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Full Length Research Paper

The optimization of the traditional extraction of the sesame oil for biodiesel production

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Abstract

The aim of this work was the optimization of the traditional extraction of the sesame oil. Two varieties of sesame were collected in the Maroua town. The physicochemical analysis was conducted for the identification. The central composite was chosen for optimization. The product obtained from the optimization was characterized. The results showed low water contents (5, 77 ± 096 for the white sesame and 5, 11 ± 062 for the dark sesame). The best test chosen for white sesame was done under the following conditions: time of germination 48,0 hours; Roasting time:10,0min; speed of centrifugation:3700,0 trs/min and the answer obtained for this test is:Y1=57,12 % and for sesame sinks we have the following conditions: time of germination 56,18heures; roastingtime:7,5 min; speed of centrifugation:2850,0 trs/min and the answer obtained for this test is:Y1 = 48,14%. The analysis also gives the value of the coefficient of regression R^2 is equal to 56, 47% for white sesame and 46, 94% for dark sesame. It is observed that the values of R^2 are lower 70% which means that the model of second order selected does not explain this model.

Keywords: physicochemical properties, sesame oil, germination, roasting, centrifugation.

Introduction

Since many centuries extraction of oilseed oils was done in the traditional way, now, it is carried out in a large-scale particularly in the industrial scale (Kumar, AppuRao & Singh, 2009) .It and sesame oil is extracted from the seeds of sésamumindicum plant from the family of despedaliacées herb. This oil is very rich in vitamins, minerals, unsaturated fatty acids and low in saturated fatty acids (Toil'd Epices, 2011). Because of its great nutritional qualities, it is mainly used in food (Daho, 2008; MignoloOulipo, 2011; Markal, Steward, Cornelius, & Hammonds, 1972). By his good resistance to oxidation, it is also found in cosmetics and pharmaceutical processing sector (Dietary, 2005). Because the structural trend lower prices for cotton, sesame culture is increasingly an opportunity and a way to fight against poverty, especially for the most disadvantaged (women, youth) (Dietary, 2005) .This plant is found in Africa and on every continent. Cameroon, its culture is underdeveloped; even in areas built for this plant (North and Far North). These regions, although favorable for sesame cultivation, many people are little interest in it; with the tendency of structural decline in the price of cotton, sesame culture is increasingly an opportunity and a way to fight against poverty, especially for the most disadvantaged (women, youth) (Dietary, 2005), it seems important to understand the sesame oil extraction mechanism and optimize its extraction.

Material and Method

Plant material

The plant material was two varieties of sesame (white and dark). They were collected at the central market of Maroua, the Far North region of Cameroon in the Department of Diamaré located in latitude 10 ° 27'N and longitude 014 ° 15'E, elevation 421m (Nacoulma, 1996). This material is cultivated during the period from July to August in this region. The choice focused on these two varieties resulted in their abundance on in the market and also consumer preference over other varieties.

Pre-sorting and routing of sesame seeds

After collecting, the sesame seeds were separated from the twigs, foreign bodies, broken and damaged seeds and forwarded to the research laboratory of Biophysics and Biochemistry food the National School of Agro-Industrial Sciences (ENSAI) to University of Ngaoundere.

Sorting

Sesame seeds collected and forwarded to the laboratory have undergone a second screen in order to remove the damaged or broken seeds. Only healthy seeds and white and dark uniform color were selected. These and sampled seeds were calibrated and standardized on the physicochemical properties.

Methods

Determination of water content

Method

The water content is the loss in mass after complete desiccation. It is determined by baking at 105 ° C to constant weight after 24 hours approximately (Barreteau, Dognin & Graffenried, 1991).

Determination of ash content

It consists in placing in a muffle furnace, the porcelain dish (crucible) containing the sample from the stoving at 105 ° C; set the oven temperature to 550 ° C and incinerate until white ash free of carbon according to standard NF T 60-209 (Wolff & Karleskind, 1992).

Determination of protein content

Dry samples are mineralized and nitrogen is then assayed. The crude protein content is obtained by multiplying the nitrogen content by the conventional factor of 6.25 (Haoua, Hassimi, Saddou & Claude-Louis, 2005).

Fat content

The extraction method used is that described by the Chemistry International Union of Pure and Applied (Yamashita, 1995).

Reducing sugars or free

The determination of reducing sugars has been performed by the colorimetric method DNS (dinitrosalicylic acid 3.5).

Statistical Analysis

Experimental design selection

Optimization of sesame oil extraction is performed by the method of composite designs.

Choice of factors

In this plan, germination time, the roasting time and centrifugation speed were selected as variables. The independent variables for optimizing the extraction of sesame oil to biodiesel production:

$X1$ = germination time sesame seeds
$X2$ = roasting time sesame seeds
$X3$ = speed centrifugation of the mixture (dough + distilled water)

The answers, respectively Y1et Y2sont oil extraction yields in g / 100g white sesame and dark sesame. The number of experiments to be performed has been found by combining the three parts of the composite plane: the factorial design consisting of 8 experiments, the experimental points located at the center of the field consist of 5 experiments and axial points on the axes of each of factors consist of 8 experiments where 19 experiences.

Design of Experiments

The ranges of optimum oil extraction conditions were selected and grouped as follows in Table 1.

Table 1: Intervals of change of selected oil factor levels

Factors	Low level	High level
Germination time (h) (x_1)	24	48
Roasting time (min) (x_2)	5	10
Centrifugation speed (trs/min) (x_3)	2000	3700

To build the matrix of different experience, the experience matrix given by Silou et al. [10] was used.

In fact this experience with composite matrix for 3 factors is in coded values and $\alpha=\sqrt{3}$ to respect the almost Rotary criterion. The values of the coded tests are summarized in Table 2. These coded values were converted into actual values (Table 3) using the following formula (Kamal-Eldin, 1995).

$$x *= \frac{2x-(a+b)}{(a-b)} \qquad (9)$$

Where the variable x is the real value in the interval [a, b], the variable x * is the value encoded in the range [-1, 1] to obtain real values, consider the test No. 1:

For x^*_1 =+1 , x^*_2=-1, x^*_3=+1 for example $x = \frac{x*(a-b)+(a+b)}{2}$ (10)

Applying this formula it gives:

$$x1 = \frac{-1(24-48)+(24+48)}{2} = 48{,}0$$

$$x2 = \frac{+1(5-10)+(5+10)}{2} = 5{,}0$$

$$x3 = \frac{-1(2000-3700)+(2000+3700)}{2} = 3700{,}0$$

For tests 2 to 19, the calculation of the true values was performed in a similar manner as above and was obtained the values of coded values in Table 2 and real values of the test in Table 3.

Table 2: The coded values of the test

N° Test	X^*_1	X^*_2	X^*_3
1	-1	+1	-1
2	-1	-1	-1
3	0	O	0
4	+1	-1	-1
5	+1,73	0	0
6	0	0	-1,73
7	+1	+1	-1
8	-1	+1	-1
9	0	0	+1,73
10	-1	-1	-1
11	0	0	0
12	-1	+1	+1
13	0	0	0
14	-1,73	0	0
15	0	0	0
16	-1	-1	+1
17	0	0	0
18	0	-1,73	0
19	0	-1,73	0

Table 3: Real values of the test

N° Test	x_1	X_2	X_3	Y1,Y2
1	48,0	5,0	3700,0	
2	48,0	10,0	3700,0	
3	36,0	7,5	2850,0	
4	48,0	5,0	2000,0	
5	56,1815	7,5	2850,0	
6	36,0	7,5	1379,5	
7	48,0	10,0	2000,0	
8	24,0	10,0	2000,0	
9	36,0	7,5	4320,5	
10	24,0	5,0	2000,0	
11	36,0	7,5	2850,0	
12	24.0	10.0	3700.0	
13	36.0	7.5	2850.0	
14	15.8185	7.5	2850.0	
15	36.0	7.5	2850.0	
16	24 .0	5.0	3700.0	
17	36. 0	7.5	2850.0	
18	36.0	11.70	2850.0	
19	36.0	3.295	2850.0	

Modeling and validation

Modeling

The model chosen for this plan is the second degree:

$$y = a_0 + a_1 x_1^2 + a_2 x_2^2 + a_3 x_3^2 + a_{12} x_1 x_2 + a_{23} x_2 x_3 + a_{31} x_3 x_1 + a_{123} x_1 x_2 x_3 + e$$

a_0= Coefficient of the model factor

x_1 = Level of factor 1

x_2 = Level of the factor 2

x_3 = Level of factor 3

$x_1\, x_2$ = Product of factor levels 1 and 2 [11].

The statgraphics Centuriun demand software input the type of experimental design, the number of variable, the number of responses and the type of model. It therefore follows the model coefficients and analysis of variance of the studied process.

Validation

The model is thus valid explains the variations in the response if the regression coefficients (R^2) is greater than 70%. Analysis of experience with the plan gives the variance analysis table (ANOVA) R^2 value (Nacoulma, 1996))

Optimization

The Centurion statgraphics software also optimizes the extraction proposals while maintaining the answers.

Experimental Procedures

Seed Treatment Phase

The seeds are sorted to have healthy seeds, and then they were divided in quantity according to the different germination time. Introduced in small basins (4littres approximately), we add a good amount of distilled water (3L) and places the contents (water and seeds) in a laboratory from the corner or the temperature is around 37 ° C. After each germinating time (Table 3), the sesame is extracted from water and spread on trays which are then introduced into an oven to be dried. After drying, the sesame seeds undergo roasting at 100 ° C, therefore the different times are divided by the range of samples (Table 3).

Extraction of Phase

After roasting the blender, was used for the seeds are completely crushed. After molded seeds, weighed an amount of 50g for each sample and placed in glass boxes (100 mL) previously well cleaned. Followed by addition of boiled water to 100 ° This one passes to the mixture using a spatula, then depositing the contents into a water bath (Salvis) set at 100 ° C (5min) .The content is centrifuged at a temperature of25 ° C using a centrifuge (DL -6000B; DZ 230-32; 230V; IEC89A GB109 45000) During the various centrifugation speeds (Table 3) and after centrifugation, the water and oil is two immiscible liquids, oil will float because its density (0.91 to 0.93) is less than that of water that is equal to 1 and the end is removed oils with a micro pipette (pastor mark) is then introduced into the bottles so that they are analyzed (determination of the iodine number, acid, and saponification of ester) (Noguchi, 2001).

Determination of the indices

After the experience of Plan sets, different numbers were determined by (Noguchi, 2001).

Results and Discussion

Proximal composition of the two varieties of sesame

The proximal composition of the two varieties of sesame are presented in Table 4

Table 4: Proximal composition of the two varieties of sesame

Sesame variety	Water contents (g/100gdb)	Ash (g/100gdb)	Organic Material (g/100gdb)	Fat (g/100gdb)	Proteins (g/100gdb)	Sugar (g/100gdb)
White sesame	5.77±0.96[b]	3.01±2.49[a]	96.99±2.49[b]	62.33±1.91[b]	9.46±1.71[b]	1.19±1.86[b]
Dark sesame	5.11±0.62[a]	4.82±2.53[b]	95.18±2.53[a]	54.52±1,48[a]	6.24±1.23[a]	0.52±0.46[a]

Values with different letters in a column are significantly different at 5% probability level

Water contents

The water content present in Table 4 varies significantly (p> 0.05) from a variety of sesame to another. They correspond to 5.77 ± 0.96 g / 100g white sesame which is the highest and 5.11 ± 0.62 g / 100g for the dark sesame which is the lowest. These values are lower than that reported in the literature which is 14.00 ± 0.90 g / 100g (Noguchi, 2001). These differences could be explained by the difference in porosity pasta, ours was not well cast, are less hygroscopic. These differences also indicate the variability of moisture in samples commonly traded high humidity generally observing during wet periods. The comparative point between sesame varieties we note that some species would present a greater susceptibility to fix moisture, thus justifying their high water content. However, these values are lower than 12% indicating their suitability for storage without risk of microbial growth. Water is an important factor in the determination of the physicochemical characteristics of the oils. 10% lower values are obtained in the case of two varieties of sesame. Values respecting this maximum are obtained in the maximum soybean oil extraction. This logic could also be explained to the two varieties of sesame. (Hirose, 1995). The water content has an influence on the chemical characteristics such as iodine numbers, saponification and peroxide; while the acid value increases slightly, the peroxide value increases with increase of the water content and the saponification index decreases with the amount of water (Kamal-Eldin, 1995). Indeed, the oils containing less water and slowly deteriorate their oxidations are also slowed (Yamashita, 1995). In the same vein it has been shown that levels less than or equal to 5.74%, the time of the dried pulp aiélé conservation of the fruit is maximum for future oil extraction (Kang & Noguchi, 1999).

Ash content

The obtained values were significantly (p> 0.05) different between the two varieties. The ash contents vary between 3.01 ± 2.49g / 100g white sesame and 4. 82 ± 2.53g / 100g for the dark sesame. These values are lower than those reported in the literature that mention that sesame seeds are also rich in assimilable organic minerals (magnesium, potassium, copper, iron), vitamins B and E for the values of 5. 76g / 100g white sesame and 6.44g / 100g for the dark sesame (Luciani, Vanni, Marta, Diana, Gabrielle, Brunella, Laura & Laura, 2001). These differences could be explained by the origin of the two varieties of sesame, some ecosystems may be favorable to mineral buildup. The time and place of harvest are other important factors affecting the levels of ash. This could mean that the seeds of our plants on the Maroua market are generally less rich in minerals. These levels are also lower than those obtained for samples of aiélé West Cameroon (5-7%) (Kang & Noguchi, 1999). This high ash content shows that these two sesame varieties could be a potential dietary source of minerals. However, between our results and those reported in the literature (Noguchi, 2001). It would be wise to check the factors influencing the effect of the origin of two sesame varieties on ash and minerals.

Levels of total lipids

The lipid contents vary significantly (p <0.05) of a variety another. Lipid extraction with hexane showed that the two analyzed sesame types are characterized by total lipid content which can range between 62.33 ± 1.96 g / MS 100 white sesame and 54.52 ± 1.48g / 100 MS for the dark sesame. These values are higher than the results reported in the literature (51g / 100g of fat) (Noguchi, 2001). Although these differences may be explained in part by the origin, treatment of the two varieties of sesame or the extraction method (harvesting period and conservation), with experimental errors that may in some cases major contributions are not excluded. Indeed, the extraction method used in this study is that of the hexane extraction which extracts only the neutral lipids as opposed to a cold extraction technique methanol / chloroform which extracts the total fat therefore it provides better performance (Kang & Noguchi, 1999). From the results obtained in this study, we can think the sesame can be good sources of vegetable lipids and therefore could be further enhanced.

Total protein content

The obtained values were significantly (p <0.05) different from the two varieties of sesame. The analysis of total protein yielded the following results in ascending order: 9.46 ± 1.71 g / 100gms white sesame and 6.24 ± 1.23 g / 100gms for the dark sesame. These values are mainly lower than that obtained in the literature. Sesame seeds are rich in high quality protein (22%) containing all essential amino acids (Noguchi, 2001). These differences are related to the determination of total nitrogen method. Indeed, in this work, non-protein nitrogen was removed and could justify the low values obtained. One can conclude from these values that the two sesame varieties could be a good source or protein supplement. However the difference between our results and those reported in the literature is very large (Noguchi, 2001); it would be wise to check the factors influencing the effect of the origin of both varieties of sesame protein levels.

Contents of organic matter

The obtained values were significantly ($p < 0.05$) different between the two varieties of sesame. They vary between 96.99 ± 2.49g / 100gdw white sesame and 95.18 ± 2.53g / 100g dwfor the dark sesame. These values are similar to those reported in the literature (Noguchi, 2001) which states that they contain around 93.56 to 94.24g / 100g.dw

Levels of reducing sugar

The obtained values were significantly ($p < 0.05$) different between the two varieties of sesame. They vary around 1.19±1,86g/100gdw for white sesame and 0.52 ± 0.46 g / 100gdw for the dark sesame. From the results obtained in this study, the conclusion made was that, sesame is not a source of reducing sugar but a source of carbohydrates.

Optimization of the extraction of sesame oil

The optimization of the extraction of oil from sesame seeds by the traditional method resulted in the realization of composite centered experience plan. It was a matter of finding optimum test that gives a good amount of extraction and then a good extraction. The plan calls for 19 experiments with repetitions. For each test, the response (Y1) is the extraction yield of the variety of white sesame was calculated and the answer (Y2) is the extraction yield of the variety of dark sesame was also calculated. The results are summarized in Table 5.

During these tests, oils (photo1) were extracted from two varieties of sesame. After all these experiments, it was found that the yield of huilevarie from one test to another. And that performance increases with the germination time and speed of centrifugation. The best test for the selected white sesame was done under the following conditions: germination time 48.0 hours; Roasting time: 10,0min; spin speed: 3700.0 rev / min and the response to this test is: Y1 = 57, 12% and for the dark sesame we have the following conditions: germination time 56,18heures; Roasting time: 7,5min; spin speed: 2850.0 rev / min and the response to this test is: Y1 = 48.14% The analysis of the plan provides for the selected quadratic model:

$$Y_1 = 73.90 - 3.83x_1 - 0.84x_2 + 0.05x_3 + 14.73x_1^2 + 0.71x_2^2 + 0.003x_3^2 + 3.25x_1 x_2 + 0.21x_1 x_3 + 0.04x_2 x_3$$

$$Y_2 = 60.45 - 2.3\ 3x_1 - 0.13\ x_2 + 0.04x_3 + 5.42x_1^2 + 0.01x_2^2 + 0.002x_3^2 + 0.30x_1 x_2 + 0.09x_1 x_3 + 0.005x_2 x_3$$

The analysis of the plan also gives the value of R^2 regression coefficient is equal to 56.47% for white sesame and 46.94% for the dark sesame. It is found that R2sont values below 70%, which means that the second-order model selected does not explain 43.53% changes in response Y1 and 53.06% the variations Y2. So this model cannot be used to explain the process. This could be explained by some factors which have not been taken into account such as the roasting temperature, germination and centrifugation as well as the solvent used during extraction.

Table 5: Extraction Results (Y1 and Y2)

Test	X1	X2	X3	Y1(%)	Y2(%)
1	48.0	5.0	3700.0	38.24	34.52
2	48.0	10.0	3700.0	57.12	43.44
3	36.0	7.5	2850.0	17.52	18.05
4	48.0	5.0	2000.0	20.17	17.81
5	56.1815	7.5	2850.0	45.0	48.14
6	36.0	7.5	1379.5	4.04	4.24
7	48.0	10.0	2000.0	23.38	27.68
8	24.0	10.0	2000.0	17.50	18.40
9	36.0	7.5	4320.5	38.30	27.10
10	24.0	5.0	2000.0	10.00	9.80
11	36.0	7.5	2850.0	16.30	15.25
12	24.0	10.0	3700.0	33.46	32.16
13	36.0	7.5	2850.0	16.02	13.25
14	15.8185	7.5	2850.0	26.26	18.02
15	36.0	7.5	2850.0	13.96	14.74
16	24.0	5.0	3700.0	24.64	25.78
17	36.0	11.70	2850.0	17.56	13.16
18	36.0	11.70	2850.0	17.56	18.63
19	36.0	3.29552	2850.0	11.29	7.52

Photo 1: Oils extracted from dark and white sesame

Some physicochemical characteristics of the oils extracted

Table 6: physicochemical characteristics of the oils extracted

Test	II_1	II_2	IA_1	IA_2	$1S_1$	IS_2
1	111	111	41	42	179	178
2	115	114	81	87	189	185
3	110	110	57	67	87	89
4	109	109	42	45	160	163
5	109	109	42	45	160	163
6	108	107	46	47	38	34
7	108	108	48	48	176	167
8	108	108	36	36	164	164
9	109	109	37	38	168	171
10	106	106	56	56	39	40
11	106	107	36	37	98	93
12	102	107	32	35	162	165
13	102	106	36	37	38	102
14	102	105	37	38	102	102
15	98	104	29	31	97	102
16	98	99	20	21	141	140
17	98	98	27	29	56	59
18	103	103	27	29	56	59
19	102	101	19	21	54	52

Iodine Value

Table 6 shows the values of the iodine value (II1 and II2) for both varieties of sesame. Knowledge of the iodine value (amount of iodine can react with fatty acid double bonds) enables a preliminary assessment on the ability of burning of the oil: the higher index can cause problems of burning. These great values in iodine value obtained for our oils show that they could be compose mostly by unsaturated fatty acid (UFA). These values are close to those obtained on the usual oils such as soybean 125-138g iodine / 100 g of lipids, cotton 102-115g iodine / 100g of fat, peanut 80-106 g iodine / 100 g of lipids olive 75-95 g iodine / 100 g of lipids [15], castor oil 85g of iodine / 100 g of lipids, 103-128g corn iodine / 100 g of lipids (Barreteau, Dognin & Graffenried, 1991). They are very far against the values obtained on palm oil which is rich in saturated fatty acids (SFA) II = 25-32 g iodine / 100 g and palm kernel oil from 14.1 to 21.1 g of iodine / 100 g of lipids. Compared to other oilseeds such as *M. myristica* of Nigeria: 85.00 ± 0.50 g iodine / 100 g fat; *X. aethiopica*: 97 g iodine / 100 g of lipids, higher values (Hirata, 1996). It shows that the oils of two sesame varieties have iodine values which are in the range (0-110), therefore they can be placed in the group of semi-drying oils (cannot enter the composition of paints, varnishes, inks) (Haoua *et al,* 2005).

The analysis of the acid value provides for the selected quadratic model:

$$\mathbf{Y_2}=93.14-0.83x_1-0.1\ 4x_2+1.05x_3+0.01x_1^2+0.02x_2^2+1.10x_3^2+3.25x_1x_2+0.21x_1x_3+0.04x_2x_3$$

The analysis of this index also gives the value of R^2 regression coefficient equal to 41.97%. It is found that the R^2 value is less than 70% which means that the selected second order model does not account for 58.0% 3 changes in response Y_2

For White sesame

The analysis of this index gives the value of R^2 regression coefficient equal to 78, 86%. It is found that this value is greater than 70%; meaning that the second order model explains 78.86% selected variations Y_2 response. The results of these indices were summarized in the mathematical model and allow us to plot the acid value variation curve as a function of germination time, roasting and then the curve of variation of the acid value in depending on the speed and the roasting time. We find that the acid value increases with the time of germination, roasting and centrifugation speed. It shows that these oils have very high acid numbers therefore, have no interest in food, but could instead be used in biodiesel production.

For the dark sesame

$$Y_1 = 48{,}89 + 0{,}32X_1 + 0{,}93X_2 + 4{,}69X_3 + 4{,}93X_1^2 + 0{,}03X_2^2 + 1{,}58X_3^2 - 1{,}48X_1X_2 + 0{,}63X_1X_3 - 3{,}72X_2X_3$$

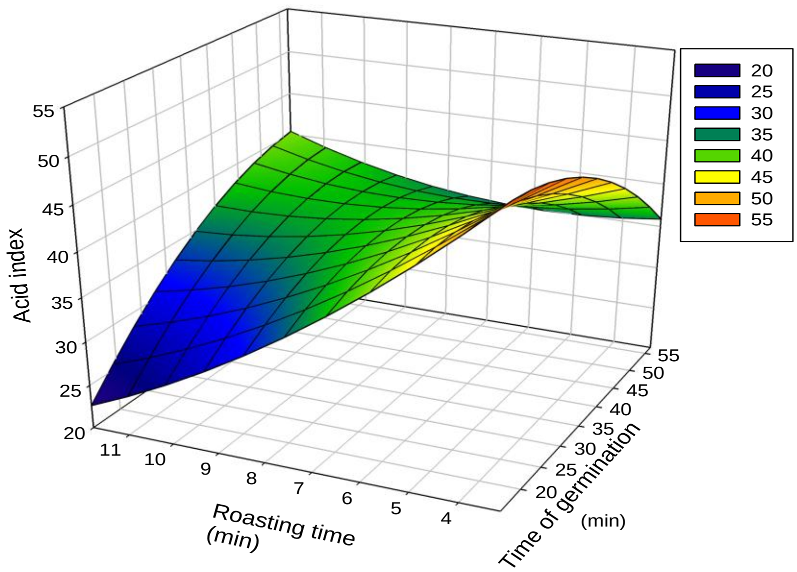

Figure 1: Variation of the acid index according to the speed and the roasting time for the white sesame

$$Y_3 = 78{,}89 + 2{,}32X_1 + 0{,}57X_2 + 4{,}69X_3 + 4{,}93X_1^2 + 0{,}13X_2^2 + 2{,}58X_3^2 - 3{,}48X_1X_2 + 0{,}63X_1X_3 - 1{,}72X_2X_3$$

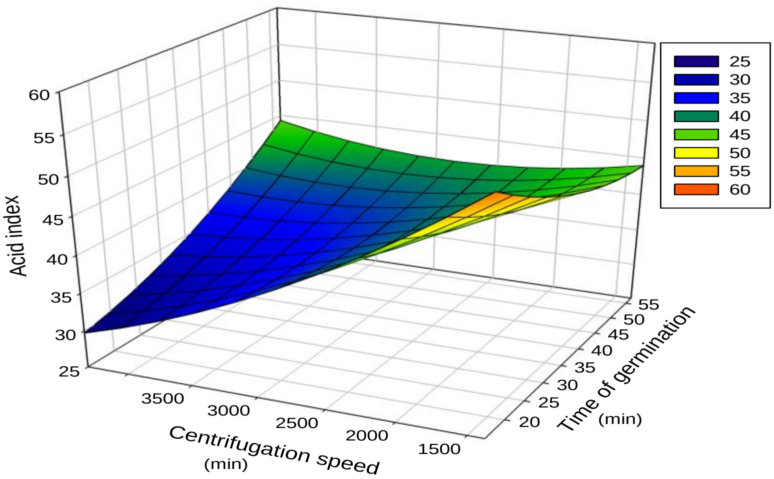

Figure 2: Variation of the index into an acid function of roasting time and germination for the dark sesame

Saponification value

Table 6 shows the values of saponification white sesame and dark sesame These values are similar to those cited by Wolff & Karleskind (1992) (187-195) and the usual oils such values as soybean (189-195), peanut (187-196), cotton (189-198), olive (184-196) (Wolff & Karleskind, 1992). These values are also lower than the values obtained for the three extractions with aiélé methods (196-206). The saponification values obtained for these two varieties of sesame, compared to other alternative oilseeds such as *jatropha curcas* of Benin (196-208 mg / g), jatropha of Congo (209mg / g), the value of the index saponification obtained is lower (Matsuma, 1998). They are also lower values to 180-185mg / g obtained for Walnut *Coulas eduli* (Hirose, 1995); 180-206 mg / g obtained for aiélé and 180mg / g obtained for Safou. (Haoua et al, 2005). It follows from this that the oil obtained from the seeds of *sesamum indicum L* contains more fatty acid per gram of oil therefore less saponifiable. However it should be noted that the methods of extraction of oil may justify the differences observed in the indices. Analysis of the saponification (figure 3) also shows the regression coefficient values R^2 equals to 76.47% for white sesame and 71, 94% for the dark sesame. It is found that the R^2 values greater than 70% which mean that the model of second order selected explain 76.47% changes in response Y1 and 94% variations of Y2. The results of these indices are summarized in the mathematical model and allow us to drawn the iodine value variation curve as a function of the centrifuge speed and time of roasting and then the curve of variation of the index of saponification according to the centrifugation speed and the roasting time. It was observed that these factors increase with saponification.

$$Y_3 = 38{,}38 + 0{,}54X_1 + 0{,}24X_2 - 3{,}59X_3 + 0{,}69X_1^2 - 1{,}14X_2^2 + 0{,}91X_3^2 + 2{,}32X_1X_2 + 2{,}12X_1X_3 + 2{,}82X_2X_3$$

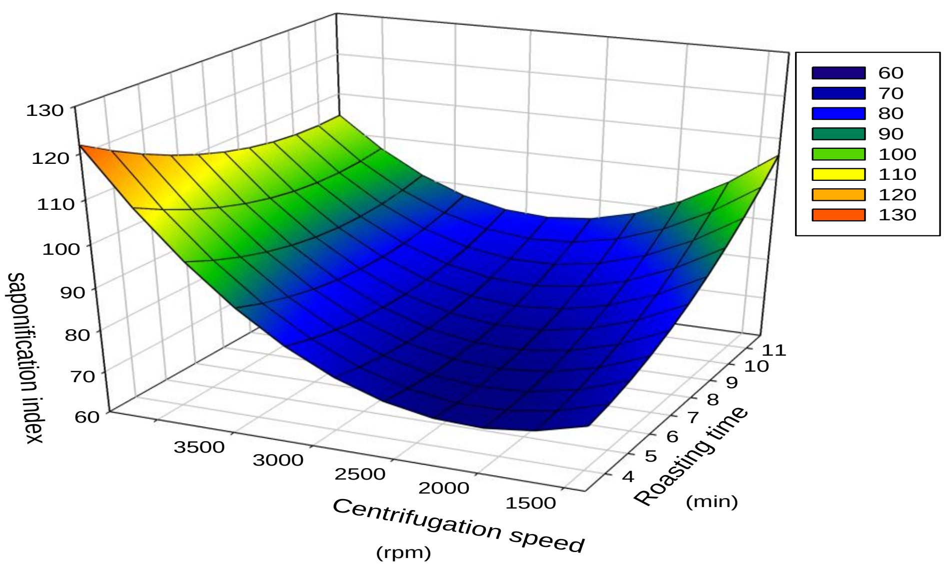

Figure 3: Variation of the saponification number according to the centrifugation speed and time of germination (white sesame)

$$Y_4 = 34{,}73 + 7{,}32X_1 + 0{,}77X_2 + 8{,}69X_3 + 9{,}93X_1^2 + 0{,}93X_2^2 + 5{,}888X_3^2 - 6{,}48X_1X_2 + 0{,}63X_1X_3 - 2{,}72X_2X_3$$

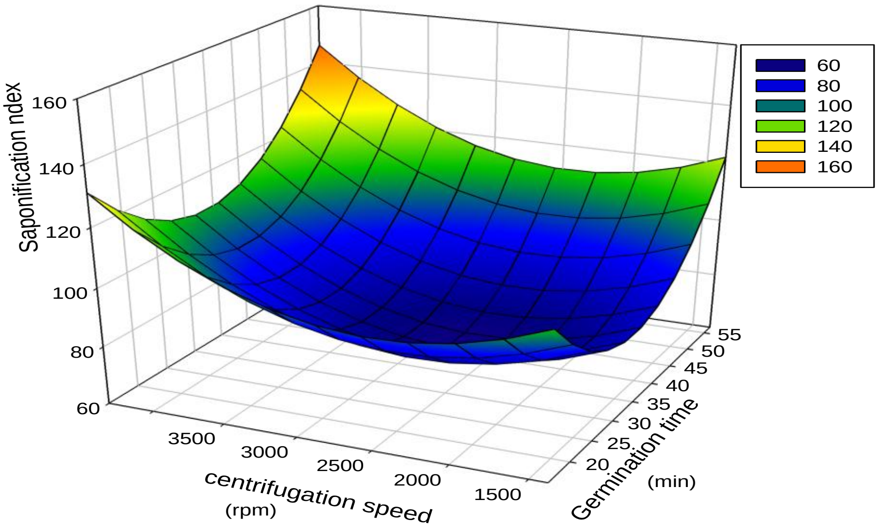

Figure 4*:* Variation of the acid number according to the speed and the germination time (white sesame)

$$Y_5 = 88{,}89 + 4{,}32X_1 + 0{,}97X_2 + 7{,}69X_3 + 8{,}93X_1^2 + 0{,}33X_2^2 + 5{,}58X_3^2 - 5{,}48X_1X_2 + 0{,}63X_1X_3 - 3{,}72X_2X_3$$

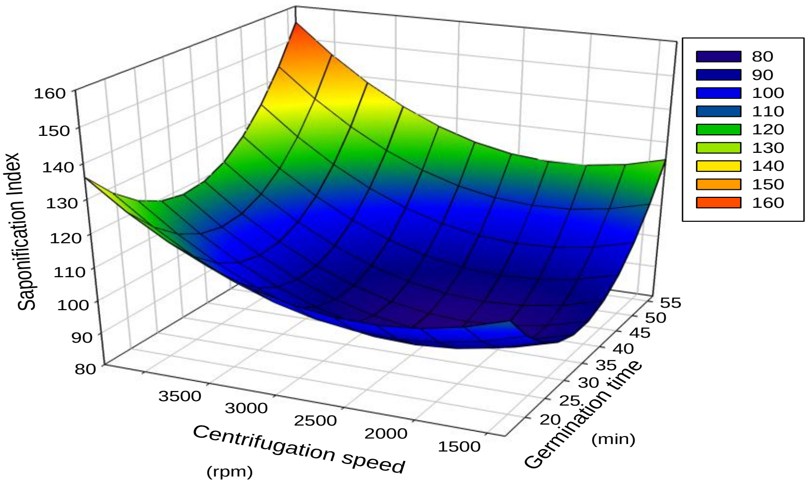

Figure 5: Change in the saponification number according to the spin speed and germination time (dark sesame)

$$Y_6 = 76{,}89 + 3{,}32X_1 + 0{,}17X_2 + 7{,}09X_3 + 2{,}93X_1^2 + 0{,}33X_2^2 + 4{,}58X_3^2 - 5{,}48X_1X_2 + 0{,}03X_1X_3 - 5{,}72X_2X_3$$

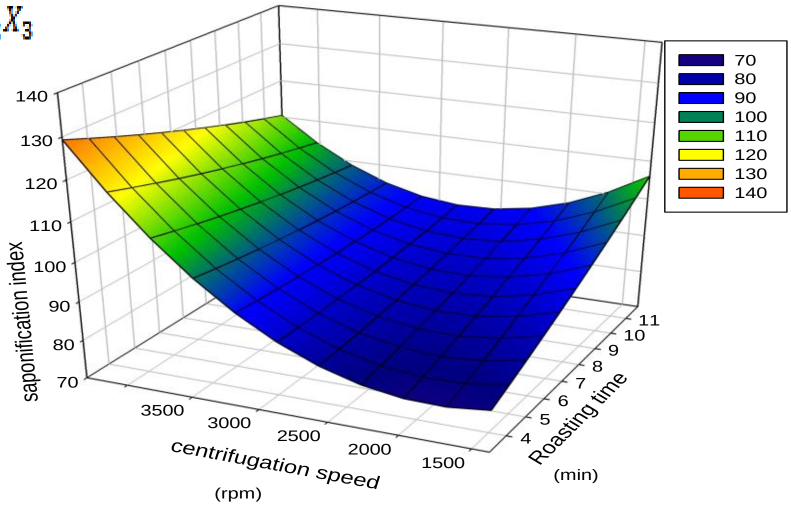

Figure 6: Change in the saponification value depending on the speed and the roasting time (dark sesame)

Conclusion

The objective of this work was to optimize the traditional extraction of oil from sesame seeds. A study focused on proximal composition was performed and it follows that these seeds contain a large fraction of total lipids, and a small fraction of water content. Then optimize the extraction of oil has led to the realization of the plan of composite centered. It was a matter of finding optimum test which gave a good amount of extraction then a good extraction. After all these tests, the best experimentally selected for white sesame test was done under the following conditions: germination time 48.00 hours; roasting time: 10, 00 min; spin speed: 3700.00 rev / min and the response to this test is 57, 12% and for the dark sesame we have the following conditions: germination time 56.18 hours; Roasting time 5.00 min; spin speed: 2850.0 rev / min and the response to this test is de48, 14%. The analysis of the plan also gives the values of R^2 regression coefficients are equal to 56.47% for white sesame and 46, 94% for the dark sesame. These values are below 70% which means that the model cannot be used to explain this process. After extracting the oil, a study of some physicochemical properties was conducted in order to assess the quality of the oil. And it turns out that these oils have a very high acid numbers therefore, have no interest in food, but could instead be used in biodiesel production.

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