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Comparative Study of Peanut Oil (*Arachis hypogea*) Produced in Andouria Brand Factories and that Produced Artisanally by Women in Kelo (Chad)

[1] Makalao Mouti Marceline, [2] Assane Kesse Michel, [3] Brahim Boye Otchom, [4] Alfred S Traore

[1, 2] Higher Normal School of Bongor, Chad
[3] Toumaï Institute, N'Djamena, Chad
[4] New Dawn University, Bobbo Dioulasso, Burkina Faso

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Corresponding Author: **Makalao Mouti Marceline**

Abstract

This study aims to evaluate the nutritional quality of the oil produced by Andouria brand factories and that produced in an artisanal manner by women in Kélo in Chad. Ten samples each of the Spanish coarse grain variety were used to produce oil by Andouria women and factories. The parameters studied are the Humidity Index, Impurity Index, Acidity Index, Saponification and Peroxide Index. The methods used are as follows: Humidity Index (ISO-662, 2016) [10], Impurity Index (ISO-663, 2007) [9], Acidity and Acid Index (ISO-660, 2020) [7], Saponification Index (ISO-365, 2002) and Peroxide Index (ISO-3960, 2007) [8]. The results show that the Humidity Index of Artisanal oil varies from 0.08 to 0.179 and that of Andouria oil between 0.11 to 0.22; the Impurity Index of Artisanal oil varies from 3.19 to 5.48 and that of Andouria oil varies from 3.09 to 6.28; the Acid Value of Artisanal oil varies from 3.25 to 15.31 and that of Andouria oil varies from 1.34 to 23.43; the Impurity Index of Artisanal oil varies from 3.19 to 5.48 and that of Andouria oil varies from 3.09 to 6.28; the acid value of artisanal oil varies from 3.25 to 15.31 and that of Andouria oil varies from 1.34 to 23.43. These results show that several parameters are 100% compliant such as the Humidity Index of Andouria oil, the Impurity Index of Artisanal oil, the Saponification Index of Andouria oil and the index of Andouria oil Peroxide. Others, on the other hand, present non-compliance: 10% of the Impurity Index of Andouria oil, 60% of the Acidity Index of Artisanal oil and 50% of Andouria oil, 10 % of the Saponification Index of the Artisanal oil, 10% of the Peroxide Index of the Artisanal oil. From all of the above, we can conclude that the parameters obtained as well as the extraction conditions show that these two oils are of good nutritional quality.

Keywords: Artisanal Oil, Andouria Oil, Nutritional Quality, Kelo, Chad

Introduction

Peanut oil, the leading food product consumed at 90% in Chad and 70% worldwide, remains a basic necessity for cooking. It is one of the rare virgin, organic oils intended for cooking at high temperatures (Stéphanie and Catherine, 2017) [15]. Furthermore, as an oleaginous oil, it has a high quantity of vegetable proteins. Peanut oil is composed on average of polyunsaturated fatty acids, monounsaturated fatty acids and saturated fatty acids (Stephanie and Catherine, 2017) [15]. Omega 3 are polyunsaturated acids from the α-linoleic family which actively contribute to a certain number of functions, at all ages and are therefore essential for the proper functioning of the body. They prevent cardiovascular risks (Karoui *et al*., 2021) [12]. The extraction of peanut oil is most often done in an artisanal manner by women, which makes the work difficult, and makes the supply lower than consumer demand (Diomane, 2017; Karoui *et al*., 2021) [3, 12]. Today, a new extraction technique in Andouria brand factories is increasing production. Research in particular on peanut oil produced in Andouria brand factories and that produced in an artisanal manner by women seems necessary to compare their nutritional quality. Peanut oil produced by women is much more appreciated by consumers compared to that of Andouria due to its salty taste and spicy flavor (Kamal, 2018) [11]. It is within this framework of evaluating the quality of Andouria and Artisanal oil that we will undertake physicochemical analyzes in order to have knowledge of their nutritional quality.

Material and methods

Study setting

The samples were taken in Kélo, capital of the Tandjilé-Ouest Department, Tandjilé province. Kelo is a crossroads town located south of Bongor (135 Km), east of Pala (105 Km), north of Moundou (98 Km) and west of Laï (58Km) (INSEED RGPH2, 2009) [6].

Sampling

The oil samples were purchased with the women who produce the oil in an artisanal way and that produced by the Andouria factories. These samples were taken in plastic bottles and labels mark the date of collection and the indication of the oil. The peanut variety is large grain spotted produced in Kelo.

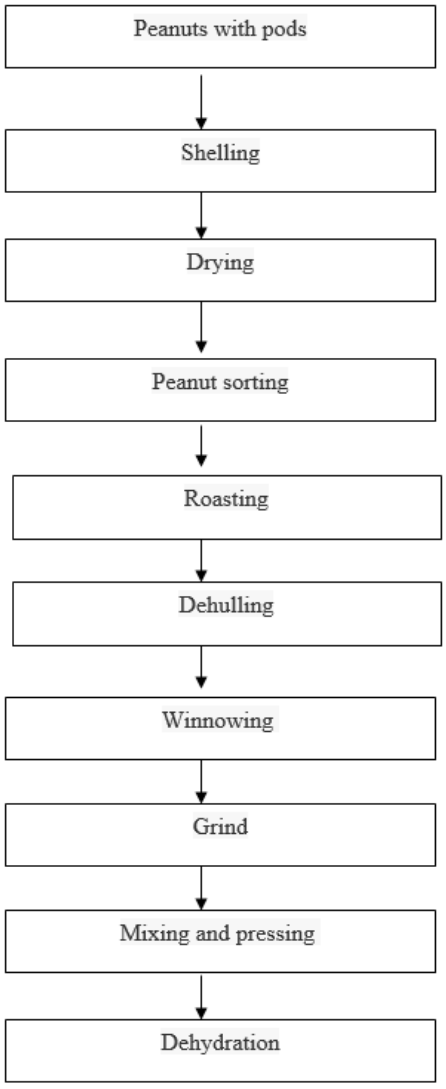

Fig 1: Diagram of transformation of peanuts into oil produced by women

Extraction by Andouria factory (see photo)

The Andouria factory is arranged in three parts:

- The steam oven which is a device in which, a barrel is placed inside the oven, and another placed next to it containing l 'water; these two barrels are connected by pipe. Another pipe leaves the barrel from inside the oven to the heating vessel;
- The heating vessel is a large container placed near the mill. This container is open at the bottom, allowing the peanuts to be released when they are slightly heated by the water vapor coming from the oven.
- The extraction mill, where a front container covered with the sieve is placed to collect the oil during the grinding of peanuts. The cakes used as food for the cattle fall on the other right side of the mill. The peanuts are mixed a little with the cakes before being ground. The collected raw oil is mixed with hot water to be sold.

Photo: Assane Kesse Michel, 2023

Photo 1: Four à vapeur; Récipient de chauffage et Moulin à extraction (Assane Kessé, 2023)

Physico-chemical parameters

Physical and chemical analyzes were carried out on samples of Andouria oil purchased in processing workshops and peanut oil produced by women. In its analyzes we were able to determine the water content (humidity H%), the impurity index (IMP), the acidity index (IA), the saponification index (IS) and the peroxide index (IP). The analyzes were carried out at the CECOQDA laboratory (Food Quality Control Center) in N'Djamena.

Water content

It is determined by the NI method (ISO-662, 2016) [10]. 20 g of oil (P1) were weighed and put in a beaker previously dried in an oven (P0). (The beaker was cooled in a desiccator and tared). The latter containing the oil was put in an oven set at 103C° for 2 hours. After cooling, the sample passes into a dessiccator, after weighing the weight of the beaker was noted (P2).

Impurity Rate

They are determined by the international standard (ISO-663, 2007) [9]. The oil is treated with an excess of solvent, then filtration of the solution, washing the residues with the same solvent (hexane) before drying it at 103°C ± 2°C to a constant mass.

Acid value

The acid number consists of determining the number of milligrams of potassium hydroxide (KOH) necessary for the neutralization of free acids contained in 1 gram of fatty substances (Salah, 2017) [13]. Is determined by the international standard (ISO-660, 2020) [7]. The principle is based on the neutralization of free acids using an alcoholic solution of potassium hydroxide titrated in the presence of phenolphthalein which is characterized by the change from pink to transparent color.

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Saponification Index

This index is determined according to standard NF ISO 3657 (fats of animal and vegetable origin). This excess is then dosed back, which makes it possible to determine the quantity of potassium hydroxide consumed. The Saponification Index reflects the length of the hydrocarbon chains of fatty acids. The Saponification Index varies from 187 to 196 (FAO, 2023) [5].

Peroxide Index

The Peroxide Index represents the degree of oxidation of unsaturated fatty acids in the fat responsible for rancidity phenomena. The higher the Peroxide Index, the more the material is oxidized (Karoui *et al*., 2021) [12]. The principle is based on the treatment of oil in solution in acetic acid and chloroform with a solution of potassium iodide. This involves titrating the iodine released by a standard solution of sodium thiosulfate (ISO-3960, 2007).

Results and discussion

In this framework of study, we were interested in the physico-chemical analysis of Andouria and Artisanal peanut oil, with a view to comparing these determined indices with the international standard then secondly the analysis of the results investigations.

Table 1: Peanut oil

Samples	Water content (%m/m)	Impurity rate (%m/m)	Acide value m/m	Acidité value (mgkoH/g)	Saponification Index (ppm)	Peroxyde Index (mEq/kg)
Ech 1	0,15±0,003	5,20±0,07	13,51±0,03	6,95±0,02	181,82±0,82	10,02±0,10
Ech 2	0,12±0,007	3,99±0,04	15,82±0,04	7,91±0,02	181,97±0,19	3,87±0,14
Ech 3	0,17±0,002	3,19±0,56	21,53±0,10	10,76±0,03	183,45±0,24	3,79±0,16
Ech 4	0,17±0,0007	3,19±0,04	21,63±0,07	10,81±0,04	174,14±0,26	4,89±0,48
Ech 5	0,12±0,002	4,19±0,05	15,31±0,14	7,65±0,06	188,61±0,36	3,59±0,33
Ech 6	0,09±0,004	5,48±0,04	3,53±0,04	1,76±0,001	177,72±0,22	7,5±0,11
Ech 7	0,16±0,001	5,00±0,02	11,60±0,43	5,80±0,05	189,27±0,12	6,69±0,14
Ech 8	0,08±0,003	5,48±0,12	3,25±0,05	1,62±0,04	175,28±0,15	16,56±0,46
Ech 9	0,10±0,002	4,89±0,05	3,75±0,02	1,87±0,07	181,35±0,38	9,69±0,38
Ech 10	0,11±0,004	5,28±0,04	3,42±0,04	1,71±0,03	200,87±0,54	5,36±0,16
Average: Deviation:	0,12± 0,002	4,70± 0,10	10,55± 0,10	5,28± 0,03	185,16± 0,32	6,08± 0,25

Table 2: Andouria oil

Samples	Water content (%m/m)	Impurity rate (%m/m)	Acide value (m/m)	Acidité value (mgkoH/g)	Saponification Index (ppm)	Peroxyde Index (mEq/kg)
Ech 1	0,21±0,00	3,09±0,05	12,78±0,00	6,39±0,02	182,62±0,50	4,94±0,03
Ech 2	0,19±0,01	3,59±0,02	7,23±0,03	3,61±0,02	172,40±0,21	6,43±0,05
Ech 3	0,19±0,00	4,39±0,02	23,43±0,01	11,71±0,02	179,63±0,21	13,29±0,05
Ech 4	0,20±0,00	4,00±0,02	12,21±0,02	6,10±0,02	183,45±0,24	8,09±0,06
Ech 5	0,13±0,00	3,89±0,007	12,72±0,01	6,36±0,01	190,58±0,37	3,79±0,01
Ech 6	0,22±0,00	5,79±0,01	3,14±0,02	1,57±0,04	194,91±0,65	12,80±0,49
Ech 7	0,13±0,00	5,38±0,04	2,18±0,007	1,09±0,04	175,12±0,09	13±0,16
Ech 8	0,11±0,00	6,28±0,02	4,75±0,02	2,35±0,02	178,32±0,12	8,78±0,28
Ech 9	0,12±0,00	3,90±0,07	10,26±02	5,13±0,01	194,02±0,03	6,35±0,17
Ech 10	0,22±0,00	4,59±0,01	1,34±0,02	0,67±0,05	185,53±0,26	9,55±0,62
Averag: Deviation:	0,18± 0,004	4,52± 0,03	9,73± 0,01	4,78± 0,04	181,54± 0,24	9,04± 0,19

Analysis of results

The parameter results were analyzed in Excel software and transferred to Word.

Water content

The water content is a quality criterion allowing the quantification of the water in oils (Benseghier and Khamed, 2014) [1]. The Codex Alimentarius sets the maximum level of water at 0.2. The water content values in the Andouria and Artisanale oil obtained respect the standard. The humidity level varies from 0.08 to 0.17. These values are all less than 0.2 and all meet the standard. These humidity values obtained are close to the value 0.10 obtained by (Tarnagda, 2016) [16].

Impurity rate in Artisanal oil

The results obtained in Table I vary from 3.19 to 5.48. All of these values are less than or equal to 5. They all meet compliance. Among these values, those of samples (2, 3, 4) are close to 3.66 obtained by Tarnagda (2016) [16] and those of samples (1, 5, 6, 7, 8, 9, 10) are greater than this value. These results can be explained by the varietal difference.

Impurity rate of Andouria oil

The impurity rate of Andouria oil varies from 0.09 to 6.28. Among these values, only the value of sample 8 does not meet the standard. That of the samples (1, 2, 3, 4, 5, 6, 7, 9, 10) meets conformity. The values of samples (1, 2, 5, 9) are close to the value 3.66 obtained by Tarnagda (2016) [16] and

those of samples (3, 4, 6, 7, 10) are slightly higher than this value. The non-compliant value of sample 8 would be due to the oil extraction conditions.

Acid value
Acid index values are twice the acidity index values.

Acidity value
Free fatty acids are naturally present in the seed where they participate in the biochemical reactions of liposynthesis. They also come from hydrolysis reactions which occur in raw oils either during their production or during storage (Chegra and Guerboub, 2020) [2]. A good quality oil should have low or no acidity (Karoui *et al*., 2021) [12]. Codex Alimantarius standards set the acidity index at 4mg/koh/g (FAO/WHO, 2019) [4] for crude oils. So the acidity index values of the artisanal and andouria oil obtained meet the standard.

Acidity index of Artisanal oil
With regard to the values obtained for this parameter, the values of the samples (6, 8, 9, 10) in results, are less than or equal to 4 mg/koh/g in accordance with the standard. On the other hand, the values of the samples (1, 2, 3, 4, 5, 7) are largely high. These oils do not meet the standard. Among the acidity index values, the values of the samples (6, 8, 9, 10) are close to the value 3.34mg/koh/g obtained by Karoui *et al*. (2021) [12] and those of samples (1, 2, 3, 4, 5, 7) are much higher than this value.

Acidity Index of Andouria oil
For the acidity index, the values of the samples (2, 6, 7, 8, 10) are less than 4mg/koh/g, in accordance with the standard on the other hand the values of the samples (1, 3, 4, 5, 9) are greater than the maximum value, not meeting the standard. The sample values (2, 6, 7, 8, 10) are very close to the value 3.34 obtained by Karoui *et al*. (2021) [12] and those of samples (1, 3, 4, 5, 9) are higher. The values of the non-compliant samples would be due to the quantity of water in the oil.

Saponification Index
The saponification Index tells us about the length of the carbon chain of the acids constituting the oil. The saponification index is higher when the carbon chain of the fatty acids is short (Benseghier and Khamed, 2014) [1]. Codex Alimantarius standards set the Saponification Index at 187-196 (FAO/WHO, 2023) [5].

Saponification Index of Artisanal oil
The results obtained from Artisanal and Andouria oil respect the standard of this codex alimantarius. Considering the results of the saponification index in Figure 16 a, the values of the samples range from 174.14-200.87. Sample values (1, 2, 3, 4, 5, 6, 7, 8, 9) lower than the normal value 187-196, meets the standard of the Codex Alimantarius. Except the sample value (10) is higher. The values of the samples (1, 2, 3, 4, 5, 6, 7, 8, 9) are close to the values 187.85 and 193 obtained by (Sbai and Tayebi, 2022) [14].

Saponification Index of Andouria oil
For the saponification index values in Figure 16 b, are all lower than the normal value 187-196. They therefore all conform to the normal value. These values are close to 187.85 and 193 obtained by Sbai and Tayebi (2022) [14].

Peroxide Value
The peroxide index is a quality criterion which allows the oxidation state of oils to be seen and the first stages of oxidative alteration to be controlled (Karoui *et al*., 2021) [12]. Codex Alimantarius standards set the peroxide index at 15meq/kg Karoui *et al*. (2021) [12] for crude oils.

Peroxide Value of artisanal oil
The results of the peroxide index presented in Table I show that for the ten (10) samples, only sample 8 has a value higher than the normal value, non-compliant. The remainder of the sample values are less than 15meq/Kg. Which explains the conformity of these oils. However, for the 10 samples, 7 samples (2, 3, 4, 5, 6, 7, 8) have values close to the value 8.46 obtained by Chegra and Guerboub (2020) [2]. The values of samples 1 and 9 are greater than this value. The higher value of the sample (8) than the normal value shows that this oil is undergoing oxidation.

Peroxide Value of Andouria oil
The results show that all the peroxide index values are lower than the normal value 15, so all these values are compliant. Among these values, the values of the samples (1, 2, 4, 5, 8, 9) are close to the value of 7.87 obtained by Diomane *et al*. (2017) [3] and that of samples (3, 6, 7) are high compared to this.

Conclusion
The physicochemical characteristics show that these oils have interesting properties overall. Several parameters respect compliance which is higher than non-compliance. The different results obtained allow us to confirm that the artisanal oil and Andouria are of good nutritional quality.

Conflict of interest
There is no conflict of interest between the different authors.

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