



Fatty acid and amino acid compositions of *Artocarpus heterophyllus* (Jackfruit) seed

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ABSTRACT

This study investigated the fatty acid and amino acid compositions of one of the under-exploited tropical African seeds- *Artocarpus heterophyllus* (Jackfruit) seed. The seed oil was found to be composed of five fatty acids-palmitic (14.66%), palmitoleic (6.60%), stearic (50.59%), oleic (7.68%), linoleic (20.40%). The oil was composed of more of saturated fatty acids with a total value of 65.25%. The seed oil was composed more of short chain fatty acids and less of unsaturated fatty acids and expressed in the saponification number (132.81) and iodine value (42.5). The result showed a reasonable value of linoleic acid (20.40%) and deficiency in linolenic acid. Seventeen amino acids, excluding tryptophan, were determined in *Artocarpus heterophyllus* seed protein and with aspartic (7.23 g/100g protein) and glutamic (8.64g/100g protein) acids as the predominant amino acids and methionine (0.81g/100g protein) as the most deficient amino acid. The total essential amino acid composition of *Artocarpus heterophyllus* seed (25.64g/100g protein) represents 45.73% of the total amino acid composition of the seed protein. The values of the essential amino acids were found to be lower than their respective FAO/WHO/UNU(1991) reference standard values. However, the total essential amino acid composition of *Artocarpus heterophyllus* seed, just like other common members of the family, for example *Treculia africana*, was very low.

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Introduction

Jackfruit (*Artocarpus heterophyllus*) is a member of the genus *Artocarpus* (in the Mulberry family, Moraceae) and contains about 50 species of the trees. Other members of the family are *Artocarpus altilis*, *Artocarpus mariannensis*, *Artocarpus camansis*, *Artocarpus integer*, *Artocarpus lakoocha*, *Artocarpus odoratissima* and *Artocarpus lingnanensis* [1]. It is native to parts of South and Southeast Asia, and is believed to have originated in the southwestern rain forests of India [2] but today it is distributed far more widely. It has been cultivated since prehistoric times and has naturalized in many parts of the tropics, especially in Southeast Asia. It is also grown in parts of Africa, Brazil, Surinam, the Caribbean, Florida and Australia. It has been introduced to many Pacific islands [1]. The jackfruit, the largest of all cultivated fruits, is oblong to cylindrical in shape and typically 30 to 40 cm in length, although it can sometimes reach 90 cm. Jackfruit usually weighs 4.5 to 30kg (commonly 9 to 18 kg), with a maximum reported weight of 50 kg. The fruit is eaten fresh, cooked as a starchy vegetable or preserved (e.g., salted like a pickle). The seeds from ripe fruits are edible. They are used as snacks/ desserts either boiled, baked or roasted. When roasted, the flavor of the seeds is comparable to chestnuts. The nutritious seeds are also milled and added to flour for baking or as ingredient to cooked dishes [3,1].

Artocarpus heterophyllus (Jackfruit) is the most unpopular and under-utilized member of the moraceae family while African breadfruit (*Treculia africana*) is the most popular, exploited and utilized member of the family. Yet, *Artocarpus heterophyllus* (Jackfruit) and several other tropical seeds form a major part of the diet of many Nigerians. *Artocarpus heterophyllus* seed had earlier been reported as a good source of

the mineral elements, carbohydrate, fiber, ash, riboflavin, thiamin and niacin but poorer source of protein, fat, vitamins A and C when compared to the most common members of the *Moraceae* family such as *Artocarpus camansi* and *Treculia Africana* [4]. The report also revealed appreciable values of alkaloid (0.61%), Saponin (3.44%), flavonoid (0.70%) but low values of tannin (0.02 mg/100g), cyanogenic glycoside as HCN (0.04mg/kg), phytate (0.41%) and trace amount of trypsin inhibitor in the *Artocarpus heterophyllus* seed sample used for the study [4]. Therefore, this research is focused on the fatty acid and amino acid compositions of *Artocarpus heterophyllus* (Jackfruit) seed. The result obtained from this study will further arouse the interest of humans on the exploitation and utilization of *Artocarpus heterophyllus* (Jackfruit) seed.

Sample collection

The seeds of *Artocarpus heterophyllus* were obtained from four different trees in four different local communities namely: Ikwuano, Umuahia North, Umuahia South and Isuikwuato Local Government Areas of Abia State. Four different mature and ripe fruit bunches from a particular tree were sampled for the seeds. The seeds were then mixed together to obtain a representative sample of the seeds.

Sample treatment

The seeds were separately cracked to remove the seed coat. The seeds were separately air-dried for one month and hammer-milled to reduce them to smaller sizes. They were subsequently milled in a laboratory mill to obtain the powdery samples of the seeds used for the study.

Determination of fatty acid profile

Five grams (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. The extraction lasted for 4 hours. The extracted oil was subsequently methylated to obtain the methyl esters of the fatty acids [5]. 0.5 μ l of the methylated oil 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) and Iodine value (I.V) were determined.⁷

Determination of amino acid profile

The amino acid profile of the sample was determined[8]. Technicon Sequential Multi-sample Amino Acid Analyzer (TSM).

Results and discussion

Result of the Fatty Acid Composition of the *Artocarpus heterophyllus* Seed Oil is presented in table 1. The result shows the presence of five fatty acids-palmitic (14.66%), palmitoleic (6.60%),stearic (50.59), oleic (7.68%) and linoleic (20.40%). Higher values of palmitic acid (19.10%), oleic acid (24.50%), linoleic acid (30.50%) and linolenic acid (2.40%) as well as a lower value of stearic acid (17.80%) had been reported for *Treulia africana* seed oil [9]. *Artocarpus heterophyllus* is composed of more of the saturated fatty acids with a total value of 65.25%. Lower values of total saturated fatty acids (39.25%) and higher values of total unsaturated fatty acids (60.37%) had been reported for *Treulia africana* seed oil [9]. The oil is however, deficient in linolenic acid. The values imply that *Artocarpus heterophyllus* is a poor source of essential fatty acids when compared to reported values for *Treulia africana* seed oil [9]. The predominant fatty acid in *Artocarpus heterophyllus* seed oil is stearic acid with a value of 50.59%.This value is high. Stearic acid (18:0) is a saturated fatty acid. However, several studies have shown that the stearic acid effect on total cholesterol is minimal and not detrimental to human health [10-13]. It has also been reported that stearic acid is less likely to be incorporated into cholesterol esters [14]. These findings may indicate that stearic acid is less unhealthy than other saturated fatty acids.

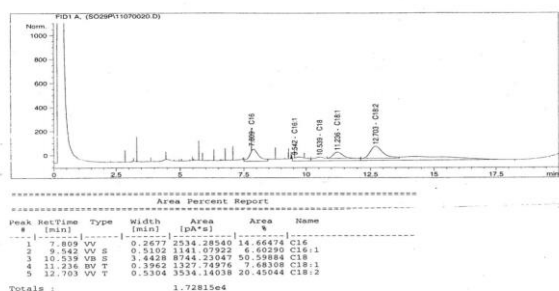


Figure 1: Chromatogram Of The Fatty Acid Separation of *Artocarpus heterophyllus* Seed Oil Using C:\HP\CHEM\1\METHODS\SO29P.M

Palmitoleic acid (C16:1 cis) is a mono-unsaturated fatty acid. It is beneficial in reducing bad cholesterol (LDL) and behaves like a saturated and not as an unsaturated fatty acid in its effect on LDL cholesterol [15].It also reduces the fat deposition in blood vessels and reduces blood clot formation [16]. Palmitoleic acid is a key enzyme that controls fat oxidation, at extraordinarily high rates [17] and has therefore, been suggested as a molecule that can help to fight weight gain.

Artocarpus heterophyllus seed oil has reasonable composition of linoleic acid (20.45%). However, it is a poorer source of linoleic acid and linolenic acid (Nil) when compared to *Treulia africana* seed oil with a reported linoleic value of

30.50% and linolenic value of 2.40% [9]. Therefore, in terms of the fatty acid composition, the consumption of *Artocarpus heterophyllus* seed oil will have no adverse health implications. However, it is nutritionally poorer than *Treulia africana* seed oil.

The saponification number (132.81) and iodine value (42.5) of *Artocarpus heterophyllus* seed oil are in agreement with the fatty acid composition and indicate that *Artocarpus heterophyllus* seed oil is composed more of saturated fatty acids and less of unsaturated fatty acids.

Amino Acid Composition

The amino acid composition of the seed sample of *Artocarpus heterophyllus* used for the study is presented in Table 2. The result shows a total of seventeen amino acids (excluding tryptophan) and with aspartic and glutamic acids as the predominant amino acids in the sample. *Artocarpus heterophyllus*, when compared to other members in the *moraceae* family has higher values of aspartic acid (7.23g/100g), proline (2.12g/100g), glycine (4.23g/100g), alanine (3.01g/100g)and cystine (1.06g/100g) than the reported values for *Artocarpus camansis* [18] and *Treulia africana* (African breadfruit) [19]. The Serine value of 2.05g/100g is comparable to the reported values for the considered members of the family. *Artocarpus heterophyllus* has lower values of tyrosine (2.09g/100g) and glutamic acid (8.6g/100g) than the reported value for *Treulia Africana* [19]. *Artocarpus Camansis* (Breadnut) has the lowest reported values of 1.45g/100g for tyrosine and 0.98g/100g for glutamic acid [18].

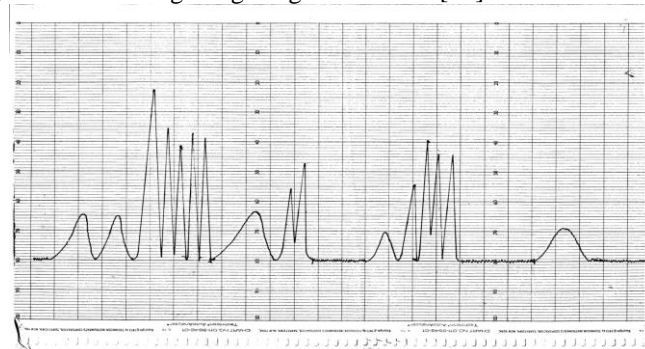


Figure 2: Chromatogram Of Standard Amino Acid Mixture Using Technicon Sequential Multi-Sample (TSM) Amino Acid Analyzer

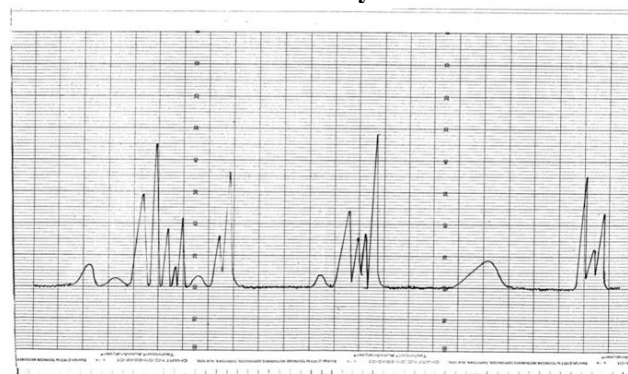


Figure 3: Chromatogram Of Amino Acid Composition Of *Artocarpus heterophyllus* Using Technicon Sequential Multi-Sample (TSM) Amino Acid Analyzer

The total amino acid composition of *Artocarpus heterophyllus* seed protein (56.07g/100g protein) is comparable to the reported value of 56.3g/100g protein for *Treulia africana* (African breadfruit) [19]. *Artocarpus camansis* (Breadnut) has the least reported value of 19.91g/100g protein [18].

Table 1: Fatty Acid Composition of *Artocarpus heterophyllus* Seed Oil Sample

Fatty Acids (%)	Carbon chain	<i>Artocarpus heterophyllus</i>
Lauric	C -12	-
Myristic	C -14	-
Palmitic	C -16:0	14.66
Palmitoleic	C -16:1	6.60
Unknown	-	-
Stearic	C-18:0	50.59
Oleic	C-18:1	7.68
Linoleic	C-18:2	20.45
Linolenic	C-18:3	-
Total		99.98
Total Saturated		65.25
Total Unsaturated		34.73
S.N		132.81
I.V		42.5

Table 2: Amino Acid Composition of *Artocarpus heterophyllus* (g/100g) seed protein

Amino Acids	Composition
Lysine	3.06
Histidine	1.88
Arginine	3.57
Aspartic acid	7.23
Threonine	2.26
Serine	2.05
Glutamic acid	8.64
Proline	2.12
Glycine	4.23
Alanine	3.01
Cystine	1.06
Valine	3.02
Methionine	0.81
Isoleucine	2.78
Leucine	5.39
Tyrosine	2.09
Phenylalanine	2.87
Tryptophan	ND
Total	56.07

Table 3: Essential amino acid composition of *Artocarpus heterophyllus* seed protein compared to reported values for *Artocarpus camansis* and *Treculia Africana* seed proteins (g/100g)

Essential Amino Acids	<i>Artocarpus heterophyllus</i>	<i>Artocarpus camansis</i>	<i>Treculia Africana</i>
Lysine	3.06	ND	2.64
Methionine	0.81	3.17	1.40
Threonine	2.26	0.78	3.10
Tryptophan	ND	ND	ND
Valine	3.02	ND	2.60
Leucine	5.39	2.60	5.25
Isoleucine	2.78	2.41	4.10
Phenylalanine	2.87	1.05	3.02
Arginine	3.57	0.66	3.85
Histidine	1.88	0.91	2.10
Total	25.64	11.58	28.06%
Total of A.As	45.73%	58.16%	49.84%

Table 4: Essential amino acid values of *Artocarpus heterophyllus*, *Artocarpus camansis* and *Treculia africana* seed proteins compared to FAO/WHO/UNU(1991) Reference Standards (%)

Essential A. Acids	<i>Artocarpus heterophyllus</i>	<i>Artocarpus camansis</i>	<i>Treculia africana</i>	FAO/WHO/UNU (1991) Ref. Stds.
Lysine	3.06	ND	2.64	5.8
Methionine + cystine	1.87	3.79	2.60	2.5
Threonine	2.26	0.78	3.10	3.4
Tryptophan	ND	ND	ND	1.0
Valine	3.02	ND	2.60	3.5
Leucine	5.39	2.60	5.25	6.6
Isoleucine	2.78	2.41	4.10	2.8
Phenylalanine+Tyrosin	4.96	2.50	5.67	6.3
Arginine	3.57	0.66	3.85	-
Histidine	1.88	0.91	2.10	-

Methionine is the most deficient amino acid in *Artocarpus heterophyllus* with a value of 0.81g/100g protein while cystine has been reported as the most deficient in *Artocarpus camansis* (0.62g/100g) [18] and *Treculia africana* (1.20g/100g) [19].

A comparison of the essential amino acid composition of *Artocarpus heterophyllus* and the reported values for *Artocarpus camansis* and *Treculia africana* (g/100g) seed proteins is presented in Table 3. The total essential amino acid composition of *Artocarpus heterophyllus* (25.64g/100g protein) as well as the reported values for *Artocarpus camansis* (Breadnut) (11.58g/100g protein) [18] and *Treculia africana* (African breadfruit) (28.06g/100g protein) [19] represent 45.73% of essential amino acids for *Artocarpus heterophyllus*, 58.16% for *Artocarpus camansis* and 49.84% for *Treculia africana*. These values may be considered reasonable based on the reported total protein content of the seeds.

Methionine (0.81mg/100g) is the most deficient amino acid in *Artocarpus heterophyllus* and with leucine (5.39g/100g) as the predominant essential amino acid. Methionine has also been reported as the most deficient amino acid in *Treculia africana* (1.40g/100g) [19] and with leucine as the predominant essential amino acid with a value of 5.25g/100g [19]. *Artocarpus camansis* has a reported methionine value of 3.17g/100g as the most predominant essential amino acid and threonine (0.78g/100g), arginine (0.66g/100g) as the most deficient essential amino acids [18]. These amino acids play different important roles in human nutrition and health.

The *Artocarpus heterophyllus* (Jackfruit) seed protein has higher values of lysine (3.06 g/100g), valine (3.02g/100g), leucine (5.39 g/100g) but lower values of methionine (0.81g/100g) threonine (2.26g/100g) phenylalanine (2.87 g/100g) arginine (3.57g/100g) histidine (1.88 g/100g) than the reported values for *Treculia africana* seed protein [19]. *Artocarpus camansis* has the highest reported value of methionine (3.17g/100g) but poorest values of the other essential amino acids than the other seeds.

The protein quality of a food material is assessed by comparing its essential amino acid values to FAO reference standard values for the respective amino acids. A comparison of the essential amino acid composition of *Artocarpus heterophyllus* and the reported values for *Artocarpus camansis* and *Treculia africana* seed proteins with the reference standard [20] values for the respective amino acids is presented in Table 4. The essential amino acids of *Artocarpus heterophyllus* (Jackfruit), *Artocarpus camansis* (breadnut) and *Treculia africana* (African Breadfruit) have lower values than their respective reference standard [20] values except the reported methionine + cystine values of 3.79% for *Artocarpus camansis* [18] and 2.60% for

Treculia Africana as well as the isoleucine value of 4.10% for *Treculia africana* [19] which are higher than the reference standard [20] values. However, the isoleucine value of 2.78% for *Artocarpus heterophyllus* measured up to the reference standard [20] value.

It can therefore, be inferred that *Artocarpus heterophyllus* seed as well as *Artocarpus camansis* (breadnut) and *Treculia africana* (African Breadfruit) are poor sources of essential amino acids.

Conclusion

This study has revealed that *Artocarpus heterophyllus* seed is a poor source of the essential fatty and amino acids. The seed oil lacks linolenic acid while the amino acids (except isoleucine) have lower values than their respective FAO/WHO/UNU (1991) reference standard values. It appears that members of the *Moraceae* family generally, are not very good sources of essential amino acids. Although that this study has revealed that *A. heterophyllus* is not rich in essential fatty acids and amino acids but it had earlier been studied and reported as a very good source of other nutrients such as the mineral elements, carbohydrate, fibre, ash, riboflavin, thiamin and niacin when compared to the most popular members of the *Moraceae* family such as *Treculia africana*. Therefore, *Artocarpus heterophyllus* seed, just like the most popular member of the family (*Treculia africana*), can serve as a source of nutrients necessary for good health.

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