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Physico-chemical, Fatty Acid Profile and Amino Acid Composition of the Fruit Pulp and Seeds of *Ximeniaamericana L.* (Tallow Plum) Obtained in Niger State, Nigeria

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Abstract: The analysis of physicochemical, fatty and amino acids of *Ximeniaamericana* were carried out. The Physicochemical characteristics of oil extracts provide a baseline for suitability of oils. The results of physicochemical properties of the oil extracts revealed the acid value (0.29±0.15, 0.56±0.15)mgKOH/g, saponification value (178.12±0.02, 179.94±1.69)mgKOH/g, peroxide value (27.80±0.11, 30.06±0.12)mEq O_2/kg, iodine value (43.17±0.25, 40.61±0.10)g I_2/100g, free fatty acids (0.15±0.10, 0.29±0.15)%, refractive index (1.4330±00, 1.4130±00), specific gravity (0.8980±00, 0.9493±00) viscosity (46.99±0.15, 48.00±0.01)gcm^3/s^{-1} and colour (light brown) for pulp and seeds respectively. The fatty acid composition of the extracted oil from X. americana seed and pulp were also carried out. The major saturated acids found in pulp oil were 2-methyloctadecane, decane and Eicosane with the corresponding values of 29.51%, 17.25% and 16.25% oil respectively, while the major unsaturated fatty acids were n-hexadecanoic acid and 1,3-propanediol accounting for 67.20% and 32.80% respectively. Similarly, the major saturated fatty acids in seed oil were E-2-octadecadecen-1-ol with 15.80% and 10-undecenal with 44.59% respectively, while that of unsaturated fatty acids were 10-undecenoic acid with a corresponding value of 24.05% and 75.95% respectively. The total non-essential amino acid values were 30.57g/100g and 51.115g/100g representing 63.00% and 65.00% for pulp and seed respectively while total essential amino acids contents were 17.88g/100g and 27.48g/100g representing 34.97% and 36.90% for pulp and seed respectively. The presence of both saturated and unsaturated fatty acids in this both fruit pulp and seed could be advantageous as they may complement the functions of one another.

Keywords: Physicochemical Properties, Fatty Acid, Amino Acids, *Ximeniaamericana*

1. Introduction

Wild fruits have helped to provide a steady supply of fruits during the dry season when cultivated fruits are scarce and expensive for low-incomeearners that traditionally have large family [1]. Millions of people in many developing countries do not have enough food to meet their daily requirements and most people are deficient in one or more micronutrients [2]. In India, most rural communities depend on the wild resources including wild edible plants to meet their food needs in periods of food crisis, as well as for additional food supplements, [3].

The genus *Ximenia* belongs to the *Olacaceae* and comprises about 8 species, as reported by [4]: *Ximeniaroiigi, Ximeniaaegyptiaca, Ximeniaparviflora, Ximeniacoriaceae, Ximenia aculeate, Ximeniacaffra, Ximeniaamericana, and Ximeniaaegyptica*. However, *Ximeniaamericana Linn*, is the most common, being native to Australia and Asia where it is commonly known as yellow plum, tallow plum or sea lemon, as reported by [5]. It is found mainly in tropical regions (Africa, India, New Zealand and Central America), especially in Africa and Brazil. In Nigeria, its local names include "Tsada" in Hausa", "Chabbuli" in Fulani, "Igo" in Yoruba, "Bwugyi" in Gbagyi, and "Anomadze" in tiv.

The *X. americana*bark, fruit and leaves have many uses in local medicine for people and animals. The roots and bark have been reported to treat skin diseases, leprotic ulcers, mouth ulcers, haemorrhoids, abdominal pains, dysentery, guinea worm, and veneral diseases [6]. In Western tropical Africa, the roots have also been used to treat sleeping sickness and febrile headache, febrile cold and cough, sexual transmitted diseases and antidote for scorpion and snake bites, as reported by [7]. The blends also reported to provides a composition providing health benefits, as reported by [8].

The present study will help to identify the wild edible plant resources among the rural dwellers of Niger State probe into their likely nutritional potential to ascertain if they could help to compliment the nutritional needs from other food sources.

2. Material and Methods

Fresh-ripe fruits of *Ximeniaamericana L.* were collected from three Local Government Areas. The samples were mixed together, washed with distilled water and dried at room temperature, and then carefully peeled and separated from the seeds. The seed was ground separately using laboratory mortar and pestle. The ground seed was stored in an air tight polyethene bags prior to analysis.

2.1. Physicochemical Properties of the Oil Extracts

The specific gravity, refractive index, viscosity, iodine value, saponification value, peroxide value were determined using the method described by [9], while acid value and percentage free fatty acids were determined by A. O. A. C [10], and the colour and state of the oil was determined using method described by Oderinde*et al.* [11]

2.2. Determination of Fatty Acid Composition of the Oils Using GC/MS

The fatty acid analysis was carried out by injecting the clear supernatant of the fatty acid methyl esters (FAMEs) in to a splitless injector interfaced 5973 mass selective detector gas liquid chromatogram equipped with a detector. The fatty acids were observed as peaks whose retention times were measured by the spectrometer detector and compared with those of known standards of the Wiley library.

2.3. Determination of Amino Acid Profiles

The Amino Acid profile in the known sample was determined using methods described by [12]. The sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technico sequential Multi-Sample Amino Acid Analyzer (TSM). The net height of each peak produced by the chart recorder of TSM (each representing and Amino) was measured. The half-height of the peak on the chart was found and width of the peak on the half height was accurately measured and recorded. Approximately area of each peak was then obtained by multiplying the height with the width at half-height.

3. Results and Discussion

Table 1. *Physicochemical properties of the oil extracted from X. americanapulp and seed.*

	Sample	
Parameters	**Pulp**	**Seed**
Acid value (mgKOH/g oil)	0.29±0.15	0.56±0.15
Saponification value (mgKOH/g oil)	178.12±0.02	179.94±1.69
Peroxide value (mEq O_2/kg)	27.80±0.11	30.06±0.12
Iodine value (g I_2/100g)	43.17±0.25	40.61±0.10
FFA (%)	0.15±0.10	0.29±0.15
Refractive index	1.4330±00	1.4130±00
Specific gravity	0.8980±00	0.9493±00
Viscosity (25°C) (g/cm^3s^{-1})	46.99±0.15	48.00±0.01
Colour	light brown	light brown

Values are means ± SD of triplicate analysis

Table 2. *Fatty Acid Composition of the extracted lipids from pulp of X. Americana.*

Compound Name	**Mol. Formula**	**Mol. Weight**	**Rel. Abundance**
Hexadecane	$C_{16}H_{34}$	226	8.74
Decane	$C_{10}H_{22}$	142	14.88
Eicosane	$C_{20}H_{42}$	282	14.12
n-hexadecanoic acid	$C_{16}H_{32}O_2$	256	9.24
2-methyloctadecane	$C_{19}H_{40}$	268	25.45
2-methyloctane	$C_{19}H_{40}$	268	6.65
1, 3-propanediol	$C_{15}H_{32}O_2$	244	4.51
3, 4-dimethyl-1-decene	$C_{12}H_{24}$	168	9.52
2-methyleicosane	$C_{21}H_{44}$	296	4.39
Undecane	$C_{11}H_{24}$	156	2.50
TUFA			13.75
TSFA			86.25
TUFA/TSFA			0.16

TUFA = Total unsaturated fatty acids; TSFA = Total saturated fatty acids.

Table 3. *Fatty Acid Composition of the extracted lipids from seeds of X. Americana.*

Compound Name	**Mol. Formula**	**Mol. Weight**	**Rel. Abundance**
Ethylbenzene	C_8H_{10}	106	3.92
2-methyloctane	C_9H_{20}	128	4.34
Decane	$C_{10}H_{22}$	142	5.80
2, 4-nonadiyne	C_9H_{12}	120	5.38
Cyclopropanepentanoic acid	$C_{20}H_{38}O_2$	310	22.26
10-undecenoic acid	$C_{19}H_{36}O_2$	296	7.05
10-undecenal	$C_{16}H_{18}O$	130	2.65
E-2-octadecadecen-1-ol	$C_{18}H_{36}O$	268	11.17
10-undecenal	$C_{11}H_{20}O$	168	31.40
Octadecylvinyl ether	$C_{20}H_{40}O$	296	6.05
TUFA			29.31
TSFA			70.71
TUFA/TSFA			0.41

TUFA = Total unsaturated fatty acids, TSFA = Total saturated fatty acids.

Table 4. *Amino acid profile of pulp and seeds of X. americana (g/100g).*

	Parts	
Amino acid	**Pulp**	**Seed**
Lysine	2.09	3.41
Histidine	1.24	2.86
Argenine	3.15	7.32
Aspartic acid	4.32	9.34
Threonine	2.10	3.18
Serine	1.94	4.00
Glutamic acid	5.26	15.21
Proline	6.25	3.02
Glycine	3.23	4.66
Alanine	4.10	3.23
Cystine	0.83	1.52
Valine	3.01	4.75
Methionine	0.83	1.61
Isoleucine	2.09	3.49
Leucine	4.20	5.84
Tyrosine	1.49	2.81
Phenylalanine	2.29	4.23
TEAA	17.88 (36.90%)	27.90 (34.97%)
TNEAA	30.57 (63.09%)	51.11 (65.03%)

TEAA = Total essential amino acids, TNEAA = Total non-essential amino acids.

The results for the physicochemical properties of oil extracted from X. Americana pulp and seed were shown in Table 1. The acid values obtained in this study were 0.29±0.15 and 0.56±0.15mgKOH/g for pulp and seed respectively. These values were lower than 0.28mgKOH/g for X. americana seed oil [13], 0.14mgKOH/g for X. americana seed oil [14]. This variation accounts for certain factors such as environment where the plant is grown, the purity of the reagent and apparatus used. For soap production higher acid values are required, consequently, the oil is not suitable for soap production with respect to its acid values [14]. Saponification value is used in assessing the adulteration. High saponification value of a given sample indicates its suitability for cosmetic production [15] while low saponification value is ideal for soap making [16]. The saponification values obtained for X. americana in this study were 178.12±0.02 and 179.94±1.69mgKOH/g for pulp and seed respectively. These values were lower than 199.182.30mgKOH/g obtained for X. americana seed [14], 182.30mgKOH/g for X. Americana as reported by [17], but lower than 11.43mgKOH/g for X. americana [14]. The peroxide values of X. americana were 27.80±0.11 and 30.06±0.12mEqKOH/g for pulp and seed respectively. The values were lower than 31.25mEqKOH/g obtained in X. americana seeds as reported by [17], 29.40mEqKOH/g in X. americana seeds as reported by [14]. However, the result obtained in the seeds in this present study is similar to 30.00mEqKOH/g as reported by [13]. Low peroxide value obtained is an indication that the oil is not likely to be liable to oxidative rancidity at room temperature [18; 19]. The iodine values of X. americana pulp was 145.30±0.25g I_2/100g while that of seed was 147.61±0.10g I_2/100g. These values were lower than 158.30g I_2/100g obtained in X. americana seeds as reported [17], 149.80g I_2/g obtained in X. americana seeds as reported by [14], but higher than 47.59g I_2/g obtained in X. americana seeds as reported by [13]. Iodine value is the measure of the degree of unsaturation in oil or fat. Iodine value is a useful parameter in studying oxidative rancidity and chemical stability properties of different oil [20; 21], also used for determining the level of oxidative deterioration of the oil by enzymatic or chemical oxidation [22]. The high iodine value of oils indicates the high content of unsaturation (C=C double bond), suggesting the usefulness of oils in domestic and industrial applications [23]. Higher quantity of double bonds in the sample has greater potential to polymerized and hence lesser stability [21]. Oil with iodine value less than 1.30 is reported to be non drying oil and is therefore not suitable for paint making [21]. The high iodine values obtained is an indication that the oil is edible. The free fatty acids obtained in this work for X. Americana were 0.15±0.10% and 0.29±0.15% (oleic) for pulp and seed respectively. These values were higher than 0.07%, for X. americana seed oil as reported by [14], but lower than 8.07% of oil for X. americana oil extract as reported by [17]. The variation could be due to environmental factors, methods used and/or reagent purity during the analysis. Free fatty acids are more susceptible to lipid oxidation which gives rise to rancidity and production of off-odour compared to intact fatty acids as reported by [24]. For soap making, oil with 2-5% free fatty acid value could be used [16]. Thus the oil obtained in this study will be suitable in soap production where free fatty acid values are considered. The refractive indexes of X. americana seed oil were 1.4330±00 and 1.4130±00 for pulp and seed respectively. These values were lower than 1.4770 reported by [13], and 1.435 [17], for X. americana seed oil but lower than 0.820 for L. owariensis and 0.920 for N. Inperalis seed oils as reported by [25]. The refractive index is used to assessed oil contamination and adulteration [26]. The standard range of refractive index for oil is 1.478-1.479 [27]. The values obtained in this study were within the permissible range. Viscosity of X. americana at 25°C were 46.99±0.15 and 48.00±0.01 for pulp and seed respectively. These values were lower than 42.00 (25°C), 227.58 (70°C) as reported by [13], and 900cp (30°C), as reported by [17].

The results of the fatty acid compositions of the lipids of pulp and seed of X. americana are shown in Table 2 and 3 respectively. The major saturated fatty acids (SFAs) found in pulp (Table 2) were Hexadecane, Decane, Eicosane, 2-methyloctadecane, 2-methyloctane, 3,4dimethyl-1-Decene, 2-methyleicosane, and Undecane while the major unsaturated fatty acids (USFAs) found were n-hexadecanoic acid and 1,3-propanediol. The total saturated fatty acids (TSFAs) were 86.25% while the total unsaturated fatty acids (TUFAs) were 13.75% and the ratio of TUFA to TSFA was 0.16. Similarly, the major saturated fatty acids (SFAs) found in seeds were Ethylbenzene, 2-methyloctane, Decane, 2,4-nonadi-yne, Isooctanol, E-2-octadecadecen-1-ol, 10-undecenal, and Octadecylvinylether while the major unsaturated fatty acids found were Cyclopropanepentanoic acid and 10-undecenoic acid. The total saturated fatty acids (TSFAs) were 70.71% while the total unsaturated fatty acids (TUFAs) were 29.31%

and the ratio of TUFA to TSFA was 0.41. However, these values were lower than 4.81 and 0.99 for K. americana and X. caffra seeds respectively, as reported by [28]. The unsaturated acids accounted for 19.51% of the total fatty acids, the saturated fatty acids accounted for 33.66%. The presence of both saturated and unsaturated fatty acids in this fruit could be an advantageous since it may complement the functions of one another [29]. However, the recommended ratio of TUFA/TSAFA for a healthy diet is 0.45%, as reported by [30]. Though the obtained values shows that the pulp oil was much more lower as compared to that of seed indicating that X. americana seed oil could be of better nutritional potential than that of pulp oil [31]. For the individuals with coronary heart diseases (CHD), it is not advisable to consume the oil due to high level of saturated fatty acids.

The results of amino acids profile of pulp and seed of X. americana are shown in Table 4. The results revealed the presence of essential and non-essential amino acids in both pulp and seeds respectively. The total essential amino acid for pulp and seeds were 17.88 and 27.48 g/100g respectively, while total non-essential amino acids for pulp and seed were 30.57 and 51.11 g/100g respectively. These values were higher than 14.87g/100g for total amino acids obtained from X. caffra seeds, as reported by [28]. The minimum amino acid intake of 1.5g/kg/day is reported to be necessary in preventing negative nitrogen balance [30] and a minimum amino acid intake of 1.0g/kg/day is recommended to avoid a negative nitrogen balance and higher than 2.5g/kg/day is not advisable [30].

4. Conclusion

The results obtained from this study shows that *X. americana* fruit is a good source of protein, fibre, vitamins, lipids, amino acids and essential minerals such as calcium, magnesium, potassium, sodium, iron, and Manganese. The low anti-nutrient content of this fruit shows that it could be exploited as good dietary supplement for both human and animal feeds formulation. The oils obtained from the seed have the potential for use as vegetable oil, food, pharmaceutical and industrial application.

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