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Physicochemical Characterization Of Oil Extracted From Cannabis Sativa Seeds Collected In Kikwit, Kwilu Province, Dr Congo

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***Abstract*—The update of the data on the physicochemical characterization of the oil extracted from seeds of Cannabis sativa was carried out by the conventional methods of analysis. The results obtained show that this oil is aligned in the category of medium oilseeds. It is a semi-drying oil by its density and refractive index values. Moreover the method of gas chromatography allowed to give the profile of the acids of its oil: it is rich in polyunsaturated fatty acids, the oil of Cannabis sativa is also rich in linoleic and linolenic acids. Cannabis sativa oil has a normal ratio between linoleic and linolenic fatty acids. The radar plot shows that Cannabis sativa (hemp) oil is similar to Annuus helianthus (sunflower) oil in its high linoleic acid content.**

Keywords—Cannabis sativa oil, physicochemical characterization, chemical profile of fatty acids, Kikwit

INTRODUCTION

Cannabis sativa is the scientific name of hemp which is of the family Cannabaceae [PAUWELS, 1993]. The plant description of *Cannabis sativa* was made by HAUMAN [1948]. Hemp is a plant of medium size, generally of a lighter green color than other types. Its leaves are composed of long and narrow blades and it is mainly used for its leaves which contain psychotropic substances.

It happens that the *Cannabis sativa* seems to be better indicated as a new source of vegetable oil because it is an undemanding plant and its use for the industrial production of oil has not yet been considered.

There are studies on *Cannabis sativa* dating from the colonial period which indicate real possibilities of sustainable development of the fatty substance sector [ADRIEANS, 1951]. Indeed, the seeds of *Cannabis sativa* are rich in fat according to ADRIEANS [1951]. This study wants to value this culture, non-conventional oleaginous, new sources in oils, which can be used in the food, the industry.

It is a documentary and experimental research. It is based on a review of the literature in the field of oilseed chemistry and natural resources and it also uses conventional and standardized chemical analysis methods used in the literature [AFNOR, 1981].

The extraction of the oil and the determination of the physicochemical parameters of the oils were carried out at the « Laboratoire de Chimie Organique et Energétique (LACOREN) » of the Faculty of Sciences of the University of Kinshasa. The chemical profile of the fatty acids was determined in the Laboratory of Chemistry of Essential Oils of the Blaise Pascal University of Clermont Ferrand in France.

I. MATERIAL AND METHODS

1.1 MATERIAL

Cannabis sativa seeds were collected in Kikwit (Kwilu Province). Seeds were collected during the period from July to September. The samples were authenticated by the Herbarium service of the Faculty of Sciences of the University of Kinshasa.

1.2 METHODS OF FAT ANALYSIS

C. sativa seeds were ground in an electric mill (FUMA JAPAN brand, FU-250) and sieved. The oils were extracted by delipidation of the powders with petroleum ether in the soxhlet, after concentration of the solvent in the rotavapor and drying in the oven at 103°C. The determination of the fat content of the seeds was carried out according to the approved French standard (NF V03-924) [AFNOR, 1981].

The physicochemical parameters were determined for the oil according to the classical analysis methods described by the French Association of Standards [AFNOR, 1981; AOAC, 2005; MAMPOUYA, 2007; WOLFF (1968)].

Two tests were performed according to the recommendations of the "Association Française des Normes" [AFNOR, 1988].

1.2.1 Determination of the fat content of the different seeds according to the French standard (NF V03-924 March 1976)

a) Procedure :

- Preparation of the sample for testing

The seeds were sorted and cleaned by hand and dried in an oven at 80°C. They were crushed and reduced so as to pass completely through the sieve. One twentieth of the sample was used to complete the cleaning of the grinder and the grind was discarded, the rest was ground and collected for extraction grinding. Approximately 10g of the sample was

weighed to within 0.01g of the end of the grinding process

- Preparation of the extraction cartridge

The test sample was placed in the previously delipidated and oven-dried cartridge and plugged with a cotton ball.

- Preparation of the flask

The 250ml flask, containing 2 pumice seeds previously dried in the oven at 103°C±2°C and then cooled for at least 1 hour in the desiccator, was filled to three quarters with petroleum ether.

➢ First extraction

The cartridge containing 10g of the test sample is placed in the Soxhlet extractor. The flask filled with the solvent is adapted to the extraction apparatus, the whole is placed in the heating mantle. It was heated for 4 hours about twenty-four siphonings. After extraction and cooling, the cartridge was removed from the extraction apparatus and placed in a stream of air in order to remove most of the solvent impregnating it.

➢ Second extraction

The cartridge was emptied into the microgrinder, the contents were ground as fine as possible. The grindings were returned to the cartridge and the cartridge to the extraction apparatus for a second extraction for another 2 hours using the same flask containing the first extraction. The solution obtained in the extraction flask was filtered through a filter paper by washing the first flask and filter paper several times with hexane. The filtrate and washing solvent were collected in a second flask previously dried and tared to the nearest 1mg.

➢ Removal of the solvent and weighing of the extract

Most of the solvent was removed by rotavapor and the last traces of solvent were removed by bubbling with nitrogen gas and heating the flask in the oven at 103°C±2°C for 20 minutes. The flask was allowed to cool in the desiccator for at least 1 hour, and weighed to the nearest 1mg. It was heated again for 10 minutes under the same conditions, cooled in the desiccator, and weighed.

Two determinations were made on the same test sample.

b) Expression of results

The hexane extract or fat content, expressed as a percentage by weight, of the product as is, is equal to : $m1 \times \frac{100}{\mathrm{m0}}$

Where :

m0 is the mass, in grams, of the test sample,

m1 is the mass, in grams, of the extract after drying.

The result is the arithmetic mean of the two determinations.

1.2.2 Preparation of the sample for laboratory analysis (NF T 60-200 March 1968)

Procedure:

The sample in its container was introduced into an oven heated to a temperature below 50°C and maintained until the sample reached this temperature.

The sample was then made as homogeneous as possible by shaking the closed container. If, after heating and stirring, the sample is not perfectly clear, the oil is filtered inside the oven kept at 50°C. Too long a stay in the oven was avoided to prevent any modification of the fat by oxidation or polymerization.

1.2.3 Determination of the density of oils (ISO 6883:1987).

a) Procedure

The empty pycnometer was tared to the nearest 0.1 mg with the thermometer and cap. Afterwards, it was filled with the test sample and the cap was put back, not including air bubbles. The filled pycnometer was placed in a hot bath at the temperature of 40°C±1°C required for the determination, until the contents reached this temperature.

The sample was allowed to flow and wipe off at the top of the flow. The temperature was recorded; the pycnometer was removed from the water bath and wiped thoroughly with a cloth. The pycnometer was weighed when it reached room temperature of 20°C.

b) Number of determinations

Two determinations were performed on the same test sample.

c) Expression of results

The density, Vθ, expressed in grams per milliliter or kilograms per liter, of the fat at ϱθ °C is equal to:

$$\frac{\mathrm{m2} - \mathrm{m0}}{\mathrm{V\theta}}$$

Where:

m0 is the mass, in grams, of the empty pycnometer ;

m2 is the mass, in grams, of the pycnometer filled with fat;

Vθ is the volume, in milliliters, of the pycnometer at temperature θ.

Take as the result the arithmetic mean of the two determinations, if the repeatability conditions are met, and express it to four decimal places.

2.4 Determination of the refractive index (NF T 60-212 November 1984 ISO 6320).

a) Procedure :

The test sample was prepared in accordance with ISO 661.

The refractometer was adjusted by measuring the refractive index of α-bromo-naphthalene.

The temperature of the prism was kept constant by means of water circulation provided by the water bath. The water temperature was monitored at the outlet of the refractometer using a precision thermometer.

Before the measurement, the movable part of the prism was lowered to a horizontal position, to wipe the surface of the prism first with a soft cloth and then with a cotton pad wetted by a few drops of hexane.

The refractive index was read to the nearest 0.0002 in absolute value by noting the temperature of the prism of the apparatus.

Immediately after the measurement, the surface of the prism was wiped with a soft cloth and then with a cotton swab moistened with a few drops of hexane. Two more measurements were then made and the average of two measurements was calculated.

b) Calculation method and formulas

If the difference between the measurement temperature t_1 and the reference temperature t is less than 3°C, the refractive index n^tD at the reference temperature t is given by the formula

a) *if* $t_1 > t$

$n^tD^D = n^{t1}D + (t_1 - t)\,F$

b) if $t_1 < t$

$n^tD = n^{t1}D - (t - t_1)\,F$

where:

t_1 is the measurement temperature;

t is the reference temperature;

F is equal to

0.00035 for t = 20°C;

0.00036 for t = 40°C and t = 60°C

The result is the arithmetic mean of the values obtained for the two determinations under the condition of repeatability.

1.2.5 Determination of the saponification number (NF T 60-206 December 1968).

a) Procedure

The sample was prepared in accordance with standard NFT 60-200 and the saponification number on the fat was determined perfectly anhydrous and filtered. 2g of the prepared fat was weighed into the conical flask to the nearest 0.001g. Exactly measured 25 ml of ethanolic solution of potassium hydroxide was added to the flask containing the test sample and the flask was fitted to the refrigerator, then brought to light boiling with occasional stirring.

After sixty minutes, the heating was stopped. Four to five drops of phenolphthalein solution were added to titrate the still hot soap solution with hydrochloric acid. Two determinations were made on the same prepared sample. A blank test was performed under the same conditions.

c) Expression of results

The saponification value is equal to: $\frac{(V0-V1)\times \mathrm{T}\times 56.1}{\mathrm{m}}$

Where:

V0 is the volume, in milliliters, of the hydrochloric acid solution used for the

the blank test;

V1 is the volume, in milliliters, of the hydrochloric acid used for the determination;

m is the mass, in grams, of the test sample,

T is the exact titre of the hydrochloric acid solution used.

The arithmetic mean without decimal places of the two determinations under repeatability conditions was taken as the result.

1.2.6 Determination of the iodine value (NF T 60-203, December 1968).

a) Procedure

The sample was prepared according to NF T 60-200. The sample was weighed in the 300ml flask 0.12g. We introduced 15ml of carbon tetrachloride to dissolve the fat. Then 25ml of iodine monochloride was introduced. The flask containing the test sample and reagents was capped, gently shaken and placed in a dark place at 20°C±5°C for one hour.

After this time, 20ml of the aqueous potassium iodide solution and 150ml of distilled water were added. Then, titration was performed with the 0.1N sodium thiosulfate solution, using starch as an indicator. The titration was continued until the blue color disappeared, after shaking very vigorously. Two determinations were performed on the same prepared sample.

Then a blank test was performed without the fatty substance under the same conditions.

b) Expression of results

The diode index is equal to: $12.69 \times \mathrm{T} \times \frac{(V0-V1)}{m}$

Where:

V0is the volume of sodium thiosulfate solution used for the blank test,

expressed in milliliters.

V1 is the volume of sodium thiosulfate solution used for the sample, expressed in milliliters.

m is the mass, in grams, of the test sample,

T is the exact titre of the thiosulfate solution used.

1.2.7 Determination of acid value and acidity (titrimetric methods, ethanol method) (NF T 60-204, December 1985)

a) Procedure

The test sample was prepared in accordance with NF T 60- 200 standard. 10g of test sample was taken in a conical flask according to the acid value from 1 to 4.

The test portion was dissolved in 100ml of ethanol previously neutralized (carefully brought to near boiling point before use) with ethanolic potassium hydroxide solution in the presence of 0.03ml of phenolphthalein solution per 100ml until a persistent faint pink coloration was obtained.

Titration was carried out with vigorous stirring with the 0.1mol/l potassium hydroxide solution until the indicator turned.

Two determinations were made on the same test sample.

b) Expression of results

The acid number is equal to: $\frac{56.1 \times V \times C}{m}$

Where:

V is the volume, in milliliters, of the potassium hydroxide standard solution used;

C is the exact concentration, in moles per liter, of the potassium hydroxide standard solution used;

m is the mass, in grams, of the test sample.

1.2.8 Determination of the peroxide value (NF T 60-220, December 1968)

a) Procedure

2.0g of fat was weighed into a glass scoop according to the peroxide value of 0 to 150 in micrograms of active oxygen per gram of fat. The bottle was uncorked and the scoop was inserted. 10ml of chloroform was added to quickly dissolve the fatty substance by shaking the flask. Another 15ml of acetic acid was added and then 1ml of potassium iodide solution.

The flask was capped immediately and shaken for one minute, then left for five minutes in the dark. Then about 75ml of distilled water was added.

The mixture was titrated by shaking vigorously. The ion thus released through the 0.01N sodium thiosulfate solution, was highlighted by starch as indicator. Two determinations were performed on the same sample.

Afterwards, a blank test was performed without the fatty substance.

b) Expression of results

The peroxide value, expressed in micrograms of active oxygen per gram is equal to :

$$8000 \times \frac{V}{E}$$

Where:

V is the volume of the sodium thiosulfate solution used for the test, corrected for the blank test, expressed in milliliters of solution N.

E is the mass in grams of the test sample

The result is the arithmetic mean of two determinations made.

1.2.9 Determination of fatty acid(FA) composition.

The determination of the chemical composition in fatty acids was carried out in the Laboratory of Clermont Ferrant in France. It was done by gas chromatography, the most suitable method.

Gas chromatography is a method for separating gaseous compounds or those that can be vaporized by heating without decomposition of the product. Its principle is based on the equilibrium of concentration of the compounds present between two immiscible phases of which one, known as stationary non-volatile liquid, is imprisoned in a column and the other, known as mobile (inert gas: H2, N2, He) moves in contact with the first one and conveys the solute [TRANCHANT et al. 1964].

A Flame ionization detector (FID) identifies the different compounds at the exit of the column. The constituents of the mixture that leave the column one after the other are identified and dosed and the signals they produce at the detector are translated into a recorder by a succession of peaks (chromatogram), characterized by a retention time (identification) and an area (dosage).

The analysis of the fat is done in two steps: the separation of the products contained in the fat and the identification of these products, preceded by a release of FA forming the TAGs by methanolysis.

a) Preparation of methyl esters.

The fatty acids constituting the acylglycerols of the fat are liberated by basic transmethylation with a methanolic soda solution.

0.4 ml of methanolic soda solution (1 N) is added to 2 drops of oil previously dissolved in 1 ml hexane; after stirring and heating for less than 1 minute, 0.4 ml hydrochloric acid (1 N) and 1 ml hexane are added. The organic phase is recovered for analysis.

b) Separation by gas chromatography

The analyses were performed with a HP 5890 chromatograph equipped with an apolar column (HP 5M, 30 m long, 0.25 mm inner diameter and 0.2 µm thick) and a FID (Flame Ionization Detector) detector under the following experimental conditions:

- carrier gas, helium at constant flow: 1 ml/mm

- oven temperature: programmed from 50 to 280 °C, with a gradient of 5 °C/min

- injector temperature: 250 °C

- detector temperature: 280 °C

- quantity injected: 1 µl.

c) Identification of fatty acids

Fatty acids are identified by their respective retention times.

The determination of fatty acids, through their methyl esters is done by the internal calibration method. A known quantity of heptadecanoic acid (C17:0) is added to the fatty substance under study and the fatty acids contained in the fatty substance under study are determined by comparison of their areas with that of C17:0 in the following manner:

FA* (mg) = mass (C17:0) x [Area (FA) / Area (C17:0)]

FA % = FA (mg) x 100/total FA (mg)

*FA : fatty acid

d) Interpretation of results

When interpreting the results, one should always keep in mind that fats are natural products and that the composition depends, therefore, on many parameters.

For example, for vegetable fats, the plant variety and location affect the composition. For animal fats, factors such as sex, age, feed and region of rearing are to be taken into account. For fish, parameters such as season and fishing area must be considered [WOLFF, 1968].

The means and standard deviations were obtained with Excel 2010. They were used to describe the data.

The arithmetic mean satisfactorily describes the data in this thesis: $\langle x \rangle = (\Sigma xi/n)$, for n values of xi.

The dispersion of a data set can be seen in a number of ways, and in particular by the magnitude between the minimum and maximum value. However, the standard deviation is the most used parameter. It has the advantage of considering each of the experimental values in relation to the mean.

It is given by the relation: $\sigma = \{[\Sigma (xi - \langle x \rangle)^2]/n-1\}^{1/2}$

II. RESULTS AND DISCUSSION

2.1 Physicochemical characterization of oils extracted from cannabis sativa seeds

The results concerning the extracted fat contents and physicochemical fat indices of seeds of non-conventional oilseeds, are recorded in Table1.

Table 1: Fat content and physicochemical indices of cannabis sativa seed oil

Paramètres	Valeur
Teneur en matière grasse (%)	23±2
Indice d'acides (mg KOH/g d'huile)	3,4±0,2
Masse volumique (15°C)	0,9213±0,0
Indice d'iode (g d'iode/100g d'huile)	228,4±0,1
Indice de peroxyde (méq O_2/kg d'huile)	nd
Indice de saponification (mg KOH/g d'huile)	189±0,0
Indice de réfraction (20°C)	1,470±0,0

nd : not determined

The results of the determination of the fat content and the physicochemical indices are reported in table 1.

The industrial exploitation of an oilseed plant is only possible from a certain fat content threshold. Therefore, in practice, only those plants that exceed this threshold are considered as oilseeds. Conventionally, this threshold is set at 15 - 20% fat content. [LOUMOUAMOU(2011).

Distinguishes between plants with low (< 20%), medium (20-50%) and high (> 50%) fat content.

It is observed that the fat content of Cannabis sativa seeds has a value that differs from the values stated in the literature. This difference can be justified by the maturity of seeds, the climatic and edaphic conditions or the methods of extraction used, which can modify the composition of the extracted oil.

It was therefore necessary to update the research to place the results in the current context of the study. It is still observed from these results that the seed of the species studied has a fat content that is 23.27%. It is therefore a species of oilseed with a medium content, which may be of interest to be valorized or exploited.

The measurement of the acid number of fat is one of the best ways to evaluate the natural alteration by hydrolysis in fatty acids [WOLFF, 1968]. It also plays an important role in determining the quality parameter in the production, storage and official control of edible oils [SKIERA C, 2012]. The acid value of C.sativa seed fat is 3.4 ± 0.2 mg.

The acid value of C. sativa seeds is within the acceptable standard of the Codex Alimentarius Commission (maximum recommended is 4mgKOH/g oil [CODEX ALIMENTARIUS ,1993]. The difference can be explained by the collection media i.e. the period of collection, the maturity, the conservation of seeds and also the conditions of analysis such as the nature of the solvents, the temperature, the purity and the nature of the reagents.

The iodine(II) index evaluates the richness in unsaturated fatty acids. It also makes it possible to classify oils into three categories: non-drying oil (low unsaturated oil, 75 ≤ II ≤ 100), semi-drying or low unsaturated oil (100≤ II ≤ 150) and drying oil: highly unsaturated oil (150≤ II ≤ 190(200) [FAO and WHO cited by MALUMBA, 2009].

An oil is said to be siccative when exposed to air, it absorbs oxygen quickly and dries by forming an elastic film, it reacts so because it is highly unsaturated in relatively considerable proportion (Anonymous, 1989). The classification of oils in dryness by the iodine index is in default for a double bond in α of a carbonyl group, in the presence of conjugated bonds according to MORDRET (1992). The value of the iodine index obtained in this study does not agree with that of ADRIAENS [1951]. These values are below that of the present study and all things being equal, it is quite indicated that a highly unsaturated oil should fix more iodine molecules than a weakly unsaturated one according to its iodine index which varies between 150 and 190 or even 200 [FAO and WHO quoted by MALUMBA, 2009].

This explains one of the aspects of the objective of the present study which is to update data from previous research. This difference can be attributed to the working and analytical conditions. The chemical or biochemical reaction can reform conjugated double bonds or triple bonds or contact time not long enough for the fixation of iodine of the studied fat.

The peroxide index (PI) can be used to check the rancidity of an oil. However, this is not a safe way to check the rancidity of an oil, as the rancidity products can be destroyed at 130°C. Rancidity produces peroxides when the unsaturated fatty acid content is too high; then, by breaking the chain, aldehydes are formed which are responsible for the rancid smell and acids (all toxic).

The saponification index (SI) provides information on the average length of fatty chains. It varies inversely with the molecular weight of the glyceride constituting the fat. Ex: SI = 200 for a triglyceride in C18 and SI = 260 for a triglyceride in C12.

The classification of oils according to the qualifiers of siccative (II ≥ 180), semi-siccative (II = 130) and non-siccative (II ≤ 90) oils, is practically abandoned, although directly related to their degree of unsaturation. Taking into account the conclusion of MORDRET [1992]. On the abandonment of the classification of the dryness of oils by the iodine index, the dryness of the oils studied is presented here only on the basis of two indices: the density and the refractive index.

The fat of *C. sativa* is classified as a semi-drying oil. This result differs from the ANONYMOUS literature [1989]. Which however classifies the fat of C. sativa in the category of drying oils. This can be explained by the proportion of linolenic fatty acid (14.79%) in the fat of C. sativa seeds. Whereas the ANONYMOUS literature [1989]. states that, for a fat to be classified as a drying oil, it must have a proportion of 40-50% linolenic acid or 70% linoleic acid of total fatty acids. This is not the case for the hemp seed fat studied.

2.2 Chemical profile of fatty acids

The chemical profile of fatty acids of *C.sativa* oil is presented in table2.

Table 2: Fatty acid composition of methyl ester oils of *Cannabis sativa*

Esters AG	Formules simplifiées	*Teneur*
Myristate *(%)*	14:0	/
Pentadécanoate*(%)*	15:0	/
Palmitate*(%)*	16:0	8,32
Palmitoléate*(%)*	16:1,n-7 cis	0,1
Isopalmitate*(%)*	16:0 iso	/
Heptadécanoate*(%)*	17:0	/
Heptadécénoate*(%)*	17:1	/
Stéarate*(%)*	18:0	3,87
Oléate*(%)*	18:1,n-9 cis	13,54
Octadécénoate*(%)*	18:1 n-9 trans	0,82
Linoléate*(%)*	18:2,n-6	55,83
Linolénate*(%)*	18:3,n-3	14,79
Arachidate*(%)*	20:0	0,88
Cis-11-Eicosénoate*(%)*	20:1,n-9	0,4
Béhénate*(%)*	22:0	0,39
Erucate*(%)*	22:1,n-9 cis	/
Lignocérate*(%)*	24:0	0,18
Nervonate*(%)*	24:1,n-9	/
Total*(%)*		99,12

The results on the determination of the fatty acid profile of the studied hemp seed oil are commented and discussed according to the data that are reported in table2. The fat of C. sativa seeds contains a high content of linoleic acid, but a less high content of oleic acid and linolenic acid.

These fatty acids are divided into three classes: saturated fatty acids 13.64%, monounsaturated fatty acids 14.86 and polyunsaturated fatty acids 70.62%.

This result agrees with the result of AUDERSET [2010] with 13% monounsaturated fatty acids, 71% polyunsaturated fatty acids including 56% linoleic acid and 17.5% γ linolenic acid in majority and stearidonic acid).

Both results show that the fat of *C .sativa* is rich in two essential fatty acids: linoleic fatty acid and linolenic fatty acid.

From a dietary point of view, the choice or nutritional interest of oils is based on their polyunsaturated fatty acid content. The polyunsaturated fatty acids, the most interesting on the physiological level, are those of two families: omega 6 and omega 3.

The n-6 polyunsaturated fatty acids are fundamental constituents of cell membranes (linoleic and arachidonic acids) and control their functioning (examples of hematuria and the resistance of blood capillaries, swelling of mitochondria), and that they play an active role in skin physiology (skin barrier effect).

N-3 polyunsaturated fatty acids are particularly abundant in the phospholipids of the central nervous system (cortex, retina) of all mammals, including humans.

A dietary deficiency in n-3 polyunsaturated fatty acids unbalances the ratio of arachidonic acid to DHA in the brain, and specifically causes disturbances in the functioning of nervous structures: visual and cognitive functions, as well as the development of the nervous system.

Given the competition between the two families of FAs named omega 6 (ω6) and omega 3 (ω3), derived respectively from linoleic acid (C18:2 n-6) and α-linolenic acid (C18:3 n-3) for the synthesis and availability of EPA and DHA, the ratio of linoleic acid to α-linolenic acid is often referred to.

Nevertheless, this ratio remains a practical reference in cases of imbalance due to a deficit in α-linolenic acid and/or an excess of linoleic acid intake, and even more so if a deficit in EPA and DHA intake is added [CUNNANE, 2004].

Thus, a table has been developed to express the ratio of linoleic acid / α-linolenic acid of extracted oils. the ratio of fatty acids. The calculation of ω6/ω3 ratio shows that the oils of C. sativa has 3.77. as mentioned above and despite its normal ω6/ω3 ratio.

To make this oil more balanced in essential fatty acids, the ideal would be to blend them according to their profile of unsaturated acids mentioned above by an appropriate technology to food oils. Thus, most vegetable oils sold on the market are made of mixtures of seed oils of different origins [APPELBAUM, 1989].

2.3 Polar coordinate representation (radar plots).

Radar plots were used to illustrate the similarity of the geometric shape of C. sativa and A. helianthus oils.

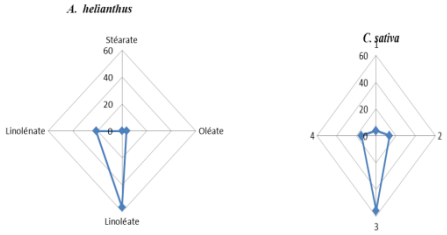

Figure 1: Radar plots of the composition of major fatty acids (stearic acid, oleic acid, linoleic acid and linolenic acid) of *Annus helianthus* seed oil and seeds.

Looking at figure 1, it appears that the geometric figures presented by C. sativa oils are close to those of A. helianthus (sunflower) oil. They are all characterized by a high content of linoleic fatty acid.

The normal omega 6 / omega 3 ratio is maximum 5 [CUNNANE, 2004]. The results displayed in Table 2 show that only the oils of M. C.sativa and present respective ratios of ω6/ω3 of 3.77. The C.sativa oil has a good ratio close to the standard,

2.4 Nutritional interest of hemp oil

The nutritional interest of fats is based on the essentiality and indispensability of certain long chain fatty acids and their triglyceride structure. The studied fats contain many C18 fatty acids. Two families of PUFAs: ω6 and ω3 from linoleic acid (C18:2 n-6) and α-linolenic acid (C18:3 n-3) are "indispensable." These fatty acids are converted into derived fatty acids called "conditionally indispensable": AA (C20:4 n-6), EPA (C20:5 n-3) and DHA (C22:6 n-3).

This is how all the essential and conditionally indispensable fatty acids constitute the essential fatty acids. A high percentage of polyunsaturated fatty acids is found in C. sativa oils (71.02%), an oil that is potentially of nutritional interest. This interest must be relativized because it will be necessary to know the position of these acids on the glycerol to confirm the dietetic value of these oils and their impact in the human food.

CONCLUSION

The objective of this study is to update the data by determining the fat content, the physicochemical indices and the fatty acid composition. The hemp seeds mentioned in this study have a medium oil content and may be of economic interest.

The fat content of C. sativa seeds has a value that differs from those reported in the literature. This difference can be justified or explained by the nature of the soil where the plant grows, the period of early or late harvest of the seeds, the conservation of the seeds, the methods of extraction and the nature of the solvents used can influence the quantity and quality of the oils.

The value of the acid value of fatty matter of hemp seeds is in accordance with the standard of oils recommended for human consumption of the codex alimentarius. C. sativa oil is a semi-siccative oil and is

suitable for human nutrition. It remains to identify the position of the fatty acids on the glycerol molecule because it is said in the metabolism of triglycerides, the fatty acid that is absorbed is the one of the β position, while the α and α' fatty acids are eliminated during lipolysis.

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