by comparing its retention time with this of authentic standard. Quantification of vitamin E identified in oil sample was done by using a standard curve (concentration versus peak area) of α-tocopherol acetate. All the data obtained were stored and processed by Empower software (Waters, USA).

Fatty acids composition

The fatty acids were converted to their methyl esters (FAMEs) as described by the European Communities (1991) methods. About 0.1 g of oil sample was mixed with 2 mL of n-heptane and 0.2 mL of a methanolic solution of potassium hydroxide (2N). The whole mixture was shaken up for 30 s and allowed to settle for 5 min. The top layer containing the FAMEs was used for gas chromatography (GC) analysis. FAMEs solution (1 µL) containing the internal standard (erucic acid) was injected into a gas chromatograph (Shimadzu, GC-9A, Japan) equipped with a mass spectrometer (MS) and a RTX5 fused silica capillary column (30 m X 0.32 mm i.d. X 0.25 µm film thickness). The carrier gas was helium and the flow rate adjusted to 23 ml/min. Temperatures of detector and injector were 250 °C. The initial column temperature was fixed to 100 °C and programmed to increase by 5 °C per min intervals until 220 °C and kept for 10 min at this temperature. The fatty acid methyl esters peaks were identified by comparing their retention times with those of standards. After adjusting areas with the internal standard (erucic acid), the yield of each fatty acid was calculated as follow: area of the fatty acid/areas of total fatty acids in the oil sample × 100 (%).

Statistical Analysis

In the present experiment each test for the sample was analyzed in triplicate. Data were performed by using StatPlus 2009 (Analystsoft Inc) software and values were expressed as means ± standard deviation (SD).

Results and Discussion

Oil yield

The oil content of *Amaranthus hybridus* seeds was 9.76 ± 0.74 %. This oil yield is lower than that of conventional oilseeds such as cotton (13%), soybean (14%) and palm fruit (20%) (Nzikou *et al*., 2007). Nevertheless, the present result showed also higher oil content compare to that (8.77%) reported by Dhellot *et al*. (2006) in Congo Brazzaville. This variation between oil yields in seeds could be attributed to their cultivation climate, ripening stage, harvesting time and the extraction method employed

(Egbekun and Ehieze, 1997). In addition, *A. hybridus* seeds are lipid rich than that (3-5%) of maize seed oil, which production in the world represents about 2.5 million tons (Gunstone, 2002).

Physicochemical properties

The physicochemical parameters of *Amaranthus hybridus* seed oil are shown in Table 1. The value of specific gravity was 0.92 ± 0.01 while refractive index was about 1.47 ± 0.00. The specific gravity and refractive index of *A. hybridus* oilseeds are within the range of those reported for most conventional edible oils (Codex-Alimentarius, 1993). The specific extinction values at 232 and 270 nm were 1.5 ± 0.00 and 1.8 ± 0.00, respectively. These parameters are linked to the oxidative stability of *A. hybridus* seed oil in terms of conjugated diene and triene products contents (Anwar *et al*., 2007). In view of specific extinction value (1.8 ± 0.00) at 270 nm, *A. hybridus* seed oil shows more oxidative stability than sunflower seed oil which extinction value at 270 nm is 1.872 (MPOB, 2005). Lovibond colour in red light (Lr) of *A. hybridus* seed oil was 20.2 ± 0.00. This parameter, generally related to carotenoids content and bleachability index of oil sample, is similar than that (20.4) of crude palm oil (Gunstone, 2002; MPOB, 2005). Consequently, the studied seed oil could be used in cosmetic industries in view to the antioxidant activity and the protective skin effect of carotenoids (Platon, 1997). The cloud point of *A. hybridus* seed oil was - 2.1 ± 0.00 °C. This parameter which is the temperature of first stage of sample crystallization indicates the liquid state and the unsaturated level of oil sample (Gunstone, 2002). This unsaturated level of *A. hybridus* seed oil is also linked to the semi-drying state indicated by the refractive index value (Rossell, 1991). With regard to this cloud point value (- 2.1 ± 0.00 °C), *A. hybridus* seed oil is more unsaturated than palm olein (4 °C), sesame seed oil (0 °C) and mixture maize seed oil/palm olein (- 1.9 °C) (Teah, 1988; Nor-Aini and Hanirah, 1997).

The food value of a greasy substance depends on its free fatty acids (FFA) content measured by the acid value. The acid and peroxide values of *A. hybridus* seed oil were 2.81 ± 0.00 mg KOH/g and 5.67 ± 0.58 meq O_2/kg, respectively. These values are lower than those (4 mg KOH/g and 10 meq O_2/kg) recommended by the Codex-Alimentarius (1993) for edible oils. The relatively low peroxide value of this oilseed may indicate that *A. hybridus* seed oil is less liable to oxidative rancidity at ambient temperature (DeMan, 1992). Therefore, this studied oil could be suitable in combination with antioxidants for cosmetic formulations (Judde, 2004). Iodine value (119.85 ± 1.22 g I_2/100 g) determined in this study is higher than that of other non-conventional oilseeds such as *Coula edulis* (90-95 g I_2/100 g), *Dacroydes edulis* (60-80 g I_2/100 g) and *Canarium schweinfurthii* (71.1-94.9 g I_2/100 g)

and other unsaturated conventional oils such as groundnut (96 g I_2/100 g) and cottonseed (112 g I_2/100 g) oils (Kapseu and Parmentier, 1997). Furthermore, the iodine value of *A. hybridus* seed oil is higher than that (113.4 g I_2/100 g) reported by Dhellot *et al*. (2006) for *A. hybridus* var 2 grown in Congo Brazzaville. In view of the results above, the studied oilseed consist predominantly in polyunsatured fatty acids and could be nutritionally beneficial to patients suffering from most of lipid disorders (Anhwange *et al*., 2010). In addition, *A. hybridus* seed oil could be recommended for soap making and in the manufacture of lather shaving creams due to its relatively high saponification value (160.82 ± 3.24 mg KOH/g) (Eka, 1980).

Table 1: Physicochemical properties of *Amaranthus hybridus* seed oil.

Parameters	Value
Specific gravity at 20 °C	0.92 ± 0.01
Refractive index at 20 °C	1.47 ± 0.00
Colour lovibond (Lr)	20.2 ± 0.00
Viscosity at 20°C (mPas)	52.05 ± 0.15
Cloud point (°C)	- 2.1 ± 0.00
pH (25°C)	5.95 ± 0.02
Acid value (mg KOH/g)	2.81 ± 0.00
Peroxide value (meq O_2/kg)	5.67 ± 0.58
Iodine value (g I_2/100 g)	119.85 ± 1.22
Saponification value (mg KOH/g)	160.82 ± 3.24

Results given as means ± standard deviation of triplicate analysis.

The effect of temperature on viscosity and the Arrhenius plot of *A. hybridus* seed oil are depicted in Figure 1. The viscosity of liquids as vegetable oil is commonly perceived as thickness, or resistance to pouring (Ndangui *et al*., 2010). The viscosity value (52.05 ± 0.15 mPas) at 20°C of *A. hybridus* seed oil was in the range (50-100 mPas) of most vegetable oils (Besbes *et al*., 2004). This value decreases exponentially to 8.3 mPas when temperature increases of 20 to 80 °C. The Arrhenius plot derived from the exponentially curve of viscosity indicate relatively low value (24.88 ± 0.01 kJ/mol) of activation energy. These results, linked to rheological properties of *A. hybridus* seed oil, corroborate the fluid state of this studied oil at ambient temperature and this physical characteristic could be suitable in food industries to provide texture and softness to products (Dubois *et al*., 2007).

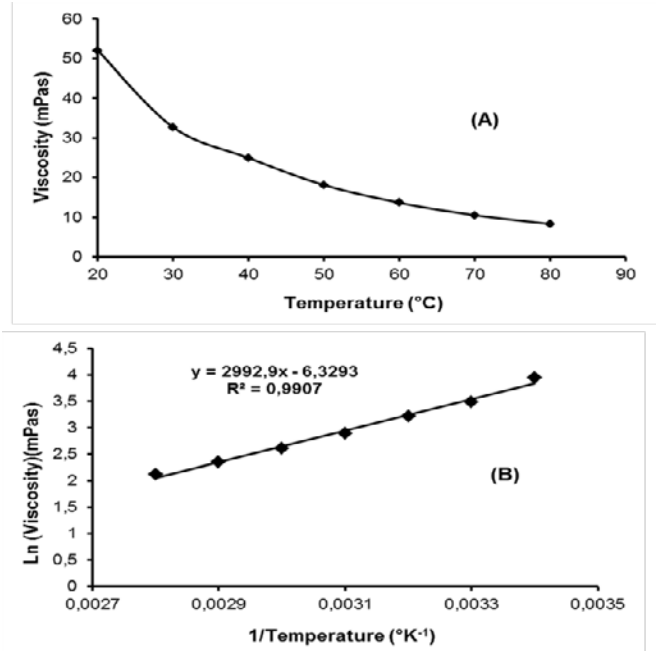


Figure 1: Effect of temperature on *Amaranthus hybridus* seed oil viscosity (A) and Arrhenius plot (B) obtained.

The visible and near infrared spectrum of *A. hybridus* seed oil is shown in Figure 2. In this spectrum, the wavelength range of visible domain was (400-800 nm) while that of near infrared domain was (800-2500 nm). The visible domain of this spectrum showed a maximum absorbance (1.47) at 450 nm. The near infrared domain of this spectrum showed four (4) main maximum absorbances (0.9, 0.84, 2.7 and 1.5) at 1200, 1400, 1725 and 2150 nm, respectively. The maximum absorbance observed at 450 is related to carotenoids compounds of the seed oil **(**Psomiadou and Tsimidou, 2001**)**. As concern the maximum absorbances observed at 1200, 1400, 1725 and 2150 nm, these are related to C-H stretching 2nd overtone (oil), C-H stretching 1st overtone (oil), CO stretching 1st overtone (oil), and C-H bending 2nd overtone (oil), respectively (Kim *et al*., 2005). Free fatty acids (FFA) of the studied seed oil are characterized by their carboxylic acid C=O, absorption (CO stretching 1st overtone) at 1725 nm whereas iodine value (IV) is characterized by absorption (vibration of C–H *cis*-unsaturation bonds) at 2150 nm (Man and Moh, 1998). The maximum absorption band at 1940 nm which is related to the moisture (water) content was not observed in the NIR spectrum of *A. hybridus* seed oil (Curcio and Petty, 1951). Compared to the NIR spectrum of rapeseed oil, *A. hybridus* seed oil was showed more unsaturation due to the highest absorption at 2150 (iodine value) and more stability to deterioration due to the lowest absorption at 1940 nm (moisture content) (Kim *et al*., 2005).

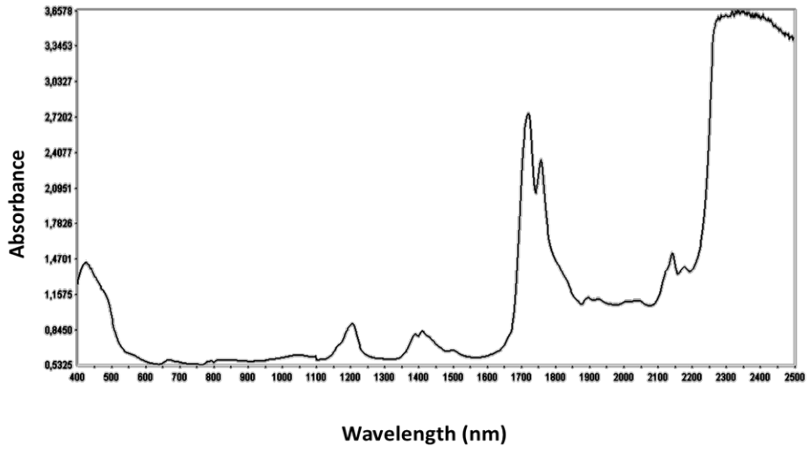


Figure 2: Visible and NIR spectrum of *Amaranthus hybridus* seed oil.

Biochemical and nutritive properties

The biochemical and nutritive properties of *A. hybridus* seed oil are shown in Table 2. Intrinsic biochemical parameters such as moisture, unsaponifiable matter, total fatty matter and total saponifiable matter were respectively closed to 0.27 ± 0.02%, 2.57 ± 0.21%, 99.69 ± 0.05% and 97.13 ± 0.16% (Table 2). The unsaponifiable matter content of this oilseed is higher than those reported for other high value oils such as cotton seed oil (0.52%), peanut oil (0.33%), palm kernel oil (0.22%) and shea butter (2%) oil (Kapseu and Parmentier, 1997). Therefore *A. hybridus* seed oil could be used as a good source of stabilizers in cosmetic and food industry (Gunstone, 2002). In addition, *A. hybridus* seed oil could have more technological ability with regard to its impurities content (0.014 ± 0.00%) which is lower than that (0.024%) of palm oil (MPOB, 2005).

Table 2: Biochemical and nutritive properties of *Amaranthus hybridus* seed oil.

Parameters	Value
Moisture (%)	0.27 ± 0.02
Impurities (%)	0.014 ± 0.00
Unsaponifiable matter (%)	2.57 ± 0.21
Total fatty matter (%)	99.69 ± 0.05
Total saponifiable matter (%)	97.13 ± 0.16
Vitamin A (mg/g)	0.44 ± 0.01
Vitamin E (mg/g)	0.25 ± 0.01
Palmitic acid ($C_{16:0}$) (%)	19.01 ± 0.01
Stearic acid ($C_{18:0}$) (%)	9.03 ± 0.01
Oleic acid ($C_{18:1}$) (%)	36.45 ± 0.01
Linoleic acid ($C_{18:2}$) (%)	33.16 ± 0.01
Linolenic acid ($C_{18:3}$) (%)	2.34 ± 0.01

Results given as means ± standard deviation of triplicate analysis.

The chromatographic profiles of vitamin A and vitamin E in *A. hybridus* seed oil are given in Figure 3 and Figure 4, respectively. Vitamin A and vitamin E contents of *A. hybridus* seed oil were 0.44 ± 0.01 mg/g and 0.25 ± 0.01 mg/g, respectively (Table 2). In vegetable oils, vitamin A is provided by β-carotene which plays an important potential role in human health by acting as biological antioxidants protecting cells and tissues from the damaging effects of free radicals and singlet oxygen (Zeb and Mehmood, 2004). Vitamin A is an essential nutrient needed in small amounts by humans for the normal functioning of the visual system, growth and development, maintenance of epithelial cellular integrity, immune function, and reproduction (Blomhoff, 1991). The content of vitamin A in *A. hybridus* seed oil is lower than that reported (1 mg/g) for palm oil (Codex-Alimentarius, 1993). Nevertheless, the consumption of this oilseed could cover vitamin A infant (0 to 6 months) needs, which are estimated at 0.375 mg per day (FAO, 2001). Vitamin E content of *A. hybridus* seed oil was compared favourably with those (0.21 and 0.25 mg/g) of palm oil and corn oil which are high oxidative stability oils used in food and cosmetic industries (Dauqan *et al*., 2011). The main biological function of vitamin E is the protection of the polyunsaturated fatty acids of cell membranes from free-radical damage in the oxidative stress (Korchazhkina *et al*., 2006).

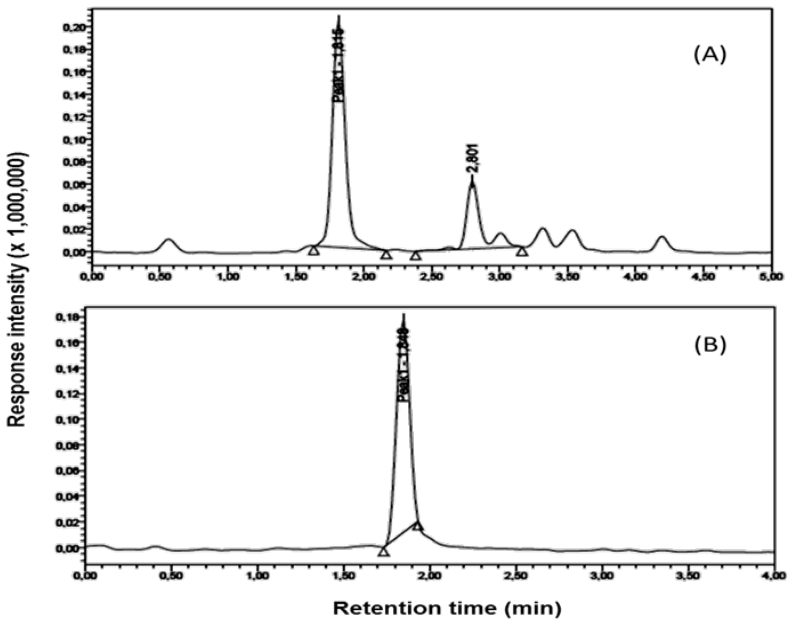


Figure 3: Chromatographic profile of vitamin A of *Amaranthus hybridus* seed oil. (A): oil sample; (B): Standard vitamin A (retinol palmitate).

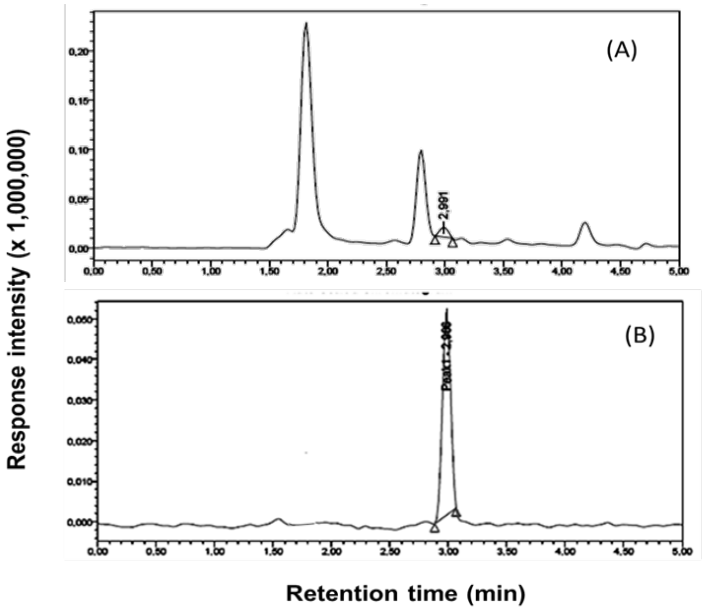
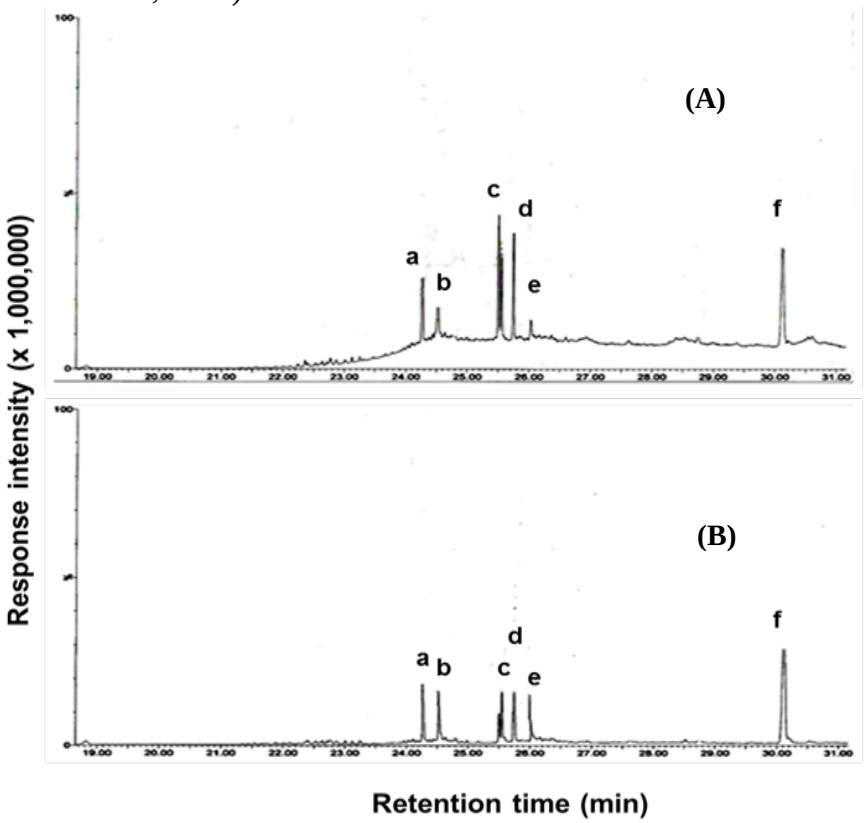


Figure 4: Chromatographic profile of vitamin E of *Amaranthus hybridus* seed oil. (A): oil sample; (B): Standard vitamin E (α-tocopherol acetate).

Chromatographic profiles of fatty acids composition and their relative amounts in *A. hybridus* seed oil are given in Figure 5 and Table 2, respectively. Fatty acid proportions of the studied oilseeds highlighted the presence of five compounds namely palmitic (19.01 ± 0.01%), stearic (9.03 ± 0.01%), oleic (36.45 ± 0.01%) , linoleic (33.16 ± 0.01%) and linolenic (2.34 ± 0.01%) acids (Table 2). Polyunsaturated fatty acids (PUFA) of the studied oilseed were essentially made up of linoleic and linolenic acids while palmitic and stearic acids was the saturated fatty acids (SFA). The proportions of PUFA and SFA were 35.5 and 28.04%, respectively. Total unsaturated fatty acids (UFA) represented 71.95% of total fatty acids. Polyunsaturated fatty acids (PUFA) amounts of *A. hybridus* seed oil is higher than those reported for most of non-conventional oilseeds as sheabutter (6.9%), avocado (15.5%), *Dacroydes edulis* (25.2%) and *Canarium schweinfurthii* (28.8%) (Chalon, 2001). The higher content of total PUFA observed in the studied oilseed may confer flexibility, fluidity and selective permeability to cellular membranes and may also be beneficial for reducing cardiovascular disease risk (Das, 2006). In view to the fatty acids profile, *A. hybridus* seed oil could be considered as oleic-linoleic oil. Oleic and linoleic acids contents obtained in this study are higher than those (28.25 and 31.72%) reported reported by Dhellot *et al*. (2006) for *A. hybridus* var1 grown in Congo Brazzaville. Moreover, the highest content of linolenic acid of *A. hybridus* seed oil than that of most common conventional linoleic oils

such as safflower (0.3%) and cotton (0.2%) oilseeds is an advantageous for anti-inflammatory, anti-thrombotic, anti-hypertensive and anti-arrhythmic actions in human nutrition (Dubois *et al*., 2007). Nevertheless, this amount of linolenic acid which is above 1% constitutes an unfavourable property for using this oil in food frying (Nzikou *et al*., 2007). Therefore, *A. hybridus* seed oil could be used in human nutrition for salad seasoning. The relatively higher linoleic acid content of *A. hybridus* seed oil could also be useful in cosmetic industries to decrease trans-epidermal water loss and to eliminate scaly lesions common in patients with essential fatty acid deficiency (Aburjai and Natsheh, 2003).



Gas chromatographic profile of fatty acids of *Amaranthus hybridus* seed oil. (A): oil sample; (B): fatty acids standards.

Conclusion

The results of the present work indicate the potential utility of *Amaranthus hybridus* seeds as a valuable source of oils for food, cosmetic and pharmaceutical industries. Indeed, the oil extracted from this plant is predisposed to human consumption due to its low content in acid and peroxide values. Saponification value and physical properties of this oil make the studied seed oil suitable in cosmetic industries for skin care

products as soaps and lather shaving. As concern biochemical and nutritive properties, *A. hybridus* seed oil is a suitable source of vitamin A and vitamin E. Furthermore, *A. hybridus* seed oil is an oleic-linoleic one and this characteristic confers to this oil, good edible, cosmetic and dietetic values.

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