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Fatty Acids Composition of Three Different Vegetable Oils (Soybean Oil, Groundnut Oil and Coconut Oil) by High-Performance Liquid Chromatography

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Abstract
Edible vegetable oil were extracted from three sources; soyabean, groundnut and coconut. These oils were processed for fatty acid analysis using high performance liquid chromatography. Three saturated fatty acid were present. Palmitic acid; (C16;O) range from 2.092% in coconut oil to 4.756% in groundnut oil, stearic acid (C16;O) range from 1.496% in soya bean oil to 12.075% in groundnut oil. Monounsaturated fatty acid was also obtained. Oleic acid (C18:1) range from 8.584% in coconut oil to 12.722% in groundnut oil. Polyunsaturated (essential) fatty acid identified was linoleic acid (C18:2 Omega-6) at concentration ranges of 5.654% in soyabean oil to 9.198% in groundnut oil. The result showed that the three samples are good sources of two essential fatty acid (lauric and palmitric acid). The predominant component of soyabean oil and coconut oil was myristic acid (C14:O) (41.039% and 33.544% respectively). The highest fatty acid component of groundnut oil is lauric acid (C12:O) at 14.567%.
Keywords: Soybean oil, Groundnut Oil, Coconut oil, Fatty acids, HPLC.

Introduction

Analysis of common fatty acids (with one straight chain and one acid group) is usually carried out by Gas Liquid Chromatography but in special cases it may be necessary to process High Performance Liquid Chromatography (HPLC) separations. The greatest value of HPLC is for volatile components (short chain fatty acids), for preparative scale separations or for studying isotopically labelled fatty acids. A simple and rapid method for determination of short-chain fatty acids by HPLC with ultraviolet detection has been reported (Stein et.al.,1992.). Positional and conformational isomers are more easily separated by HPLC than GLC. Vegetable oils in particular are natural products of plant origin consisting of ester mixtures derived from glycerol with chains of fatty acid contain about 14 to 20 carbon atoms with different degrees of unsaturation (Emmanuel and Mudiakeoghene 2008.). Vegetable oils play important functional and sensory roles in food products, and they act as carriers of fat-soluble vitamins (A, D, E, and K). They also provide energy and the essential fatty acids (linoleic and linolenic acids), responsible for growth (Fasina et.al.,2006). One important parameter of different vegetable oils is the amount of unsaturation of the constituent fatty acids (Nikolas and Theophanis 2000).

Most native oils and fats have limited applications in their unmodified forms, imposed by their triacylglycerol (TAG) and fatty acid (FA) compositions. It is widely known that the physical and chemical properties of oils are a strong function of the TAG and FA composition. By changing the natural physical and chemical characteristics of a fat or oil, it offers greater functionality for a large number of product formulations (Abdukarim et.al., 2010). Physico-chemical properties of triglyceride and its applications depend upon fatty acid constituents in molecule. However, the differences are due primarily to chain length degree and position of unsaturation. The short chain fatty acids are of lower melting point and are more soluble in water. Whereas, the longer chain fatty acids have higher melting points. Unsaturated acids will have a lower melting point compared to saturated fatty acids of similar chain length (Christie and Han 2010). Analyses of some common vegetable oils such as sunflower oils, olive oil and some plant seed oils are common in literature using GC (Christie and Han 2010 and Wolf 1994), GC-MS (Ackman 1986), GC-MS and GC-FID (Mohammad etal., 2007) or Reversed phase HPLC (Ling Tong etal., 2007). The aim of this work is to determine fatty acids concentration in SO, GO and CO.

Material and methods

Materials used were coconuts, soybeans and groundnuts and were obtained from market. Analar Grade n-hexane and sodium methoxide were obtained from chemical store.

Oil Extraction Procedure

The mesocarp of the coconut was scooped and grounded, using a mechanical grinder, and defatted in a soxhlet apparatus, using n-hexane (boiling point of 40–60°C). The extracted lipid was obtained by filtrating the solvent lipid contained to get rid of the solid from solvent before the hexane was removed using rotary evaporator apparatus at 40°C. Extracted seed oil was stored in freezer at −2°C for subsequent physicochemical analysis.

Extraction for HPLC

0.100g of the sample was dissolved in N-hexane in a test tube. 0.15ml of Sodium Methoxide was added and shaken for 2 minutes in a closed 20ml vial. The resultant mixture was centrifuged and a clear solution was obtained. The N-hexane was evaporated, the resultant residue was dissolved in 1.0ml acetonitrile and 20ml of the supernatant was injected into HPLC for fatty acid analysis.

Results and Discussion

The fatty acid compositions of the three different vegetable oils determined by HPLC are as reported in Table 1.
There are three main types of fatty acids that can be present in a triglyceride which is saturated (Cn: 0), monounsaturated (Cn: 1) and polyunsaturated with two or three double bonds (Cn: 2,3). Various vegetable oil is a potential feedstock for the production of a fatty acid methyl ester or biodiesel but the quality of the fuel will be affected by the oil composition. Ideally the vegetable oil should have low saturation and low polyunsaturation i.e. it is high in monounsaturated fatty acid (Gunstone 2004).
Predominant amongst the fatty acid in Soybean Oil and Coconut Oil is Myristic acid (C14:0) (41.039% and 33.544% respectively). Soybean oil has the highest content of monounsaturated fatty acids (MUFAs); that is oleic acid (C18:1) (Omega-9). Various studies indicates that a diet rich in oleic acid decreases the development of atherosclerosis and lowers serum cholesterol by diminishing oxidative stress and inflammatory mediators while promoting antioxidant defenses. The deleterious effects of oleic acid have been attributed to increase in the permeability of both vascular and alveolar epithelium to solute caused by changes in membrane fluidity and increase in intracellular calcium concentration (Davidson etal., 2000, Wang etal., 1994 and Vadaz 2005). The major unsaturated fatty acid detected was linoleic acid (C18:2 Omega - 6) present in soya bean oil; 5.654%, Groundnut oil 5.224% and coconut oil 9.198%. linoleic acid is primarily used to produce hormone like substances that regulate a wide range of functions; such as; blood clothing, the immune response, the inflammation to response to injury and infection, blood lipid levels, and blood pressure. This has make it useful in the beauty products industry because of its beneficial properties on the skin (Egmond etal., 1996 and Shank and Heise 1993). Unsaturated (especially polyunsaturated) fatty acids are also more prone to oxidation and the observed content in each of the oil in this study is lower than 10%. In contrast, dietary intake of certain unsaturated fatty acids, in particular conjugated linoleic and fat-soluble antioxidants (e.g. α-tocopherol, carotenoids) has been linked to potential health benefits (Dennys et al., 2006 and Gillian et al., 2008). The presence of lauric acid (12:0) was found in soybean oil (14.436%) and coconut oil (14.567%). As a matter of fact, Lauric acid is the highest content of fatty acid found in groundnut oil. This result is in line with the work of Gregorio (Gregorio 2005 and Gopala *et al*.,2010), they reported that coconut oil is a major source of lauric acid.
Palmitic acid is a saturated fatty acid present in the three samples in a small proportion. (soyabean oil 3.456%, coconut oil 2.092 and groundnut oil 4.755%). It is one of the most common saturated fatty acid found in butter, cheese, milk, animals and plants and it is an antioxidant, a nematicide used in making soups. However, high dietary intakes of saturated fatty acids (SFAs) are a risk factor for development of obesity, cardiovascular disease (Gillian et al., 2008). Oils are important nutrients and energy sources that are composed mostly of triacylglycerols. Dietary triacylglycerols are composed of fatty acids that may vary in their chain length, degree of unsaturation, isomeric orientation of double bonds and position within the triacylglycerol molecule (Edem 2002). Soybean oil contains a high proportion of myristic acid as well as considerable quantities of oleic and linoleic acids which give it a higher unsaturated fatty acid content than coconut oil and groundnut oil. Groundnut oil contains a considerable low quantity of saturated fatty acids.

Conclusion

The fatty acid composition of the three vegetable oil study contains a healthy mixture of all the types of saturated and unsaturated fatty acids. The fatty acid profile plays a key role to the physicochemical properties of the oil rather than evaluation of oils based on sensory evaluation especially visual appearance. Therefore, this is useful knowledge base for further advanced research.

References

Stein P.E., Boodhoo A., Armstrong G.G., Cockie S.A., Klein M.H. and Read R.J. (1992), Crystal structure of the cell-binding B Oligomer of Verotoxin-1 from E.coli. Nature, 355:748 -750.
Emmanuel O. A., and Mudiakeoghene O. (2008), The use of antioxidants in vegetable oils – A review. *African Journal of Biotechnology*. **7**(25): 4836-4842.
Fasina O.O., Hallman C. H. M., and Clementsa C.(2006), Predicting Temperature-Dependence Viscosity of Vegetable Oils from Fatty Acid Composition. *JAOCS*. **83**(10): 899-903.
Nikolas B.K. and Theophanis K. (2000), Calculation of iodine value from measurements of fatty acid methyl esters of some oils; comparison with the relevant American oil. Chemists society method. *JAOCS*, **77**(12); 1235-

1238.
Abdulkarim S.M., Myat M.W. and Ghazali H.M. (2010), Sensory and Physicochemical Qualities of Palm Olein and Sesame Seed Oil Blends during Frying of Banana Chips. *Journal of Agricultural Science*. **2**(4): 18-29.
Chayanoot S., Ausa C., Jaruwan N. N. and Chakrit T. (2005), Effect of solvent on fatty acid profile of stearin sepated from crude palm oil. ICEE 1-4.
Christie, W. W.and Han, X. (2010), Lipid Analysis Isolation, Separation, Identification and Lipidomic Analysis (4^{th} edition), 446 pages (Oily Press, Bridgwater, U.K.) www.pjbarnes.co.uk/op/la4.htm.
Wolff, R.L.(1994) Analysis of α-linolenic acid geometrical isomers in deodorized oils by capillary GC on cyanoalkyl polysiloxane stationary phases a note of caution. *J. Am. Oil Chem. Soc.,* **71**, 907-909.
Ackman,R.G.(1986), WCOT (capillary) gas-liquid chromatography.In: Analysis of Oils and Fats. (edited R.J. Hamilton & J.B. Rossell, Elsvevier Applied Science, London). 137-206
Mohammad, A. Kamal and Peter Klein (2007), Estimation of Fatty Acid in Corn Oil by Gas Capillary Chromatography. *Saudi Journal of Biological Sciences.* **14**, (1) ;17-20.
Ling Tong, Lei Zhang, Shauanghui Chen, Kaishun Bi. (2007), Analysis of Fatty Acids from *periploca sepium* by GC-MS and GC-FID *Asian Journal of Traditional Medicine,* **2,** (3); 110-114.
Gunstone F.D. (2004), The chemistry of oils and fats; sources, composition, properties and uses. London: Blackwell Publishing Ltd. ; 30-33.
Dennys E. C. C., Andre G. V. C., Maria do C. G. P., Sergio Matta D.S., Marco T. C. S., and Neuza M. B. C. (2006), Lipid profile of rats fed high-fat diets based on flaxseed, peanut, trout, or chicken skin. *Nutrition*. **22:** 197–205.
Gillian B., H., Jacob N., Tina S., Chris S., Mick D. E., Roy S. and Carlo L. (2008), Fatty acid and fat-soluble antioxidant concentrations in milk from high- and low-input conventional and organic systems: seasonal variation. *J Sci. Food Agric.* **88**:1431–1441.
Gregorio C. G. (2005), Fatty Acids and Derivatives from Coconut Oil. Bailey's Industrial Oil and Fat Products, Sixth Edition, John Wiley & Sons, Inc. *Stein J et al., J Chromatogr1992,**53,**576.*
Gopala K. A.G., Gaurav R., Ajit S. B., Prasanth K. P. K. and Preeti C. (2010), Coconut Oil: Chemistry, Production and Its Applications - A Review. *Indian Coconut Journal*.15-27 http://coconutboard.
Edem D.O. (2002), Palm oil: Biochemical, physiological, nutritional, hematological and toxicological aspects: A review. *Plant Food for Human Neutrinos*. **57**:319-343.
K.G Davidson, A. D. Bersten, H. A. Barr, K. D. Dowling, T. E. Nicholas and I. R. Doyle (2000), Lung function, permeability, and surfactant composition in oleic acid-induced acute lung injury in rats. *Am J Physiol Lung Cell Mol Physiol;* **279**:1091-1102.
L. Y. Wang, J. K. Ma, W. F. Pan, D. Teledovelasquez, C. J. Malanga and Y. Rojanasakul (1994), Alveolar permeability enhancement by oleic acid and related fatty acids: evidence for a calcium-dependent mechanism. *Pharm Res*; **11**:513-517.
I, Vadasz, R. E. Morty, M. G. Kohstall, A, Olschewski, F. Grimminger, W. seeger and H. A. Ghofrani (2005), Oleic acid inhabits alveolar fluid reabsorption: a role in acute respiratory distress syndrome? *Am J. Respir Crit Care Med;* **171**:469-479.
A.W. van Egmond, M. R. Kosorok, R, Koscki, A Laxova and P. M, Farrell (1996), Effect of linoleic acid intake on growth of infants with cystic fibrosis, *The American Journal of Clinical Nutrition,* **63**, (5),. 746-752.
M. Shanks and H. Heise (1993), Plant oils: Tropical application and anti-inflammatory effects (Croton oil test)". *Dermatol. Monatccchr* 179: 173.

Table 1: Fatty composition of three different vegetable oils

Fatty Acid		**Soybean Oil**	**Coconut Oil**	**Groundnut Oil**	**Concentration Standard**
Lauric Acid	**P/A**	193.0644	99.5955	194.8095	4.9531
	%	14.436	7.447	14.567	0.04
Myristic Acid	**P/A**	143.8241	70.5350	Nd	0.7788
	%	41.039	33.544	Nd	0.04
Palmitic Acid	**P/A**	45.7200	27.6730	62.8983	12.0252
	%	3.456	2.092	4.755	0.10
Stearic Acid	**P/A**	76.5708	79.7258	54.0056	18.9532
	%	1.496	7.790	12.075	0.20
Oleic Acid	**P/A**	181.4980	308.1217	161.6979	1.1555
	%	14.544	8.584	12.722	0.01
Linoleic Acid	**P/A**	189.8289	107.8346	178.6687	0.9327
	%	5.654	9.198	5.224	0.003
Weigth of oil		0.108	0.108	0.110	

P/A: Peak Area
Nd: Not Detected

HPLC conditions:

Column: C18
Mobile Phase: Acetonitrile: Acetone (59:41)
Flow Rate: 1.5ml/min
Detector: UV 215nm
Temperature: Ambient
Equipment: AKTA HPLC

Calculation

Concentration = $\frac{peak\ area\ of\ sample}{peak\ area\ of\ stdandard}\ X\ Conc. of\ std\ \ X\ dilution\ factor$

Dilution Factor = $\frac{1.0}{wt\ of\ oil}$