International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

YIELD PERCENTAGE AND FATTY ACID COMPOSITION OF LECITHIN EXTRACTED FROM SELECTED NIGERIAN VARIETIES OF SOYBEAN (*GLYCINE MAX*)

A.Y. Mumeen[1*]; A Umar[1], O. Ejiro[1], E.C. Egwim[2], A.Y. Kabiru[2] and O. Kester[1]

[1]National Cereals Research Institute, Badeggi, Nigeria

[2]Federal University of Technology, Minna, Nigeria

ABSTRACT

Lecithin is an important by-product of vegetable oil processing that has many functions in health, food manufacturing and processing, industrial product development and pharmaceutical formulation. The importation of lecithin to Nigeria for Industrial use may be reduced through sourcing of lecithin from Nigerian varieties soybean which is an oil bearing crop. Following careful selection of seeds, sorting and cleaning; oil was extracted from four varieties of Nigerian varieties of soybean using soxhlet procedure. Lecithin was subsequently isolated from the extracted oil through the process known as degumming. Fatty acid compositions of the isolated lecithin varieties were also measured using Gas Chromatography Mass Spectrophotometry (GCMS). Percentage yield of lecithin isolated from the selected varieties of soybean namely: TGX 1904-6F, TGX 1987-62F, TGX 1448-2E and TGX 1978-.10F are 2.71 %, 2.57 %, 2.28 % and 2.07% respectively. Seven types of fatty acids; (Linoleic, arachidonic, oleic, recinoleic, palmitoleic, stearic and linolenic acids) were detected in each of the isolated lecithin variety. The ratio of unsaturation to saturation is 5:2. This study has provided detailed information from the yield stand point and fatty acid components as a quality index of lecithin isolated from the evaluated soybean varieties; such data is however desirable so as to channel each of the selected soybean varieties to appropriate utilization and enhanced value addition necessary to improve the soybean value chain in Nigeria. This study therefore concludes that quality lecithin may be sourced from some Nigeria varieties of soybean to meet various industrial purposes.

Keywords: Soybean, lecithin, quality index, oil characteristics, oil degumming, Nigerian.

INTRODUCTION

Lecithin is an important by-product of vegetable oil processing industries which have several applications in health, agriculture and food industries (Dreon et al, 2010). The compound is a

 Copyright © IJAER 2018, All rights reserved

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

mixture of glycerol-phospholipids from animal, vegetable and microbial sources. It contained varying amount of triacylglycerols, fatty acids glycolipids, sterols and sphingolipid (Gordon, 2000). The major source of commercial lecithin is soybean oil and it is called 1,2-diacylglycerrro-3-phosphoryl choline (Dashiel, 2003).

Lecithin has diverse role in human nerve activities especially in the control of nerve activities and breathing (Garden, 2003). Lecithin is extensively used in agriculture, one of its major applications is its incorporation into animal feeds where it supplies essential ingredients needed in animal ration (Nahoski, 2013): lecithin also improves feed processing and adds to physicochemical characteristics required for feed palatability to animals. As a source of choline, lecithin serves as antioxidants for the highly unsaturated oils in animal feeds as well as in fertilizer production, lecithin serves as conditioning and spreading agent. It is also incorporated into pesticides where it is used for adhesion, as an antioxidant, biodegrading and dispersing agent, as an emulsifier, stabilizer, viscosity modifier and penetrating agent (Callins, 2010).

Lecithin is both lipophilic and hydrophilic hence its ability to attract both-water and fat characteristic which made it act as a bridge between water and oil (Olisa, 2009).

Industrially, lecithin plays diverse roles as a result of hydrophilic and lipophilic properties and these includes but not limited to roles play in several industrial sectors as an emulsifying agent, dispersing, wetting, conditioning agents. Also, antioxidant properties of lecithin made the compound essential as an ingredient in production of items such as; chocolate foods, chewing gum, edible oil, ice cream, instant foods, insecticides, ink, leather, macaroni and noodles etc. (Dreon et al, 2010).

Other industrial sectors where lecithin is required for production also includes; pharmaceutical and drug manufacturing, cosmetics, Self Emulsifying Drug Delivery Systems (SEDDS), beverage manufacturing and paint manufacturing (Lisa et al, 2016).

Production and quality of lecithin could however, be affected by crude oil storage, soil type, nutrient availability, climate changes, drying process and handling manner (Renfree, 2005).

Soybean (*Glycine Max(L*)) belongs to the leguminosae family, a plant which originated from Eastern Asia (Singh and Shivakumer, 2010). Nigeria is one of the largest producers of soybean in the world with an annual production output of 600,000 MT/annum (NCRI, 2016). The crop consists of approximately 40 % protein, 23 % carbohydrate, 20 % oil, 5 % mineral, 4 % fibre and 8 % moisture (Njoku et al, 2015). In 2009, soybean accounted for 365million tons of vegetable oil in the world far ahead of other oil crops (Singh and Shivakumar, 2010).

 Copyright © IJAER 2018, All rights reserved

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Soybean is however, one of the most valuable crop in the world as a source of oil and protein necessary for livestock, aquaculture and most importantly, for human consumption (Egbo, 2012). The production and demand of soybean world over has increased dramatically because of its growing popularity. For instance, the world production of soybean has grown from 28.6 million of metric tons in 1961-1965 to 217.6 million fold increase (Masuda and Goldsmith, 2009).

There are numerous varieties and ecotypes of soybean adapted to various ecological conditions (Ismaila et al, 2010). However, the National Cereal Research Institute – a Nigerian Government research and development organization has developed and released nine (9) different varieties of soybean adapted to various ecological and agronomic conditions of Nigeria (NCRI, 2016).

The Nigerian Industrial sector imports approximately 1500 tons of lecithin annually for use in the agriculture, healthcare, pharmaceutical manufacturing, food processing, instant food production, cosmetics formulation, paint manufacture etc. (NBS, 2011).

Meanwhile, the importation of such large amount of lecithin into the country constitutes a lot of pressure on the value of the Nigerian currency (Naira) as the importation involves huge amount of foreign exchange. Therefore, there is a growing pressure on local manufacturers to source raw materials locally, hence the need to conduct research towards the exploration of raw materials of oil- bearing seeds such as soybean which is being cultivated abundantly across most of the agricultural belt of the country.

Lack of significant information and data in terms of biochemical components such as lecithin as well as the unavailability of information concerning yield of such compounds and their relative characteristics have been discovered to be a major limiting factor to the development of a robust oilseed value chain in Nigeria (RMRDC, 2004).

Therefore, the evaluation of lecithin yield of some Nigeria varieties of soybean is essential to the improvement of oilseed value chain in Nigeria. This is however, because if oil is extracted from soybean and lecithin is subsequently produced from the extracted oil, such development would enhance the value of soybean produced in Nigeria, hence the objective of this study. The enhancement of the value of soybean produced in Nigeria through its positioning as a reliable source of lecithin for industrial incorporation is however expected to yield increased cultivation of soybean in commercially large quantities, leading to the creation of more agri-business jobs and help to manifest the potentiality of the crop in contributing substantially to the Agricultural Transformation Agenda Support Programme (ATASP) of the current Federal Government of Nigeria.

The aim of this study was to however extract, determine yield percentage and evaluate fatty acid contents of lecithin from oil of selected varieties of Nigeria soybean for industrial application.

 Copyright © IJAER 2018, All rights reserved

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

MATERIALS AND METHOD

The four cultivars of soybean namely; TGX 1904-6F, TGX 1957- 62F, TGX 1443- 2E and TGX1987-10F were obtained from the Soybean Research Programme of the National Cereals Research Institute, Badeggi in Niger State, Nigeria. The seeds were subsequently, subjected to the following experimental procedures:

Seed Preparation

500g each of the four varieties were manually washed with distilled water, sorted and then dried at room temperature for two weeks after which they were pulverized using electronic blending machine and kept at 4^{0c} until use.

Extraction of Seed Oil

The extraction of oil from the soybean seed varieties was carried out in accordance to the AOAC method (1990) which involves the use of soxhlet apparatus using petroleum ether as the extraction solvent which was added to the extracting flask in 2:1 volume ratio and each variety of the soybean sample was made to extract for between 5-7 hours after which the solvent and oil mixture was evaporated and the oil recovered from the solvent.

Production of lecithin from Soybean Oil

70ml each of soybean oil was measured into a cleaned and dried conical flask and heated up to 70^{0}c, 2% of water was added at this temperature, six (6) drops of Hydrogen peroxide was then added and stirred with a magnetic stirrer for 1 hour, in accordance with Donatus et al, (2016). This method is called degumming of oil.

Gas Chromatography Mass Spectrometry (GC/MS) analysis for the determination of fatty acid composition of isolated lecithin

The GCMS analysis leading to the determination of the fatty acid components of the lecithin isolated from each of the soybean varieties was performed using a Gas Chromatography interfaced with Mass Spectrophotometry machine: Skyray model 6808, manufactured in the United States of America and comprising of an AOC-20i auto sampler. The determination was carried out after samples were converted to fatty acid methy esters with 0.5N NaOH in methanol at room temperature in accordance with the IUPAC 2,301 and ISO 5508 1990 methods.

Fatty acids contents of the lecithin samples were detected and identified based on the retention time of the GCMS machine; Skyray model 6808.

 Copyright © IJAER 2018, All rights reserved

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Statistical Analysis

Values generated from triplicate laboratory trials were analyzed using Statistical Packages for Social Science (SPSS) version 16 (SPSS Inc. USA) and presented herewith as means and Standard Error of Means (SEM). Comparisons between different groups were determined by one way Analysis Of Variance (ANOVA) followed by Duncan Multiple Range Test (DMRT). The level of significance was set at $P<0.05$. Values presented in tables are means and SEM of three (3) determinations. Values along the same row with different superscripts are significantly different ($P<0.05$).

RESULT AND DISCUSSION

The percentage oil yield of the evaluated soybean samples are presented in table 1. The oil yield was higher in TGX 1987 -10F (32.23 ± 0.13 %) when compared to the yields from TGX 1904-6F (28.46 ± 0.30 %),TGX 1448 -2E (30.56 ± 0.43 %) and TGX 1987 -62F (28.26 ± 0.23 %) which had the lowest oil yield. From the result shown in table 1, each of the soybean varieties used in this study can be said to posses appreciable inherent oil yield potential capable of making them useful as sources of vegetable oil through which raw materials such as lecithin can be produced. This is however so, as oil content of soybean is expected to range between 25-35 % depending on a number of factors such as varietal morphological characteristics, agronomic conditions, environment etc (IPGRI, 2014).

Table 1: Percentage oil yield of selected Nigerian Soybean varieties.

S/N	Sample Description	Oil Yield %
1	TGX 1904-6F	28.46±0.30
2	TGX 1987-62F	28.26±0.23
3	TGX 1448-2E	30.56±0.48
4	TGX 1987-10F	32.23±0.28

Lecithin was isolated from oil of each of the evaluated Nigerian varieties of soybean, as presented in Table 2, lecithin yields of (2.71 %, 2.57 %, 2.28 % and 2.07 %) were obtained from TGX 1904-6F, TGX 1987 -62F, TGX 1448 -2E and TGX 1987-10F respectively. Lecithin yield from oils of the evaluated soybean seeds are higher than yield previously reported for Nigerian varieties of melon seeds (0.72-1.17%) (Olisa, 2009). The higher yield of lecithin form the evaluated soybean varieties as compared to other oil seed is an indication that oils from these soybean varieties can serve as potential sources of industrial lecithin for commercial purposes.

 Copyright © IJAER 2018, All rights reserved

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Table 2: Percentage Yield of Lecithin Isolated from Selected Nigerian Soybean

S/N	Sample Description	Yield %
1	TGX 1904-6F	2.71±0.05
2	TGX 1987-62F	2.57±0.12
3	TGX 1448-2E	2.28±0.04
4	TGX 1987-10F	2.07±0.04

The fatty acid composition of the lecithin isolated from each of the evaluated soybean varieties was obtained and presented in table 3. The percentage of linoleic acid was between 3.97 - 5.72 %, arachidonic acid ranged between 7.23 -9.27 %, oleic acid was between 5.86 - 8.44 % , recinoleic acid ranged between 38.05 -51.93 %, palmitoleic acid was between 0.54 - 0.92 %, stearic acid was however between 9.46-10.54 % while linolenic acid ranged between 2.39 – 3.51 %. Also, the ratio of unsaturated fatty acid to detected sequel to the GCMS analysis is 5:2 which implies that; of all the seven fatty acids present in the isolated lecithin, five are unsaturated and also includes the essential linoleic acid whoch plays siqnificant role in neurological responsis in human(Uddin et al,2011) while only two saturated fatty acids were detected in each of the lecithin samples isolated from the evaluated varieties of soybean. However, given the relationship of unsaturated fatty acids with the production of High Density Lipoprotein (HDL) which helps to prevent a number of cardiovascular disorders as well as type 2 diabetes, the fatty acids composition of the isolated lecithin is therefore an indication of their potential usefulness in the food industry and other manufacturing industries where unsaturated fatty acids contents lecithin is desirable.

 Copyright © IJAER 2018, All rights reserved

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Table 4.8: Fatty Acid Composition of Lecithin Isolated From Selected soybean and beniseed samples.

S/N	SAMPLE PARTICULARS	% Linoleic acid	% Aracidonic acid	% Oleic acid	% Recinoleic acid	% Palmitoleic acid	% Stearic acid	% Linolenic acid	% Total Fatty acids
1	TGX 1904-6F	5.466±0.03	7.264±0.02	8.071±0.02	49.620±0.66	0.551±0.04	16.540±0.67	2.39±0.66	89.90±1.83
2	TGX 1987-62F	5.440±0.04	7.230±0.01	8.033±0.01	49.386±0.46	0.543±0.01	9.462±0.35	3.51±0.68	83.61±2.04
3	TGX 1448-2E	5.721±0.02	7.602±0.01	8.447±0.02	51.931±0.35	0.623±0.01	13.310±0.46	3.37±0.32	91.00±3.45
4	TGX 1987-10F	3.972±0.03	9.279±0.00	5.865±0.02	38.059±0.89	0.927±0.00	22.020±0.67	3.45±0.45	83.58±1.78

Values along the same row with different superscript are significantly different ($P < 0.05$).

Copyright © IJAER 2018, All rights reserved

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

CONCLUSION AND RECOMMENDATIONS

This study has shown that the evaluated Nigerian varieties of soybean contain appreciable and viable quantities of lecithin which may be explored as sources of i lecithin for industrial utilization.

A major quality index of lecithin is the fatty acid profiling, this study has provided data from such quality standpoint which is in turn, capable of positioning the evaluated varieties for proper and effective utilization as well as increased in specific demand from the lecithin dependent Nigerian industrial sectors. However, such development may result to increased cultivation of these varieties of Nigerian soybean leading to the creation of more direct and indirect jobs; a situation which can also help to build a robust soybean value chain in Nigeria which is a necessary requirement for the maximization of the contributions of this crop (soybean) to the Agricultural Gross Domestic Product (GDP) of the Nigerian economy.

A research into the physicochemical characterization of lecithin isolated from Nigerian varieties of soybean may be beneficial to the adoption of lecithin from the crop by the Nigerian industrial stakeholders.

REFERENCES

Adebisi, M.A., Ajala, M.O., Ojo, D.K, Salau A.W. (2005). Influence of population density and season on seed yield and its components in Nigerian sesame genotypes. Journal of Tropical Agriculture, 43 (2), 13 -18.

Adebayo, S. E. Orhevba, B, A., Adeoye, P. A., Musa, J. Y Fase, (2012).Solvent extraction and characterization of oil from African star apple (*Chrysophyllumalbidum*) seeds. Academic Research International, 3(2), 23-27.

Anbarasu, K., Vijayalakshmi, G. (2007). Improved shelf life of protein-rich tofu using *Ocimum sanctum* (tulsi) extracts to benefit Indian rural population. Journal of Food Science, 72, 300-305.

AOAC (Association of Official Analytical Chemists) (1990). Official methods of analysis, 13th Ed., Washington D.C: 98

Borchani C., Besbes, S., Blecker C. H., & Attia, H. (2010).Chemical Characteristics and Oxidative Stability of Sesame Seed, Sesame Paste, and Olive Oils. Journal of Agriculture, Science and. Technology. 12, 585-596

 Copyright © IJAER 2018, All rights reserved

Chemonics International Inc. (2002). *Overview of the Nigerian Sesame Industry*. The United States Agency for International Development (USAID)/Nigeria RAISE IQC Contract No. PCE-I-00-99-00003-00

Fariku, S., Ndonya, A.E., &Bitrus, P.Y. (2007). Biofuel characteristics of beniseed (*Sesanumindicum*) Oil. African Journal of Biotechnology,6 (21), 2442-2443.

Dashiell, A. (2003). American. Oil chemist Society (AOCS).Central Soya Coy. Fort Wayne. Indiana, 46818 USA; 443.

Donates, C.O; Obioma, U.N., Patrick E.A, Jonas, A.O (2016).Extraction and characterization of lecithin from Nigerian Melon. Journal of Advances in Biology and Biotechnology. 10 (1) 264 – 272

Dreon, D.M, Vranizan, K.M., Krauss, R.M, Austin, M.A, Wood, P.D. (2010). The effects of polyunsaturated fats versus monounsaturated fat on plasma lipoproteins Journal of American Medical Association, 263(18), 2462 – 2466

Egbo, N.N. (2012). Evaluation of the nutrient content and oil characteristics of melon seeds. M.Sc. Thesis in the Department of Microbiology, University of Port Harcourt, Port Harcourt, Nigeria, 97

FAO (2008). Stat-Agriculture: Food and Agriculture Organization of the United Nations. Available from: http://www.fao.org/site/2008. [Accessed Date: May 23, 2008].

FAO/WHO, (1980). Specification of identity and purity of sweetening agents, emulsifying agents, flavouring agents and other food additives. Retrieved on 24thMarch, 1980 from https://books.google.com.bd/books.FAO/WHO.

Furumoto T., Iwata M., FerojHasan A. F., &Fukui H. (2003). Anthrasesamones from roots of *Sesamumindicum*. *Phytochemical,* 64(4), 863-866

Gordon, M.W. (2000). Contemporary Nutrition Issues and insight.4th Edition. Boston McGraw-Hill Publishers: 23-45

IACST (1986). Official methods of analysis. International Association for Cereals Science and Technology.6th edition. Available on http/www.icc.org.

Ismaila, U., Gana, A.S., Tswanya, N. M., Dogara, D. (2010). Cereals production in Nigeria: Problems, constraints and opportunities for betterment. African Journal of Agricultural Research, 5(12), 1341-1350

 Copyright © IJAER 2018, All rights reserved

IPGRI (International Plant Genetic Resources Institute) (2004). Descriptors for soybean (*Glycine max*) the International Plant Genetic Resources Institute, Rome, Italy,IPGRI

ISO (1990).Official methods of analysis, International Organisation for Standardization: ISO: 5508.

IUPAC (International Union of Pure and Applied Chemistry) (1988). Official methods of analysis, IUPAC: 2.301. Available on http/www.iupac.org

Kandangath R. A., Pal, A, Khanum, F, Bawa, A. S. (2010). Nutritional, Medicinal and Industrial Uses of Sesame (*Sesamumindicum*L.) Seeds - An Overview, Agriculturae Conspectus Scientificus, 75, 4 159-168.

Kolawale, O, Ojo, S.O. (2007). Economic efficiency of small scale food crop production in Nigeria. Journal for social science, 14(2), 123-130.

Liu, C., Wang, X., Ma, H., Zhang, Z., Gao, W, Xiao. L. (2008). Functional properties of protein isolates from soybeans stored under various conditions. Food Chemistry, 111, 29-37

Masuda, T, Goldsmith, P. D. (2009). World Soybean Production: Area Harvested, Yield, and Long-Term Projections. International Food and Agribusiness Management Review, 12, 143-161.

NBS (Nigerian Bureau of Statistics) (2011). Raw material commodity survey, 3rd quarter report, Nigerian Bureau of Statistics, Abuja, Nigeria: NBS.

NCRI (National Cereals Research Institute) (2016). Beniseed research programme report. Annual research evaluation and monitoring workshop. National Cereals Research Institute, Badeggi, Nigeria: NCRI.

Njoku, U, Ifeoma, I. (2015). Evaluation of the nutritional potentials of Beniseed. Nigerian Journal of Biochemistry and Molecular Biology, 23 (1), 39-41.

Olisa, N.M. (2009).Extraction, Characterization And Industrial Uses Of Lecithin From Three Varieties of *CucumisMelo* (Melon Seed) Oil.M.sc. Thesis in the department of Biochemistry, University of Nigeria, Nsukka, Nigeria. Pp58

Phillips K. M., Ruggio D. M, Ashraf-Khorassani, M. (2005). Phytosterol composition of nuts and seeds commonly consumed in the United States. Journal of Agriculture and Food Chemistry, 53(24), 9436-9445.

 Copyright © IJAER 2018, All rights reserved

Renfree. C. (2005).Lecithin Chemical and Supplementation American Oil Chemists Society. Indiana, Fortwayne publications: 97

RMRDC (Raw Materials Research and Development Council) (2004). Survey report of ten selected agro raw materials in Nigeria. Raw Materials Research and Development Council, Abuja, Nigeria. 89 .

Salunkle, D.K., Hamalathan, K., Krisnapura, P., & Sreeramaiah, H.(1991). Sesame. In: World oil seeds; history, technology and utilization. New York, van Nostand, 371 – 402.

Singh G, Shivakumar, B. G. (2010).The Role of Soybean in Agriculture. In: Singh. G (eds.). *Soybean: Botany, Production and Uses.* Wallingford, UK, Cabi Publishing:24-47

Spiller, G.A. (2006).Handbook of lipids in human Nutrition. Boca, Raton. CRC. Press: 34

Sugano, M, & Akinmoto, K.A. (1993). Multifunctional Giftfrom Nature. Journal of Chinese Society and Animal Science,18, 1-11.

Uddin, M.S., Kishimura, H., & Chun, B.S.(2011). Isolation and Characterization of Lecithin from Squid (*Todarodespacificus*) Viscera Deoiled by Supercritical Carbon Dioxide Extraction. *Journal of Food Science*, 76 (2), 350-354.

USDA (United State Data Agency) (2012). Annual report. Available on www.usda.org.

Vasconcellos, J.H. (1982). American Oil Chemists Society, 59 (2), 79-81.

Were, B. A., Onkware, A. O., Gudu, S., Welander, M. and Carlsson, A. S. (2006). Seed Oil Content and Fatty Acid Composition in East African Sesame (*Sesamumindicum* L.) Accessions Evaluated over 3 Years. *Field Crops Research*, 97, 254-260.

 Copyright © IJAER 2018, All rights reserved