

Review Paper

The Mystery Prickly Berry: *Solanum torvum*

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Abstract

Solanum torvum (Afufa, anara (Igbo); Ijegun-eegun (Yoruba) is native and cultivated in Africa and West Indies. It is also widely distributed in India, Pakistan, China, Philippines and tropical America. It belongs to the family Solanaceae, and they are about 2000 species of *Solanum* in the world that are mainly distributed in the tropical and sub-tropical areas. It is erect spiny, prickly perennial shrub, evergreen and widely branched and grows up to a height of 5M. The fruits grow in clusters of tiny green spheres, thin-fleshed and contain numerous flat round, brown seeds. The fruits and leaves are found edible and particularly incorporated into soups and sauces. Human life cycle depends to a great extent on plants. Apart from the nutritional purposes, the leaves, fruits, bark and roots of a large number of plants are valuable for medicinal purposes. The plant extracts have been widely used in folk medicine for the treatment of a large number of human ailments. Generally, in different places and cultures, it has found wide applications as a therapeutic agent for treating myriad of sickness and disease conditions. Its medicinal properties range from preventing to curative. This review attempts to highlight the novelty of *Solanum torvum*: evaluating the traditional uses, nutritional and chemistry, phytochemistry, biochemistry, pharmacology, medicinal properties and anti-microbial potentials of this plant.

Keywords: *Solanum torvum*, Biochemistry, Medicinal Uses

Introduction

Mystery is used to describe someone or something that people do not recognize or know anything about especially when this causes great interest. This prickly berry (*Solanum torvum* (Afufa, anara; Igbo); Ijegun-eegun (Yoruba) is used in my community in Nigeria for the treatment and cure of a host of ailments and various diseases of diverse physiopathology, hence, it is referred to as: “mystery prickly berry”.

Solanum torvum (wild egg plant) is native and cultivated in Africa and West Indies [1]. It is also widely distributed in India, Pakistan, China, Philippines and tropical America [2]. For many decades, different ethnic groups and cultures have used various parts of the plant for the treatment of diverse ailments.

The fruits are used commonly in traditional medicine as anti hypertensives [3]. A decoction of the fruits is given for cough ailments and is considered useful in cases of liver and spleen enlargement [4]. Fruits are often eaten as vegetables while the ripened are used in the preparation of tonic for the treatment of pain and anemia [5]. A decoction of the roots, bark, leaves and fruits have been used in the treatment of a large number of human ailments in Nigeria [6]. The plant has been used in the treatment of epileptic fit, diarrhea, digestive, skin diseases, cough, diabetes, dental problems, wounds, menstrual pains, jaundice, colds, anemia, pain, athlete foot, fever and inflammatory activities [6]. Plant parts are used as sedative, diuretic and digestive [4].

Pharmacological studies on this plant have demonstrated the ability of this plant to exhibit anti-oxidant [7, 21], anti-microbial [8, 9], anti-diabetic [10], anti-inflammatory [11], anti-viral [12], analgesic [5, 11], anti-hypertensive [11, 13], cardiovascular and anti-platelet activities [14, 22], nephroprotective [15], immune-secretory [16], anti-ulcerogenic [17], sedative, digestive, hemostatics and diuretic activities [18], cytotoxic activities [19], angiotensin and serotonin receptor blocking activities [20].

This review attempts to evaluate the novelty of *Solanum torvum*, its nutritional and traditional uses, chemistry, phytochemistry, biochemistry, pharmacology, medicinal properties and anti-microbial potentials.



Plate 1: Prickly Berry plant: *Solanum torvum* with the fruit

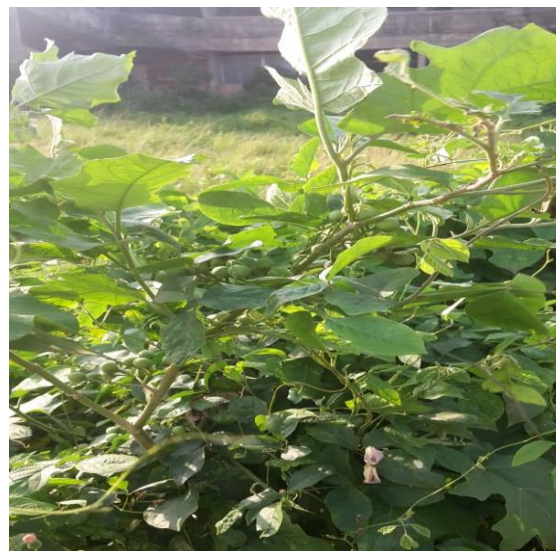


Plate 2: Prickly Berry plant: *Solanum torvum*

Botany

Solanum torvum is mainly distributed in tropical and subtropical areas. It is erect spiny, prickly perennial shrub [23, 24, Plate 1]. The stems of this plant are armed with stout, straight [25] and curved prickles, broad leaved, evergreen and widely branched [23] and grows up to 5M in height and 8cm in basal diameter [24, Plate 2]. It has the potential to invade variety of ecosystems both wet and dry [24].

Once established, it can sprout from the roots, creating large thickets that could displace native vegetation. The stem bark is gray with raised lenticels. The roots are white. Foliage is confined to the growing twigs [26, 27, 28].

The twigs are grey-green and covered with star-shaped hairs. The spines are short and slightly curved, vary in thickness throughout the plant [27, 28]. The leaves are opposite or one per node, broadly ovate with the border entirely or deeply lobed [20, 25]. The petioles are 1 to 6cm long and the blades are 7 to 23 by 5 to 18cm and covered with short hairs. The flowers are white, tubular with 5 pointed lobes and grouped in corymbiform cymes [25, 26].

The fruits are berries that grow in clusters of tiny green spheres (Plate 1), yellow when fully ripe, thin-fleshed and contains numerous flat, round, brown seeds [20, 24] that are flattened and discoid (1.5-2mm long) and slightly reticulate [20, 29, 30].

Taxonomical Classification

Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Solanales
Family:	Solanaceae
Genus:	Solanum
Species:	Torvum [29, 31, 32]

Vernacular Names

Nigeria:	Afufa, Anara (Igbo), Iyegun-eegun (Yoruba)
Ghana:	Kittily
Liberia:	Susumber
Jamaica:	Tekokak, Rimbang, Berenjena
Japan:	Jurubeba
English:	Pea, Cherry and Wild eggplant, Turkey berry
French:	Mé longène-diable, Auberginepois.
India:	Bhurat, Bhankatiya, Sundai [27, 29, 30, 31]

Traditional Medicinal Uses Of *Solanum torvum*

There are so many health benefits associated with *Solanum torvum*. This plant has been shown to contain a number of chemical entities which are related to their traditional concept. Scientific evidences exist with respect to their minor or major constituents [23]. The traditional medicinal uses have been extensively explored and evaluated for their therapeutic effect. The novelty and applicability of *S. torvum* are shown in Table 1. For many decades, different ethnic groups and cultures have used various part of this plant for the treatment of different diseases. These benefits have come from the root, stem, bark, fruit, seeds and leaves. Apart from the numerous health benefits of *S. torvum*, this plant is also toxic when consumed in excess and it is not recommended for example to glaucoma patients.

Table 1: Traditional medicinal uses of *Solanum torvum*

Traditional uses	Parts used	Formulation	Reference
Cold and cough	Leaves and fruits	Decoction	4, 6, 34
Diabetes	Roots and leaves	Decoction	6, 25, 10
Anemia, haemopoietic agents	Ripened fruits, root	Tonic, root juice	5, 6, 16, 25, 32
Fever	Leaves and roots	Leaves and fruit juice	6, 11, 20
Tooth-ache	Roots	Root extraction	6, 20, 11
Wounds	Leaves, stem	Leaf and stem extraction	6, 8, 9, 11, 20
Pain	Ripened fruit, aqueous extract of leaves	Tonic	5, 6, 11
Poison anti-dote	Leaves and bark	decoction	20, 11
Hypertension	Dry fruit, root and leaves	Leave extract, combination of root and leaves juice	3, 11, 13, 25
Liver diseases	Fruit, dry root	Decoction	4, 32, 25, 34
Spleen enlargement	Fruit, dry root	Decoction	4, 25, 34
Epileptic fit	Root, fruits	Root and fruit juice	6
Diarhoea	Leaves	Leaves extraction	6
Digestive	Leaves	Leaves extraction	4, 18
Skin diseases	Leaves	Paste	6
Menstrual pains	Bark	Decoction	6
Athlete foot	Bark, root	Bark and root extraction	6, 25
Diuretic and sedative	Aqueous extract of leaves	Tonic	4, 18, 20
Flu	Leaves and fruit	Boil and filter	
Cancer	Fruit and seed	Decoction, soup	
Osteoporosis	Seed	Fry, mix and stir with other vegetables	
Hemorrhoid	Leaves	Boil in hot water and filter	
Increase sexual desire	Fruit and seed	Boil in water until boiling, filter and drink	
Solve erectile dysfunction	Fruit and seed	-----do-----	
Lunch bloodstream	Fruit and seed	-----do-----	
Neutralize toxin	Seed	-----do-----	
Minus eyes	Fruit	Soup and stir fry	
High uric acid	Seed	Serve with pineapple and little shrimp	

Nutritional Composition

Human life-cycle depends to a great extent on plants. *Solanum torvum* is native and cultivated in Africa and West Indies [1]. The fruits of *S. torvum* are edible and commonly found in farms and markets [20]. The fruits and leaves are eaten as vegetables and particularly incorporated into soups and sauces. It is an essential ingredient in Thai cuisine [23].

The edible fruit has been shown from studies to be a good source of proteins, calories, fibre, minerals and vitamins [Tables 2 and 3]. The fatty acid profile has also shown high degree of unsaturation [Table 4] which is of great nutritional significance. The high content of iron, calcium, phosphorus, zinc and vitamin C demonstrates the great nutritional benefit of this plant.

Table 2: Proximate analysis (fruits)

Composition	Moisture	Protein	Fat	Carbohydrate	Fibre	Ash	Reference
Fruit (g/100 g)	84.4	2.4	0.4	10.7	6.1		35
Fresh fruit (g/100 g)	71.7					1.54	36
Dry fruit (g/100 g)						5.53	36
Fruit (%)	86.23	2.32	0.78	7.03	3.99	0.143	33, 37
Fresh fruit (g/100 g)	84.43	1.44	0.80		0.69	2.35	24
Dry fruit (g/100 g)		5.33	1.30		1.35	4.80	24
Fruit powder (g/100 g)	6.11	5.73	1.35		1.35	5.40	24

Table 3: Minerals and vitamins (fruits)

Composition	Fe	Mn	K	Ca	Cu	Zn	P	Pro-vit A (mg/100 g)	Vit A (mg/100 g)	Vit C (mg/100 g)	B-carotene (µg/100 g)	Lutein (mg/100 g)	Ref
Fruit (mg/kg)	76.86	19.46		221.58	2.46	21.46			0.078	2.68			33
Fruit (mg/100 g)	4.6			104			70			4	390		35
Fruit (g/100 g)													
Dry fruit powder	4.78												36
Fresh fruit (g/100 g)										24.64			36
Fresh fruit (mg/100 g)	77.60		695	67.85				0.095		2.86		0.0109	24
Dry fruit (mg/100 g)	60.10		1,975	151.20				0.055		1.83		2.4223	24
Fruit powder (mg/100 g)	90.30		1,660	48.10				0.027		2.93		2.7405	24

Table 4: Total amount and relative percentages of free fatty acids (FFA) and bound fatty acids (BFA) in *S. torvum* fruits [36]

Relative percentage (%)	Saturated fatty acids							Unsaturated fatty acids	
	Caprylic	Capric	Lauric	Myristic	Arachidic	Stearic	Behenic	Oleic	Lignoceric
BFA	1.99	1.98	2.00	12.86	13.24	12.83	7.99	42.35	4.56
FFA	0.52	-	6.47	1.05	1.72	4.08	0.52	84.36	1.28

Chemical Composition

Solanum torvum has been extensively studied for its chemical constituents. Phytochemical screening using different extracts have shown the presence of alkaloids, flavonoids, saponins, tannins and glycosides [9]. Recent studies reveal that its flavonoid content is mainly responsible for its antioxidant [38,39], antihypertensive [11], metabolic correction and nephroprotective activities [15]. A number of these metabolites are in good yield and

some have been shown to possess useful biological activities belonging mainly to steroid glycosides, flavonoids, saponins, iron salts and steroidal alkaloids.

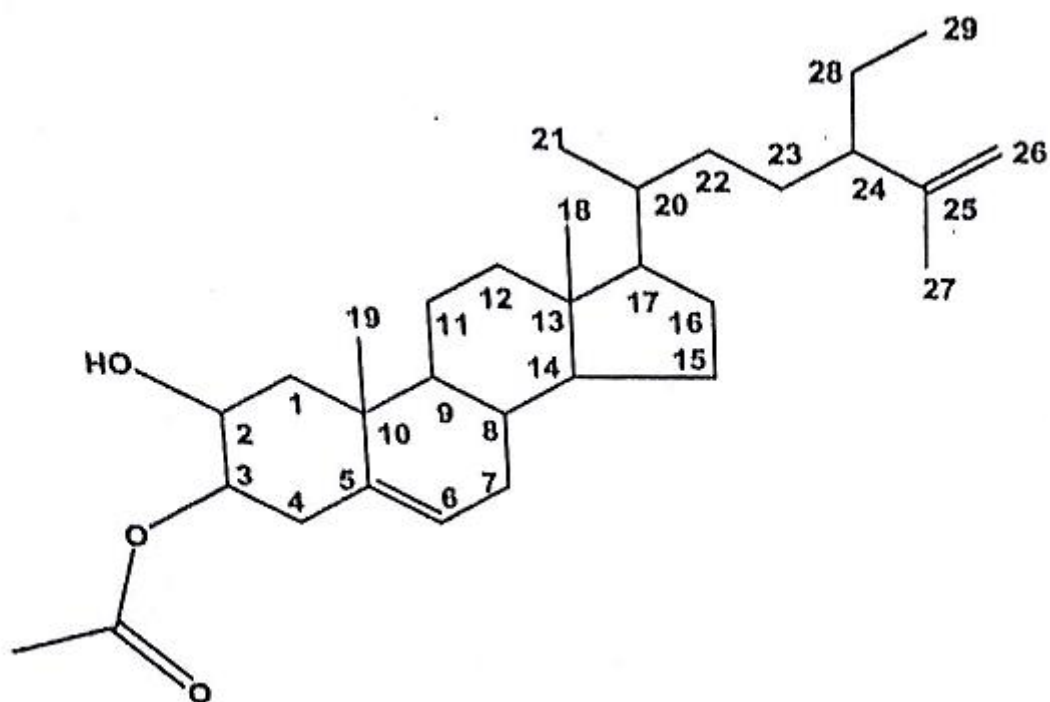
The plant extracts also contain substantial amount of phenolics and this is responsible for its antioxidant activities [7, 21]. A good correlation was observed with radical scavenging activity of extracts and total phenolics. This is very crucial in view of the involvement of free radicals in the pathogenesis of a large number of many degenerative diseases. Anticancer phenolic compounds have also been isolated from fruits and leaves of this plant [25].

Solanum torvum has a good number of chemical constituents that are responsible for its pharmacological activities. Torvoside A-L have been isolated [23]. Torvoside M and N has antimicrobial activity and show cytotoxic activity with cell lines [9, 41]. Torvonin A, B have been reported [42, 43] from ethanolic extracts of aerial parts.

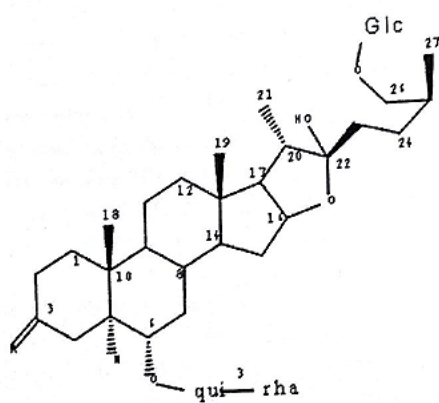
Some other chemical constituents such as astorvosides A-G (steroidal glycosides) [25], solanolactosides A, B, solanolide, yamogenin [41], rutin, kaepferol, quercetin, isoquercetin amongst others have been isolated from the various parts [Table 5, Figure 3].

Table 5: Chemical compounds of *Solanum torvum*

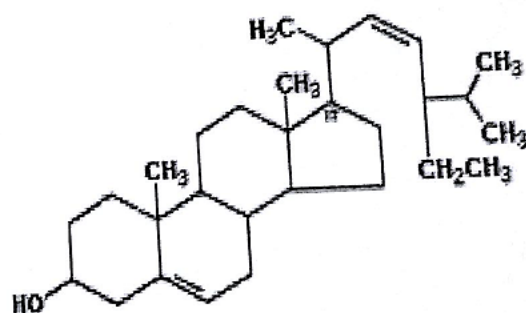
Names	Part of plant	Extraction solvent	Molecular formula	Molecular weight (g/mol)	Uses	Reference
Methyl stearate	fruits	Dichloromethane	C ₁₉ H ₃₈ O ₂₂	298.511	As flavor	
Torvanol A	Leaves and fruits	Methanol	C ₂₀ H ₂₀ O ₁₀	452.43	Antiviral, Antidepressant, antilytic and adaptogenic activities	12
Solanolactoside A	Arial parts	Methanol	C ₃₄ H ₅₄ O ₁₂			41
Solanolactoside B	Arial parts	Ethanol	C ₃₃ H ₅₂ O ₁₂	640.75878		41
Torvoside H	Fruits	Methanol	C ₄₅ H ₇₄ O ₁₈	903.069		12
Torvoside A	Fruits	Methanol	C ₄₅ H ₇₆ O ₁₈	905.0741		12
Torvoside L	Fruits	Methanol				46
Torvoside M		Ethanol	C ₃₉ H ₆₂ O ₁₃	738.912	Anti-microbial,	7,8,9
Torvoside N		Ethanol	C ₃₉ H ₆₄ O ₁₄	756.927	Cytotoxic activity	7,8,9
Torvoside J		Methanol	C ₃₉ H ₆₄ O ₁₃	740.928		46
Torvoside K		Methanol	C ₃₉ H ₆₄ O ₁₃	740.928	Antifungal and antimycotoxigenic activities	46
Torvoside B	Fruits		C ₄₅ H ₇₆ O ₁₈	905.0741		
Torvoside C	Fruits		C ₃₉ H ₆₄ O ₁₃	740.9177		
Torvoside E	Fruits		C ₄₀ H ₆₆ O ₁₄	770.954		
Torvoside G	Fruits		C ₃₄ H ₅₆ O ₉	608.803		
Torvoside K	Fruits	Methanol	C ₃₈ H ₆₂ O ₁₃	726.8911		
Torvoside K	Fruits	Methanol	C ₄₅ H ₇₄ O ₁₈	903.0583		
Torvonin A	Fruits		C ₃₉ H ₆₄ O ₁₂	724.929		43
Torvonin B	--do--		C ₃₉ H ₆₄ O ₁₃	740.918		42



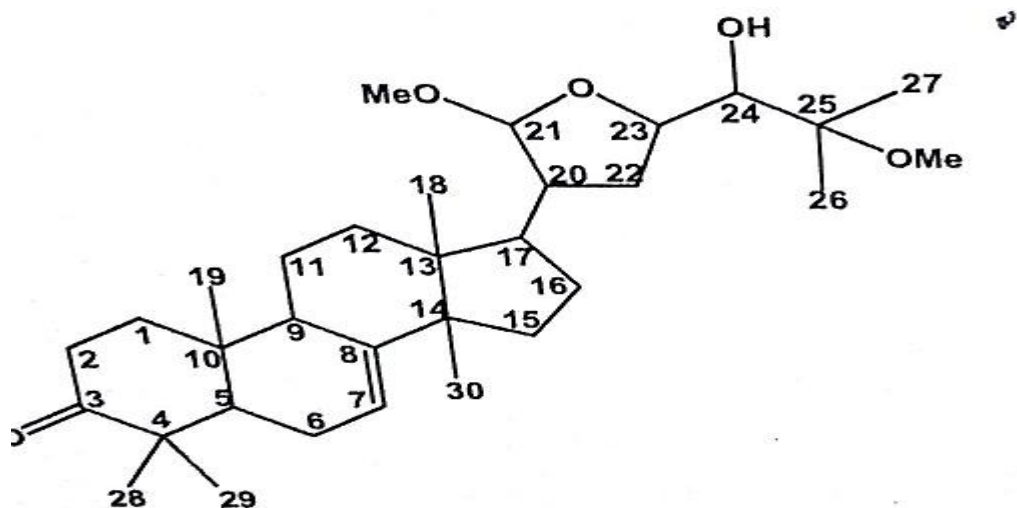
3-O-acetyl-stigmasta-5,25-diene-2,3-diol



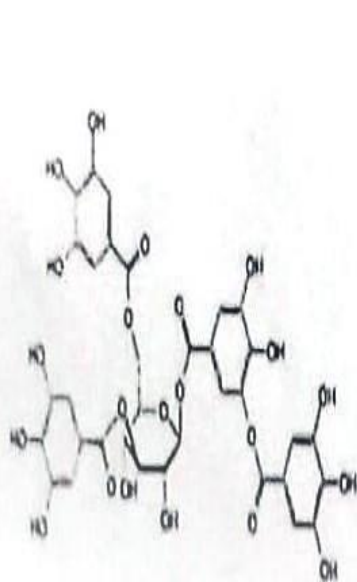
Torvoside A



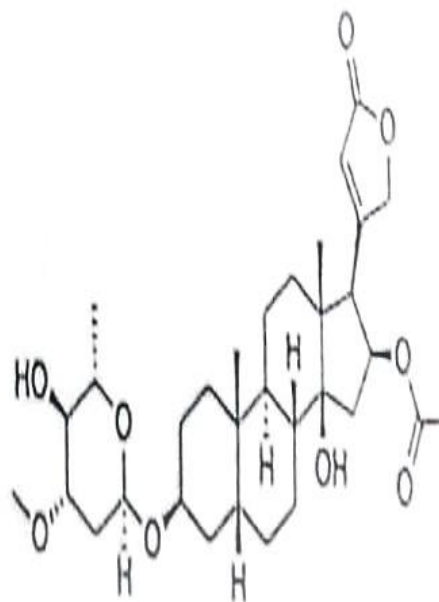
Torvoside B



21,25-dimethylmelianodiol



Tannic acid, a type of tannin



Oleandrin, a cardiac glycoside

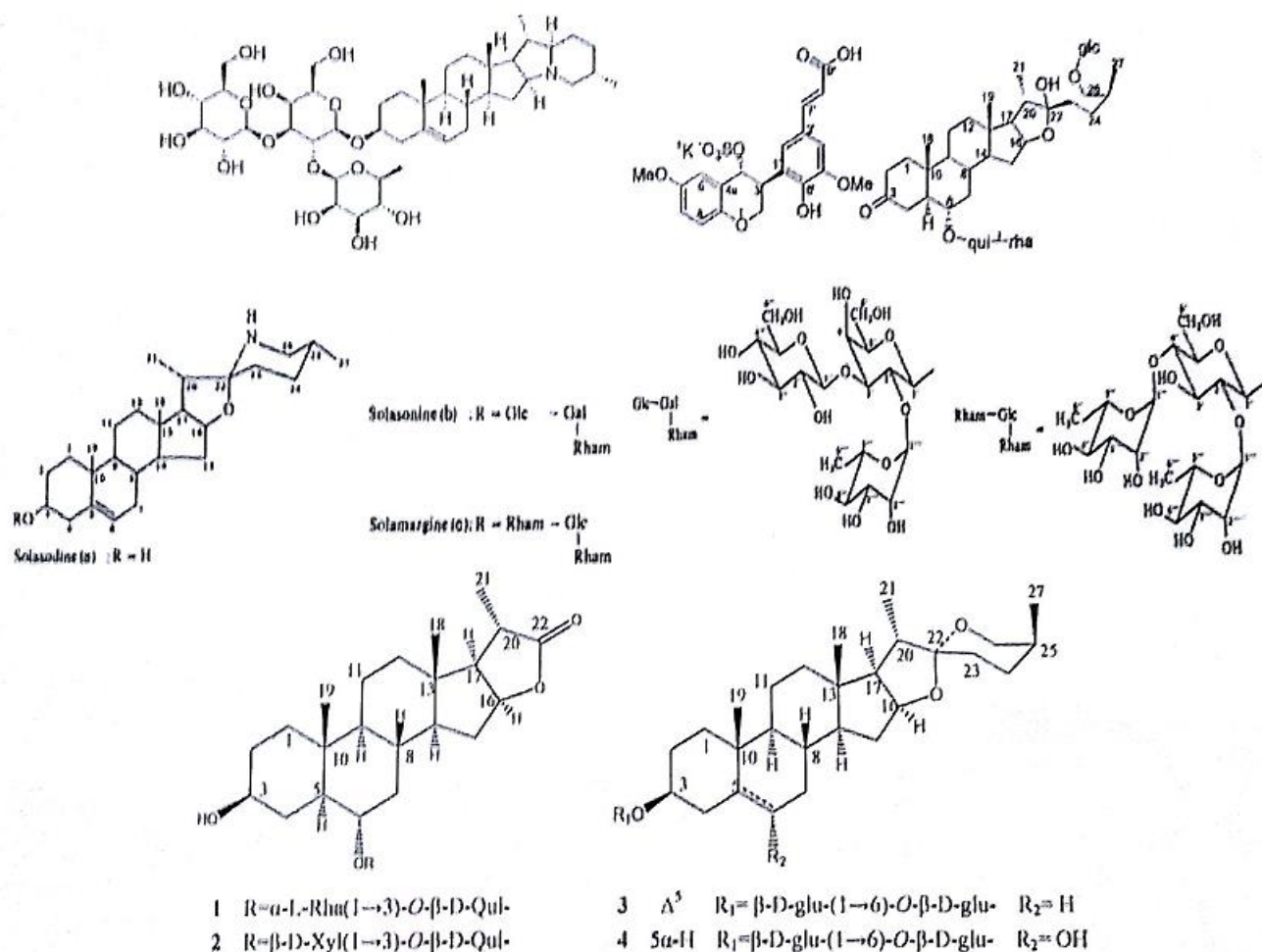


Figure 3: Compounds isolated from *Solanum torvum*

Pharmacological Properties

Pharmacological studies on the various part of this plant have demonstrated antimicrobial activities against human and animal clinical isolates [8, 9]. An antiviral isoflavonoid has also been isolated from the fruits [12]. It has antioxidant [7], antihypertensive [11, 13], immunosecretory [16], analgesic and anti-inflammatory [11], cardiovascular [22], nephroprotective [15], anti-platelet aggregation [14, 22], antidiabetic, cytotoxic [19], angiotensin and serotonin receptor blocking [20], anti-ulcerogenic [17], sedative, diuretic and digestive properties [18]. The immunomodulatory and erythropoietic [16, 44] and antiulcer activities [45] have been documented.

Conclusion

The significance and use of *Solanum torvum* as an important source of nutraceuticals besides its nutritional composition was highlighted in this review. This plant has been used extensively in traditional medicine practice in the treatment of several ailments of non-related pathophysiology. Based on the pharmacological studies and the activities or potentials demonstrated, it is reasonable to conclude that, this plant following the recent interest in its composition, shall be a novelty in phytomedicine and therapeutics. The pharmacological investigations so far, have to a great extent supported the traditional medicinal uses of this plant.

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