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Solanum nigrum L. Seeds as an Alternative Source of Edible Lipids and Nutriment in Congo Brazzaville

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Abstract: *Solanum nigrum* L. seeds have been subjected to standard analytical techniques in order to evaluate proximate composition, physicochemical properties and contents of nutritional valuable elements and fatty acids of the seeds and oils. Physicochemical analysis indicate that the oil content was 37.12±0.75 and 38.88±0.4 for Bligh and Dyer and Folch method, respectively. The seeds are rich in protein (17.66±0.67 g/100 g) and carbohydrate (33.48±35.24 g/100 g). *Solanum nigrum* L. seeds have ash content of 7.18% (with the presence of following minerals: Ca, K, Na and Mg) moisture content is of 3.86 ±0. 97%. Of green color *Solanum nigrum* L. seeds oil has the fatty acid composition following: 18:2n-6 (67.77%), 18:1n-9 (14.59%), 16:0 (12.46%) and 18:0 (4.31%) and 18:3n-3(0.63%). DSC analysis shows three peaks; two at low melting point (-36 and 21.23°C) and one high melting point at 31°C. The majors TAG in *Solanum nigrum* L. seeds oil are Oleodilinolein (OLL) at 56.54% of total triacylglycerols followed by palmitooleo-linolein (POL) and dioleolinolein (OOL) varying between 14.79 and 22.04%. The oil extracts exhibited good physicochemical properties and could be useful as edible oils and for industrial applications.

Key words: Oil, *Solanum nigrum* L., linoleic acid, arrhenius law, macro elements, unconventional oilseed

INTRODUCTION

Solanum nigrum L. valorization passes by the edible oil extraction from its seeds and obtaining the oil cakes containing of proteins having interesting functional properties.

Solanum nigrum L. still called Morelle black is an annual herbaceous plant from 10 to 60 cm in height to green, smooth stem and more or less climbing. The opposed sheets, with whole limb, ovals in rhombus are cogged a little. It is a rather common species in wood wet, at the edges of water and the old walls. One meets it a little everywhere in Africa, America and France.

In India *Solanum nigrum* L. mixed with other medicinal plants has a hepatic protective effect on the patients reached of cirrhosis and this effect is due to its antioxidant action, diuretic, anti-inflammatory drug and immuno modulating (Fallah *et al*., 2005). It also protects from the viral infection from hepatitis B (De Silva *et al*., 2003; Galitskii *et al*., 1997; Kalab and Kerchler, 1997). *Solanum nigrum* L. is especially known for its toxicity because it contains solanine, a glyco neurotoxic alkaloid (Abbas *et al*., 1998). One allots to his fruits anti tumoral properties and their extract can be used as neuropharmacologic substance and chemopreventive against cancer (Son *et al*., 2003; Perez *et al*., 1998). Traditionally, *Solanum nigrum* L. is employed in Egypt for the treatment of the wounds and infections (Abas *et al*., 2006). The extracts of *Solanum nigrum* L. ripe fruits to ethanol have inhibiting properties on cells MCF-7 according to Son *et al*. (2003).

The *Solanum nigrum* L. leaves are consumed in Congo like green vegetables. Former studies showed that the mother's milk of the Congolese is rich in essential poly unsaturated acids and also presents a good ratio 18:2n-6/18:3n-3 (around 7) whereas it is better between 1 and 12 (Rocquelin *et al*., 1998; 2003). What is due to the food of those? For this reason we plan to make a study of the plants usually consumed in Congo, particularly *Solanum nigrum* L. The determination of the chemical composition of *Solanum nigrum* L. can thus have an interest for example the extension of its consumption of its

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production to Congo Brazzaville. The aim of this study is to contribute initially to knowledge on free sugars, the fatty acids (seed oil including), proteins content and minerals composition of *Solanum nigrum* L. seeds. In the second place, after having shown its food profile, data of knowing at which point *Solanum nigrum* L. seeds are nutritional goal for the people mode who consumes it.

MATERIELS AND METHODS

Seed material: *Solanum nigrum* L. seeds coming from the South of Congo Brazzaville were bought in a Brazzaville market. The seeds are then dried and crushed at the Laboratory for a long conservation.

Chemical composition of powdered seeds

Protein content: Proteins are polymers of amino acids. Total protein was determined by the Kjeldahl method. Protein was calculated using a nitrogen conversion factor of 6.25 (Al-Gaby, 1998). Data were expressed as percent of dry weight.

Ash and mineral contents: To remove carbon, about 0.5 g of powdered seed samples were ignited and incinerated in the muffle furnace at 550°C for about 12 h. The ashes were dissolved in H_2SO_4 and the mineral constituents (Ca, Na, K and Mg) were determined using an atomic absorption spectrophotometer (Perkin-Elmer, model HGA 700).

Dry matter: The dry matter was determined according to the AOAC (1997).

Oil extraction

Bligh and dyer method: According to Bligh and Dyer (1959), 100 mg of seed powder are homogenized with a chloroform mixture: methanol (1:1) and water. We obtain two phases, aqueous layer (methanol-water) and organic layer (chloroform).

Folch method: Oils from the seeds were extracted mainly according to Folch *et al*. (1957), this chemical method makes it possible to obtain the cold lipids in anhydrous mixture chloroform: methanol (2:1; v/v).

The oils were recovered by distilling the solvent in a rotary evaporator at 45°C, then dried to constant weight in a vacuum oven at 90°C for 1 h and weighed.

Physicochemical analyses of seed oil

Chemicals analyses (Dzondo *et al*., 2005)

Acid value,% FFA: Acid value of seed oil was determined according to AOAC (1997). Official Method Cd 3a-63. Percentage free fatty acids (FFAs) were calculated using linoleic acid as factor.

Iodine value: Iodine value of seed oil was determined according to AOAC (1997).

Saponification value: The saponification value was determined according to AOAC (1997).

Peroxide value: The peroxide value was determined according to AOAC (1997).

Differential Scanning Calorimetry (DSC): Calorimetric evaluations of sample melting behavior were performed in a Perkin-Elmer (Model Pyris 1, Perkin Elmer Corp. and Norwalk CT). All samples were tempered in the DSC cell according to the following conditions: samples were tempered at -60°C during 10 min. DSC analysis were performed from 60 to 60°C at a scan rate of 5°C/min. The onset, major peak maximum temperatures and enthalpy of melting (J/g) were analyzed from thermograms using the Pyris software (version 2.04, 1997).

Viscosity: Rheological properties of *Solanum nigrum* L. oils were performed under steady shear and dynamic conditions using a thermostated Stresstech Rheologica® apparatus equipped with a UP30 stried plate-plate device (gap 0.5 mm). Flow curves were determined as a function of hydrolysis degree and temperature. Experimental conditions were set as fellows: temperature gradient ranging from 45 to 5 at 1°C/min, delay time 10 sec; stress 50 Pa.

Fatty acids composition by Gas chromatography (GC): Fatty acid composition of each lipid classes was determined after transmethylation using potassium hydroxide in methanol (2 N) by gas chromatography. A PerichromJ 2000 system gas chromatograph (Perichrom, Saulx les Chartreux, France), equipped with a flame-ionization detector and was used for analyzing FAME. Chromatographic parameters were set as fellows: fused silica capillary column (30 m×0.22 mm id. ×0.25 Fm film thickness, BPX70 SGE Australia Pty. Ltd., analytical products); injector and detector temperatures 260°C; oven temperature programming: held 5 min at 145°C then ramped to 210°C at 2°C/min followed by a hold period of 10 min. Fatty acid were identified by comparison of their retention times with standard mixtures ($PUFA_1$ from marine source and $PUFA_2$ from animal source; Supelco, Bellfonte, P.A.)

Triacylglycérol (TAG) composition: Triacylglycerol (TAG) composition was obtained by High Performance Liquid Chromatography (HPLC). It's constitute by: HP 1050 pump (Hewlett Packard, Palo-Viola, CA, the United States); 20 µL Rheodyne loop injector valve model 7125 (Rheodyne, Cotati, CA, the United States), evaporative detector with diffusion of light Sedere Sedex 75 (Sedere, Alfortville, France). Column temperature was controled using a furnace Croco-lash (Cluzeau, Sainte-Foy-la-stat_cryostat julabo CPU F10 (Touzart and Matignon, Ulis, France). Software Azur v2.0 (Datalys, Saint Martin d' Hérès, France) done using for data acquisition. TAG were separated at 20°C using a Kromasil C18 250×4.6 mm (Thermo Quest, Ulis, France) column and was eluted from the column with a mixture of acetonitrile/dichloromethane (63:67) at the flow rate of 1 mL min^{-1}. Detector parameters were optimized and are as follows:

T = 37°C, P = 3.5 bars, Profit = 11, time constant = 1. Acetonitrile (Acros, New Jersey, the USA) and dichloromethane (Carlo Erba, Rodano, Italy) are HPLC quality. Oils were dissolved in $MeCN/CH_2Cl_2$ (50:50); the concentration and volume injected were adapted in such way that a peak taken in reference (PLL) has the same surface always appreciably.

Statistical analysis: Each reported value is the mean of determinations for triplicate samples. The statistical processing was carried out with Microsoft Excel 8.0 software.

RESULTS AND DISCUSSION

Physicochemical characterization of seeds: Oil content: The oil content of *Solanum nigrum* L. seeds varies between 37.12 and 38.88% (Table 1). They are as rich in oil as *Canarium schwenfurthii* fruits (36.1%) (Kapseu *et al*., 1999) and less rich person that the *Balanites aegyptiaca* almonds (48.3%) and *Dacryodes edulis* pulp (43.2%) (Dzondo *et al*., 2005). Their oil content is also higher than that of some conventional oilseeds: cotton seed, soybean, sunflower, rapeseed and palm fruit (Table 2). The duration of the extraction method would explain certainly the difference observed on the lipid level between Folch (38.88±0.4%) and Bligh and Dyer method (37.12±0.75%).

Ash content and minerals: Ash content was highest (3.86±0.97%), the *Solanum nigrum* L. seeds used are thus relatively pure.

It is of interest to note that the most prevalent mineral element in *Solanum nigrum* L. seeds is magnesium which is as high as 426±6.5 mg/100 g dry matter (Table 1). Mg plays a significant role in photosynthesis, carbohydrate metabolism, nucleic acids and binding agents of cell walls

Table 1: *Solanum nigrum* L. physicochemical properties

Properties	Bligh and dyer	Folch	Mean
Oil yield (%)	37.12±0.75	38.88±0.4	38.00
Proteins (%)	17.66±0.67		17.66
Carbohydrate	35.24±0.63	33.48±0.54	34.36
R_1	2.10	2.20	2.15
Calorific value	545.68±11.95	554.48±8.44	550.08
Ash (%)	3.86±0. 97		3.86
Moisture (%)	6.12±0.14		6.12
Minerals			
Magnesium	426±6.5		
Potassium	134.04±3.2		
Calcium	37.8±1.7		
Sodium	18.04±0.8		

Proteins = N_T x 6.25; R_1 = % lipids/% proteins, carbohydrate = 100- [% Lipids + % Proteins + % Ash + % Moisture] Minerals (mg/100 g); Calorific value (kcalg^{-1})

Table 2: Typical oil extraction from 100 kg of oilseeds

Oilseeds	Oil content from 100 kg of oilseed
Cotton seed	13.00
Soybean	14.00
Palm fruit	20.00
Sunflower	32.00
Mustard	35.00
Palm kernel	36.00
Canarium schwenfurthii	36.10 (Kapseu *et al*., 1999)
Rapeseed	37.00
***Solanum nigrum* L.**	**38.00**
Groundnut kernel	42.00
Dacryodes edulis	43.20 (Dzondo *et al*., 2005)
Balanites aegyptiaca	48.30 (Tchiegang, 2003)
Sesame	50.00
Castor seed	50.00
Copra	62.00

The others from http://journeytoforever.org/biodiesel_bubblewash.html

(Russel, 1973). Calcium (134.04±3.2 mg/100 g dry matter) is also the major component of bone and assists in teeth development (Brody, 1994).

Proteins content and dry matter: Moisture content was lowest (6.12±0.14%) in *Solanum nigrum* L. seed. With low moisture levels could store for a longer time without spoilage seeds, since a higher moisture content could lead to food spoilage through increasing microbial action (Onyeike *et al*., 1995).

Crude protein was highest (17.66±0.67%), the concentrations of protein in the seeds analyzed suggest that it can contribute to the daily protein food (Table 1).

Solanum nigrum L. seeds proteins content is less rich than that Dacryodes edulis pulp (34%) and certain current oilseeds: groundnut (48%), sunflower (34%) soybean (40%) (Silou *et al*., 2004).

But it is high compared to that of majority of the cereals which return in our daily food (corn, sorghum, corn, rice etc), which generally does not exceed 13%. With a ratio R_2 = (%lipids /%proteins) = 2.10, *Solanum nigrum* L. seeds are more oilseed than proteagineous.

Physicochemical characterizations of oils:

Acidity: Oils obtained have a low acidity ranging between 0.74 and 1.18% oleic acid. Free Fatty Acid (FFA) concentration is below the maximum limit of 2.0% reported for highgrade Codex Alimentarius (Codex Alimentarius, 1993). The nutritional value of a fat depends, in some respects, on the amount of free fatty acids which develop.

According to, Bassir (1971) and Onyeike and Acheru (2002), the free fatty acid content of cooking oil lies within limits of 0.0-3.0% The low levels of % FFA in all the oils investigated indicate that the oils could probably be good edible oils that may be stored for a long time without spoilage via oxidative rancidity.

Saponification value: Saponification value varies between 160.98±4.84 and 200.75±7.2 mg KOH g^{-1} (Table 3). The oil extracted by the method of Folch has the highest of saponification value (200.75 mg KOH g^{-1}).

The average value (180.86) is lower than that Dacryodes edulis pulp oil (201) (Omoti and Okyi, 1987); (230) (Kapseu *et al*., 1997) and those of oils extracted from conventional oilseeds as soybean (189-195), the groundnut (187-196) and cotton (189-198) (Codex Alimentarius, 1993).

The high saponification values of oil 180.86 mg KOH g^{-1} oil, suggest that the oils could be good for soap making and in the manufacture of lather shaving creams (Eka, 1980).

Iodine value: The iodine value lies between 109.07±0.27 and 114.71±0.15 (Table 3). It is noted that there is no considerable difference. With an average value of 111.89, this oil is unsaturated in comparison with that of *Dacryodes edulis* pulp oil (60-85) (Omoti and Okyi, 1987; Kapseu and Parmentier, 1997), coula edulis (90-95) and *Canarium schwenfurthii* (71-95) (Kapseu *et al*., 1999; Abayeh *et al*., 1999).

With iodine value content around 112, this oil could be utilized for cooking and may find application as a raw material in industries for the manufacture of vegetable oil-based ice-cream (Ibiyemi *et al*., 1992).

Peroxide value: Peroxide values are Bligh and Dyer (3.18±0.02 meq O_2 kg^{-1}) and Folch (2.81±0.01 meq O_2 kg^{-1}) (Table 3). These oils are fresh because the content peroxide lower than 10 meq O_2 kg^{-1} and bus oils grow rancid when the content peroxide lies between 20.0 and 40.0 meq O_2 kg^{-1} (Pearson, 1976; Ojeh, 1981). In the contrary case, oils having high percentages of peroxide are unstable and grow rancid easily (an unpleasant odor).

Viscosity: Viscosity is a measure of the resistance of a fluid to deform under shear stress. It is commonly perceived as thickness, or resistance to pouring. Viscosity describes a fluid's internal resistance to flow and may be thought of as a measure of fluid friction.

In optics to know the rheological properties of these oils, we studied the influence of the temperature on viscosity. Activation energies of the various classes of fatty acids contained in these oils were given in Table 3.

When the temperature increases, viscosity decreases exponentially (Fig. 1) some is the extraction method (Igwe, 2004; Arslan *et al*., 2005). Viscosity varies

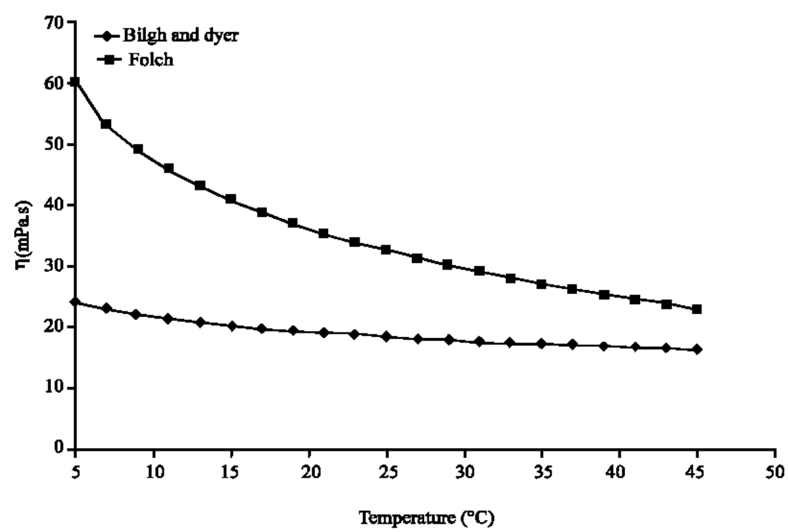

Fig. 1: Effect of temperature on *Solanum nigrum* L. seed oil viscosity

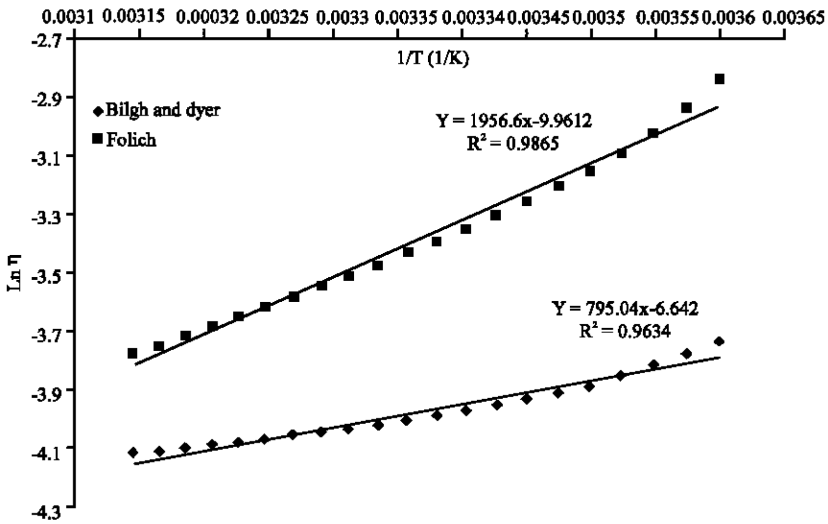

Fig. 2: Arrhenius plot of *Solanum nigrum* L. seed oil

between 60 and 23 mPas when temperature decreases of 45 to 5°C by Folch method. By Bligh and Dyer method, the viscosity of oil decreases of 24.17 to 16.34 mPas (Table 8).

This calculator calculates the effect of temperature on reaction rates using the Arrhenius equation.

$$\eta = A * \exp^{(-Ea/R_*T)}$$

Where η is the viscosity, A is a constant, E_a is the activation energy (in kJ mol^{-1}), R is the universal gas constant and T is the temperature (in degrees Kelvin).

R has the value of 8.314×10^{-3} kJ $mol^{-1}K^{-1}$ .We should use this calculator to investigate the influence of temperature on viscosity.

Linear regression analysis was applied to the logarithmic form of Arrhenius equation in order to determine the parameters of the relation (Fig. 2 and Table 9).

ln η against 1/T, - E_a/R is the slope from which E_a was evaluated. Activation energies of oils are given in Table 3. The highest value of activation energy is obtained by Folch *et al.* (1957) method (16.26 kJ mol^{-1}) and 6.61 kJmol^{-1} by Bligh and Dyer (1959) method.

Table 3: *Solanum nigrum* L. seed oil physicochemical properties

Parameters	Bligh and dyer	Folch	Mean
Acidity	1.18±0.05	0.74±0.01	0.96
SV	160.98±4.84	200.75±7.2	180.86
IV	109.07±0.27	114.71±0.15	111.89
PV	3.18±0.02	2.81±0.01	3.00
Ea	6.61	16.26	8.44
Fatty acids			
16:0	12.35±0.08	12.56±0.2	12.46
18:0	4.22±0.12	4.4±0.11	4.31
SFA	**16.57**	**16.96**	**16.77**
18 :1n-9	14.55±0.08	14.62±0.1	14.59
MUFA	**14.55**	**14.62**	**14.59**
18 :2n-6	67.93±0.15	67.6±0.23	67.77
18 :3n-3	0.62±0.08	0.64±0.02	0.63
PUFA	**68.55**	**68.24**	**68.40**
R^2	**5.02**	**4.88**	**4.95**
n-6/n-3	**109.56**	**105.62**	**107.59**

Acidity in % oleic acid; SV: Saponification Value in mg KOH g^{-1}; IV: Iodine Value; PV: Peroxide Value in meq $O_2.kg^{-1}$; η: viscosity in m Pa.s; R_2= UFA/SFA Ea: activation energy in kJ mol^{-1}

Fatty acids composition of oils: The fatty acids composition of *Solanum nigrum* L. seed lipids are listed in Table 3. Linoleic acid is the major component (67.77%), followed by palmitic (16 .77%) and oleic acids (14.59%).

Both stearic (4.31%) and linolenic acids (0.63%) were detected. *Solanum nigrum* L. seed oil was found to be highly unsaturated: 83.1% and 82.86% for Bligh and Dyer (1959) and Folch *et al.* (1957) method, respectively.

The lipid pattern of *Solanum nigrum* L. seed is comparable with that of sunflower, walnut and grapeseed oils (Table 4).

It is well known that dietary fat rich in linoleic acid, apart from preventing cardiovascular disorders such as coronary heart diseases and atherosclerosis, also prevents high blood pressure and also linoleic acid derivatives serve as structural components of the plasma membrane and as a precursors of some metabolic regulatory compounds (Omode *et al.*, 1995; Vles and Gottenbos, 1989). The presence of one of the essential fatty acids in the seed oils make them nutritionally valuable. The oils have higher percentage of unsaturated fatty acids (83%) than saturated ones. This is of nutritional significance. One notes also the presence of the linolenic acid (0.63%). The 18:3n-3 content being lower than 2, these oils can be used in the frying of food.

Table 4: Fatty acid composition of usual oils and fats edibles (from CIQUAL databases. Martin and Zesiger, 2005) Composition by percentage (%) of saturated and unsaturated fatty acid in major usual oils

			PUFA		
Oil	SFA	MUFA	18:2n-6	18:3n-3	18:2n-6/18:3n-3
Coconut oil	91.00	7.00	2.00	< 0.10	20.00
Palmkernel oil	77.00	20.00	2.00	< 0.10	20.00
Palm oil	36.00	49.00	14.50	0.60	24.20
Peanut oil	21.00	50.50	20.00	0.10	200.00
Corn oil	17.00	20.00	57.00	6.00	9.50
***Solanum nigrum* L.**	**16.77**	**14.59**	**67.77**	**0.63**	**107.59**
Olive oil	15.00	68.00	17.00	0.50	34.00
Soybean oil	15.00	22.00	56.00	7.00	8.00
Maize oil	14.00	27.00	58.00	0.80	72.50
Grapeseed oil	11.00	16.00	70.00	0.30	233.30
Sunflower oil	11.00	22.00	67.00	0.10	670.00
Canola oil	8.00	61.00	22.00	9.00	2.40
Walnut oil	5.00	22.00	65.00	8.00	8.10

Table 5: Thermal analysis of *Solanum nigrum* seed oil

	Extraction method	
Parameters	Bligh and dyer	Folch
Peak 1 (°C)	-36.23	-35.85
ΔH [J/g]	20.00	18.00
Peak 2 (°C)	-15.22	-21.23
ΔH [J/g]	0.19	6.20
Peak 3 (°C)	30.71	31.81
ΔH [J/g]	0.96	0.87

Table 6: TAG content of *Solanum nigrum* L. seed oil

TAG	Bligh and Dyer	Folch	Mean
LLL	0.00	1.11	0.56
OLL	61.39	51.69	56.54
POL	17.14	22.04	19.59
OOL	14.79	19.02	16.91
SOL	1.61	2.22	1.91
POO	2.99	2.52	2.76
PSL	2.09	1.40	1.75
Tri saturated	76.18	71.82	74.00
Di saturated	21.73	26.78	24.26
Mono saturated	2.09	1.4	1.75

Table 7: TAG composition of some edible oils

TAG	Melting point (°C)	Sunflower	Grape seed	Walnut	*Solanum nigrum* L.
LLL	-13.3	36.3	35.7	2.5	0.56
OLL	-6.7	29.1	21.0	16.0	56.54
PLL	-5.6	11.3	17.0	2.5	0.0
POL	-2.8	4.0	15.9	9.0	19.59
OOL	-1.1	6.5	10.3	24.5	16.91
SLL	-1.1	7.5			
OOO	5.6	0.6		31.5	
SOL	6.1	2.1			1.91
POO	15.6	0.4		8.5	2.76
SOO	22.8			3.0	
PPL	27.2	0.5			
PSL	30.0				1.75
PPO	35.0	0.7			
Tri unsaturated		72.5	67.0	74.5	74.00
Di unsaturated		25.3	32.9	23.0	24.26
Mono unsaturated		1.2	0.0	0.0	1.75

With a ratio $R_{1=}$ (UFA/SFA) = 5.72, there are thus unsaturated oils. All this reinforces the interest which one can grant to these seeds.

Table 8: Oil viscosity at various temperature in degree celsius (Fig. 1)

	η (mPa.s)	
T (°C)	Bligh and Dyer	Folch
5	24.1766414	60.3
7	22.977387	53.40453
9	22.0816522	49.3040838
11	21.3664217	46.0299407
13	20.7710075	43.3042863
15	20.2609675	40.9694529
17	19.814861	38.9272911
19	19.4184306	37.1125336
21	19.0617131	35.4795719
23	18.7374715	33.9952764
25	18.4402828	32.634822
27	18.1659782	31.3791257
29	17.9112842	30.2132012
31	17.6735828	29.1250648
33	17.4507477	28.1049826
35	17.2410284	27.144941
37	17.0429664	26.2382633
39	16.8553336	25.3793282
41	16.6770864	24.5633582
43	16.5073305	23.7862589
45	16.3452936	23.0444948

Table 9: Energy plot derived from the Arrhenius equation (Fig. 2)

	Ln η	
1/T	Bligh and dyer	Folch
0.00359712	-3.72236834	-2.83200908
0.00357143	-3.77324472	-2.92985971
0.0035461	-3.81300823	-3.00974837
0.00352113	-3.84593467	-3.07846321
0.0034965	-3.87419713	-3.13950366
0.00347222	-3.89905903	-3.19492854
0.00344828	-3.92132307	-3.2460597
0.00342466	-3.94153263	-3.29380053
0.00340136	-3.9600735	-3.33879819
0.00337838	-3.97722994	-3.38153369
0.0033557	-3.99321773	-3.4223754
0.00333333	-4.00820476	-3.46161239
0.00331126	-4.02232436	-3.49947632
0.00328947	-4.03568425	-3.53615614
0.00326797	-4.04837278	-3.5718084
0.00324675	-4.06046336	-3.60656458
0.00322581	-4.07201769	-3.6405365
0.00320513	-4.08308814	-3.67382029
0.00318471	-4.09371957	-3.70649945
0.00316456	-4.10395072	-3.73864722
0.00314465	-4.11381528	-3.77032837

Differential Scanning Calorimetry (DSC): DSC analysis makes it possible to determine the variations of bound energy on a change of state (Table 5). Melting point of peaks and the fusion enthalpy are obtained by analyzing the thermo grams using the software Pyris I (Perkin Elmer Corp, Norwalk, the USA). The data, show the existence of two peaks at low melting point some is the method of extraction.

The first peak appears around -36°C with an enthalpy of fusion (ΔH_f) of 20 J g^{-1}, second is with -15°C with ΔH_f = 0.2 J g^{-1} for Bligh and Dyer extraction. By Folch extraction, the second melting point is at -21.23°C (6.2 J g^{-1}). An other peak appear at high melting point at 31°C (0.9J g^{-1}).

Melting point decreases with increase in the degree of unsaturation (Table 7). The lower melting point oils may therefore be useful in the manufacture of soft and easy-to digest margarine and have been shown to be valuable in the manufacture of oil creams (British Standard Instituation, 1958).

TAG composition: HPLC analysis of triacylglycerols in control seeds showed seven molecular species. Oleodilinolein (OLL) is the major fraction, representing about 56.54% of total triacylglycerols (Table 6). The levels of palmitooleo-linolein (POL) and dioleolinolein (OOL) are also higher varying between 14.79 and 22.04% of total. The other molecular species: trilinolein (LLL), dioleopalmitin (POO), stearooleolinolein (SOL) and palmitosteraolinolein (PSL) are minor and do not exceed 5%.

The oils are rich on tri saturated triacylglycerol (71.82-76.18%); linoleic acid is the most esterified. *Solanum nigrum* L. seed oil is liquid at room temperature. One notes the absence of the tri saturated triacylglycerol (PPP or SSS), these triglycerids having hypercholesteriomics properties, it can cause cardiovascular disorders such as coronary heart diseases and atherosclerosis. The studies showed that palmitic acid atherogenicity propertie is more significant when it is located in internal position of food TAG (Innis *et al.*, 1994). The majority of the palmitic acid is on the external positions. On a nutritional level, AG in central position on glycerol does not have the same one to become after pancreatic digestion (Small, 1991). Indeed, AG located in TAG external positions are hydrolized preferentially and can be eliminated by the organization when they form with the intestinal calcium of insoluble salts. On the other hand, fatty acid located in TAG central position are preferentially and effectively absorbed through the intestinal wall, in of β-mono acylglycerols (MAG) form.

This situation reinforces the nutritional interest of oils of *Solanum nigrum* L. when it is known that the saturated acids with long chains, in particular when they are located in sn-2 position of TAG have hypercholesterolemics properties and artherogenes (Stuffin, 1967).

The development of the production this oil can contribute to the reduction of the deficiency in lipids of the feed rations noted in under area. The export of oil of cosmetic use could also get currencies. However, this study deserves to be continued for a checking and of a confirmation of the preliminary results. After the control of the manufacturing process of oil, it would be considered studies of optimization on a pilot scale and the technology transfer to Small and Medium-sized company (SME) (for the production of an oil of high added value) finally, with the peasant (for the production of the edible oil for an autonomy on the lipidic production).

Solunum nigrum L. oil being of green color contains chlorophyllian products, must be preserved safe from the light because these photosensitive molecules are catalysts of oxidation. In the presence of the visible and ultraviolet light, oxygen with the state singulet is added very quickly on the double connections, formant of the unstable intermediaries transformed in their turn into hydro more stable peroxides. Those affect the nutritional value of oils, greasy substance or food lipids because their essential fatty acids then are partially destroyed. They are very unstable compounds, in particular at the high temperatures and they are thus broken up into volatile molecules of which sensory perception is very characteristic (Grosch, 1987).

Comparison with conventional or unconventional oilseeds: Analytical results showed that the iodine, acidic and peroxide values ranged, respectively, at 180.86± 0.21, 0.96±0.04 and 3±0.01 meq kg^{-1} (Table 2) contribute to the stability of oil.

The high saponification values suggest the possibility of industrial applications for foods (table or cooking oils) or even in non-food area (i.e., skin cream or liquid soap).

Unbleached oil had an olive green colour and was semi-solid at room temperature.

Table 2 reports the oil content extracted from 100 kg of conventional or unconventional oilseeds. The oil content of *Solanum nigrum* L. seed (38%) is higher than Canarium schwenfurthii 36.1 (Kapseu, 1999) and conventional oilseeds as Cotton Seed and Soybean (13-14%), palm fruit (20%) and sunflower, mustard and palm kernel (32-36%). It is lower than unconventional oilseeds as Dacryodes edulis at 43.2% (Dzondo, 2005) and Balanites aegyptiaca at 48.3% (Tchiegang, 2003) or than conventional oilseeds as sesame, castor seed and copra (50-62%). Compared to what precedes, *Solanum nigrum* L. seed can be regarded as no conventional oilseed.

According to the Table 4 which represents the fatty acids compositions of edibles oils, linoleic acid content (68%) in *Solanum nigrum* L. seed oil is similar of walnut oil (65%), sunflower oil (67%) and grapeseed oil (70%).

The importance of oil was determined by its composition correlated with its production. Generally, it is recognised that a high concentrations of PUFA is essential for health by reducing coronary heart diseases. According to Rocquelin (1998); 18:2n-6/18:3n-3 ratio is better when it lies between 1 and 7 or then the ratio is smaller, oil is more balanced.

Solanum nigrum L. seed oil (107.59) is best than grapeseed oil (233.3) and sunflower oil (670).

CONCLUSIONS

These seeds are therefore good sources of edible oils that can be used in cooking and in the manufacture of soap as they congeal when exposed to air, probably due to the presence of saturated fatty acids. The oils can also find use in cosmetic industries and in the manufacture of margarine.

Solanum nigrum L. seeds give a considerable yield of oil and the oil seems to be a good source of essential fatty acids and lipid-soluble bioactives. The high linoleic acid content makes the oil nutritionally valuable.

Solanum nigrum L. seeds could be nutritionally considered as a new non-conventional supply for the pharmaceutical industries and for edible purposes.

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