

Fatty Acid and Amino Acid Profiles of an Under-Utilized Tropical African Seed: *Adenanthera pavonina*.

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ABSTRACT

The fatty acid and amino acid compositions of *Adenanthera pavonina*, an under-utilized tropical African seed have been determined in this paper. The seed sample is composed of 66.67% of unsaturated and 31.98% of saturated fatty acids. It has linoleic acid (44.01%) as the predominant unsaturated fatty acid and stearic acid (17%) as the predominant saturated fatty acid. The essential fatty acids; linoleic acid (44.01%) and linolenic acid (3.42%) make up 47.45% of the total fatty acids.

The total amino acid composition of the seed sample reveals a total of 17 amino acids (excluding tryptophan) with glutamic acid (12.81g/100g protein) and aspartic acid (10.10g/100g protein) as the predominant amino acids and methionine (1.15g/100g protein) as the most deficient amino acid. The amino acids have a total value of 79.64g/100g protein. The essential amino acids make up 41.84g/100g of the total amino acids (excluding tryptophan). This value represents 52.54% of the total amino acid composition of the seed sample. The essential amino acids; lysine (7.14%), leucine (7.30%), valine (4.24%), and isoleucine (3.47%) score higher than their respective FAO/WHO/UNU (1991) reference standards. The values for methionine + cystine (2.47%) and phenylalanine+tyrosine (6.85%) are comparable to their respective reference values. Thus, *Adenanthera pavonina* seed, just like the most popular legume seeds, can serve as a good source of essential fatty acids and amino acids to consumers

(Keywords: *Adenanthera pavonina*, seed, fatty acid, amino acid, composition)

INTRODUCTION

Legumes belong to the family *Leguminosae* [1, 2]. They have contributed significantly as food for human consumption. They are good sources of protein and energy and have been utilized both as grains and pulses in Nigeria. The grains are usually used for food following either minimal processing (such as cooking) or extensive processing such as dehulling, grinding, steaming or frying).

The most widely used legumes in Nigeria are cowpea (*Vigna unguiculata*), groundnut (*Arachis hypogaea* L.) and soybean (*Glycine max*). They have gained wide acceptability as good sources of essential nutrients necessary for health.

The utilization of other legumes for human consumption is still limited in Nigeria. They are not widely cultivated hence, they are not very common and are therefore, relatively unknown. *Adenanthera pavonina* is a relatively unknown leguminous plant and hence, one of the most under – exploited and under-utilized member of the *leguminoceae* family.

Adenanthera pavonina L. (Family: *Mimosaceae*), known as red sandal wood or red bead tree is a medium to large sized deciduous tree [3]. Its height ranges from 6 – 24m with a diameter of 45 – 240cm depending on location. It is endemic to South East China and India with first report in India [4]. It has been introduced throughout the humid tropics and has become naturalized in Malaysia, Western and Eastern Africa and most of the Pacific and the Caribbean Islands [4].

Historically, the seeds were used as weight measures for jewelry and goldsmith due to their small variation in weight [5,6]. The bright red seeds are also used for making necklace and decorative ornaments [4].The seeds are known

as “food trees” in Melanesia and Polynesia. The seeds of this tree are roasted over fire and eaten by children and adults alike.

Cowpea, groundnut, and soybean cannot be the only good leguminous plant sources of essential nutrients. Therefore, there is the need to explore and exploit other leguminous plant species as additional (or alternative) sources of essential nutrients. The proximate, mineral, vitamin and phytochemical compositions of *Adenanthera pavonina* seed had earlier been reported [7]. The report revealed that the seed has very good values of ash (6.70%), crude protein (26.16%), crude fat (13.70%) but low values of crude fibre (1.90%) and carbohydrate (51.48%). The compositions of the minerals; Ca (1.80%), Mg (0.65%), Na (0.58%), P (0.84%) Fe (45.50mg/kg), Mn (32.40mg/kg), Zn (139.60mg/kg) are quite good and higher than reported values for the most common legumes.

The Na/K ratio (0.537), as well as the Ca/P ratio (2.14), indicates that the seed sample has good health implications. The seed is a good source of vitamin A (3.28mg/kg), vitamin E (16.40mg/100g), riboflavin (0.50mg/kg), thiamine (0.80mg/kg) and niacin (8.40mg/kg) but very poor source of vitamin C (18.60mg/100g). The values of the anti-nutritional principles; tannins (0.02mg/100g), cyanogenic glycoside, as HCN, (0.07mg/kg), phytate (0.14%) and trace amount of trypsin inhibitor have no toxic significance in human nutrition. This research work is therefore, aimed at determining the fatty acid profile of the seed oil and amino acid profile of the seed flour.

MATERIALS AND METHODS

The *Adenanthera pavonina* tree is not common. It is only found, within the capital city and the environs of Umuahia Campus of Abia State University, in the Umuahia North Local Government Area of Abia State. The seeds were obtained from twenty different mature and dry fruit pods. The seeds from the different pods 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 sample of the seeds used for the study.

Determination of Fatty Acid Profile

Five (5) g 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 according to the method of A.O.A.C (2006) [8].

One half (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 (Standard Analytical Methods, 1999) [9].

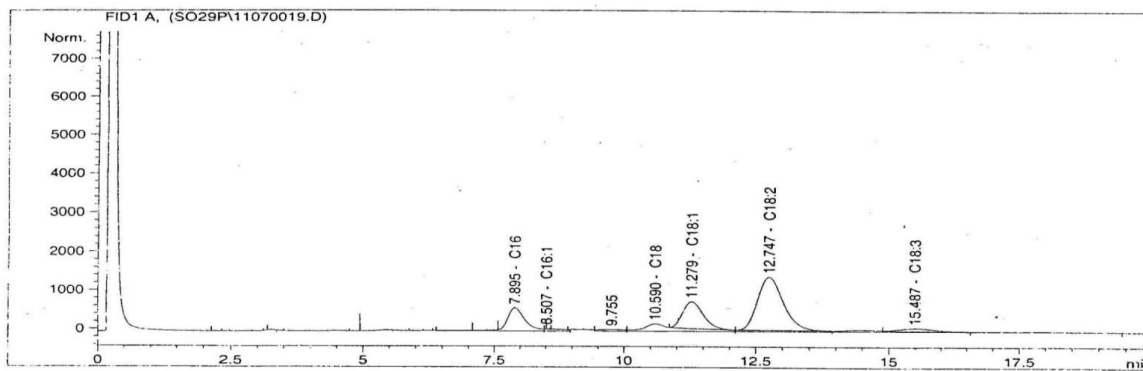
The saponification number (S.N) and Iodine value (I.V) were determined according to the various methods described by James (1995) [10].

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 analyzer as described by Spackman *et al.*, (1958) [11].

RESULTS AND DISCUSSION

The chromatogram of the separated fatty acid methyl esters of *Adenanthera pavonina* seed oil is presented in Figure 1 while the fatty acid composition of *Adenanthera pavonina* seed oil is presented in Table 1. The result of the fatty acid composition of *Adenanthera pavonina* seed oil sample (Table 1) shows that *Adenanthera pavonina* has a total saturated fatty acid composition of 31.98%. This value is comparable to the reported value of 33.3% for cowpea [12]. The reported values of 15.2% for soybean [13] and 12.3% for groundnut [14] are lower. These values indicate that *Adenanthera pavonina*, just like the most common legumes, is composed more of unsaturated fatty acids.



Area Percent Report

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Area %	Name
1	7.895	VV	0.3664	1.46351e4	13.98945	C16
2	8.507	VV	0.2116	1276.06592	1.21977	C16:1
3	9.755	VV S	0.4591	1404.88293	1.34291	?
4	10.590	VB S	1.2237	1.88263e4	17.99584	C18
5	11.279	BV X	0.4204	1.88336e4	18.00280	C18:1
6	12.747	VV X	0.5136	4.60632e4	44.03119	C18:2
7	15.487	VB X	0.6844	3575.78369	3.41804	C18:3
Totals :				1.04615e5		

Figure 1: Chromatogram of the Fatty Acid Separation of *Adenanthera pavonina* Seed Oil using Hewlett Packard 6890 Gas Chromatograph, C:\HP CHEM\1\METHODS\SO29P.M

Table 1: Fatty Acid Composition of *Adenanthera pavonina* Seed Oil Sample.

Fatty Acids (%)	Carbon chain	<i>Adenanthera pavonina</i>
Lauric	C -12	-
Myristic	C -14	-
Palmitic	C -16.0	13.99
Palmitoleic	C -16:1	1.22
Unknown		1.34
Stearic	C-18:0	17.99
Oleic	C-18:1	18.00
Linoleic	C-18:2	44.03
Linolenic	C-18:3	3.42
Total		99.99
Total Saturated		31.98
Total Unsaturated		66.67
S.N		105.20
I.V		58.40

However, *Adenanthera pavonina* seed oil with 66.67% of total unsaturated fatty acid is less unsaturated than soybean oil with a reported value of 84.5% [13] and groundnut oil with a reported value of 81.5% [14]

These findings imply that *Adenanthera pavonina* seed oil is as good as soybean and cowpea seed oils in the supply of essential fatty acids. Linoleic acid and Linolenic acid are members of the groups of essential polyunsaturated fatty acids called Omega-6-fatty acids and Omega-3-fatty acids respectively. These groups of fatty acids play very important roles in human nutrition. These two fatty acids work together in a competitive balance to regulate blood clotting, immune response and inflammatory processes. Deficiency of linoleic acid leads to dry hair, hair loss [15] and poor wound healing [16]. It also leads to poor growth, fatty liver, skin lesions and reproductive failure [17]. It has been reported that linolenic acid plays a role in lowering the risk of cardiovascular disease [18]. It has also been found that the intake of linolenic acid in the diet protects against fatal ischemic heart disease [19].

In summary, dietary linolenic acid is especially important in the development of the brain and the retina and has antiarrhythmic actions to prevent cardiac arrest in patients with ischemic heart disease.

Stearic acid (17.99%) is the predominant saturated fatty acid in *Adenanthera pavonina*

seed oil. Stearic acid (18:0) is a saturated fatty acid. Several studies have shown that the stearic acid effect on total cholesterol is minimal and not detrimental to human health [20-23]. For practical purposes, stearic acid is essentially neutral in its effects on serum total cholesterol, similar to oleic acid [24]. It has been reported that the fraction of dietary stearic acid oxidatively desaturated to oleic acid is 2.4 times higher than the fraction of palmitic acid analogously converted to palmitoleic acid. It has also been reported that stearic acid is less likely to be incorporated into cholesterol esters [25]. These findings indicate that stearic acid is less unhealthy than other saturated fatty acids.

The saponification number (105.20) and iodine value (58.40) of the seed oil imply that the oil is fairly saturated/unsaturated.

Amino Acids

The Chromatograms of standard amino acid mixture and the amino acid composition of *Adenanthera pavonina* seed sample are presented in Figures 2 and 3 while the amino acid composition of the seed sample of *Adenanthera pavonina* is presented in Table 2. A total of seventeen amino acids, excluding tryptophan, were determined in the sample. Aspartic (10.1g/100g) and glutamic (12.81g/100g) acids are the predominant amino acids in the sample.

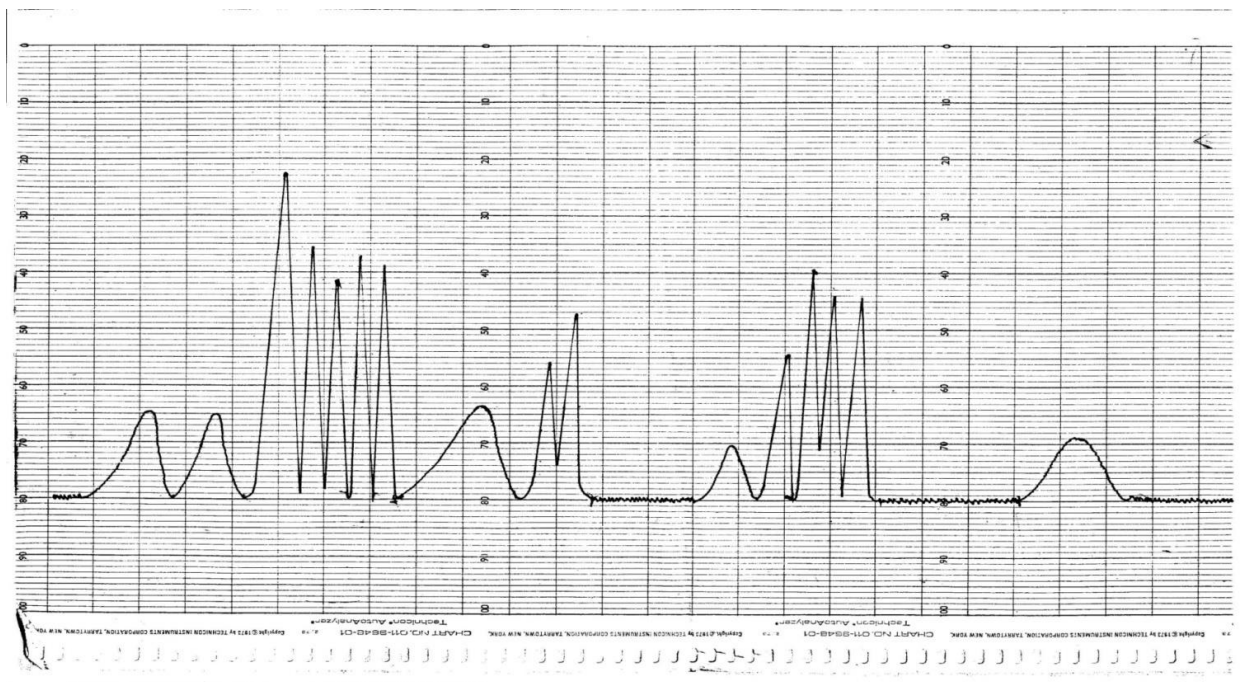


Figure 2: Chromatogram of Standard Amino Acid Mixture Using Technicon Sequential Multi-Sample (TSM) Amino Acid Analyzer.

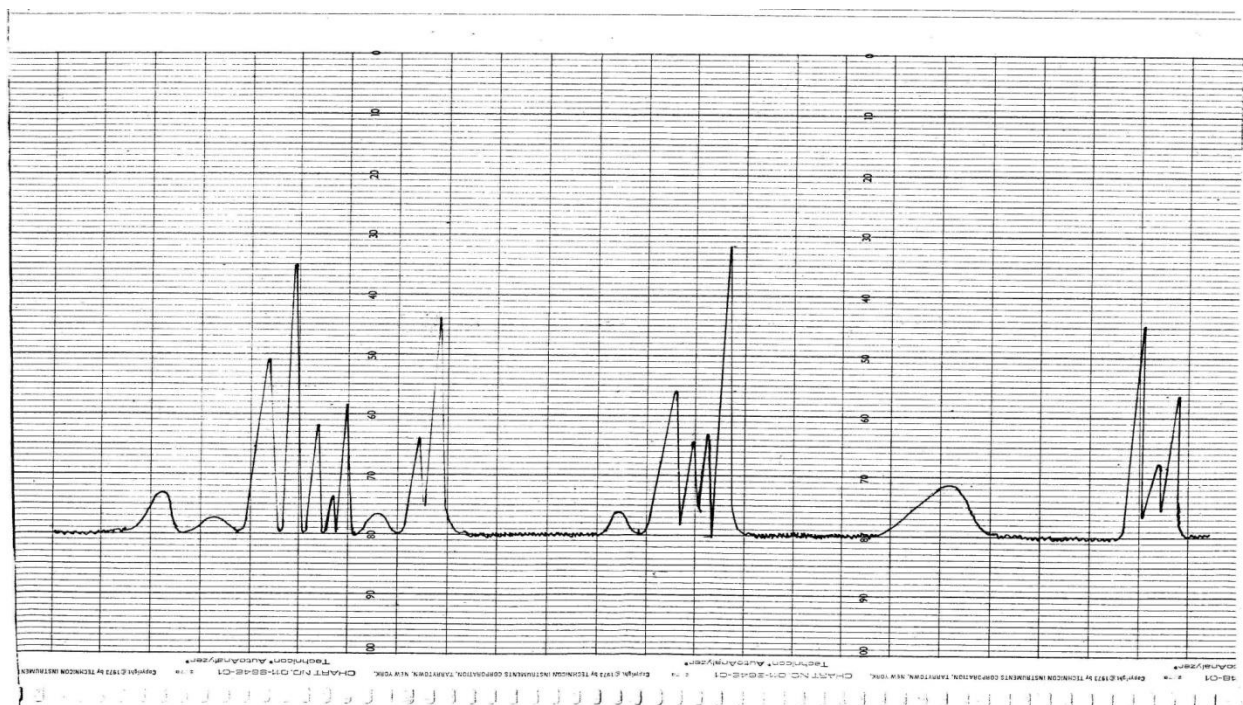


Figure 3: Chromatogram of Amino Acid Composition of *Adenanthera pavonina* using Technicon Sequential Multi-Sample (TSM) Amino Acid Analyzer.

Table 2: Amino Acid Composition of *Adenanthera Pavonina* (g/100g Protein).

Amino Acids	Composition
Lysine	7.14
Histidine	2.44
Arginine	4.77
Aspartic acid	10.10
Threonine	3.16
Serine	3.80
Glutamic acid	12.81
Proline	3.08
Glycine	3.84
Alanine	4.17
Cystine	1.32
Valine	4.24
Methionine	1.15
Isoleucine	3.47
Leucine	7.30
Tyrosine	3.22
Phenylalanine	3.63
Tryptophan	ND
Total	79.64

ND:-Not Determined

The seed sample of *Adenanthera pavonina* used for the study has a total amino acid content of 79.64g/100g protein.

In comparison with the other legumes such as soybean, cowpea, and groundnut, *Adenanthera pavonina* has comparable total amino acid composition (79.64g/100g protein) with soybean with a reported value of 80.9g/100g protein [26]. Groundnut has a higher reported value (92.4g/100g) [27] while cowpea has a lower reported value (64g/100g) [28]. The predominant amino acids in the legume seeds are glutamic and aspartic acids but the most deficient is methionine except in cowpea which has a reported cystine value of 0.4g/100g protein [28] as the most deficient amino acid.

The protein quality of a food material is assessed by its content of the essential amino acids. The essential amino acids composition of the seed sample of *Adenanthera pavonina* is presented in Table 3.

Table 3: Essential Amino Acid Composition of *Adenanthera pavonina* (g/100g) Protein.

Amino Acid	<i>A. pavonina</i>
Lysine	7.14
Methionine + cystine	2.47
Threonine	3.16
Tryptophan	ND
Valine	4.24
Leucine	7.30
Isoleucine	3.47
Phenylalanine + Tyrosine	6.85
Arginine	4.77
Histidine	2.44
Total	41.84
% Total of A.As	52.54

The total essential amino acid composition of *Adenanthera pavonina* (excluding tryptophan) is 41.84g/100g protein. A higher value of 44.30g/100g protein had earlier been reported for soybean [26] while a lower value of 28.10g/100g protein had earlier been reported for cowpea [28]. These values represent 52.54% of essential amino acid for *Adenanthera pavonina*, 54.76% for soybean [26] and 43.91% for cowpea [28]. These values show that the essential amino acid composition of *Adenanthera pavonina* is reasonable when compared to the most popular legume seeds.

Adenanthera pavonina appears to be poorer in the essential amino acids than soybean except in lysine (7.14g/100g) and methionine (1.15g/100g) where soybean has lower reported values [26] than *adenanthera pavonina*. *Adenanthera pavonina* has higher values of the essential amino acids when compared to reported values for cowpea [28].

Adenanthera pavonina is a better source of lysine, threonine, leucine and histidine but a poorer source of methionine, valine, isoleucine, phenylalanine and arginine when compared to reported values for groundnut [27]. The seed of *Adenanthera pavonina* is as rich in protein and the essential amino acids, as well, deficient in methionine as the other common and most popular leguminous seeds.

The branched chain amino acids; valine, leucine and isoleucine make up 15.01g/100g of *Adenanthera pavonina* seed protein. These three essential amino acids make up about one third of the skeletal muscles in human body. Branched

chain amino acids are basically required for protein synthesis, and repair and maintenance of the muscle tissues. Apart from this, each of the branched chain amino acids is concerned with some specific functions. For example, leucine plays a crucial part in insulin secretion, healing of skin, muscle tissues and bones, while isoleucine is known to regulate the level of blood sugar, and is required for hemoglobin production. Valine on the other hand, facilitates muscle metabolism and repair of tissues. It also helps to maintain the balance of nitrogen in the body. In general, branched amino acids are believed to increase endurance and enhance energy, for which their supplementations are so widely used by the athletes to increase exercise performance (<http://www.buzzle.com/articles/branched-chain-amino-acids.html>).

The sulphur-containing amino acids; methionine and cysteine make up 2.47g/100g protein of *Adenanthera pavonina* seed. Methionine assists in the breakdown of fats and thus prevents the build-up of fat in the arteries. It also assists with the digestive system and removes heavy metals from the body since this sulphur containing amino acid can be converted to Cysteine which is very important nutrient in detoxifying the liver.

Methionine is also a great antioxidant because the sulphur it supplies to the body inactivates free radicals. It is also one of the three amino acids that are needed by the body to manufacture a compound called monohydrate, which is very essential for energy production and muscle building. (http://www.ourgoodhealth.org/aminoacids/Sulphur_Containing_Amino_Acids.html)

The nutritive value of plant's protein quality is usually assessed by comparing its essential amino acid content with reference standard ideal protein set by the World Health Organization [29], which is based on the amino acid need for the children aged 2- 5 years. The essential amino acid score of *Adenanthera pavonina* in comparison with the World Health Organization [29] reference standard is presented in Table 4.

Table 4: Essential Amino Acid of *Adenanthera pavonina* In Comparison With FAO/WHO/UNU Reference Value (%).

Essential Amino Acid	<i>A. pavonina</i>	FAO/WHO/UNU (1991) Ref. Value
Lysine	7.14	5.8
Methionine + Cystine	2.47	2.5
Threonine	3.16	3.4
Tryptophan	ND	1.0
Valine	4.24	3.5
Leucine	7.30	6.6
Isoleucine	3.47	2.8
Phenylalanine + Tyrosine	6.85	6.3
Arginine	4.77	-
Histidine	2.44	-

From the table, lysine (7.14%), leucine (7.30%), valine (4.24%), and isoleucine (3.47%) score higher than their respective reference standards. The values for methionine + cystine (2.47%) and phenylalanine + tyrosine (6.85%) are comparable to their respective reference values. However, the methionine + cystine, and isoleucine contents of *Adenanthera pavonina* are below the recommended amino acids requirements (4.6g/100g protein) for infants, but adequate for both pre-school children between the age of 2 –5 years, school children between the age of 10 – 12 years and adults [30]. Likewise, the leucine content is adequate for both infants, preschool children between the age of 2 –5 years, school children between the age of 10 - 12 years and the adults [30]. These amino acids are found to be higher than 1.9g/100g protein set as World Health Organization reference standards [29], which imply that the amino acids composition of *Adenanthera pavonina* has 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 (decreasing with age),

while arginine is made by the body at all ages, only at a slower rate in the early years.

CONCLUSION

The fatty acids of *Adenanthera pavonina* seed oil are health friendly. *Adenanthera pavonina* seed protein can supply appreciable amounts of amino acids comparable to the most popular common legume seeds. The essential amino acids: lysine, leucine, isoleucine, valine, phenylalanine + tyrosine have higher values than the World Health Organization reference values for the respective amino acids. Thus, *Adenanthera pavonina* seed, just like the most popular legume seeds, can serve as a good source of essential fatty acids and amino acids to consumers.

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