Available online at www.elixirpublishers.com (Elixir International Journal)

Applied Chemistry

Elixir Appl. Chem. 67 (2014) 21560-21564

ISSN: 2229-712X

Fatty Acid and Amino Acid Compositions of the Larva of Oil Palm Weevil (Rhyncophorous Ferrugineus)

Ogbuagu M.N* and Emodi, N.V

Department Of Chemistry, Michael Okpara University Of Agriculture, Umudike,P.M.B. 7267 Umuahia, Abia State Nigeria.

ARTICLE INFO

Article history:

Received: 2 October 2013;

Received in revised form:

24 January 2014;

Accepted: 7 February 2014;

Keywords

Amino Acid,

Fatty Acid,

Oil Palm,

Weevil.

ABSTRACT

This study is focused on the fatty acid and amino acid compositions of the larva of oil palm weevil (Rhyncophorous ferrugineus). The fatty acid composition of the oil showed the presence of twelve fatty acids comprising of six known fatty acids (lauric acid 0.05%, myristic acid 0.41%, palmitic acid 35.80%, stearic acid 7.82%, oleic acid 50.04% and linoleic acid 4.28%) and six unknown fatty acids. The oil is composed of more of unsaturated fatty acids with a total value of 54.32%, predominantly oleic acid; 50.04%.The iodine value (41.67 $\pm$ 0.26) and saponification number (191.64 $\pm$ 0.33) compared favorably with values reported as standard values for tallow. The free fatty acid value of the oil (7.01 $\pm$ 0.114 %) was very high when compared to reported values of 0.65% for lard or 1.25% for edible tallow. The specific gravity of the oil (0.7981) was lower than the values reported as standards for edible animal fats, such as lard, pork and tallow. The larva of the oil palm weevil (Rhyncophorous ferrugineus) protein showed a total of 17 amino acids (excluding tryptophan) and with glutamic acid (12.68g/100g) as the predominant amino acid. The amino acids have a total value of 77.53 g/100g protein. The essential amino acids, including arginine and histidine, make up 35.89 g/100g of the total amino acids. This value represents 46.29% of the total amino acids. The larva of the oil palm weevil has high values of phenylalanine (4.14g/100g), leucine (7.52g/100g) and arginine (6.47g/100g) but low value of lysine (4.51g/100g).The fatty acid composition of the larva of oil palm weevil oil indicated that the consumption of the larva of oil palm weevil would have no adverse health implications. The essential amino acids: leucine, isoleucine, phenylalanine+tyrosine had higher values than the FAO reference standard values. Methionine+cystine and threonine had reasonable values. Thus, the larva of oil palm weevil can serve as a substitute for beef meat and fish in the supply of fatty acids and essential amino acids necessary for good health.

Introduction

Insects have played important roles in the history of human nutrition. The insect species commonly consumed include locust, termites, grasshoppers, weevils and various caterpillars [1]. *Rhynchophorus Spp*. (palm weevils) are major pests of date palms, coconut palm, raffia palms, oil palms and sugarcane [2, 3]. Although that they are very destructive, their nutritional potentials have endeared them to man.

Rhynchophorus ferrugineus (oil palm weevil) is a highly cherished member of the *Rhynchophorus Spp*. It is found in wide geographical areas such as Africa, Southern Asia and Southern America [4].The weevil attacks dying or damaged parts of palm such as the trunks. It can also attack undamaged palms as well as decaying sugarcane.

In Nigeria, the larva is roasted and garnished with spices and consumed with palm wine. It can also be fried with little oil because of its oily nature. It is usually taken in place of meat and fish with such foods as rice, beans etc. The larva of the oil palm weevil (*Rhynchophorus ferrugineus*) is believed to contain very necessary nutrients required by the body for good health.

The larva is highly relished by the inhabitants of some rural communities. Yet, it still remains relatively unknown and strange to many.

Our paper presents the fatty acid and the amino acid compositions of the larva of oil palm weevil. The result obtained from this study will reveal the potentials of the larva of oil palm weevil as a good source of essential nutrients as well as a potential substitute to meat and fish in the supply of essential nutrients necessary for human health and nutrition.

Materials And Methods

The live larvae of the oil palm weevil were purchased from the dealers at Ndoru in Ikwuano L .G. A. in Abia State. They were properly washed with water. The heads were cut off and the internal (alimentary) tissues (organs) were squeezed out. They were subsequently cut open longitudinally and dried in the oven for 72 hours. The dried larvae were then milled to obtain the powdery sample used for the study.

Determination Of Fatty Acid Profile

5g of the milled sample was weighed into the extraction thimble and the fat was extracted with a 50:50 mixture of analytical grade ethanol and N-Hexane using soxhlet extraction apparatus as described by A.O.A.C [5]. The extraction lasted for 4 hours. The solvent was distilled off leaving the oil in the round – bottomed flask. 0.8g of the oil sample was placed in a 200cm^3 round-bottomed glass flask. 10cm^3 of 0.5M potassium hydroxide, in methanol, was added to the oil. The mixture was refluxed for 30 minutes. 2cm^3 of 1:4 HCL/methanol mixture was added through the top of the condenser and refluxed further for 15 minutes and then allowed to cool. The flask was disconnected from the condenser and 10cm^3 of pentane was added to the flask.

Tele:

E-mail addresses: ogbuagumn@yahoo.com

$20cm^3$ of saturated sodium chloride solution was also added. The solution was left to salt out. The liquid was then transferred to a glass separating funnel leaving the salt behind in the flask. The bottom layer was drained off and discarded. The upper pentane layer containing the fatty acid methyl esters of the oil was then transferred into a glass test tube. 0.5 μ l of the sample was then injected into the Hewlett Packard 6890 Gas Chromatograph and the chromatogram of the separated fatty acid methyl esters was obtained [6]. The saponification number (S.N), Iodine value (1.V), Peroxide value (PV) were determined [7]. The acid value and the free fatty acid (FFA) were also determined [8]. The specific Gravity was determined according to A.O.A.C. method (9).

Determination of Amino Acid Profile

The defatted powdery (flour) sample was then employed in the determination of the amino acid profile using the Technico-Sequential Multi-Sample (TSM) Automatic Amino Acid Analyser [10].

Results And Discussion

Fatty Acid Composition:

The fatty acid composition of the larva of oil palm weevil oil is presented in table 1.The result shows the presence of twelve fatty acids comprising of six known fatty acids (lauric acid 0.05%, myristic acid 0.41%,palmitic acid 35.80% , stearic acid 7.82%,oleic acid 50.04% and linoleic acid 4.28%) and six unknown fatty acids. The oil is composed of more of unsaturated fatty acids with a total value of 54.32%. Oleic acid is the predominant fatty acid and with a value of 50.04% of the total fatty acid composition of the oil. The saturated fatty acids account for 44.08% of the total fatty acid composition of the oil and with palmitic acid (35.80%) as the predominant saturated fatty acid.

Table 1: Fatty acid composition of the larval oil of oil palm weevil (Rhyncophorous ferrugineus).

Fatty Acid	% Composition
Lauric acid	0.05
Unknown	0.09
Myristic acid	0.41
Unknknown	0.29
Unknown	0.43
Unknown	0.23
Palmitic acid	35.80
Unknown	0.23
Stearic acid	7.82
Oleic acid	50.04
Linoleic acid	4.28
Unknown	0.32
Total S.Fatty Acids	**44.08**
Total Uns.Fatty Acids	**54.32**
Total Unknown F.A.	**1.59**
Total Fatty Acids	**99.99**

The values of the fatty acids show that the oil is fairly saturated/unsaturated, and as such, would be fairly stable to oxidation. The stearic acid (7.82%) and linoleic acid (4.28%) compositions are also appreciable. A palmitic acid composition of 20-30% for lard, pork and tallow had been reported as standard values [13].

The stearic acid composition (7.82%) is low. Higher values of 15.3 ±4.2% for goat meat [14] and 10.54% for oily fish [15] had been reported. A stearic acid composition of 8-22% for lard and pork had been reported as a standard value [13].The stearic acid composition of legumes range from 2% to 8% [14]. Although that stearic acid (18:0) is a saturated fatty acid, but several studies have shown that the stearic acid effect on total cholesterol is minimal and not detrimental to human health [17, 18, 19, 20]. It has also been reported that stearic acid is less likely to be incorporated into cholesterol esters [21]. These findings indicate that stearic acid is less unhealthy than other saturated fatty acids. The oleic acid composition of the oil, 50. 04 % is comparable to values of 35-55% for lard and pork as well as 30-45% for tallow reported as standards [13].Oleic acid is a monounsaturated fatty acid found in large quantities in olive oil. Numerous studies indicate that a diet rich in olive oil decreases the development of atherosclerosis and lowers serum cholesterol by diminishing oxidative stress and inflammatory mediators while promoting antioxidant defenses [22].

The linoleic acid composition of the oil (4.28%) is in agreement with the values of 4-12% for lard and 1-6% for tallow reported as standards [13]. Linoleic acid (Omega-6-fatty acids) and linolenic acid (Omega-3-fatty acids) are members of the groups of essential fatty acids.

Table 2: Physicochemical properties of the larval oil of oil palm weevil (*Rhyncophorous ferrugineus)*.

Parameters	Compositions
Specific gravity	0.7981
Free fatty acid (%)	7.01 ± 0.114
Iodine value (Wij's)	41.67 ± 0.26
Saponification number (mgKOH/g)	191.64 ± 0.33
Peroxide value (mEq/kg	9.7 ± 0.05
Acid value (mgKOH/g)	14.02 ± 0.23

Thus, the consumption of the larva of oil palm weevil will not be detrimental to human health. Palmitic acid, in its ester form, for example, retinyl palmitate is an anti-oxidant and a vitamin A compound added to low-fat milk to replace the vitamin content lost during the removal of milk fat.

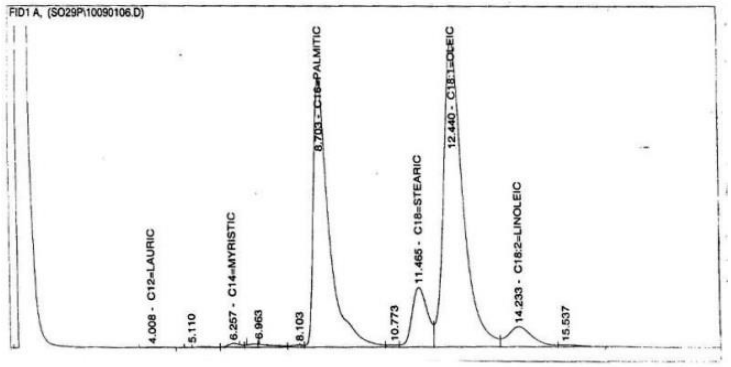
It has been claimed by the World Health Organization (WHO) that dietary intake of palmitic acid increases risk of developing cardiovascular disease [23].However, it has also been reported that palmitic acid has no hypercholesterolaemic effect if intake of linoleic acid is greater than 4.5% of energy. On the other hand, it has also been shown that if the diet contains trans fatty acids, the health effects are negative, causing an LDL cholesterol increase and HDL cholesterol decrease [24].

Physicochemical Properties Of The Oil:

Results of the physicochemical properties of the larva of the palm weevil oil (Table 2) show that the oil has free fatty acid value of 7.01 ± 0.114 %, Wij's iodine value of 41.67 ± 0.26, saponification number of 191.64 ± 0.33 mgKOH/g , peroxide value of 9.7 ± 0.05 mEq/kg), acid value of 14.02 ± 0.23 mgKOH/g) and a specific gravity of 0.7981.

The iodine value (41.67 ± 0.26) and saponification number (191.64 ± 0.33 mgKOH/g) compare favorably with values reported as standard values for tallow [13]. The free fatty acid value of the oil (7.01 ± 0.114 %) is very high when compared to reported values of 0.65% for lard or 1.25% for edible tallow [13]. The specific gravity of the oil (0.7981) is lower than the values reported as standards for edible animal fats, such as lard, pork, tallow etc. [13].This could be as a result of the very high free fatty acid content of the oil. However, the oil may be purified and used for edible purposes. The peroxide value (9.7 ± 0.05 mEq/kg) is in agreement with the maximum value of 10

mEq/kg fat reported, as standard, for edible lard, tallow, pork, etc. [13].



1	4.008	PB	0.3316	259.84116	0.04981	C12=LAURIC
2	5.110	PV	0.2579	491.37442	0.09420	?
3	6.257	VV	0.3449	2133.62622	0.40903	C14=MYRISTIC
4	6.630	VV	0.1707	1508.20081	0.28913	?
5	6.963	VV	0.3434	2259.39551	0.43314	?
6	8.103	VV	0.2408	1189.92615	0.22811	?
7	8.703	VV	0.4425	1.86720e5	35.79512	C16=PALMITIC
8	10.773	VV	0.3232	1207.94263	0.23157	?
9	11.465	VV	0.4619	4.08102e4	7.82350	C18=STEARIC
10	12.440	VV	0.5519	2.61038e5	50.04209	C18:1=OLEIC
11	14.233	VV	0.7120	2.23263e4	4.28005	C18:2=LINOLEIC
12	15.537	VB	0.6018	1691.49023	0.32427	?
Totals :				5.21637e5		

Figure 1: **Chromatogram Of The Fatty Acid Methyl Esters Of The Larval Oil Of Oil Palm Weevil(*Rhyncophorous ferrugineus)* Using Hewlett Packard 6890 Gas Chromatograph, C:\HP CHEM|1|METHODS\SO29P.M**

Amino Acid Composition:

The amino acid composition of the larva of the oil palm weevil *(Rhyncophorous ferrugineus)* is presented in table 3. The result shows a total of 17 amino acids (excluding tryptophan) and with glutamic acid (12.68g/100g) as the predominant amino acid. The amino acids have a total value of 77.53 g/100g protein.

The essential amino acids; lysine (4.51 g/100g), methionine (2.16 g/100g), threonine (3.50 g/100g), valine(3.49 g/100g), leucine (7.52 g/100g), isoleucine (4.08 g/100g), phenylalanine (4.14 g/100g), arginine (6.47 g/100g) and histidine (3.51 g/100g) (Table 4) make up 35.89 g/100g of the total amino acids. This value represents 46.29% of the total amino acids. This value may be considered reasonable.

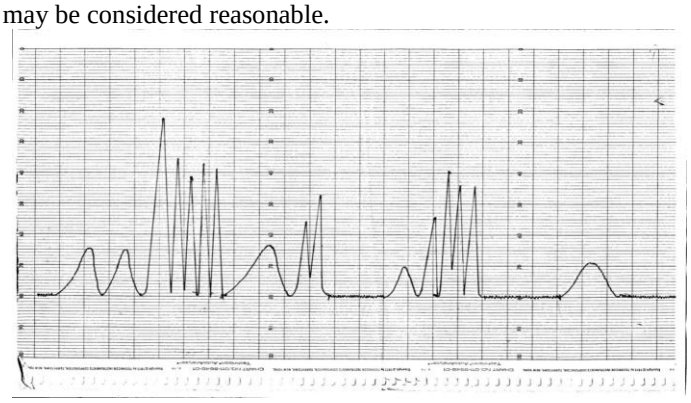


Figure 2: **Chromatogram Of Standard Amino Acid Mixture Using Technicon Sequential Multi-Sample (TSM) Amino Acid Analyzer**

The larva of the oil palm weevil has high values of phenylalanine (4.14g/100g), leucine (7.52g/100g) and arginine (6.47g/100g) but low value of lysine (4.51g/100g). Higher values of lysine have been reported for some legumes such as soybean (6.40g/100g) [25] and groundnut (6.83g/100g) [26] .The reported leucine values of the common legumes range from 5.9/100g in cowpea [27] to 7.80g/100g in soybean [25].

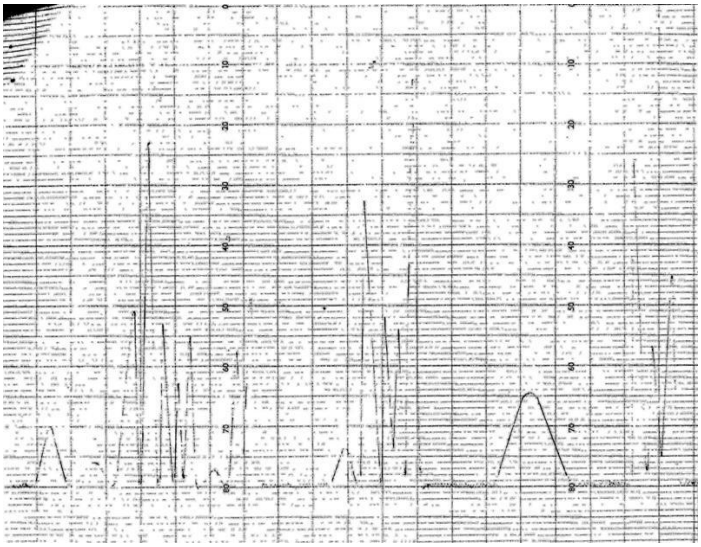


Figure 3: **Chromatogram Of Amino Acid Compostion Of *The Larva Of Oil Palm Weevil* Using Technicon Sequential Multi-Sample (TSM) Amino Acid Analyzer**

The essential amino acids are those amino acids in the protein which the body cannot synthesize from carbon and nitrogen donors. The nonessential amino acids are those the body can produce from carbon and nitrogen donors. Therefore, the nutritional quality of a food material is assessed by its content of the essential amino acids.

Table 3:Amino acid composition of the larva of oil palm weevil (*Rhyncophorous ferrugineus)* protein (g/100g)

Amino acid	Concentration
Lysine	4.51
Histidine	3.51
Aspartic acid	6.47
Threonine	3.50
Serine	3.64
Glutamic acid	12.68
Proline	3.29
Glycine	3.65
Valine	3.49
Methionine	2.16
Isoleucine	4.08
Leucine	7.52
Arginine	6.47
Tryptophan	Not Determined
Tyrosine	3.22
Phenylalanine	4.14
Alanine	4.21
Cystine	0.99
Total AA	**77.53**
Total EAA	**35.89**
% Total EAA	**46.29**

The larva of the oil palm weevil also has appreciable values of threonine (3.50 g/100g), leucine (7.52g/100g), phenylalanine (4.14g/100g), arginine (6.47 g/100g) and histidine (3.51 g/100g) when compared to reported values of threonine (4.00 g/100g), leucine (8.40 g/100g), phenylalanine (4.00 g/100g), arginine (6.61 g/100g) and histidine (2.90 g/100g) for beef meat [28] as well as the values of threonine (4.80 g/100g), leucine (8.40 g/100g), phenylalanine (3.50 g/100g) arginine (7.50 g/100g) and histidine (2.10 g/100g) for goat meat [28]. The values imply that the larva of oil palm weevil is as good as the legumes, goat and beef meats in the supply of essential amino acids.

Table 4: Essential Amino Acid Composition Of The Larva Of Oil Palm Weevil (*Rhyncophorous ferrugineus)* Protein (g/100g)

Essential A.A	Composition
Lysine	4.51
Methionine	2.16
Threonine	3.50
Tryptophan	ND
Valine	3.49
Leucine	7.52
Isoleucine	4.08
Phenylalanine	4.14
Arginine	6.47
Histidine	3.51
Total E.AAs	**35.89**
% Total of E.AAs	**46.29**

Table 5: Essential Amino Acid Composition Of The Larva Of Oil Palm Weevil Protein Compared To FAO/WHO (1973) and FAO/WHO/UNU (1991) Reference Standards

EAAs	Composition	FAO/WHO (1973) Ref. standard	FAO/WHO/UNU (1991) Ref. standard
Lysine	4.51	5.5	5.8
Methionine+Cystine	3.15	3.5	2.5
Threonine	3.50	4.0	3.4
Tryptophan	ND	1.0	1.0
Valine	3.49	5.0	3.5
Leucine	7.52	7.0	6.6
Isoleucine	4.08	4.0	2.8
Phenyalanine+Tyrosine	7.36	6.0	6.3
Arginine	6.47	-	
Histidine	3.51	-	

Protein quality of foods is usually assessed by comparing its essential amino acids content with reference standard ideal protein set by the World Health Organization. The essential amino acid composition of the larva of oil palm weevil in comparison with FAO/WHO [11] and FAO/WHO/UNU) [12] reference standards is presented in table 5. The result shows that leucine (7.52) and phenyalanine+Tyrosine (7.36) have higher scores than the FAO/WHO [11] reference standard. Methionine+cystine (3.15), threonine (3.50) and isoleucine (4.08) have comparable values with FAO/WHO [11] reference standard values for the respective amino acids. However, in comparism with FAO/WHO/UNU [12] reference values, leucine (7.52), isoleucine (4.08), phenyalanine+tyrosine (7.36), and methionine+cystine (3.15) have higher scores than their respective reference standards. The values of threonine (3.50) and valine (3.49) are almost the same with their respective FAO/WHO/UNU [12] reference values. However, the methionine+cystine, and isoleucine contents of the larva of oil palm weevil protein are below the recommended amino acids requirements (4.6g/100g protein) for infants, but adequate for both pre-school children between 2 and 5years of age, school children between 10 and 12 years of age and the adults [29]. Likewise, the leucine content is adequate for both infants, preschool children between 2 and 5 years of age, school children between 10 and 12 years of age and the adults [29]. These amino acids are higher than 1.9g/100g protein set as reference standards [12] which imply that the protein of the larva of oil palm weevil is composed of amino acids with a high biological value and could contribute in meeting the human requirements for these essential amino acids. Histidine and arginine are also essential for children and infants. Histidine is essential for infants and small children (decreasingly with age), while arginine is made by the body at all ages, but only at a slower rate in the early years.

Figure 4: **Larva of Oil Palm Weevil (*Rhyncophorous ferrugineus).***

Thus, the larva of oil palm weevil can supply required amounts of leucine, isoleucine and phenyalanine+tyrosine to consumers.

Conclusion

The fatty acid composition of the larva of oil palm weevil oil indicates that the consumption of the larva of oil palm weevil will have no adverse health implications. The essential amino acids: leucine, isoleucine, phenylalanine+tyrosine have higher values than the FAO reference standard values. Methionine+cystine and threonine have reasonable values. Thus, the larva of oil palm weevil can serve as a substitute for beef and fish in the supply of fatty acids and essential amino acids necessary for good health.

References

[1]. Ene, J.C. (1963) Insects and man in West Africa. Ibadan University Press. Ibadan. p. 66.

[2]. Vidyasagar, P.S.P.V., Hagi, M., Abozuhairah, R.A., Al-Mohanna, O.E. and Al-Saihati, A. (2000). Impact of mass pheromone trapping on the red palm weevil:Adult population and infested level in date palm gardens of Saudi Arabia. *The Planter*,**76**:347–355.

[3]. Aldryhim, Y. and Al-Bukiri, S. (2003). Effect of irrigation on within-grove distribution of red palm weevil (*Rhynchophorus ferrugineus*). *Sultan Qaboos University journal for scientific research in Agriculture, Agricultural and marine sciences, 8(1):Pp.47-49.*

[4]. Kalshoven, L.G.E. and Laan, P.A.V. (1981). Pests of crops in Indonesia. Jakata: P.T. Ichitiar Van Hoeve. Pp. 463-468.

[5]. A.O.A.C. (2006). Official Methods of Analysis of the Association Of Analytical Chemists. (W.Horwitz Editor) Eighteenth Edition, Washington, D.C.

[6]. Standard Analytical methods (1999). Determination of the fatty acid Distribution of Oils, fats and soaps by Gas chromatography (Reflux method). No. SO29. Appendix A. Pp 1-3

[7]. James, C.S. (1995). Analytical Chemistry of Foods. Blackie Academic and Professional. Glasgow. Pp.71-91.

[8]. Pearson, D. (1976). Chemical Analysis of foods. Churchill Livingston, Edinburgh, U.K. p.572.

[9]. AOAC. (1990). Official Methods of Analysis of the Association of Official Analytical Chemist, 15th edition, Washington, DC.

[10]. Spackman, D.H., Stein, E.H. and Moore, S. (1958). Automatic Recording Apparatus for use in the chromatography of amino acids. *Analytical Chemistry, 30:1191.*

[11]. FAO/WHO. (1973). Energy and Protein Requirements. Report of a Joint FAO/WHO Ad Hoc Expert Committee. WHO Tech.Rept. Ser. No. 522, World Health Organization, Geneva, Switzerland.
[12]. FAO/WHO/UNU. (1991). Protein quality evaluation. Food and Agricultural organization of the United Nation Rome; Italy.
[13]. CODEX-STAN 211(1999). http://www.codexalimentarius.net/download/standards/337/CXS_211e.pdf.
[14]. Casey, N.H. and Van Niekerk, W.A. (1985). Fatty acid composition of subcutaneous and kidney fat depots of Boer goats and the response to varying levels of maize meal. *South African Journal of Animal Science.* 15: 60-62.
[15]. Sadler, M., Lewis, J. and Buick, D. (1993). Composition of trim lamb. *Food Aust.* 45 (Suppl): S2-12.
[16]. Adeyeye, E., Oshodi, A.A. and Ipinmoroti, K.O. (1999). Fatty acid composition of six varieties of dehulled African yam bean flour. *Int .J, Food Sci. Nutr.* 50: 357-365
[17]. Bonanome, A. and Grundy, S. (1988). Effect of dietary stearic acid on plasma cholesterol and lipoprotein levels. *N. Engl. J. Med*. 318:244-248.
[18]. Zock, P.L. and Katan, M.B. (1992). Hydrogenation alternatives:effects of *trans*-fatty acids and stearic acid versus linoleic acid on serum lipids and lipoprotein in humans. *J. Lipids Res*. 33:399-410
[19]. Kris-Etherton, P.M., Deer, J., Mitchell, D.C., Mustad, V.A., Russell, M.E., McDennell, E.T., Slabsky, D. and Pearson, T.A. (1993). The role of fatty acids saturation on plasma lipids, lipoproteins: I. Effects of whole food diets high in cocoa butter, olive oil, soybean oil, dairy butter, and milk chocolate on the plasma lipids of young men. *Metabolism* 42:121-9.
[20]. Judd, J.T., Baer, D.J., Clevidence, B.A., Kris-Etherton, P., Muesing, R.A. and Iwane, M. (2002). Dietary *cis* and *trans* monounsaturated and saturated FA and plasma lipids and lipoproteins in men. *Lipids* 37(2):123-131.
[21]. Emken, E.A. (1994). Metabolism of dietary stearic acid relative to other fatty acids in human subjects. *American Journal of clinical Nutritional. (The American Society for Clinical Nutrition, Inc) 60: 1023S -1028S.*
[22]. Moreno, J.J. and Mitjavila, M.T. (2003). The degree of unsaturaton of dietary fatty acids and the development of atherosclerosis (review). *J. Nutr. Biochem. 14:182 -195.*
[23]. WHO. (2003). Technical report series 916: Report of a joint WHO/FAO expert consultation, World Health Organization, Geneva. p. 88.
[24]. French, M.A., Sundram, K. and Clandinin, M.T. (2002). Cholesterolaemic effect of palmitic acid in relation to other dietary fatty acids. *Asia Pacific journal of clinical nutrition 11 (Suppl 7):S401 -407.*
[25]. Iwe, M.O. (2003).The science and technology of soybean: Chemistry, Nutrition, Processing, Utilization. Rojoint comm..serv. ltd., Nigeria. p.36.
[26]. Onyenuga, V.A. (1968). Nigeria's food and feeding-stuffs.3rd Edn. Ibadan University Press, Ibadan, Nigeria.