

Analysis of Refined Cottonseed Oil According to Physicochemical Quality Parameters

Hamadoun Abba TOURE

Laboratory of Analytical Chemistry and bromatology
Faculty of Pharmacy, University of
Technical Sciences and Technology, Bamako, Mali
National Health Laboratory

Mariam SINGARE

National Health Laboratory

Aboudou DOUMBIA

Institute of Applied Sciences
University of technical Sciences and Technology, Bamako, Mali

Blaise DACKOUO

Laboratory of Analytical Chemistry and bromatology
Faculty of Pharmacy, University of
Technical Sciences and Technology, Bamako, Mali

Madani MARIKO

Laboratory of Analytical Chemistry and bromatology
Faculty of Pharmacy, University of
Technical Sciences and Technology, Bamako, Mali

Benoît Y KOUMARE

National Health Laboratory

Gaoussou KANOUTE

Laboratory of Analytical Chemistry and bromatology
Faculty of Pharmacy, University of
Technical Sciences and Technology, Bamako, Mali

ABSTRACT

Cottonseed oil is highly consumed and produced in Mali. To assess the quality locally produced cottonseed oils, 52 samples were collected from plants. The study showed 59.6 % were of good physicochemical quality. There is a need to undertake further study. Authorities are advised to take actions.

Key words: Physicochemical analysis, refined cottonseed oil, quality parameters.

INTRODUCTION

Cottonseed oil is known as heart healthy oil for containing enough un-saturates such as palmitic, stearic, myristic, oleic, linoleic and linolenic acids. Additionally, it is more and used to prepare foods for its high smoke point and its usability for frying food articles [1]. It also contains fibers high quantity and is stable against auto-oxidants [2]. The purpose of refining crude oil is to get rid of impurities and undesirable compounds in order to obtain an oil of quality required for good use and good conservation. Oil is refined by performing degumming or acid conditioning, chemical neutralization, discoloration, and deodorization processes [3]. It however required monitor oil quality after the refining in laboratory to ensure that it is free of undesirable compounds after various stages of refining, and that maximum residue limit in technology accessory follows regulation guidelines [4]. Additionally to triglycerides and free fatty acids, dietary lipids contain other constituents that are mainly health beneficial. These are also called minor constituents because of their quantity compared to triglycerides and weigh 0.5 to 2 % of the oil mass. They mainly contain phospholipids, tocopherols, sterols, carotenoid pigments, and gossypol in the case of cottonseed oil [5]. COT diets improved growth performance is due to greater energy density without any impact of carcass composition on the treatment [6]. Cottonseed oil as well as the other vegetable oils has specific physicochemical properties that give them key roles in human diet [7]. Cottonseed oil is for cooking making food products. It is refined in many ways [7]. Physico-chemical properties such as refractive index, specific gravity, color, melting point, free fatty acids, iodine value, peroxide value, saponification value, rancidity are assessed to monitor oil quality [8]. These parameters are very important and are usually measured in accordance with ASTM D6751 guidelines [9].

Synthesized Cottonseed oil-based bio-lubricant is usable as energy-saving lubricant to reduce dependency on petroleum-based lubricant in automotive engines [10]. Vegetable oils and fats are refined by the most important processes of oil production technology to reduce waste and losses [11]. Being one of most ancient source of oil many types of cottonseed exist leading to variety of quality produced and divers' methods of oil production. It is then necessary to monitor oil quality including its physicochemical properties. For Karim et al, cottonseed oil can be used as edible after refinement [12]. The objective of such characterizations is to check the resistance of oil to oxidative rancidity or its usability to manufacture Soap, body creams, cosmetics, plasticizers and lubricants [13]. The impacts of cottonseed methyl ester usability as an additive into neat diesel fuel on the combustion was evaluated by Sarıdemir et al in 2019. The study showed that methyl ester in cottonseed oil made it an alternative solution to the use of diesel fuel without any modification in diesel engines [14].

Several methods and instrumental techniques are nowadays available for the monitoring of oil quality [15]. The use of cottonseed oil plays in diet is essential in fighting cardiovascular diseases, anti-allergic response, anticancer activity, antioxidant activity. The evaluation of these characteristics and their health benefits to improve their usefulness needs more investigations [16]. Researchers admitted that Cottonseed oil is more preferable for consumption than some available oils [17]. The purpose of oil refining treatments is to get rid of undesirable contents and obtain higher quality oils in crude canola oil [18]. Cottonseed oil monitoring studies advise regulatory authorities to take actions [19]. Many types of analysis can be performed on cottonseed oil; we herein assessed physicochemical parameters [20, 21]. In this study, some physicochemical quality factors were characterized in cottonseed oil produced in Mali.

STUDY DESIGN

Study place

Samples were collected from May to March 2020 from oil production units. The study was performed at the National Laboratory of Health (LNS) in Bamako.

Apparatus

The density was measured by a CE Gibertini DensiMat EL-10-229 5/5 densimeter. The moisture was assessed by a Memmert 105°C EL-xx-222 stove. The refractive Index was determined by a CETI Belgium 972396 refractometer. The iron concentration was measured by a Spectro UV Visible Type DR 5000 lange (Hach) N°1 EL-08-171 spectrophotometer. The Vitamin A content was assessed by an I Check Carotene BioAnalyt GmbH.RheinstraBe17.14513 Teltow, Germany 100 Top-Innovator 2014 N°. LCA 03020371 device. The Soap content, the peroxide index, the acid index, the iodine index et and impurity content were determined by titrimetric.

Methods

Soap content

Diluted with acetone at 3%, soap was determined by volumetric titration using hydrochloric acid as titration and Bromophenol as color indicator.

Moisture level

A sample was dried at 105° C in oven in five hours and dry material was weighted after deduction.

Peroxide index

Excess sodium thiosulfate was titrated by potassium iodide that release iodine after being oxidized by peroxides in the sample.

Acid Index

The acid index is referred as the mass of sodium hydroxide (KOH) used to neutralize free fatty acids in a gram of sample. According to the Codex Alimentarius, the acid index of refined oils is 0.6 g of KOH in a gram of oil.

Density

The measurement was determined by densitometer.

Refractive index

This parameter is considered as physical constant as well as the density and the melting point. It was measured by a refractometer and values are expressed in percentage.

Impurity content

Excess n-hexane or ether was added to sample. Solution obtained was filtrated and filtrate was washed with same solvent to eliminate oil residue then dried at 105 °C and weighted.

Iodine index

This one is referred as the mass of iodine expressed gram bended to 100 gram of oil. The parameter is useful in oil identification.

The Wijs reagent is a solution of iodine chloride more used for this determination than iodine but strictly equivalent in terms of number of moles linked to double bounds. The Wijs reagent added in known excess to the sample, reaction occurs and the amount Wijs excess is determined the number of moles can be deduced from the number of unsaturated bounds of the unsaturated fatt.

Vitamin A content

The vitamin A content was measured by a colorimeter in cottonseed oil

Iron content

A sample was mineralized, then Ferrozine was added and mixture was agitated and left for five minute. Amounts were determined by DR 5000. Results are expressed in mm/Kg.

Gossypol identification

It has been established that Gossypol is the only extracted compound from cottonseed that has two adsorption peaks at 300 – 520 nm. The LOD is 0.474 ppb. This method is sensible and specific form Gossypol identification in cottonseed oil.

RESULTATS ET DICUSSION

In this study 52 samples of cottonseed oils were collected from oil production industries in Mali. Eleven physicochemical parameters were assessed they are: the Soap content, the Moisture level, the Peroxide index, the Acid Index, the vitamin A content, the iron content, the gossypol identification, the iodine index, the impurity content, the refractive index and the density. Between them two that are the vitamin contents the iron content were not judgment criteria. Study results shown in the following tables. From the results obtained it was observed that Gossypol was identified in two samples. The study showed that the iodine in the sample were not in accordance with the standard. Four samples were out of standard in terms of acid index. The peroxide index of four samples was higher than standard values. Six samples did not comply with standards. Seven samples had larger values than standards in terms of density. Moisture index values of nine samples were not in accordance the standard. The remaining samples were in accordance with the standard.

Table I: Results of the physicochemical parameters of cottonseed oils

Cottonseed oils	Soap content	Moisture level	Peroxide index	Acid index	Density	Refractive index	Impurity	Iodine index	Vitamin A	Iron
E ₁	0	0.36	6.26	0.67	0.913	1.452	0	113.12	1.2	4.99
E ₂	0	0.15	10.29	0.34	0.916	1.456	0	98.25	1.4	4.2
E ₃	0	0.04	15.18	0.28	0.914	1.459	0	90.14	1.2	4.1
E ₄	0	0.11	0	0.53	0.919	1.462	0	114.23	1.2	5.99
E ₅	0	0.13	7.29	0.75	0.919	1.470	0	102.64	0.82	0
E ₆	0	0.12	17.31	0.31	0.921	1.470	0	110.54	2.47	0
E ₇	0	3.13	4.53	0.34	0.924	1.464	0	116.23	1.12	0
E ₈	0	0	0.69	0.36	0.925	1.462	0	98	1.1	0
E ₉	0	0.05	4.59	0.5	0.926	1.462	0	104.22	2.2	0
E ₁₀	0	0.13	5.59	0.39	0.919	1.462	0	110.23	1.2	2.99
E ₁₁	0	0	3.19	0.42	0.922	1.460	0	101.24	2.1	0
E ₁₂	0	0.03	5.59	0.42	0.924	1.460	0	113.25	2.2	3.99
E ₁₃	0	0.01	8.43	0.22	0.918	1.461	0	114.23	1.2	2.1
E ₁₄	0	0.2	1.49	0.31	0.918	1.460	0.001	99.23	1.2	2.02
E ₁₅	0	0.38	3.75	0.22	0.922	1.462	0	104.23	2.2	3.2
E ₁₆	0	0.07	0.8	0.25	0.920	1.436	0	116	1.2	2.2
E ₁₇	0	0.002	9.69	0.6	0.919	1.462	0	112.32	2.2	2.66
E ₁₈	0	0.004	3.3	0.67	0.918	1.462	0	114.23	3.3	2.02
Standard	0.005	0.2	10	0.6	0.918 - 0.926	1.458-1.466	<2%	99-119	-	-

The results in red are not in accordance with the standards.

Ex= Sample number

Table II (Table I continued): Results of the physicochemical parameters of cottonseed oils

Cottonseed oils	Soap content	Moisture level	Peroxide index	Acid index	Density	Refractive index	Impurity	Iodine index	Vitamin A	Iron
E ₁₉	0	0.13	3.38	0.49	0.922	1.465	0	114.23	1.2	0
E ₂₀	0	0.12	2.15	0.28	0.918	1.456	0	112.23	3.3	2.2
E ₂₁	0	0.06	4.98	0.3	0.920	1.462	0	112.24	3.12	4.5
E ₂₂	0	0.2	5.59	0.19	0.922	1.460	0.001	99.24	1.2	2.24
E ₂₃	0	0.08	6.89	0.22	0.924	1.462	0.12	114.25	2.2	1.28
E ₂₄	0	0.06	0.69	0.28	0.922	1.464	0	100.22	0	5.66
E ₂₅	0	0.06	4.79	0.28	0.922	1.464	0	112.24	2.2	2.45
E ₂₆	0	0.11	0	0.31	0.920	1.462	0	114.24	2.14	2.99
E ₂₇	0	0.01	2.09	0.11	0.919	1.462	0	104.12	4.2	2.3
E ₂₈	0	0.03	9.07	0.16	0.918	1.466	0	112.2	2.2	4.45
E ₂₉	0	0.23	0.9	0.44	0.920	1.459	0	112.42	1.2	2.64
E ₃₀	0	0.04	4.34	0.45	0.918	1.460	0	115.15	3.42	5.64
E ₃₁	0	0.03	1.99	0.36	0.920	1.464	0	112.42	3.25	5.45
E ₃₂	0	0.12	0	0.6	0.922	1.464	0	115.46	1.2	3.98
E ₃₃	0	0.35	4.75	0	0.918	1.460	0	114.23	4.15	0.2
E ₃₄	0	8.04	2.99	0.34	0.913	1.460	0	107.93	3.03	0.4
E ₃₅	0	1.96	11.45	0	0.913	1.460	0	115.33	3.02	0
E ₃₆	0	0.09	4.04	0	0.918	1.461	0	99.37	3.35	1.99
E ₃₇	0	0.1	6.39	0.42	0.918	1.462	0	102.36	3.57	0.78
Standard	0.005	0.2	10	0.6	0.918 - 0.926	1.458-1.466	<2%	99-119	-	-

The results in red are not in accordance with the standards.

Ex= Sample number

Tableau III (Table I continued): Results of the physicochemical parameters of cottonseed oils

Cottonseed oils	Soap content	Moisture level	Peroxide index	Acid index	Density	Refractive index	Impurity	Iodine index	Vitamin A	Iron
E38	0	0.01	5.83	0.39	0.918	1.460	0	110.4	2.95	0.19
E39	0	0.006	3.54	0.39	0.918	1.462	0	102.07	3.61	1.59
E40	0	0	0.25	0.25	0.913	1.460	0	112.2	2.2	4.58
E41	0	15.4	0	0.39	0.920	1.463	0	114.22	3.2	4.88
E42	0	0.02	1.35	0.6	0.918	1.460	0	99.8	2.97	0
E43	0	0.07	0.5	0	0.920	1.462	0	102.69	0.82	1.79
E44	0	0.05	0.15	0.39	0.918	1.460	0	105.17	1.2	3.2
E45	0	0.05	0.2	0.56	0.921	1.462	0.02	110.09	2.04	0.2
E46	0	0.51	3.89	0.22	0.924	1.460	0.006	99.12	2.47	0
E47	0	0.03	4.64	0.6	0.922	1.465	0.02	108.69	0.45	0
E48	0	0.006	3.54	0.39	0.918	1.462	0	102.07	3.61	1.59
E49	0	0.0179	1.8992	0.3923	0.929	1.470	0.006	104.7084	0	1.2
E50	0	0.0179	1.8992	0.3923	0.918	1.460	0.006	104.708	2.03	0
E51	0	0	0	0.1683	0.921	1.473	0	101.7448	3.93	0
E52	0	0	1.7474	0.6728	0.921	1.473	0.06	109.9926	3.87	1.7843
Standard	0.005	0.2	10	0.6	0.918 - 0.926	1.458-1.466	<2%	99-119	-	-

The results in red are not in accordance with the standards.

Ex= Sample number

CONCLUSION

This study showed that it is possible characterizes cottonseed oil in laboratory of the national health in Mali. It advises patience, dedication serenity. Samples came from oil mills in Mali. Study results showed that 59.6 % were in accordance with the standard. It is alarming that 40.4% of sample tested were not in accordance with the standard.

Provided that vegetable oils are important in diet and provided the study result, there is an emergency to monitor all oils consumed in Mali, establish standards in Vitamin A en Iron contents and to investigate a larger sample size.

References

- [1]. Saxena, D. K., Sharma, S. K., & Sambi, S. S. (2011). Comparative extraction of cottonseed oil. *ARPN Journal of Engineering and Applied Sciences*, 6(1). ISSN 1819-6608.
- [2]. Riaz, T., Iqbal, M. W., Mahmood, S., Yasmin, I., Leghari, A. A., Rehman, A., Mushtaq, A., Ali, Khubaib., Azam, M., & Bilal, M. (2021). Cottonseed oil: A review of extraction techniques, physicochemical, functional, and nutritional properties. *Critical Reviews in Food Science and Nutrition*, 1-19.
- [3]. SONTIE C., 2015. Technologie de production de l'huile de coton. Technologie des corps gras. Mémoire de fin de cycle. Université Catholique de l'Afrique de l'Ouest (UCAO) ; 32 pages.

- [4]. TALL M., 2015. Contribution à l'analyse des paramètres physico-chimiques de l'huile raffinée "SAVOR". Mémoire de fin de cycle. Université Polytechnique De Bobo-Dioulasso ; 43 pages.
- [5]. KOUIDRI M., 2013. Extraction et caractérisation physico-chimique de l'huile d'argan provenant d'arbres cultivés dans deux régions de l'Algérie (FINDOUF et MOSTAGANEM). Mémoire pour l'obtention du diplôme de Master en sciences alimentaires. Université Hassiba Ben Bouali-Chlef d'Algérie; 79 pages.
- [6]. Villela, C. C. E. J., Cox, R. B., Shurson, G. C., Compart, K.M., Urriola, P. E., Johnston, L. J. Effects of adding minimally refined cottonseed oil or crude glycerol to diets containing 40% corn distiller's dried grains with solubles on growth performance, carcass characteristics, and pork fat firmness of growing-finishing pigs. *J Anim Sci.* 2017 Jul; 95(7):3057-3067. doi: 10.2527/jas.2017.1383. PMID: 28727094.
- [7]. Zia, M. A., Shah, S. H., Shoukat, S., Hussain, Z, Khan, S. U., Shafqat, N. Physicochemical features, functional characteristics, and health benefits of cottonseed oil: a review. *Braz J Biol.* 2021 Aug 9; 82:e243511. doi: 10.1590/1519-6984.243511. PMID: 34378680.
- [8]. Aslam, F., Iqbal, S., Imran, M., Rebezov, M., Chumakov, V., Kenijz, N., & Shariati, M. A. (2021). PHYSICOCHEMICAL PROPERTIES OF CHEMICALLY INTERESTERIFIED VEGETABLE OILS. *Journal of microbiology, biotechnology and food sciences*, 10(5), e4291-e4291. DOI: <https://doi.org/10.15414/jmbfs.4291>
- [9]. Jamshaid, M., Masjuki, H. H., Kalam, M. A., Zulkifli, N. W. M., Arslan, A., Alwi, A., Khuong, L. S., Alabdulkarem, A., & Syahir, A. Z. (2019). Production optimization and tribological characteristics of cottonseed oil methyl ester. *Journal of Cleaner Production*, 209, 62-73. <https://doi.org/10.1016/j.jclepro.2018.10.126>
- [10]. Gul, M., Zulkifli, N. W. M., Masjuki, H. H., Kalam, M. A., Mujtaba, M. A., Harith, M. H., Sayhir, A. z., Ahmed, W., & Farooq, A. B. (2020). Effect of TMP-based-cottonseed oil-biolubricant blends on tribological behavior of cylinder liner-piston ring combinations. *Fuel*, 278, 118242. <https://doi.org/10.1016/j.fuel.2020.118242>
- [11]. Sh, I. S. (2019). Research of changes in the quality indicators of bleached cottonseed oil and its products. *Austrian Journal of Technical and Natural Sciences*, (3-4).
- [12]. Karim, S. M. M., Samad, A., Roy, S. K., Rahman, Z., Hassan, S. M. M., & Naher, S. Comparative Assessment on Physico-Chemical Properties and Mineralogical Analysis of Different Types of Cottonseed Available in Bangladesh. ISSN 2224-1698.
- [13]. Maliki, M., Ikhuoria, E. U., & Ifijen, I. H. (2020). Extraction and physiochemical characterization of oils obtained from selected under-utilized oil bearing seeds in Nigeria. *ChemSearch Journal*, 11(1), 110-117. <http://www.ajol.info/index.php/csj>. eISSN: 2384-6028. print ISSN: 2276-707X
- [14]. Saridemir, S., & Ağbulut, Ü. (2019). Combustion, performance, vibration and noise characteristics of cottonseed methyl ester–diesel blends fuelled engine. *Biofuels*, 1-10. <https://doi.org/10.1080/17597269.2019.1667658>
- [15]. Hirayama, S., Shinozaki, D., & Izumi, Y. (2020). LC/MS Analysis of Cyclo Fatty Acid-containing Triacylglycerols in Cottonseed Oil. *Science Journal of Analytical Chemistry*, 8(1), 12.
- [16]. Zia, M. A., Shah, S. H., Shoukat, S., Hussain, Z., Khan, S. U., & Shafqat, N. (2021). Physicochemical features, functional characteristics, and health benefits of cottonseed oil: a review. *Brazilian Journal of Biology*, 82. <https://doi.org/10.1590/1519-6984.243511>
- [17]. Neeharika, B., Harichandana, P., Suneetha, J., Kumari, B. A., & Maheswari, K. U. (2017). Physico-chemical and sensory evaluation of groundnut and cottonseed oil blends. *Journal of Pharmacognosy and Phytochemistry*, 6(6), 1534-1538. E-ISSN :2278-4136. P-ISSN: 2349-8234. JPP 2017:6(6):1534-1438.
- [18]. Özcan, M. M., Duman, E., & Duman, S. (2021). Influence of refining stages on the physicochemical properties and phytochemicals of canola oil. *Journal of Food Processing and Preservation*, 45(2), e15164. <https://doi.org/10.1111/jfpp.15164>
- [19]. Faso, B. Cottonseeds and Crude Peanuts Oils Production Technology and the Edible Oils Sale Conditions in Ouagadougou and Bobo Dioulasso Markets. DOI: 10.18502/jnfs.v5i3.3796.

- [20]. Prus-Walendziak W, Kozłowska J. Lyophilized Emulsions in the Form of 3D Porous Matrices as a Novel Material for Topical Application. *Materials (Basel)*. 2021 Feb 17;14(4):950. doi: 10.3390/ma14040950. PMID: 33671458; PMCID: PMC7922258.
- [21]. Prus-Walendziak, W., & Kozłowska, J. (2021). Design of Sodium Alginate/Gelatin-Based Emulsion Film Fused with Polylactide Microparticles Charged with Plant Extract. *Materials (Basel, Switzerland)*, 14(4), 745. <https://doi.org/10.3390/ma14040745>