



Pharmacognostical, Phytochemical and Pharmacological Profile of Natural Remedy *Lagenaria siceraria* (Mol.) Standly: A Review

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Herbal medicines are the promising choice over modern synthetic drugs because they show minimum/no side effects and are considered to be safe for human being. Bottle gourd or Lauki or *Lagenaria siceraria* (Mol.) Standly is a member of the Cucurbitaceae family like melon, squash and cucumber. *Lagenaria siceraria* has been used in different system of traditional medication for the treatment of diseases and ailments of human beings. This vegetable is very high in water content and very low in calories. The seeds also have a cooling effect on the body and they are used in headache and constipation. Several bioactive compounds have been isolated from *Lagenaria siceraria* including triterpenoids, sterols, cucurbitacins, flavones, C-glycosides and β -glycosides. The edible portion contains thiamine, riboflavin, niacin, and ascorbic acid as a vitamins source. It is used as medicine in India, China, Africa, Brazil and European countries for its cardioprotective, hepatoprotective, diuretic, antidiabetic and antihyperlipidemic activities. In this review, an attempt has been made to explore the current phytochemical and pharmacological knowledge about this well known plant species as well as several promising aspects for research on *Lagenaria siceraria*.

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Keywords: *Lagenaria siceraria*; lauki; bottle gourd; cucurbitacins; phytochemistry and pharmacology.

1. INTRODUCTION

Many herbal remedies have been employed in various medical systems for the treatment and management of various diseases. Generally herbal formulations involve use of fresh or dried plant parts. In addition, herbs have provided us some of the very important life saving drugs used in the modern system of medicine. Correct knowledge of such crude drugs is very important aspect in preparation, safety and efficacy of the herbal product. Pharmacognosy is a simple and reliable subject, by which complete information of the crude drug can be obtained [1].

Lagenaria siceraria (Molina) Standley [Family: Cucurbitaceae], commonly known as Bottle guard, Ghiya and Lauki, is an excellent fruit in the nature having composition of all the essential constituents that are required for normal and quality health of humans [2]. It is also a good source of carbohydrate, minerals, amino acids, pectin and contains highest level of choline (lipotropic factor) which is crucial for brain function [3]. It is commonly used as vegetable in India [4]. It is described as cardiogenic and general tonic in Ayurveda. The medicinal properties of the Lauki had been described since ancient times. Different parts of the plant viz. leaf, fruit and seed have been explored for their therapeutic benefits [5].

The plant enjoys the reputation of being one of the earliest plants to be domesticated on the earth. Traditionally *L. siceraria* is used in pain, ulcers, fever, asthma, diabetes and other bronchial disorders [6,7]. The seed oil is applied in headache. Lagenin has been isolated from the lyophilized water extract of seeds which is known to possess immunosuppressive, antitumor, antiviral, antiproliferative and anti-HIV activities [8]. Various extracts of fruit of *Lagenaria siceraria* were found to have anti-inflammatory [9], analgesic [10], hepatoprotective [11,12] antioxidant [13], anti-hyperlipidemic [12,14,15], diuretic [16], antistress [17], antidepressant [18,19], antiulcer [20,21], cardioprotective [22] and antibacterial activities [23]. Ethanol extract of fruit has been evaluated where free radical play a major role in the pathogenesis of various diseases [13].

2. SYNONYMS

Sanskrit: Alobu, Tumbi Ishavaaku, Katutumbi, Tiktaalaabu, Alaabu. **Bengal:** Laus, Lokitumbi.

English: Bottle Gourd. Gujarati:Dudi, Tumbadi. **Hindi:** Lauki, Ghiya. **Kannad:** Isugumbala, Tumbi. **Malyalam:** Chorakka, Churan, Choraikka, Piccura, Tumburini, cura, Tumburu. **Marathi:** Phopla. **Punjabi:** Tumbi, Dani. **Tamil:** Shorakkai, Surai, Suraikkai. **Telugu:** Sorakaya, Anapakaya. **Urdu:** Ghiya, Lauki.

3. TAXONOMICAL CLASSIFICATION

Kingdom: Plantae. **Division:** Magnoliophyta. **Class:** Magnoliopsida. **Order:** Cucurbitales. **Family:** Cucurbitaceae. **Genus:** *Lagenaria*. **Species:** *L. siceraria* [3].

4. CULTIVATION AND COLLECTION

Lagenaria siceraria is mainly cultivated in countries of African and Asian origin. In India, it is cultivated in various states like Delhi, Uttar Pradesh, Punjab, Haryana, Gujarat, Assam, Meghalaya, Maharashtra, Karnataka and Rajasthan. It can be cultivated in all kinds of soil, but thrives best in heavily manure loams. It requires a warm humid climate or plenty of watering when grown during dry weather. It is popular vegetable, grown almost all around the year. Seeds may be sown in nursery beds and seedlings transplanted when they have put forth 2-3 leaves. They may also be sown directly. Seeds are sown in well manured beds or pits 5-6ft. apart. Healthy seedlings are retained, while others are removed and transplanted. Generally two crops are raised in India. Round fruit type crop is sown from the middle of October to the middle of March and the bottle shaped crop from the beginning of March to the middle of July [24].

5. MORPHOLOGICAL CHARACTER OF DIFFERENT PARTS OF PLANT

Lagenaria is a large, softly pubescent, climbing or trailing herb with stout 5-angled stems and bifid tendrils.

5.1 Leaves

Leaves are large, petioled, 3-5 lobed, 10-40 cm wide, soft slightly hairy on both sides. The organoleptic studies of leaves were found to be light green in color with acrid and mucilaginous taste [25].

5.2 Flowers

Flowers are small and medium; Petals are ovate, 3-4 cm long. Calyx is green, mottled gray or white (Fig. 1), usually as thick as it is long. Male flowers are usually up to 7 cm in diameter.

5.3 Fruits

Fruits vary widely in shape and size up to 25-60 cm long (Fig. 2), mainly found in bottle, mace or club shaped with a hard shell- like epicarp when ripe; numerous seeds are also present in fruit. External surface is smooth, pale green in colour [26].

5.4 Ethnomedicinal Uses of Various Parts of Plant

Traditionally *Lagenaria siceraria* has been used in the management of various diseases. The roots are emetic, purgative and anti-inflammatory and are useful in various conditions such as constipation and inflammation [27]. The leaves are bitter, refrigerant, emetic, purgative, expectorant, diuretic and febrifuge [28]. They are useful in cough, bronchitis, asthma, fever, inflammations, leprosy, skin diseases, jaundice, decaying teeth, cephalalgia, constipation, flatulence and baldness [29]. Flowers are cooling and useful in ophthalmia and odotalgia [30]. The fruits are refrigerant, emetic, purgative, anti-inflammatory, depurative, nervine tonic expectorant, diuretic and febrifuge. They are useful in various conditions as like burning of the feet, cough, bronchitis, inflammation, skin disease, leprosy and fever. The fresh fruit juice of bottle gourd is used in hyperlipidemic condition. Its fruits are also used for its cardioprotective, cardio tonic, general tonic and aphrodisiac

properties. Seeds are purgative, diuretic, brain tonic, dropsy, anthelmintic and produce cooling affect that is why used in headache. Flowers are regarded as counter poisons [31].

5.5 Parts Used

Whole plant.

6. PHYTOCHEMISTRY (PRIMARY AND SECONDARY METABOLITES)

6.1 Primary Metabolites

Fruits and seeds of *Lagenaria siceraria* contain number of primary metabolites. It forms an excellent diet being rich in dietary constituents, minerals, amino acids and vitamins (Tables 1-4).

6.1.1 Fruit

These contains pectin, vitamin b and ascorbic acid (fruit); glycine, histidine, lysine, methionine, tryptophan, linoleic, oelic, palmitic, palmitoleic, punicic, stearic acids, fructose, galactose, glucose, rhamnose, raffinose, stachyose, and sucrose [32,33].

6.1.2 Seed

These contains pectin, vitamin B and ascorbic acid, glycine, alanine, valine, histidine, lysine, methionine, tryptophan, tyrosine, phenylalanine, linoleic, oelic, palmitic, palmitoleic, punicic and stearic acids, fructose, galactose, glucose, rhamnose, raffinose, stachyose, and sucrose [32,33].

The nutritional composition of fruit (with peel and without peel) is given in Tables 1 and 2.



Fig. 1. Leaves and flower of *Lagenaria siceraria*



Fig. 2. Fruits of *Lagenaria siceraria*

Table 1. Dietary constituents of bottle gourd fruit

Sr. no.	Dietary constituents	With peel (g/100 g)	Without peel (g/100 g)	Reference
1	Total sugar	5.87	8.29	[32]
2	Reducing sugar	5.22	7.92	
3	Non-reducing sugar	0.65	0.29	
4	Starch	1.31	1.57	
5	Curd fiber	4.45	3.40	
6	Neutral detergent fiber	22.71	21.16	
7	Acid detergent fiber	16.26	15.67	
8	Hemicellulose	6.45	5.58	
9	Cellulose	16.07	16.40	
10	Lagenin	0.19	0.16	

Table 2. Mineral content of bottle gourd fruit

Sr. no.	Minerals	With peel (mg/100 g)	Without peel (mg/100 g)	Reference
1	Iron	11.87	2.33	[32]
2	Phosphorous	240.33	187.33	
3	Potassium	332.00	335.00	
4	Zinc	3.77	3.47	
5	Magnesium	162.33	146.33	
6	Copper	0.19	0.24	
7	Sodium	27.88	36.68	
8	Manganese	0.26	0.31	
9	Calcium	80.20	52.78	

Table 3. Amino acids present in bottle gourd (fruit and seed)

Sr. no.	Amino acids	Fruit (g/100 g)	Seed (g/100 g)	Reference
1	Tryptophan	0.43	[32]
2	Threonin	0.01	0.90	
3	Isoleucine	0.03	1.26	
4	Leucine	0.03	2.07	
5	Methionine	2.07	
6	Cystine	0.55	
7	Phenylalanine	0.01	1.22	
8	Valine	0.02	1.97	
9	Arginine	0.14	4.03	
10	Histidine	0.68	

Table 4. Vitamins content of bottle gourd (Fruit and seed)

Sr. no.	Vitamins	Fruit (mg/100 g)	Seed (mg/100 g)	Reference
1	Vitamin C	10.10	1.90	[32]
2	Thiamin	0.02	0.21	
3	Riboflavin	0.02	0.32	
4	Niacin	0.32	1.74	
5	Vitamin B6	0.04	0.22	
6	Pantothenic acid	0.15	0.33	
7	Vitamin E	160.0	10.00	
8	Choline	16.20 mg/g (dry basis)		

6.2 Secondary Metabolites

Various secondary metabolites isolated from the fruits of *Lagenaria siceraria* such as

cucurbitacins (Basic structure shown in Fig. 3) (triterpenoid substances-well-known for their bitterness and toxicity), which are the characteristic property of the family

Cucurbitaceae. Structurally cucurbitacin have a tetra cyclic cucurbitane nucleus namely 19 β -methyl-19-nor-lanosta-5-ene, which is divided in different categories. Cucurbitacin B, D, G and H. Mainly cucurbitacin B; having a bitter principle, is present in the fruit as aglycone. Leaves contain cucurbitacin B and roots contain cucurbitacins B, D (structural difference shown in Table 5) [34]. Cucurbitacins have been reported as the bitter principle in the Cucurbitaceae family [35]. On maturity of the fruits due to the effects of the enzyme elaterase, cucurbitacins are hydrolyzed to its non bitter principles [35]. Various other chemical constituents have also been isolated by

scientist such as oleanolic acid structure shown in Fig. 6) triterpenoids (22- deoxocucurbitacin D and 22-deoxoisocucurbitacin D, structure shown in Figs. 4, 5), sterols (campesterol and β sitosterol, structure shown in Figs. 9, 10) [11], flavone C-glycosides [36], tannins, saponins and flavonoids (isoquercitrin and kaempferol, structure shown in Figs. 7, 8) [11]. Friedooleanane-type triterpenoids C and D were also isolated [37].

A summary of various metabolites, found from different part of plant shown in Table 6.

Table 5. Structural differences between cucurbitacin B and cucurbitacin D

Sr. no.	Constituents	R ₁	R ₂	R ₃	R ₄
1	Cucurbitacin B	O	OH	H	OCOCH ₃
2	Cucurbitacin D	O	OH	H	OH

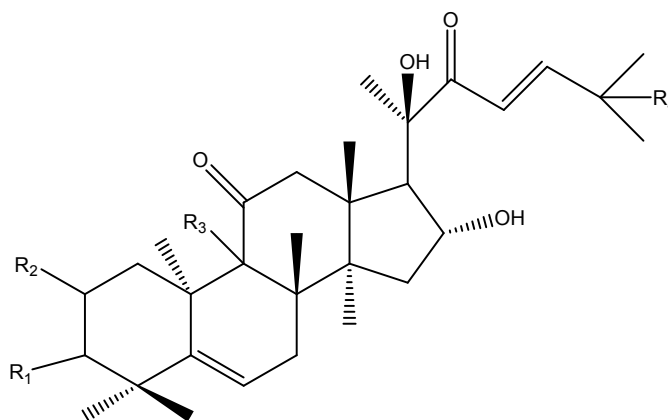


Fig. 3. Basic structure of cucurbitacin

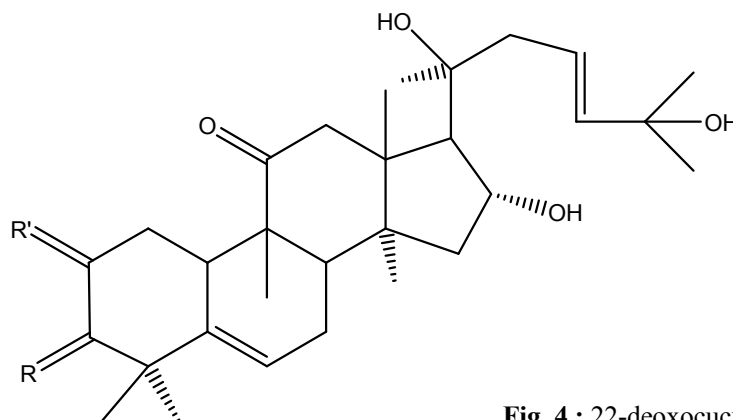


Fig. 4 : 22-deoxocucurbitacin D

R- O
R'- H

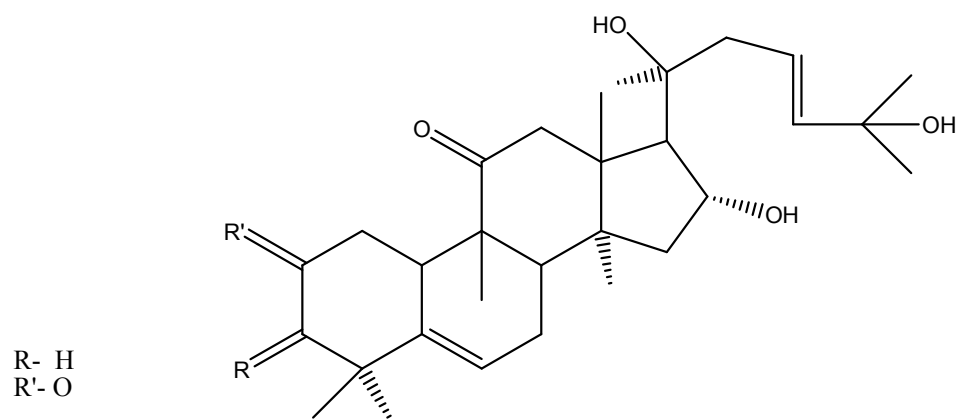


Fig. 5: 22-deoxy isocucurbitacin D

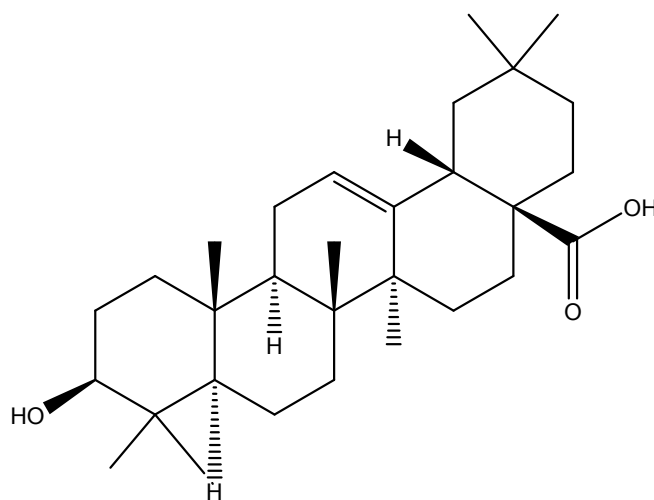


Fig. 6: oleanolic acid

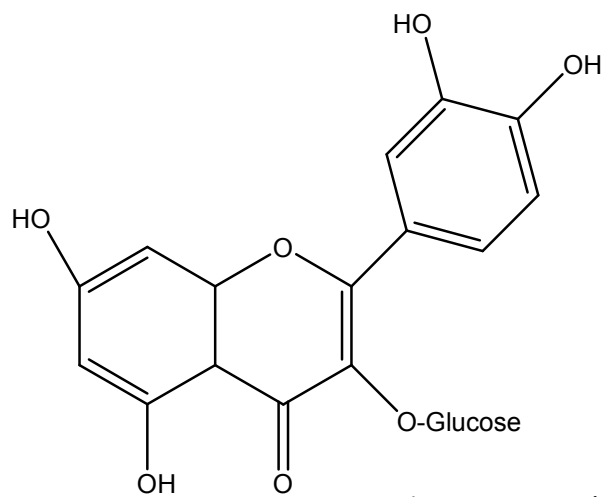


Fig. 7: Isoquercitrin

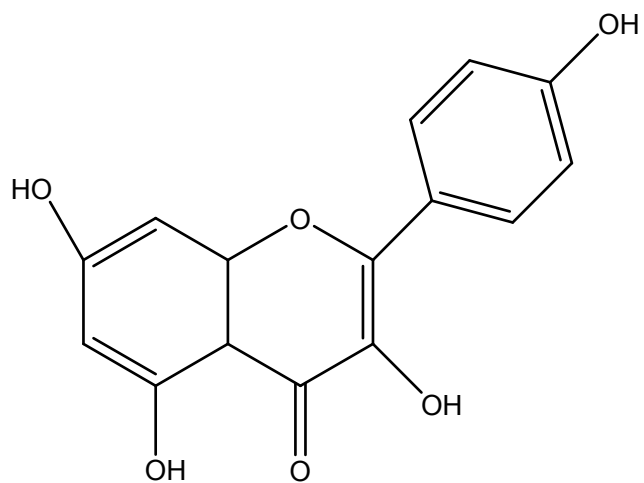


Fig. 8: Kaempferol

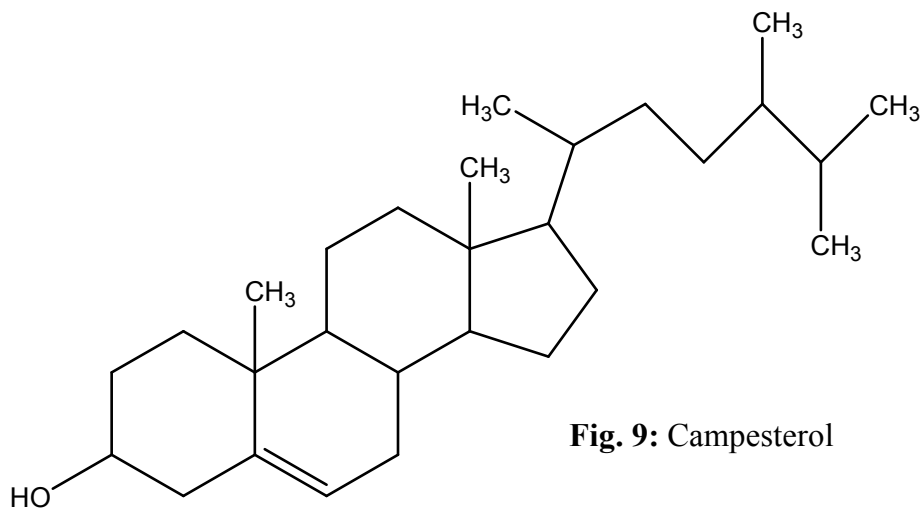


Fig. 9: Campesterol

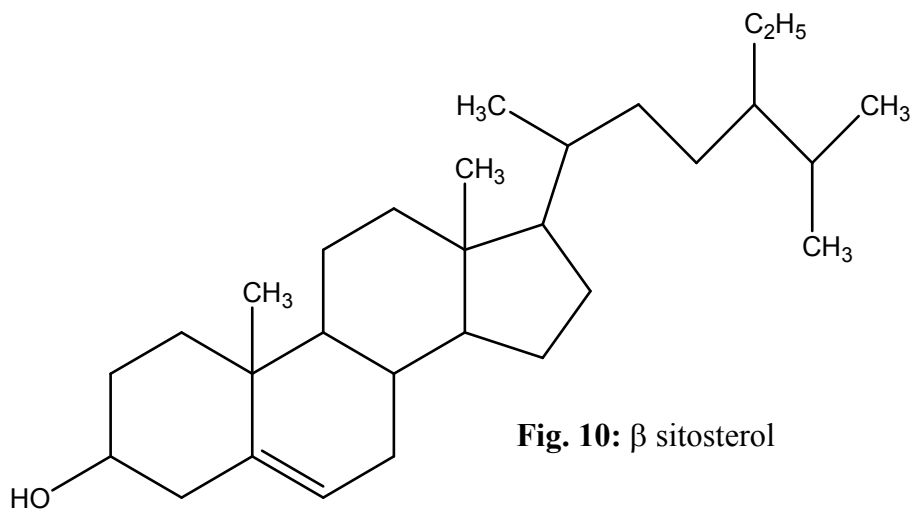


Fig. 10: β sitosterol

Table 6. Secondary metabolites from various parts of *Lagenaria siceraria*

Sr. no.	Plant part	Extract	Isolated compound	References
1	Fruit	Methanolic extract	Flavone C Glycosides	[36]
2	Fruit	Different fraction of Ethanolic extract	Sterols (β -sitosterol and campesterol)	[11]
3	Fruit	Various fraction of Methanolic extract	Triterpenoids, flavanoid (isoquercitrin, kaempferol) and Sterols (β -sitosterol and campesterol)	[38]
4	Stem	Methanolic Extract	D: C-friedooleanane-type triterpenoids	[37]

7. PHARMACOLOGICAL ACTIVITIES

activity was due to presence of sterols (campesterol and fucosterol).

7.1 Antidepressant Activity

Prajapati et al. [19] evaluated the antidepressant activity of methanolic extract of *Lagenaria siceraria* fruits in rats by using forced swim (behavior despair) model. The extract was used in doses of (50, 100 and 200 mg/kg, orally). The extract possesses antidepressant activity in dose dependent manner. The activity may be due to presence of flavanoids, triterpenoids, sterols and saponins.

7.4 Diuretic Activity

Ghule et al. [16] evaluated *Lagenaria siceraria* fruit for its diuretic activity in albino rats. The rats treated with vacuum dried fruit juice extract and methanol extract (100-200 mg/kg; per oral) showed higher urine volume when compared to the respective control. The activity indicated that vacuum dried fruit juice extract and methanolic extract act as effective hypernatremic, hyperchloremic and hyperkalemic diuretics (increased Na^+ , K^+ and Cl^- excretion values).

7.2 Antistress Activity

Lakshmi et al. [17] evaluated the antistress activity of ethanolic extract of *Lagenaria siceraria* in mice by using anoxia tolerance and chronic cold restraint stress models. The extract was evaluated in doses of (100, 200 and 400 mg/kg, per oral). The extract prolonged the onset of clonic convulsion, and amelioration of cold stress induced changes, thereby suggested an antistress and adaptogenic property. The activity was due to presence of flavonoids, glycosides, saponins, triterpenes, cucurbitans and steroids.

7.5 Analgesic and Anti-inflammatory Activity

Ghule et al. [40] investigated analgesic and anti-inflammatory effects of *Lagenaria siceraria* (Molina) Stand. Fruit juice extract (LSFJE) in rats and mice. LSFJE was studied for its analgesic effect on acetic acid-induced writhing and formalin pain tests in mice. The anti-inflammatory effects were investigated employing the acute inflammatory models, i.e. ethyl phenyl propionate induced ear edema, carrageenan, and arachidonic acid-induced hind paw edema and also the albumin-induced paw edema in rats. The activity was due to the presence of flavonoids.

7.3 Hypolipidemic and Antihyperlipidemic Activity

Ghule et al. [39] evaluated the hypolipidemic and antihyperlipidemic effect of different extract viz, Petroleum ether, Chloroform, Alcoholic and Aqueous extract of *Lagenaria siceraria* fruit in Triton- induced hyperlipidemic rats. Among the extract chloroform and alcoholic extract at two doses (200 and 400 mg/kg, per oral) showed significant effects in lowering total cholesterol (TC), triglyceride (TG) and low density lipoprotein (LDL) along with an increase in HDL level. The

7.6 Antiulcer Activity

Srivastava et al. [21] evaluated antiulcer activity of methanolic extract of the fruit of *Lagenaria siceraria* against Aspirin, Pylorus ligation and Ethanol induced ulcer models. The extract were used in dose of (100 and 200 mg/kg, per oral) and proved that the methanolic extract of the fruit in a dose (100-200 mg/kg, per oral) possesses potent antiulcer activity in rats.

7.7 Antidiabetic Activity

Saha et al. [41] evaluated the methanolic extract of *Lagenaria siceraria* aerial parts for Antidiabetic activity using Streptozotocin induced diabetic rats. The extract of were used in dose of (200 and 400mg/kg, per oral). Streptozotocin induced diabetic rats treated with methanolic extract showed the significant reduction in blood sugar levels and proved that the aerial part of the *Lagenaria siceraria* possess potent Antihyperglycemic activity, which is probably due to its rich flavanoid and polyphenolic contents.

7.8 Anticancer Activity

Saha et al. [42] evaluated the methanolic extract of *Lagenaria siceraria* (Mol.) Standly aerial parts for anticancer activity against Ehrlich Ascites carcinoma (EAC) model in mice. The extract was used in dose of (200 and 400 mg/kg, per oral). In EAC tumor bearing mice, a regular rapid increase in ascites tumor volume was observed. Ascitic fluid is the direct nutritional source for tumor cells and a rapid increase in ascetic fluid with tumor growth would be the means to meet the nutritional requirement of tumor cells. The extract significantly inhibited the tumor volume, packed cell volume and viable tumor cell count, increasing the non viable cell count. The extract possesses significant anticancer activity which may be due to presence of flavanoid.

7.9 Cardioprotective Activity

Upaganlawar et al. [22] evaluated the cardioprotective activity of *Lagenaria siceraria* fruit powder extract against Isoproterenol-induced Myocardial Infarction induced in Wistar male rats and proved that the *Lagenaria siceraria* possessed cardioprotective effect against Isoproterenol induced Myocardial infarction in rats. These effects might be due to the high conc. of polyphenolic components in the fruit of *Lagenaria siceraria*.

7.10 Hepatoprotective Activity

Deshpande et al. [12] evaluated hepatoprotective activity of the ethanolic extract of the *Lagenaria siceraria* fruit epicarp against the carbon tetra chloride induced hepatotoxicity. The extract of the fruit epicarp was used in doses of (100 and 200 mg/ kg, per oral). Silymarin was used as

standard in dose of (100 mg/kg, per oral). The extract in a dose of (200 mg/kg/, per oral) showed significant prevention of elevated levels of serum glutamate oxaloacetate transferase (SGOT), serum glutamate pyruvate transaminase (SGPT), alkaline phosphatase (ALP), acid phosphatase (ACP) and bilirubin. The activity was due to presence of sterols (campesterol and fucosterol).

7.11 Antioxidant Activity

Deshpande et al. [12] investigated the antioxidant activity of ethanolic extract of the *Lagenaria siceraria* fruit epicarp against the CCl₄-induced hepatotoxicity. The extract of fruit epicarp was used in doses of (100 and 200 mg/ kg, per oral). Silymarin was used a standard in dose of (100 mg/kg, per oral). The extract in a dose of (200 mg/kg) shows significant prevention of elevated levels of serum glutamate oxaloacetate transferase (SGOT), serum glutamate pyruvate transaminase (SGPT), alkaline phosphatase (ALP), acid phosphatase (ACP) and bilirubin. The activity was due to presence of sterols (campesterol and fucosterol).

7.12 Immunomodulatory Activity

Sathaye et al. [45] evaluated the immunomodulatory effect of fresh fruit juice of *Lagenaria vulgaris* against Pyrogallol induced immune-suppression in rats. They observed that fresh fruit juice cause stimulation of both humoral and cellular immune response in immune-compromised condition. Various non specific immunity parameters were also measured such as Neutrophils and total Leukocyte count. There was increase in Neutrophils and total Leukocyte count, which could be responsible for stimulation of non specific immunity.

7.13 Anthelmintic and Antimicrobial Activity

Badmanaban et al. [23] evaluated the anthelmintic and antimicrobial activity of the different leaf extract of *Lagenaria siceraria*. Ethanolic leaf extract showed the presence of carbohydrates, flavonoid, tannins and sterols. It is quite apparent from the studies that the sterols present in the ethanolic extract possess significant anthelmintic activity and antimicrobial activity.

8. WHY SHOULD WE USE BOTTLE GOURD FRUIT REGULARLY?

Bottle gourd, Lauki or Ghiya is one of the excellent fruit gifted by the nature to human beings having composition of all the essential constituents that are very important for human health. It forms an excellent diet because it is rich in carbohydrate, vitamins, amino acids and minerals. The fresh juice of Lauki is helpful in constipation, hyperlipidemia, diabetes, urinary disorders, insomnia and ulcer. It has the highest content of choline among all the vegetable

known to man till date, which serve as the precursor of neurotransmitter acetylcholine, which in turn is crucial for learning and memory. Bottle gourd juice is also helpful in regulation of blood pressure of hypertensive patients because of its high potassium content. It is helpful in losing weight quickly due to its high dietary fiber & low fat and cholesterol content. It is also useful in the management of many diseases like cardiac disorders, hepatic disorders and ulcer.

A detailed summary of pharmacological activities are given in Table 7.

Table 7. Pharmacological activities of different parts of *Lagenaria siceraria*

Sr. no.	Activity	Plant part	Extract/compound	References
1	Hepatoprotective	Fruit pulp	Ethanol extract	[11]
		Fruit	Ethanol extract	[12]
2	Immunomodulatory	Fruit epicarp	Ethanol extract	[12]
		Dried fruit	Methanol extract	[44]
		Fresh fruit	Fresh juice	[45]
3	Diuretic	Fruit	Vacuum dried extract, Methanol extract	[16]
4	Antidepressant	Fruit	Methanol extract	[18]
		Fresh fruit juice		[19]
5	Hypolipidemic and Antihyperlipidemic	Fruit	Petroleum ether,	[39]
		Fruit	Chloroform, alcoholic and	
	Fruit epicarp	Aqueous extract		
	Antihyperlipidemic	Fresh fruit	Methanol extract	[39]
			Ethanol extract	[12]
			Hydroalcoholic extract	[15]
6	Cardioprotective	Fruit	Fruit extract	[22]
7	Antiulcer activity	Fruit	Methanol extract	[21]
		Fresh fruit	Fresh fruit juice	[20]
8	Antihyperglycemic	Aerial parts	Methanol extract	[41]
		Fruit epicarp	Ethanol extract	[12]
9	Anticancer	Aerial parts	Methanolic extract	[42]
		Stem	Methanolic extract	[37]
		Fruit		[43]
10	Antibacterial activity	Leaf	Aqueous extract, ethanolic extract	[23]
11	Anthelmintic activity	Leaf	Aqueous extract, Ethanolic extract	[23]
12	Analgesic	Fruit	Aqueous extract, Methanolic extract	[10]
13	Anti-inflammatory	Root	Ethanolic extract	[9]
14	Antistress activity	Fruit	Ethanolic extract	[18]
		Fruit	Methanolic extract	[19]
15	Antioxidant (<i>In-vitro</i>)	Leaves	Ethanolic extract	[13]
		Fruit	Fresh juice	[45]
		Fresh and dried	Ethyl acetate and n-butanol	[46]
	Fruit	Extract		
Antioxidant (<i>In-vivo</i>)	Fruit	Ethanolic extract	[47]	
	Fruit epicarp	Ethanolic extract	[12]	

9. CONCLUSION

The traditional and therapeutic application of *Lagenaria siceraria* with its phytochemical profile need to be explored further based on its different activities. The phytochemical and pharmacological potential outlined throughout this review will help to maximize the desired therapeutic benefits of this well known plant. The plant needs to be further evaluated based on combined approaches of exploitation and exploration, which may help to find effective leads for further research.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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