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E-mail: bjsir07@gmail.com

Lipid composition of *Basella alba and Basella rubra* leaves consumed in South-Western Nigeria: Nutritional implications

A. J. Adesina* and S. O. Adefemi

Department of Chemistry, Ekiti State University, PMB 5363, Ado-Ekiti, Nigeria

Abstract

The levels of fatty acids, phospholipids and sterols were determined in the samples of *Basella alba* and *Basella rubra* commonly consumed in the South-Western Nigeria by gas chromatography. Results showed that the crude fat levels were 4.40 and 4.41 % in the *Basella alba* and *Basella rubra* samples respectively. The fatty acid composition of *Basella alba* and *Basella rubra* samples shows that the SFA was 26.0 and 24.9 %, MUFA was 1.19 and 1.24 % and PUFA was 72.5 and 73.8% respectively. The other quality parameters of *Basella alba* and *Basella rubra* were found: PUFA/SFA, 2.79 and 2.97; MUFA/SFA, 0.046 and 0.050; n-6/n-3, 2.47 and 3.31; LA/ALA, 0.890 and 1.12 and EPSI (PUFA/MUFA), 60.8 and 59.5 respectively. Phospholipids present in *Basella alba* and *Basella rubra* were 1679 and 1920 mg/100g respectively. In the group of phytosterols, sitosterol was highest with values of 196 mg/100g and 275 mg/100g in *Basella alba* and *Basella rubra* samples respectively. Linear correlation at $\alpha_{= 0.05,\ df: n-1}$ showed that significant difference exists between the fatty acid, quality parameters of the fatty acids phospholipids and sterols.

Keywords: *Basella* species; Lipid composition; Fatty acid; Phospholipid; Phytosterol; Gas chromatograph

Introduction

Basella (*alba* L. and *rubra* L.) is an extremely heat tolerant, fast growing perennial vine (vegetable) which belongs to the family *Basellaceae* (Grubben and Denton, 2004; Rathee *et al.,* 2010) commonly known as Malabar spinach, Indian spinach, Ceylon spinach, vine spinach (Roy *et al.,* 2010) and locally called "Amunu - tutu" and "Alaari" in the south western part of Nigeria. The red leaf form belongs to the *rubra* species, whilst the green leaf form is classified in the *alba* species (James, 1994). Due to easy adaptation to a variety of soils and climates, *Basella* sp is considered one of the best tropical spinach throughout the tropical world (Palada and Crossman, 1998). It is one of the wild leafy vegetables, which is rare in its natural habitat but nowadays, it is grown for its nutritive value (Deshmukh and Garkwad, 2014) throughout the temperate regions as an annual and the tropics as a perennial vegetable.

In Ekiti State and other parts of Yoruba land, few rural and urban dwellers cultivate few stands of *Basella* species at their backyard for consumption and can be available throughout the year if well maintained. Bargquist (2006) reported that fruits and vegetables possess major food constituents such as protein, fat and carbohydrate, micro nutrients such as vitamins, minerals, and trace elements in addition to other compounds such as ascorbic acid, carotenoids and flavonoids that have a positive effect on human health. According to Khare (2007), the plant consists of essential amino acids such as arginine, isoleucine, leucine, lysine, threonine, and tryptophan along with several vitamins, minerals and a low percentage of soluble oxalates.

Lola (2009) has studied the fat content of raw *Baselle rubra* which was about 0.3%. Oladele and Aborisade (2009) have evaluated the influence of different drying methods and storage on the quality of *Basella rubra.* They observed significant reduction in Ca, Mg, Na, Fe, Mn, and Zn during drying and storage. Linnaeus first described two species of *Basella* L. in species Plantarum, and that the species (*Basella rubra* and *Basella alba*) were separated from each other on the basis of leaf character and stem colour (Deshmukh and Gaikwad, 2014).

Leaves and shoots of *Basella* are useful as vegetable which can be eaten cooked as green or added to soups (Oloyede *et al.,* 2013; James, 1994). Leafy vegetables have generally been reported to add taste, flavour and substantial amount of nutrients to the diet (Oloyede *et al.,* 2013). Information on this vegetable, especially antioxidants, minerals,

* Corresponding author e-mail: unclejoshua2012@gmail.com

proximate compositions has been published with nothing reported on the lipid (fatty acid, phospholipid and sterol) composition. This study is therefore aimed at assessing the lipid composition of the two common species of *Basella* in Ekiti State, Nigeria as this will encourage their maximum and wider utilization as part of everyday meal.

Materials and methods

Sample collection and treatment

The fresh leaves of *Basella alba* and *Basella rubra* were collected from vegetable gardens located in Ado- Ekiti metropolis area of Ekiti State.

The leaves were properly sorted, washed and air-dried for about two weeks. The dried leaves were made into fine powder using pestle and mortar, packed in airtight plastic sample bottles and kept in refrigerator for analysis.

Determination of ether extract

An aliquot (0.25 g) of each sample was weighed in an extraction thimble and 200 ml of petroleum ether (40-60 ^{o}C boiling range) was added. The covered porous thimble containing the sample was extracted for 5 h using a Soxhlet extractor. The extraction flask was removed from the heating mantle when it was almost free of petroleum ether, oven dried at 105 ^{o}C for 1 h, cooled in a desiccator and the weight of dried oil was determined.

Preparation of fatty acid methyl esters and analysis

A 50 mg aliquot of the dried oil was saponified for 5 min at 95 ^{o}C with 3.4 ml of 0.5 M KOH in dry methanol. The mixture was neutralized by 0.7 M HCl and 3 ml of 14 % boron trifluoride in methanol was added. The mixture was heated for 5 min at 90 ^{o}C to achieve complete methylation. The fatty acid methyl esters were thrice extracted from the mixture with redistilled n-hexane and concentrated to l ml for analysis. The fatty acid methyl esters were analyzed using an HP gas chromatograph [HP gas chsomatograph powered with HP ChemStation rev A09.01 (1206) software (GMI, Inc., Minnesota, USA)] fitted with a flame ionization detector. Nitrogen was used as the carrier gas with a flow rate of 20-60 ml/min. The oven programme was: initial temperature at 60^{o} C, ramping at 10^{o} C /min for 20 min, held for 4 min, with a second ramping at 15^{o} C /min for 4 min and held for 10 min. The injection temperature was 250 ^{o}C and the detector was 320^{o} C. A polar (HP-INNOWAX) capillary column (30 m x 0.25 mm x 0.25 μm) was used to separate the esters. A split injection was used with a split ratio of 20:1. The peaks were identified by their relative retention time compared with known standards.

Sterol analysis

Aliquots of the dried oil were added to screw-capped test tubes. The sample was saponified at 95^{o}C for 30 min, using 3 ml of 10 % KOH in ethanol, to which 0.20 ml of benzene was added to ensure miscibility. Deionised water (3 ml) was added and 2 ml of hexane was used in extracting the unsaponifiable materials. Three extractions, each with 2 ml of hexane, were carried out for 1 h, 30 min and 30 min respectively, to achieve complete extraction of the sterols. Hexane was concentrated to 1 ml for gas chromatographic analysis. Other procedures followed same as in the analysis for fatty acid methyl esters.

Phospholipid analysis

Phospholipid analysis was done using a modified method of Raheja *et al.,* (1973). About 0.01 g of the dried oil was added to test tubes. Any remaining solvent was removed by passing a stream of nitrogen gas over the oil. Then 0.40 ml of chloroform was added, followed by addition of 0.10 ml of the chromogenic solution. The tube was heated to 100 ^{O}C in a water bath for 1 min 20 sec., cooled to room temperature, 5 ml of hexane was added and the tube was shaken gently several times. After separation of the solvent and aqueous layers, the hexane layer was recovered and concentrated to 1.0 ml for analysis. Analysis was performed using the gas chromatograph with a polar (HP5) capillary column (30 m x 0.25 mm x 0.25 μm). The oven programme was: initially at 50 ^{o}C ramping at 10 ^{o}C /min for 20 min, held for 4 min, a second ramping at 15 ^{O}C /min for 4 min and held for 5 min. The injection temperature was 250 ^{o}C, and the detector temperature was 320 ^{o}C. As previously described, a split injection type was used having a split ratio of 20: 1. Peaks were identified by comparison with known standards.

Statistical evaluation

Data from the results were subjected to statistical analysis of correlation coefficient (r_{xy}), coefficient of alienation (C_A), index of forecasting efficiency (IFE), regression coefficient (R_{xy}) and coefficient of determination or variance (r_{xy}^2) (Chase, 1976). The r_{xy} values were compared with the critical Table value to see if significant differences existed among the sample results at r=0.05 (Oloyo, 2001). Other descriptive statistics done were the determination of mean, standard deviation and coefficient of variation percent (Oloyo, 2001).

Results and discussion

Results in Table I depicted the crude fat, total fatty acid and total energy from the *Basella alba* and *Basella rubra*

samples. *Basella alba* had correspondingly higher values than *Basella rubra* in all the three parameters. The coefficient of variation percent was 4.99 in all the three parameters. The value of crude fat 4.40 and 4.10 g/100g in the samples were higher than the value reported for the testa of Bambara groundnut (*Vigna substerranea* L), flour (2.84 g/100g) (Adeyeye *et al.,* 2015) and fermented lima bean (1.8 – 3.9 g/100g) (Adegbehingbe, 2013) but comparably lower than levels reported for raw and roasted Terminalia catappa seeds kernel (45.2 – 46.1 g/100g) (Adesina, 2013) and fermented and unfermented Parkia biglobosa seeds (16.9 – 19.5 g/100g) (Adeyeye, 2013). Also in Table I, the differences in the values of crude fat, total fatty acids and total energy between the two sample were shown. The differences were: crude fat (0.30 g/100g), total fatty acid (0.24 g/100g), energy (kg/100g) (8.88 g/100g) and the percentage difference in all was 6.82%, meaning that for each parameter, *Basella alba* was 6.82% more concentrated than the corresponding *Basella rubra* values.

Table I. Crude fat, total fatty acid and Total energy in *Basella alba* (BA) and *Basella rubra* (BR) samples

Parameters	BA	BR	Mean	SD	CV%	Diff (BA - BR)	% Diff
Crude Fat (g/100g)	4.40	4.10	4.25	0.212	4.99	+0.30	6.82
*Total Fatty acids (g/100g)	3.52	3.28	3.40	0.170	4.99	+0.24	6.82
Energy(kJ/100g)	130	121	126	6.28	4.99	+8.88	6.82

*crude fat x 0.8

Table II depicts the percentage composition of the various fatty acids in the samples of *Basella alba* and *Basella rubra*. The total SFA in the *Basella alba* was 26.0% of the total fatty acids whereas the *Basella rubra* SFA value was 24.9%. This mean that SFA in *Basella alba* was 1.10 g/100g or 4.22% better than in the *Basella rubra* sample. The most concentrated SFA in both samples was palmitic acid (C16: 0) with values of 20.0% (*Basella alba)* and 19.2% (*Basella rubra*) followed by stearic acid (C18: 0) with values of 4.31% (*Basella alba*) and 3.73% (*Basella rubra*).

According to the report of Oyenuga (1978), SFA values from seed fat of African locust bean (%) were: SFA (46.0) and composed of palmitic acid (31.0), stearic acid (7.70), arachidic acid (4.2) and behenic acid (3.10). Both palmitic acid and stearic acid from literature values were close to the present results with respective values in *Basella alba* and *Basella rubra* samples as 20.0% and 4.31% and 19.2% and 3.73%.

Long chain fatty acids have 14 to 18 carbon atoms and can either be saturated, monosaturated or polysaturated. Myristic acid (C14: 0) is a ubiquitous component of lipids in most living organisms, but usually at levels of 1 – 2% only. In the present samples, C_{14}: 0 ranged from 1.64% to 1.89%. This fatty acid is found very specifically in certain proteolipids, where it is linked via an amide bond to an N – terminal glycine residue, and is essential to the function of the protein components (Adeyeye, 2013). Palmitic acid (C16:0) is usually considered the most abundant SFA in nature, and it is found in appreciable amounts in the lipids in most animal tissues, and it is present in amounts that vary from 10 – 40% in seed oils (Adeyeye, 2013). Although C16: 0 in the present samples fell within this range with values of 20.0% and 19.2% in *Basella alba* and *Basella rubra* respectively; these results were in perfect agreement with the literature values being the most abundant SFA in foods from plant origin. Stearic acid (C18: 0) is the second most abundant SFA in nature and again it is found in the lipid of most living organisms. In these samples, C18: 0 occupied the second position (4.31% and 3.73% for *B. alba* and *B. rubra* respectively) in the SFA group.

Also contained in Table II are the monounsaturated fatty acids (MUFA). The total MUFA levels ranged from 1.19 % to 1.24% with the *Basella alba* sample predominating. The most predominant cis- MUFA in both samples was oleic acid (C18: 1 cis – 9) with values of 0.814% and 0.753% respectively in *Basella alba* and *Basella rubra* respectively. The monoenes in trans – form was much in favour of *Basella rubra*, although the levels were much lower than the levels reported for fermented and unfermented locust bean (Adeyeye, 2013), raw and processed sorghum bicolour (Adeyeye and Adesina, 2013), Bambara groundnut flours (Adeyeye *et al.,* 2015) and tropical almond seed kernels (Adesina, 2013).

Oleic acid (18: 1(n-9)) is by far the most abundant monoenoic fatty acid in plant and animal tissues, both in structural lipids and in fat depots (Adeyeye, 2013). Olive oil contains up to 78% of oleic acid, and is believed to have valuable nutritional properties as part of Mediterranean

Table II. Fatty acid composition of *Basella alba* (BA) and *Basella rubra* (BR) samples

Fatty acid (%)	BA	BR	Mean	SD	CV%	Diff (BA - BR)	% Diff
C14:0	1.64	1.89	1.77	0.177	10.0	-0.25	15.2
C16:0	20.0	19.2	19.6	0.566	2.89	+0.80	4.00
C18:0	4.31	3.73	4.02	0.410	10.2	+0.58	13.5
C20:0	0.015	0.032	0.02	0.012	50.7	-0.02	112
C22:0	0.014	0.029	0.02	0.011	49.3	-0.02	107
C24:0	0.002	0.004	0.00	0.001	50.7	-0.002	112
Total SFA	26.0	24.9	25.4	0.775	3.05	+1.10	4.22
C14:1(cis-9)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16:1(cis-9)	0.131	0.144	0.14	0.009	6.69	-0.01	9.92
C18:1(cis-6)	0.181	0.202	0.19	0.015	7.75	-0.02	11.6
C18:1(cis-9)	0.814	0.753	0.78	0.043	5.51	+0.06	7.49
C20:1 (cis-11)	0.057	0.120	0.09	0.045	50.3	-0.06	111
C22:1(cis-13)	0.005	0.010	0.01	0.004	50.3	-0.01	110
C24:1(cis-15)	-	-	-	-	-	-	-
Total MUFA cis	1.19	1.23	1.21	0.029	2.42	-0.04	3.48
C18:1 (trans-6)	0.005	0.012	0.01	0.004	51.0	-0.01	113
C18:1 (trans-9)	0.0005	0.001	0.00	0.00	47.1	+0.001	100
C18:1 (trans-11)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total MUFA trans	0.006	0.013	0.009	0.005	50.7	-0.01	112
Total MUFA	1.19	1.24	1.22	0.034	2.78	-0.05	4.01
C20:2 (cis-11,14)	0.002	0.005	0.00	0.002	51.4	-0.002	114
C18:3 (cis-9,12, 15)	20.9	17.1	19.0	2.69	14.1	+3.80	18.2
C20:3 (cis-11,14,17)	0.009	0.020	0.01	0.007	50.8	-0.01	112
C20:5 (cis-5,8,11,14,17)	-	-	-	-	-	-	-
C22:6 (Cis-4,7,10,13,16,19)	-	-	-	-	-	-	-
Total (n-3)	20.9	17.1	19.0	2.68	14.1	+3.79	18.1
C18:2 (cis-9,12)	18.6	19.1	18.9	0.354	1.88	-0.50	2.69
C18: 2 (trans-9,11)	0.006	0.013	0.010	0.005	48.1	-0.01	103
C18:3 (cis-6,9,12)	32.9	37.5	35.2	3.25	9.24	-4.60	14.0
C20:3 (cis-8,11,14)	0.110	0.091	0.101	0.013	13.4	+0.02	17.3
C20:4 (cis-5,8,11,14)	0.014	0.00	0.007	0.010	141	+0.01	100
C22:2 (cis-13,16)	0.002	0.004	0.003	0.001	50.7	+0.002	112
Total (n-6)	51.6	56.7	54.2	3.59	6.62	-5.08	9.83
Total PUFA	72.5	73.8	73.2	0.911	1.24	-1.29	1.78

diet. It has a number of important biological properties, both in the free and esterified form (Daley *et al.,* 2010). Oleic acid is the biosynthetic precursor of a family of fatty acids with the (n – 9) terminal structure and with chain lengths of 20 – 24 or more carbon atom (Adeyeye, 2013).

As contained in Table II, the five important long chain and very long chain fatty acid were C18: 2 cis – 9, 12; C18: 3 cis – 6, 9, 12; C18: 2 cis – 9, trans – 11, C18: 3 cis – 9, 12, 15 (all in the group of long chain fatty acids) and C20: 2 cis – 11, 14 (under very long chain fatty acids). Two essential fatty acids are C18: 2 cis - 9, 12 and C18: 3 cis – 9, 12, 15 with respective values of 18.6% to 19.1% and 20.9% to 17.1% in Basella alba and Basella rubra samples. Another important long chain fatty acid was γ – linoleic acid (GLA). It had a major level of 37.5% to 32.9% in both samples. It is found in evening primrose, borage and black currant oils. The body makes GLA out of omega 6 linoleic acid and uses it in the production of substances called prostaglandin localized tissue hormone that regulate many processes of the cellular level (Daley *et al.,* 2010).

Eicosadienoic acid (C20: 2 cis – 11, 14 or 20: 2 (n-6) all cis – 11, 14 – eicosadienoic acid) or homo – gamma – linoleic acid is an uncommon naturally occurring polyunsaturated fatty acid (PUFA). It is not enriched in any particular tissue; it is rare in all lipid classes. It formed a very low percentage in the present samples: 0.002% for Basella alba and 0.005% for Basella rubra. These values were much lower than the values reported for sorghum bicolor (Adeyeye and Adesina, 2013). Rumeric acids were generally low in the samples; however, the level was more concentrated in the Basella rubra (0.013%) than in Basella alba (0.006%). Conjugated linoleic acids (CLA) make up a group of polyunsaturated fatty acids found in meat and milk from ruminant animals and exists as a general mixture of conjugated isomers (also referred to as rumenic acid or RA) accounts for up to 80 – 90% of the total CLA in ruminant products (Nuernberg et al., 2002). Naturally occurring CLAs originate from two sources: bacterial isomerization and/or biohydrogenation of trans fatty acids in adipose tissue and many glands (Griinari *et al.,* 2000).

Table III. Summary of the quality parameters of fatty acids of *Basella alba* (BA) and *Basella rubra* (BR) Quality parameter

	BA	BR	Mean	SD	CV%	Diff (BA - BR)	% Diff
Total SFA	26.0	24.9	25.4	0.775	3.05	+1.10	4.22
MUFA cis	1.19	1.23	1.21	0.029	2.42	-0.04	3.48
MUFA trans	0.006	0.013	0.009	0.005	50.7	-0.01	112
Total MUFA	1.19	1.24	1.22	0.034	2.78	-0.05	4.01
n-3 PUFA	20.9	17.1	19.0	2.68	14.1	+3.79	18.1
n-6 PUFA	51.6	56.7	54.2	3.59	6.62	-5.08	9.83
Total PUFA	72.5	73.8	73.2	0.911	1.24	-1.29	1.78
DUFA cis	18.6	19.1	18.9	0.357	1.89	-0.50	2.71
DUFA trans	0.006	0.013	0.0	0.005	48.11	-0.01	103
Total DUFA	18.6	19.1	18.9	0.361	1.91	-0.51	2.75
TUFA cis	33.0	37.6	35.3	3.247	9.19	-4.59	13.9
TUFA trans	-	-	-	-	-	-	-
Total TUFA	33.0	37.6	35.3	3.247	9.19	-4.59	13.9
MUFA/SFA	0.046	0.050	0.0	0.003	5.83	-0.004	8.59

Table III. Summary of the quality parameters of fatty acids of *Basella alba* (BA) and *Basella rubra* (BR) Quality parameter (Continued)

	BA	BR	Mean	SD	CV%	Diff (BA - BR)	% Diff
PUFA/SFA	2.79	2.97	2.9	0.124	4.29	-0.17	6.26
n-6/n-3	2.47	3.31	2.9	0.596	20.61	-0.84	34.1
EPSI	60.8	59.5	60.1	0.924	1.54	+1.31	2.15
LA/ALA	0.890	1.12	1.0	0.161	16.00	-0.23	25.5

Table III depicts the summary of the quality parameters of fatty acids of Basella alba and Basella rubra samples. The SFA levels were 26.0% and 24.9% with a percentage difference of 4.22 in favour of Basella alba. MUFA contents were 1.19 - 1.23% with a difference of 4.01% in favour of Basella rubra. The relative values of PUFA (72.5% in Basella alba and 73.8% in Basella rubra) in the samples made them important in diet. The eicosanoids help regulate blood clot formation, blood pressure, blood lipid (including cholesterol) concentration, the immune response, the inflammatory response to injury and infection and many other body functions (Whitney et al., 1994). n - 3 and n-6 are the major component of PUFA; in the present samples, n – 6 components form the major percentage (51-6 % in Basella alba and 56.7 % in Basella Rubra). A deficiency of n-6 fatty acids in the diet leads to skin lesions. A deficiency of n – 3 fatty acids leads to subtle neurological and visual problems. Deficiency in PUFA leads to health conditions such as growth retardation, reproductive failure, skin abnormalities, kidney and liver disorders (Tapiero et al., 2002).

The relative amounts of PUFA and SFA in oils are important in nutrition and health. The ratio of PUFA/SFA in the samples were 2.79 and 2.97 for *Basella alba* and *Basella rubra* respectively. This ratio is important in the determination of detrimental effects of dietary fats. The higher the PUFA/SFA ratio the more nutritionally useful is the oil. Honatra (1974) reported that the severity of the disease condition such as atherosclerosis is closely associated with the proportion of total energy supplied by PUFA and SFA. The n– 6 and n– 3 fatty acids have critical roles in the membrane structure and as precursors of eicosanoids, which are potent and highly reactive compounds. Since they compete for same enzymes and have different biological roles, the balance between the n – 6 and n – 3 fatty acids in the diet can be of considerable importance (Kinsella, 1990; WHO/FAO, 1994). WHO/FAO (1994) stated that the ratio of n-6/n-3 or specifically LA to aLA in the diet should be between 5:1 and 10:1 or 4 – 10g of n – 6 to 1.0g of n – 3 fatty acids (Canadian Government Publishing Centre, 1990). As LA is almost always present in foods, it tends to be relatively abundant in animal tissues. The n– 6 / n – 3 and 2n – 6 / 3n – 3 (LA / aLA) in the samples (B. alba and B. rubra) were 2.47:1 and 3.31:1, and 0.890:1 and 1.12:1 respectively. These fatty acids are the biosynthetic precursors of C20 and C22 PUFAs, with 3 – 6 double bonds, through sequential desaturation and chain elongation steps (Adesina, 2012). Whilst it would be easy for the humand body to synthesize arachidonic acid (AA) C20: 4 (n – 6) from C_{18}: 2 (n–6), it may be difficult to synthesize the n–3 PUFA series especially eicosapentaenoic acid C_{20}: 5 (n – 3) or EPA because of the low level of C18 (n–3) and so the diet must be enriched in this PUFA (Adeyeye, 2013).

From Table III, a cursory look at the parameters showed that Basella alba was only better in three (or 17.6%) parameters (SFA, n – 3 PUFA, and EPSI) whereas *Basella rubra* was shown to be better in fourteen parameters (or 82.4%) compared to *Basella alba.*

The level of various phospholipids in the two samples are shown in Table IV. Phospholipids are not essential nutrients. They are just another lipid and as such contribute a kCal/g of energy (Adeyeye, 2013). The total phospholipids ranged between 1679 – 1920 (mg/100g). The results showed that *Basella rubra* sample was of higher phospholipid content than the *Basella alba* sample. These values were comparably higher than what was reported for raw, germinated, and steeped samples of guinea corn grains (Adeyeye and Adesina, 2013), African locust bean (Adeyeye, 2013), and raw and roasted *Terminalia catappa* L. (Adesina, 2013). Phosphatidylethanolamine, phosphatidylcholine, phosphatidylserine and lysophosphatidylcholine were all better concentrated in the *Basella rubra* sample than the *Basella alba* sample whereas phosphatidylinositol has reverse situation. Phosphatidylcholine is usually the most abundant phospholipid in animals and plants, often amounting to

Table IV. Phospholipids levels in *Basella alba* (BA) and *Basella rubra* (BR) samples

Phospholipids (mg/100g)	BA	BR	Mean	SD	CV%	Diff (BA - BR)	% Diff
Phosphatidylethanolamine	464	558	511	66.5	13.0	-94.0	20.3
Phosphatidylcholine	626	720	673	66.5	9.88	-94.0	15.0
Phosphatidylserine	280	336	308	39.6	12.9	-56.0	20.0
Lysophosphatidylcholine	0.724	1.91	1.32	0.839	63.7	-1.19	164
Phosphatidylinositol	309	306	308	2.12	0.69	+3.00	0.971
Total	1679	1920	1800	170	9.47	-241	14.4

almost 50% of the total, and as such it is the key building block of membrane bilayers (Adeyeye, 2013). This observation is true for Phosphatidylcholine values in the present results with percentage values of (37.3 and 37.5). Phosphatidylcholine (PC) are a class of phospholipids that incorporate choline as a head group. They are a major component of biological membranes and can be easily obtained from a variety of readily available sources such as egg yolk or soybean. Phosphatidylcholine was the highest in both samples (626 mg/100g for *Basella alba* and 720 g/100g, *Basella rubra*) followed by phosphatidylethanolamine (464 and 558 mg/100g respectively). The least concentrated phospholipid being lysophosphatidylcholine (0.724 and 1.91 mg/100g respectively).

Cephaline (phosphatidylethanolamine) is found in all living cells; although in human physiology, it is found particularly in nervous tissue such as the white matter of brain, nerves, neutral tissue and in spinal cord (Adeyeye, 2013). The US Food and Drug Administration (USFDA) have stated that consumption of PS may reduce the risk of cognitive dysfunction in the elderly (Adeyeye and Oyerekua, 2011).

The results of phytosterols in the samples are depicted in Table IV. The total phytosterol levels were 324 and 443 mg/100g with the higher value being in *Basella rubra* sample. The following phytosterols; cholesterol, cholestanol, and ergosterol had values between 408 e-5 – 3.09 e-3 mg/100g in the two samples with 196 mg/100g and 275 mg/100g of sitosterol for *Basella alba* and *Basella rubra* respectively. The result showed that all the phytosterols had higher concentration in *Basella rubra* sample compared to *Basella alba.*

Table V. Phytosterols levels in *Basella alba* (BA) and *Basella rubra* (BR)

Phytosterol (mg/100g)	BA	BR	Mean	SD	CV%	Diff (BA - BR)	% Diff
Cholesterol	6.33e-4	3.09e-3	1.86e-3	1.74e-3	93.3	-0.0025	388
Cholestanol	4.08e-5	4.10e-4	2.25e-4	2.61e-4	116	-0.0004	905
Ergosterol	1.91e-3	2.70e-3	2.31e-3	5.59e-4	24.2	-0.0008	41.4
Campesterol	67.7	103	85.4	25.0	29.2	-35.3	52.1
Stigmasterol	8.23	11.4	9.8	2.24	22.8	-3.17	38.5
5- Avenasterol	52.6	53.5	53.1	0.636	1.20	-0.90	1.71
Sitosterol	196	275	236	55.9	23.7	-79.0	40.3
Total	324	443	384	84.1	21.9	-119	36.7

Statistical analysis

Statistically, in Table VI, the linear correlation at $\alpha_{= 0.05}$, df: n-1 showed that significant difference existed between the fatty acids, phospholipids and sterols except in the fatty acids parameters. The IFE (%) values were high in all the results (91.1 – 96.2) compared and as such accompanied by low values of coefficient of alienation (C_A) at 3.80 – 8.90 %. The high values of IFE in fatty acids, quality parameters, sterols and phospholipids make the comparison of the two samples easy because the higher the IFE % values the lower is the error of prediction.

275mg/100g) than the recommended daily intake of 300 mg per day. On the whole, the samples would serve as good plant products in dietary fat sources although *Basella rubra* species appears better in all the nutritional parameters considered, rather than *Basella alba* species.

Table VI. Statistical analysis (linear correlation and regression) of the results from Tables I, II, III, IV and V

Results	r_{xy}	r_{xy}^2	R_{xy}	X_m	Y_m	C_A (%)	IFE(%)	TV	Remark
RT 1	1.000	1.000	1.000	46	42.8	na	na	na	na
RT 2	0.996422	0.992857	0.992641	7.80	7.86	8.45	91.5	0.3620	S
RT 3	0.996061	0.992138	0.991614	20.2	20.9	8.90	91.1	0.5179	S
RT 4	0.999282	0.998564	0.998205	336	384	3.80	96.2	0.9000	S
RT 5	0.998710	0.997422	0.996992	46.4	63.3	5.10	94.9	0.8236	S

RT 1= results from Table I, RT 2= results from Table II, RT 3= results from Table III, RT 4= results from Table IV, RT 5 = results from Table V, X_m = mean of the X variables, Y_m = mean of the Y variables, C_A = coefficient of alienation, IFE = index of forecasting efficiency, S= significant, na = not applicable TV= table value (standard value) at $\alpha =_{0.05} df_{=n-1}$

Conclusion

The findings of this study showed that the crude fat levels were of slight unequal distribution with values of 4.49 and 4.10% in *Basella alba* and *rubra* respectively . The SFA was lower (26.0 % and 24.9 %) than the total unsaturated fatty acids in both of the two vegetable samples (72.5% and 73.8 %); thereby making the fats good for human health. The proportion of cholesterol neutral stearic FA (C18:0) was 4.31% (Basella alba) and 3.73 % (Basella rubra). The cholesterol-elevating SFAs such as myristic (C14:0) and palmitic (C16:0) were 1.64 % and 20.0 % *(Basella alba)*; and 1.89 % and 19.2% *(Basella rubra)*. The phospholipids were high (1679 mg/100g and 1920 mg/100g) and good for the health of consumers. The sitosterol was the only sterol of significance and was fairly lower (196 mg/100g and

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