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Phytochemical, Ethnobotanical and Pharmacological Profile of *Lagenaria siceraria*: - A Review

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In traditional systems of medicine, different parts (leaves, stem, flower, root, seeds and even whole plant) of *Lagenaria siceraria* (known as lauki in Hindi), has been used in the ointment for ailment of various diseases throughout India. The fruit of cultivated *Lagenaria siceraria* is the good source of different nutrients components like protein, fat, fibre, carbohydrates, calcium, magnesium. The plant has also been suggested to possess antioxidant activity, laxative, cardioprotective, diuretic, hepatoprotective, hypolipidemic, central nervous system stimulant, anthelmintic, antihypertensive, immunosuppressive analgesic, adaptogenic and free radical scavenging activity. This work reviews the pharmacological evidence of extracts of plants from the *Lagenaria siceraria*, giving an overview of the most studied biological effects and the known phytochemical composition. Although more studies are necessary, *Lagenaria siceraria* exhibits proven potential to become of important pharmacological interest.

Keyword: *Lagenaria Siceraria*, *Cucurbitaceae*, Phytochemistry, Pharmacological Activity.

1. Introduction

There is a worldwide belief that herbal remedies are safer and less damaging to the human body than synthetic drugs. Therefore laboratories around the world are engaged in screening of plants for biological activities with therapeutics potential. The Ayurveda has emphasized importance of food in the management of diseases. Even practitioner of modern system has realized the significance of dietary items, in the form of nutraceutical elements, in the treatment of chronic diseases^[1]. The dietary principles exist in plants of Cucurbitaceae family has a tremendous genetic diversity, extending to vegetative and reproductive characteristics^[2]. They grow in tropical, subtropical, arid deserts and temperate locations and are usually called as

gourds. The gourd family consists of a number of bioactive plants, which have been used extensively from ancient time for their therapeutic values. *Lagenaria siceraria* member of gourds and is traditionally used for treatment of various disorders. The plant, *Lagenaria siceraria* (Molina) standley (Family: Cucurbitaceae), known as bottle gourd, is a common fruit vegetable used throughout the India. Since time immemorial the fruit is used as immunosuppressant^[3], diuretic^[4], cardio-tonic, cardio-protective^[5] and nutritive agent^[6]. The fruit is also reported to have good source of vitamin-B complex and choline along with fair source of vitamin-C and β -carotene^[7]. It is also reported to contain Cucurbitacins, fibres, and polyphenol^[8]. Two sterols namely campesterol

and sitosterol have been identified and isolated from the petroleum ether fraction of methanol extract of *Lagenaria siceraria* fruits, which is reported to possess antihepatotoxic activity^[9]. The fruit has been reported to possess antioxidant activity^[10], hypolipidemic and triton-induced hyperlipidemic rats^[11]. HPLC analysis of methanol extract from plant shows the presence of flavones-c glycosides^[12]. Lagenin, a ribosome inactivating protein (RIP) isolated from the seeds of *Lagenaria siceraria* possesses immunoprotective, antitumor, anti HIV and antiproliferative properties^[13]. In view of the immense medicinal importance of the plant, it has been emphasized to compile all the information reported on its phytochemical, biological and pharmacological properties and an attempt has been made to generate concern among the researchers regarding its immense potential principles.

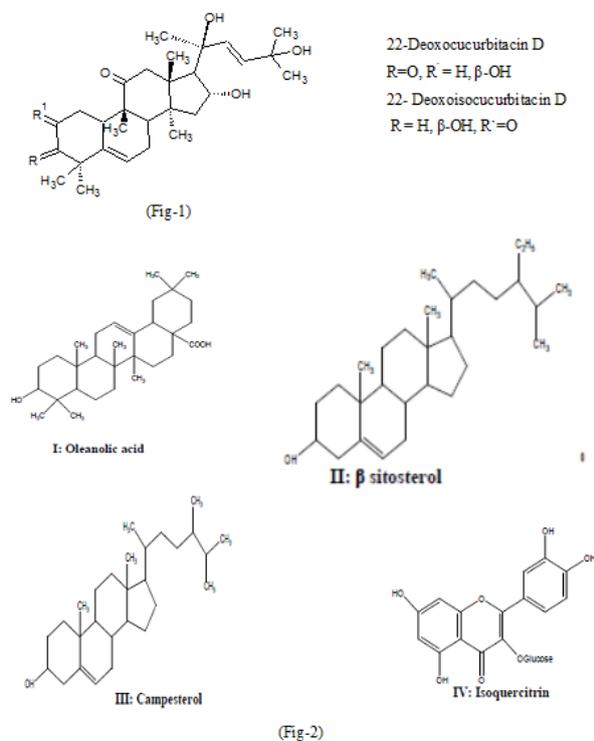
1.1 Macroscopic Study

Lagenaria siceraria is 7.9-15.5 cm long, elliptical shaped having entire margin and parallel venation. The apex of the plant is acute having leathery surface with firm texture, dark green color, bitter taste and characteristic odour. The transverse section of *Lagenaria siceraria* leaf showed upper epidermis consists of elongated parenchymatous cells, covered by cuticle. The upper epidermis shows few stomata, which are of anisocytic type. Lower epidermis contains elongated wavy walled parenchymatous cells covered by cuticle. Number of Covering and collapsed trichomes are present, while very few glandular trichomes are also present. Palisade cells are present at upper and lower epidermis. Mesophyll is made up of 3-4 layered chloroplasts containing, compactly arranged, oval to circular cells. It is interrupted by vascular bundles of various sizes. Vascular bundles are surrounded by 2-3 layered sclerenchyma; they are conjoint, collateral and closed. Xylem is placed towards upper epidermis and phloem towards lower epidermis^[14].

1.2 Phytochemistry

Alkaloids, phenols, tannins, flavonoids and steroidal compounds are known in the genus. Literature survey has revealed that a number of reports are available on *Lagenaria siceraria*, are discussed below. The phytochemical analysis of edible portion of the fruit it is shown that it is a good source Glucose and fructose. The amino acid composition of the fruit is as follows: leucines 0.8; phenylalanine 0.9; valine 0.3; tyrosine 0.4; alanine 0.5; threonine 0.2; glutamic acid 0.3; serine 0.6; aspartic acid 1.9; cystine 0.6; cysteine 0.3; arginine 0.4; and proline 0.3mg/g. The fruit is a good source of vitamins B and a fair source of ascorbic acid. Bitter fruits yield 0.013% of solid foam containing cucurbitacins B, D, G and H, mainly cucurbitacin B. These bitter principles are present in the fruit as aglycones. Leaves contain cucurbitacin B and roots, cucurbitacins B, D and E^[15]. Phytochemical screening of the fruit revealed two steroids were isolated from the petroleum ether fraction and they were identified as fucosterol and campesterol^[16]. Sugar and phenolic content of the fresh product were assayed, providing a partial nutritional characterisation of this vegetable. Glucose and fructose and traces of sucrose were found; in addition, a small amount of unidentified mono- and dicaffeoylquinic acid derivatives was detected^[17]. HPLC analysis of extract of flowering plant of *Lagenaria siceraria* shows presence of flavone-C glycoside^[12]. A water-soluble polysaccharide, isolated from fruiting bodies of *Lagenaria siceraria*, is composed of methyl- α -d-galacturonate, 3-O-acetyl methyl- α -d-galacturonate, and β -d-galactose in a ratio of nearly 1:1:1. This polysaccharide showed cytotoxic activity *in-vitro* against human breast adenocarcinoma cell line (MCF-7)^[18]. It is also reported to have content more proportion of soluble dietary fibers (SDF) than insoluble fibers. SDF are having profound effect in lowering serum cholesterol, which also reveals that the pectin is predominant component of soluble fibers in *Lagenaria siceraria* fruits^[19]. Peroxidase and polyperoxidase activity in relation to its blanching period and total enzymatic inactivation of blanched sample (i.e., residual peroxidase

activity is less than one) is also reported in 180 seconds.



In addition, small amount of unidentified mono- and dicaffeoylquinic acid derivative was detected. 30% inhibition of superoxide formation in xanthine and xanthine oxidase medium by methanolic extract (500 Mg/ml) from fruit of *Lagenaria siceraria* is reported^[20]. The seed of *Lagenaria siceraria* is also a good nutritive agent which contains vitamins, minerals, amino acids along with saponins and essential fixed oils and the seed is also used in dropsy and in worm infections^[21,22]. There are two triterpenoids isolated from its fruit 22- Deoxocucurbitacin D and 22- Deoxoisocucurbitacin D^[23] (fig-1) and some more compounds which have been isolated from the fruits of *Lagenaria siceraria* like oleanolic acid, β-sitosterol, campesterol, isoquercitrin^[24]. (fig-2)

1.3 Traditional Uses

The fruits, leaves, stem, seeds and oil of *Lagenaria siceraria* are traditionally used in the

treatment of jaundice, diabetes, ulcer, piles, colitis, insanity, hypertension, congestive cardiac failure, and skin diseases. The fruit pulp is used as an emetic, sedative, purgative, cooling, diuretic, antibilious, and pectoral. The flowers are an antidote to poison. The stem bark and rind of the fruit are diuretic. The seed is vermifuge. Extracts of the plant have shown antibiotic activity. Leaf juice is widely used for baldness^[25,21,26]. LS juice is an excellent remedy for heart problems, digestive and urinary disorders, and in diabetes. Dietary fibre present in LS helps in constipation, flatulence, and even in piles. Topical application of a mixture of LS juice and sesame oil on scalp gives beneficial results in baldness (hair loss). The juice also shows better effects in the treatment of insomnia, epilepsy, and other nervous diseases, moreover it helps break up calculus (stones) in the body. In summer or hot conditions, LS juice prevents excessive loss of sodium, satiating thirst, and giving a cooling effect^[21]. The tribal communities (Koyas, Gutti Koyas, and Lambadas) located in the northern Telangana zone use the dry hard shells of bottle gourd fruits for various purposes. Bottle gourd is variously referred as sorakaya, anapakaya, anapakaya, burrakaya, and tumri in the vernacular language by the tribal communities. Domestic utensils like bottles, bowls, milk pots, spoons, and containers of several types are made out of the dried shells. It is a common sight everywhere in the tribal dominated pockets of Khammam district that the ethnic groups are mainly using the dry shells for carrying country liquor (*mahua* drink, toddy), honey, and water.

In some of the pockets it is being used for making stringed and wind musical instruments and pipes. At few places, the natives use the dried shells as floats on water bodies as well. Though it is nutritionally less calorific, tribal prefer bottle gourd as a vegetable for preparation of curries and pickles [27, 28, 29]. The Koya community uses the fruits of the wild types for medicinal purposes (purgatives). Probably, the bitter principle found in the wild bottle gourds is responsible for the purgative property.

Nutrient components of the fruits of cultivated *Lagenaria siceraria*: (per 100g of edible portion)

Nutrient components	Denomination	Value
Water moisture	G	96.1
Protein	G	0.2
Fat	G	1.0
Minerals	G	0.5
Fibre	G	0.6
Carbohydrates	G	2.5
Energy	Calorie	12
Calcium	Mg	120
Magnesium	Mg	5
Phosphorous	Mg	10
Iron	Mg	0.7
Sodium	Mg	1.8
Potassium	Mg	87
Copper	Mg	0.3
Sulphur	Mg	10
Vitamin-A	IU	60
Thiamine	Mg	0.03
Riboflavin	Mg	0.01
Nicotinic acid	Mg	0.2
Vitamin-C	Mg	5
Oxalic acid	Mg	27

The pulp of the fruit is considered cool and diuretic^[30, 31]. Leaves of *Lagenaria siceraria* are taken as emetic in the form of leaf juice or decoction. This by adding sugar also used in Jaundice. Crushed leaves are used for baldness and applied on the head for the headache. Leaves are also used as alternative purgative^[22]. Fruit of *Lagenaria siceraria* is rich source of water and minerals and are believed to possess vitamin A, C and B complex^[32] details are expressed in table.

1.3 Pharmacology

1.3.1 Hepatoprotective activity

Lakshmi BVS, *et al*^[33], evaluated the hepatoprotective activity of *Lagenaria siceraria* fruit extracts against carbon tetrachloride (CCl₄)-induced hepatotoxicity on rats. Hepatotoxicity was induced in male Wister rats by Intraperitoneal injection of CCl₄ (1 ml/kg/day for 7 days). The ethanolic extracts of *Lagenaria siceraria* juice extract (LSJE) were administered to the experimental rats (400 mg/kg/day, p.o. for 10 days). The hepatoprotective effect of these extracts was evaluated by the assay of liver

function biochemical parameters (total bilirubin, serum protein, alanine aminotransaminase, aspartate aminotransaminase, and alkaline phosphatase activities), liver weight and histopathological studies of the liver. In LSEE-treated animals, the toxic effect of CCl₄ was controlled significantly by restoration of the levels of serum bilirubin, protein and enzymes as compared to the normal and the standard drug Silymarin - treated groups. Histology of the liver sections of the animals treated with the extracts showed the presence of normal hepatic cords. Experimental results revealed that *L. Siceraria* fruits possess significant hepatoprotective activity.

1.3.2 Central nervous system activity

The central nervous system activity of *Lagenaria siceraria* activity has been studied by P.C. Jayashree^[34]. In this study petroleum ether, methanol and chloroform extract shows significant analgesic activity but Petroleum ether extract shows maximum analgesia among them the petroleum ether extract and methanolic extract significantly and in dose dependent manner reduce the nociception induced by acetic acid. In hot plate and tail flick test methanolic and petroleum ether extract shows more significant action than chloroform extract. In the study of the CNS-depressant effect, the methanolic extract significantly reduces spontaneous motor activity at higher doses than petroleum ether extract. The fall off time (motor coordination) was also decreased. A potentiation in the pentobarbitone-induced sleep due to the sedative effect of the methanolic extract was observed. The result shows that petroleum ether extract and methanolic extract shows analgesic and CNS-depressant activity is due to the presence of different chemical compounds present in that extracts.

1.3.3 Antioxidant activity

Acetone extract of fruit epicarp of *Lagenaria Siceraria* fruit showed maximum antioxidant activity against *in vitro* model using DPPH (1, 1-diphenyl-2-picryl hydrazyl). The fresh juice of the fruit also shows antiradical activity. The juice

as such and its ten times dilution showed radical scavenging activity whereas 100 and 1000 times diluted juice does not show any radical scavenging activity^[35]. Extract is also effective in CCl₄ induced liver damage where it maintained the level of endogenous antioxidant enzymes (superoxide dismutase, catalase and glutathione peroxidase) and marker of lipid peroxidation to that of normal^[5].

1.3.4 Cardioprotective activity

M Hassanpur Fard *et al.*^[5] evaluated the cardioprotective activity of *Lagenaria siceraria* fruit powder rat. Male Wistar albino rats (250-300 gm) were divided in three groups. The drug was studied against Doxorubicin induced cardiotoxicity at 200 mg/kg, p.o for 18 days. L.S. prevents the alteration in endogenous antioxidants (superoxide dismutase, reduced glutathione) and lipid peroxidation whereas markers of cardiotoxicity i.e. CK-MB (Creatine kinase) and LDH (lactate dehydrogenase) were significantly reduced. Further the L.S powder also showed the protection against changes in ECG and histopathological alteration induced by doxorubicin.

1.3.5 Diuretic Activity

Vacuum dried extract and methanol extract of *Lagenaria siceraria* fruit was evaluated for its diuretic activity by Ghule *et al.*^[4] Diuretic activity was assessed by measuring different parameters like total urine volume, urine concentration of sodium, potassium and chloride and found that both the extracts (100-200 mg/kg, p.o.) showed higher urine volume and exhibited dose dependent increase in excretion of electrolytes when compared with respective control.

1.3.6 Antihyperglycemic activity

Antihyperglycemic activity of methanol extract of *Lagenaria siceraria* aerial parts (MELS) for its purported use in diabetes has been reported. Hyperglycemia was induced by streptozotocin (50 mg/kg, i.p.) in rats. Treatment was done by MELS at doses of 200 and 400 mg/kg, p.o. for 14 days. Glibenclamide (500 µg/kg) was used as a reference drug. Antihyperglycemic potential was

assessed by fasting blood glucose (FBG) measurement (on days 0, 4, 8 and 15), biochemical tests (SGPT, SGOT, ALP, total cholesterol, triglycerides), antioxidant assay (lipid peroxide, catalase and glutathione) and histologic study of the liver, kidney and pancreas tissue. Significant reduction (P<0.001) in FBG levels was observed with treatment duration. Antioxidant and biochemical parameters were significantly improved by MELS and glibenclamide treatment. Histologic observations showed good correlations with the results obtained. The study explored the potent antihyperglycemic activity of MELS, which shows presence of good Flavonoid content in *lagenaria siceraria* plant^[36].

1.3.7 Cytotoxic activity

Chiy-Rong Chen *et al.*^[37] reported D: C-Friedooleanane-Type Triterpenoids from *Lagenaria siceraria* showing Cytotoxic Activity. Air-dried pieces of the stems of *L. siceraria* (19.4 kg) were extracted three times with methanol at room temperature. The methanolic extract was evaporated in vacuum to give a black residue, which was suspended in H₂O and then partitioned sequentially using EtOAc and n-BuOH. The EtOAc fraction (195 gm) was chromatographed over silica gel, using mixtures of n-hexane and EtOAc of increasing polarity as eluents. Twenty-two fractions were collected. The cytotoxicity of compounds 1-9 was measured using the MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-Diphenyltetrazolium bromide] colorimetric method based procedure. Compounds 3b -O-(E)-coumaroyl-D: C-friedooleana-7, 9 (11)-dien-29-oic acids and 20-epibryonolic acid showed significant cytotoxic activity against the SK-Hep 1 cell line with IC₅₀ values of 4.8 and 2.1 mg/ml, respectively.

1.3.8 Antihyperlipidemic effect

Methanolic extract of *Lagenaria siceraria* fruits (LSFE) (100, 200 and 300 mg/kg; p.o.) was administered to the high fat-diet-induced hyperlipidemic rats for 30 days to evaluate its antihyperlipidemic activity. Atorvastatin (10 mg/kg; p.o.) was used as a standard drug. At the

30th day, most significant reduction in lipid levels in the LSFE treated rats as compared to the rats fed with high-fat diet at the 0th day were: total cholesterol 290.14 ± 18.42 mg/dl vs. 228.58 ± 16.38 mg/dl, low density lipoprotein cholesterol 195.14 ± 8.86 mg/dl vs. 120.57 ± 8.11 mg/dl, triglyceride 232.41 ± 15.22 mg/dl vs. 181.79 ± 15.68 mg/dl, very low-density lipoprotein cholesterol 46.48 ± 3.04 mg/dl vs. 36.35 ± 3.13 mg/dl ($P < 0.0001$). Conversely, high-density lipoprotein cholesterol levels were significantly ($P < 0.0001$) increased from 48.52 ± 6.52 to 71.66 ± 5.14 mg/dl. The increase in weight in rats administered with LSFE was less when compared to rats fed with high-fat diet^[38].

1.3.9 Anticancer activity

Anticancer activity of methanol extract of *Lagenaria siceraria* aerial parts has also been reported on Ehrlich's Ascites Carcinoma (EAC) model in mice. After inoculation of EAC cells into mice treatment with MELS (200 mg and 400 mg/kg) and standard drug 5-fluorouracil (20 mg/kg) were continued for 9 days. Evaluation of the effect of drug response was made by the study of tumour growth response including increasing in life span, study of haematological parameters biochemical estimation and antioxidant assay of liver tissue. Experimental results revealed that *L. siceraria* possesses significant anticancer activity which may be due to its cytotoxicity and antioxidant properties^[39].

1.3.10 Analgesic activity

The analgesic activity of methanolic and aqueous extract of fruit of *Lagenaria siceraria* was evaluated using the tail immersion method in rats. The rats were evaluated for the pain threshold at a different interval of time up to 180 minutes. The methanolic extract shows a moderate activity at 180 min (3.97 ± 0.013) while aqueous extract shows a significant activity at 180 min (5.81 ± 0.006). The results support the traditional use of this plant in some painful and inflammatory conditions^[40].

1.3.11 Antidepressant activity

Prajapati R. *et al.*^[41] evaluated the antidepressant activity of methanolic extract of *Lagenaria*

siceraria fruits using forced swim model. *Lagenaria siceraria* were dried and extracted with methanol in soxhlet apparatus for 5-6 hours. Male Wistar albino rats (250-300 gm) were subjected to behavior despair test. Imipramine was used as a reference standard drug. The *Lagenaria siceraria* fruits (50, 100 and 200 mg/kg PO) showed dose dependent significant reduction in duration of immobility ($p < 0.01$) in behavior despair test. Experimental results revealed that *L. Siceraria* fruits possess significant antidepressant activity.

1.3.12 Immunomodulatory activity

Immunomodulatory effects of n-butanol-soluble and ethyl acetate soluble fractions of successive methanolic extracts of the fruits were evaluated in rats. Oral administration of these fractions at doses 100-500 mg/kg significantly inhibited delayed-type hypersensitivity reaction in rats. A dose-dependent increase in both primary and secondary antibody titer was observed. Fractions also significantly increased both white blood cell and lymphocyte count^[42].

1.3.13 Antistress and adaptogenic property

Lakshmi BV, *et al.*^[43] evaluated the antistress potential of ethanolic extracts of fruits in albino Wistar rats and investigated the influence of forced swimming endurance stress on swimming endurance time, organ weights, and changes in biochemical parameters in rats. They investigated the acute heat stress induced changes in biochemical parameters, adrenal gland weight, and stress-induced perturbations in blood cell counts in rats. As a standard reference drug, *Withania somnifera* was used. Pre-treatment with the extract at different doses significantly ($P < 0.05$) ameliorated stress-induced variations in the following biochemical parameters in these stress models: serum glucose, triglyceride, cholesterol and cortisol levels, blood cell counts, and organ weights. Extract-treated animals also showed increase in swimming endurance time. LS prolonged swimming time and ameliorated stress-induced changes in both stress models. This ability suggests both antistress and adaptogenic properties.

1.3.14 Antimicrobial activity

Goji M, *et al*^[44] evaluated antimicrobial activity of methanolic extracts of the leaves, seeds, and fruit-flesh of *L. siceraria* using the agar-well diffusion method. Results revealed LS extract to show activity against *Pseudomonas aeruginosa* and *Streptococcus pyogenes*, but not against clinical isolates of *S. aureus* and *Escherichia coli*. Thus LS can be used to treat various skin disorders.

2. Conclusion

In recent years emphasis of research has been on utilised traditional medicines that have a long and proven history of treating various ailments. In this regard ancient classical literature and ethnomedical surveys discussed the use of *Lagenaria siceraria* in traditional system of medicine for the treatment of different diseases such as fever, pain, ulcer, cough, and asthma. A number of active principles like oleanolic acid, β -sitosterol, campesterol, kaempferol and isoquercitrin isolated from the plant are potent antioxidant and are useful to overcome various therapeutic complications arising from reactive oxygen species. The pharmacological actions attributed to *Lagenaria siceraria* in Ayurvedic texts have been validated by scientific researches, and the result indicate potent antioxidant activity, diuretic activity, antihyperglycemic activity, anticancer activity, analgesic activity and antidepressant activity exhibited from major component of the plant. Further evaluation on active principles and therapeutic efficacy needs to be carried out on *Lagenaria siceraria* in order to explore the hidden bioactive compound and their clinical application.

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