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Ethnomedicinal and pharmacological profile of *Abelmoschus esculentus*: A literature based review

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Abstract
Herbal medicine is one of the oldest valuable bestowals that were given to mankind. Many plants and herbs hold their prestigious position in the field of medicine. Plants are being used from more than 1000 years to treat diseases. Medicinal plants which act as therapeutic agents are also a good source of information for a wide variety of phytochemical constituents which can be developed as drugs with precise and good selectivity. These are the bank of potentially useful active constituents which could serve as novel leads and clues for newer drug design. Okra is a cultigen (a plant that has been altered by humans through a process of selective breeding). The exact origin of okra is unknown, but it is thought to have come from Africa, where it has been grown as a crop for centuries. Evidence suggests it was grown in Egypt as long ago as 2,000 BC. Medicinal plants are believed to be safer and proved elixir in the treatment of various ailments. *Abelmoschus esculentus* (Okra) is an important medicinal plant of tropical and subtropical India. Its medicinal usage has been reported in the traditional systems of medicine such as Ayurveda, Siddha and Unani. This review aimed at summarizing phytochemical reports and biological activities of *Abelmoschus esculentus L.* from the database sources. The findings suggest that *A. esculentus* contains various nutrients and important phytochemicals. It possesses a number of important ethnomedicinal and biological activities.

Keywords: Abelmoschus esculentus, phytochemicals, anti-cancer activity, okra, herbal medicine.

Introduction
In biological systems a variety of naturally occurring compounds and their association with the prevention in various ailments like cardiovascular diseases, liver, kidney disorders, chronic diseases and certain forms of cancer have been investigated and several studies have shown that diet rich in fresh food and vegetables like carrot, beetroot, tomato, grapes, Spanish, green tea, garlic and turmeric etc. provide a shield against degenerative diseases. In the recent years, natural compounds isolated from several plants have attracted the focus of researchers for their medicinal and dietary values. Although their biologically active components are unknown, herbal drugs are prescribed widely because of their effectiveness, fewer side effects, and relatively low cost. Due to lack of awareness of a satisfactory remedy for serious liver diseases and increasing doubt on the efficacy and safety of the currently used drugs or herbal formulations, there is a need to find effective and safe drugs or herbal medicines for liver disorders [1,2]. *Abelmoschus esculentus* L. (Family: Malvaceae), also known as Hibiscus esculentus, is an important vegetable, widely distributed from Africa to Asia, Southern Europe, and America that is more commonly known as Ladies finger, okra, or gumbo. Okra (*Abelmoschus esculentus*) is the only vegetable crop of significance in the Malvaceae family and is very popular in the Indo-Pak subcontinent. In India, it ranks number one in its consumption but its original home is Ethiopia and Sudan, the north-eastern African countries. It is one of the oldest cultivated crops and presently grown in many countries and is widely distributed from Africa to Asia, southern Europe and America[2].
It is a tropical to subtropical crop and is sensitive to frost; low temperature, water logging and drought conditions, and the cultivation from different countries have certain adapted distinguishing characteristics specific to the country to which they belong. It is an oligo purpose crop, but it is usually consumed for its green tender fruits as a vegetable in a variety of ways. These fruits are rich in vitamins, calcium, potassium and other mineral matters. The mature okra seed is a good source of oil and protein has been known to have superior nutritional quality. Okra seed oil is rich in unsaturated fatty acids such as linoleic acid, which is essential for human nutrition. Its mature fruit and stems contain crude fibre, which is used in the paper industry [3,4].

Synonyms
Okra is known by many local names in different parts of the world. It is called lady's finger in England, gumbo in the United States of America, guino-gombo in Spanish, guibeiro in Portuguese and bhindiin India. In its origin of Ethiopia it is also called Kenkase (Berta), Andeha (Gumuz), Bamia (Oromica/Amharic). The name Okra probably derives from one of Niger-Congo group of languages (the name for okra in the Twi language is nkuruma). The term okra was in the use of English by the late 18th century [4,5].

Origin and Distribution
Okra is an allopolyploid of uncertain parentage (proposed parents include *Abelmoschus ficulneus*, *A. tuberculatus* and a reported "diploid" form of okra). Truly wild (as opposed to naturalised) populations are not known with certainty and the species may be a cultigen. The geographical origin of okra is disputed, with supporters of South Asian, Ethiopian and West African origins. The Egyptians and Moors of the 12th and 13th centuries used the Arabic word for the plant, bamya, suggesting it had come into Egypt from Arabia, but earlier it was probably taken from Ethiopia to Arabia. The plant may have entered southwest

Asia across the Red Sea or the Bab-el-Mandeb straight to the Arabian Peninsula, rather than north across the Sahara, or from India. One of the earliest accounts is by a Spanish Moor who visited Egypt in 1216 and described the plant under cultivation by the locals who ate the tender, young pods with meal. From Arabia, the plant spread around the shores of the Mediterranean Sea and eastward. The plant was introduced to the Americas by ships plying the Atlantic slave trade by 1658, when its presence was recorded in Brazil. It was further documented in Suriname in 1686. Okra may have been introduced to South-eastern North America from Africa in the early 18th century. By 1748, it was being grown as far north as Philadelphia. Thomas Jefferson noted it was well established in Virginia by 1781. It was commonplace throughout the Southern United States by 1800, and the first mention of different cultivars was in 1806 [6,7].

Botany and Cultivation

The species is a perennial, often cultivated as an annual in temperate climates, and often grows to around 2 metres (6.6 ft) tall. As a member of the Malvaceae, it is related to such species as cotton, cocoa, and hibiscus. The leaves are 10-20 centimetres (3.9-7.9 in) long and broad, palmately lobed with 5-7 lobes. The flowers are 4-8 centimetres (1.6-3.1 in) in diameter, with five white to yellow petals, often with a red or purple spot at the base of each petal. The pollens are spherical with approximately 188 microns diameter. The fruit is a capsule up to 18 centimetres (7.1 in) long with pentagonal cross-section, containing numerous seeds. *Abelmoschus esculentus* is cultivated throughout the tropical and warm temperate regions of the world for its fibrous fruits or pods containing round, white seeds. It is among the most heat- and drought-tolerant vegetable species in the world and will tolerate soils with heavy clay and intermittent moisture, but frost can damage the pods. In cultivation, the seeds are soaked overnight prior to planting to a depth of 1-2 centimetres (0.39–0.79 in). Germination occurs between six days (soaked seeds) and three weeks. Seedlings require ample water. The seed pods rapidly become fibrous and woody and, to be edible as a vegetable, must be harvested when immature, usually within a week after pollination. Okra is available in two varieties, green and red. Red okra carries the same flavour as the more popular green okra and differs only in colour. When cooked, the red okra pods turn green. The most common disease afflicting the okra plant is verticillium wilt, often causing a yellowing and wilting of the leaves. Other diseases include powdery mildew in dry tropical regions, leaf spots, and root-knot nematodes [8,9].

Fig 1: Abelmoschus esculentus plant

Fig 2: Abelmoschus esculentus fruits

Fig 3: Abelmoschus esculentus leaves

Fig 4: Abelmoschus esculentus flower

Fig 5: Abelmoschus esculentus seeds

Culture

Annual that is easily grown in moist, moderately fertile, well-drained soils in full sun. Best flowering is in full sun, thrives in hot summer climates. Seeds are sensitive to cold temperatures and should not be planted outside until soil temperatures have

risen to 60 ^{0}F. and night temperatures no longer dip below 55 ^{0}F. As an alternative, seed may be started indoors about 1-2 weeks prior to last frost date with seedling planted outside as soon as soils warm. Harvest the pods when they reach 3" long. First harvest of okra will occur about 55 days after seeds sprout. Seed may be harvested from garden plants for planting the following year. *Abelmoschus esculentus*, commonly called okra, is native to tropical Africa and Asia. It is an annual that typically grows 3-5' tall. It is grown for harvest of its edible fruit/seed pods which are perhaps best noted as the signature ingredient in gumbo. Species plants feature hibiscus-like yellow flowers (to 2-3" wide) with purplish centers. Cultivars expand the available flower colours to include attractive shades of pink, orange-red and red often with white centers. Flowers last only for one day, but plants bloom freely throughout the growing season to frost. Flowers give way to fruit capsules which have a musky aroma, hence the common name. Hairy, dark green leaves are deeply cut into 3-7 lobes. Genus name is believed to come from the Arabic *abu-l-mosk* in reference to the smell of the seeds. Specific epithet means good to eat or edible [10].

Table1: Taxonomical classification

Kingdom	**Plantae - Plants, Planta, Vegetal**
Subkingdom	Virindiplantae – Green Plants
Infrakingdom	Streptophyta – Land Plants
Superdivision	Embryophyta
Division	Magnoliophyta
Subdivision	Spermatophytina
Class	Magnoliopsida
Order	Malvales
Superorder	Rosanae
Family	Malvaceae
Genus	Abelmoschus
Species	A. esculentus
Binomial name	Abelmoschus esculentus

Phytochemistry

The Okra fibre contains 67.5% α-cellulose, 15.4% hemicellulose, 7.1% lignin, 3.4% pectic matter, 3.9% fatty and waxy matter, and 2.7% aqueous extract. Petals yield 13 flavonoid glycosides, gossypetin and hibiscetin glucosides. Fresh fruits are rich in pectin and mucilage; they contain oxalic acid, protein, fat, minerals (potassium, sodium, magnesium, sulphur, copper, manganese, and iodine), carbohydrate, calcium, and phosphorus. The mucilage of fruits contains flavonoids, d-galactose, l-rhamnose, and d-dalacturonic acid. Ripe seeds contain 10–22% edible oil. Essential oil isolated from the pods and seeds contain aliphatic alcohols, cyclohexanol, p-tolualdehyde (in fruits), α-terpenylacetate (in seeds), and citral; non-volatile neutral part contains β-sitosterol and its 3β-galactoside (in seeds). Ethanolic and aqueous fruit extracts contain carbohydrate, gums and mucilages, proteins, phytosterols, flavonoids, tannins, phenolic compounds, and volatile oil. The fruit also contains some important vitamins; these include vitamin A, B complex (B1, B2, B3, and B9), C, E, and K [11,12].

Table 2: Chemical constituents from Abelmoschus esculentus

S. No.	**Compound**	**Name**
1	Hyperoside/Hyperin	dihydroxyphenyl-3-[(3R,4S,5R,6R)-3,4,5-trihydroxy-6-(hydroxymethyl) oxan-2-yl] oxy-4H-chromene-4,5,7-triol
2	Flavonoid glycoside	5,7,3’,4’-tetrahydroxy-4’’-O-methyl flavonol-3-O-β-D-glucopyranoside
3	Flavonoid glycoside	5,7,3’,4’-tetrahydroxy flavonol-3-O-[β-D-glucopyranosyl-(1→6)]-β-D-glucopyranoside
4	Coumarin scopoletin	7-hydroxy-6-methoxychromen-2-one
5	Uridine	1-[(3R,4S,5R)-3,4-dihydroxy-5-(hydroxymethyl) oxolan-2-yl] pyrimidine-2,4-dione

Ethnomedicinal use

Lady’s finger is widely used in ethnomedicine in diverse cultures. In Ayurveda, it is used to treat various diseases specified in following Table 3.

Table 3: Ethnomedicinal reviews [13-25]

S. No.	**Plant parts**	**Used for**
1	Root	Used as stomachic to treat diabetics, ulcer; used as laxative to treat jaundice, to treat cuts, wounds and boils, treatment of syphilis, Used for demulcent and emollient action
2	Leaves	Extract of leaves mixed with egg albumin and applied on hair, which makes black and silky hair
3	Flower	Used for the treatment of bronchitis and pneumonia
4	Fruit	For treating dysentery and diarrhoea in acute inflammation and irritation of the stomach, bowels and kidneys catarrhal infections, ardour urinae, dysuria, diuretic, antipyretic, plasma replacement and gonorrhoea, used for demulcent and emollient poultice, use as anti-spasmodic, cordial and stimulant, to treat spermatorrhoea
5	Seed	Has a sudorific property, to treat diabetes mellitus by increased blood glucose level, remedies for tumor

Pharmacological profile

Hepatoprotective activity

Plant extract having antioxidant activities also leads to the inhibition of oxidative damage to a targeted tissue. Considering such antioxidant potential, the *in vivo* hepatoprotective effect of *A. esculentus* was evaluated using CCl_4 intoxicated HepG2 cell line and Wistar rats by estimating the levels of hepatic and anti-oxidant markers. The root extract of *A. esculentus* showed IC50 values of 270.99 and 532.86 µg/mL for DPPH and hydroxy radical scavenging assays, respectively. The incubation of HepG2 cells with CCl_4 drastically decreased the cell viability and increased the leakage of transaminases. Pre-treatment with the extract significantly restored the cell death by 31.25% and 39.04% at 200 and 400 µg/mL concentrations, respectively. The reduction of ALT leakage by the treatment was 18.62%, 38.59% and 52.15% compared to the CCl_4 treated cells at 100, 200 and 400 µg/mL, respectively. In *in-vivo* experiments, the treatment reduced the levels of transaminases, ALP, MDA, total bilirubin and hepatic TNF-α level as well as increased the anti-oxidant levels in a dose dependent manner. Histological observations of liver sections showed reduction in steatosis, necrosis and inflammation [26].

Anti-cancer activity

Cancer is an abnormal type of tissue growth in which the cells exhibit an uncontrolled division, relatively in an autonomous fashion, leading to a progressive increase in the number of dividing cell. Cancer is one of the ailments, which cannot be completely subdued by chemotherapy. Literature review revealed that okra is used as a chemo-preventive agent by inhibiting the growth of cancer cells by proper signaling mechanisms. Metabolic product such as indole-3-carbinols from the seeds and flowers of *A. esculentus* are known to be examined in the treatment of several cancers. The flowers of *A. esculentus* were tested for its anti-cancer activity against human liver cancer HePG2 cell line by MTT assay. The MTT assay of the compound isolated from the ethyl acetate fraction of flowers of A. esculentus. The CTC50 value of the sample was 444.22 µg/ml against liver cancer HePG2 cell lines for MTT assay. Results showed that phytochemical compounds of this plant from flowers have great potential to act as a source of useful anticancer drug [27].

Lipid lowering effect

Dichloromethane and methanol fruit and whole plant extracts (30g of dry extract/kg [p.o.]) also reduced cholesterol and triglyceride

Levels in tyloxapol-induced hyperlipidemia mice (n = 7) [28], whereas the peel and seed powder of the plant were evident to show an anti-hyperlipidemic activity in STZ-induced diabetic rats [29].

Anti-bacterial activity: Lyophilized and fresh water extracts of the pods were found to act against *Rhodococcus erythropolis*, *Rhodococcus opacu*s, Mycobacterium sp., *Mycobacterium aurum*, *Staphylococcus aureus*, *Escherichia coli*, Xanthobacter Py2, and *Pseudomonas aeruginosa* (minimum inhibitory concentration: 12.5–80% v/v) [30].

Gastro protective effect

In a recent study, the ethanol extract of the plant (500, 250, or 100 mg/kg) was also shown a gastroprotective effect by a significant decrease in edema, hemorrhage, inflammation scores, and apoptosis, whereas an increase in serum β-carotene and retinol levels in ethanol-induced acute gastric mucosal injury Wistar rats [31].

Anti-fatigue and Anti-oxidant effects

Anti-oxidant assays, including 1-diphenyl-2-picrylhydrazyl scavenging, ferric reducing antioxidant power, reducing power test and weight-loaded swimming test showed its seeds possessed significant anti-oxidant and anti-fatigue effects. Moreover, biochemical determination revealed that anti-fatigue activity of okra seeds is caused by reducing the levels of blood lactic acid and urea nitrogen, enhancing hepatic glycogen storage, promoting anti-oxidant ability by lowering malondialdehyde level and increasing superoxide dismutase and glutathione peroxides levels [32].

Cardiovascular disease

This study investigated the effect of mucilage of okra (crude water extract and water fraction) fruit on lipid parameters in a high-fat diet fed rats. Okra crude water extract (500 and 1000 mg/kg body weight) or water fraction (50 and 100 mg/kg body weight) was provided with a high fat diet to hypercholesterolemic rats for one week. The effect of treatment of okra fruit on lipid parameters of hypercholesterolemic rats were evaluated and compared with the negative control and positive control rats. Crude water extract (1000 mg) and the water fraction of okra (50 mg and 100 mg) had the potential to reduce ($p < 0.01$) different lipid fractions (total cholesterol, triglycerides, LDL and VLDL) and atherogenic index in the test group. The mucilage had the potential to increase the HDL fraction ($p < 0.01$) of the test group. These results suggest that crude water extract and the water fraction of the okra fruit modulate the blood lipid levels favourably and have the potential to be used as a "heart friendly" vegetable [33].

Neurological disorders

Literature review revealed that okra attenuates the production of the proinflammatory mediators, NO and ROS, as well as production of TNF-α and IL-1β, in LPS-stimulated BV2 microglial cells by suppressing Akt-mediated NFκB pathway. The findings provide evidence that okra possesses potential anti-oxidative and anti-inflammatory activities in neuronal disorders induced by activated microglia [34].

Immunomodulating activity

Their immunomodulatory activity was evaluated with an *in vitro* cell model (RAW264.7 cells). *In vivo* immunomodulatory activity of RPS-2 was evaluated in normal and cyclophosphamide-induced immunosuppressed mice. The results showed that the molecular weights of RPS-1, RPS-2, and RPS-3 were 600, 990, and 1300 kDa, respectively. RPS-1 and RPS-2 were mainly composed of galactose, rhamnose, galacturonic acid, and glucuronic acid, while RPS-3 was mainly composed of galactose, rhamnose, galacturonic acid, glucuronic acid, and glucose. FT-IR and NMR spectrum data indicated a

Rhamnogalacturonan I characteristic of polysaccharide. Both RPS and its purified fractions RPS-1, RPS-2, and RPS-3 significantly increased RAW264.7 cell proliferation, nitric oxide (NO) production, inducible nitric oxide synthase (iNOS) expression, and tumor necrosis factor (TNF)-α, interferon (IFN)-γ, and interleukin (IL)-10 secretion ($p < 0.05$). The purified fraction RPS-2 also increased the spleen index, splenocyte proliferation, and cytokine secretion *in vivo*. These results indicate that okra polysaccharides may potentially serve as novel immunomodulators [35].

Pharmaceutical applications

Okra mucilage or okra gum can be used as pharmaceutical excipients include gelling, thickening, suspending and emulsifying agents to formulate solid oral dosage form. Literature review revealed that okra gum has acceptable pH and organoleptic properties. It is extracted from the fruits of *Abelmoschus esculentus* using organic solvent such as acetone. It has diverse pharmaceutical applications [36].

Eye-sight improvement and skin nourishment

For eyesight improvement lady's finger pods are used. These pods are implausible options for vitamin A and β-carotene that are both important nourishment for sustaining an excellent eye-sight along with healthy skin [37].

Nootropic potential

The seed extracts of *Abelmoschus esculentus* L. possess anti-oxidant, anti-stress and nootropic activities, which promisingly support the medicinal values of this plant. So the pretreatment of mice with aqueous and methanolic seed extracts of *A. esculentus* (200 mg/kg; p.o.) for seven days significantly ($p < 0.01$) attenuated scopolamine-induced cognitive impairment in the passive avoidance test. These extracts reduced the blood glucose, corticosterone, cholesterol and triglyceride levels elevated by acute restraint stress [38].

Toxicological reports

Reports on the toxic effects of *A. esculentus* is inadequate. A study conducted with aqueous and methanolic seed extracts of the fruit demonstrated that it produced no signs of toxicity or death up to a dose of 2000 mg/kg (p.o.) in Swiss mice ($n = 6$) for 7 days [38].

Discussion

From the ancient plants are the eminent source of nutrients and organic metabolites for the health and remedies. *A. esculentus* has been used as a popular vegetable in many countries of the world. It may be due to it is rich in vitamins, minerals, and other essential components of a balanced diet. According to the nutritional composition and phytochemical reports *A. esculentus* contains a number of antioxidant vitamins (e.g., vitamins A, C, and E). Moreover, it also contains essential oil and phenoic compounds and antioxidant glycosides in its various parts. There are reports that demonstrate that these types of compounds are strong anti-oxidants and can protect animal organs. *H. pylori* is one of the major causative pathogens of infection and inflammation in our gastrointestinal tract (GIT), mucosal injury and edema, hemorrhage, and inflammation in the stomach re also evident to occur in the GIT. Cancer is a complex disease, characterized by the uncontrolled and unscheduled production of immature cells in our body with abnormal and/or always harmful biochemical activities. Among the anticancer treatments, using chemotherapeutic agents from various origins is one of the best modalities. The use of natural products, especially those from plant origin in this context, is a good target.

Conclusion

The use of plant extracts to cure many diseased conditions has been the traditional method in many parts of the world. The plant extracts are found to be effective in their mode of action and do not cause any side effects to the patient treated. Many plants and trees are found to have various medicinal values. Among all the plants found all over the world, many plants are found in India. The above review reveals that the *Abelmoschus esculentus* is a source of pharmacologically and medicinally bio-active compounds and have wide variety physiological and pharmacological effects; hence, this drug encourages finding its new therapeutic applications. The information presented here shows the potential nutritional importance of Okra and its role in improved nutrition and health. It is an affordable source of protein, carbohydrates, minerals and vitamins, dietary fibre and health promoting fatty acids. Scientific studies provide some evidence to support the potential beneficial effects of Okra components in lowering the risk for various chronic diseases, although information pertaining to the role of edible plant parts of Okra in disease prevention and the mechanisms of action are limited to date. This is due to the complex nature of disease etiology and various factors impacting their occurrence. It is imperative the scientific community continues to unravel the mechanisms involved in disease prevention and determine how food bio-actives from such foods as Okra can influence human health. Further research, needs to be performed to provide compelling evidence for the direct health benefits of Okra consumption. Therefore, promoting the consumption of traditional vegetables such as Okra could provide cheap sources of macro and micronutrients and mineral elements that can improve the nutritional status of resource-poor subsistence farmers in the area in particular and in Ethiopia in general. Furthermore, this vegetable can also be used as an indispensable tool when it comes to reducing the prevalence of malnutrition, especially among resource constrained urban households in addition to rural household. Consumption of Okra by both low-income and high-income groups can also used as a means of dietary diversification approach. From the findings of this review, it is evident that *A. esculentus* is a prominent source of nutrients and important phytochemicals (e.g., flavonoids, lectins, and glycosides). The plant and its parts, as well as their derived components, possess various important biological effects, including anti-oxidant, anti-inflammatory, anti-bacterial, and anti-cancer activities. The reports on its toxicological effects suggest that the plant, especially its fruit and seeds, are nontoxic, which may be one of the important issues for considering it as a valuable vegetable for human consumption. More research is necessary on this edible medicinal plant in the context of drug discovery and development.

Conflict of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Nil.

References

1. Kochlar SI. Okra (lady finger) in tropical crops, a text book of economic botany. 1986; 1:263-264.
2. Narender Boggula. Phytochemical evaluation and *in vitro* anti bacterial activity of dried seeds of Abrus precatorius. International journal of pharmaceutical sciences review and research. 2017; 44(1):101-107.
3. Chopra RN, Nayar SL, Chopra IC. Glossary of Indian Medicinal Plants (Including the Supplement). Council of Scientific and Industrial Research, New Delhi, 1986.
4. Facciola S. Cornucopia- A Source Book of Edible Plants. Kampong Publications, 1990.
5. Huxley A. The New RHS Dictionary of Gardening. 1992. MacMillan Press, Int. Res J Pharm. App Sci. 2013; 3(4):129-132.
6. Gemede H, Haki GD, Beyene F, Woldegiorgis AZ, Rakshit SK. Proximate, mineral, and antinutrient compositions of indigenous Okra (*Abelmoschus esculentus*) pod accessions: Implications for mineral bioavailability. Food Science & Nutrition. 2015; 4 (2):223-33.
7. Martin Franklin W. "Okra, Potential Multiple-Purpose Crop for the Temperate Zones and Tropics". Economic Botany. 1982; 36(3):340-345.
8. Torkpo SK, Danquah EY, Offei SK, Blay ET. Esterase, total protein and seed storage protein diversity in okra. West Africa journal of applied ecology. 2008; 9:8-18.
9. Farooq Anwar, Umer Rashid, Muhammad Ashraf, Muhammad Nadeem. "Okra (*Hibiscus esculentus*) seed oil for biodiesel production". Applied Energy. 2010; 87(3):779-785.
10. Huang Z, Wang B, Eaves DH. Phenolic Compound Profile of Selected Vegetables Frequently Consumed by African Americans in the Southeast United States. Food and Chemical Toxicololy. 2007; 103:1359-1402.
11. Honda AH, Nakagawa S, Ashida H, Kanazawa K. Simultaneous Determination of All Polyphenols in Vegetables, Fruits and Teas. Journal of Agriculture and Food Chemistry. 2003; 51:571-581.
12. Male A, Grandhi S. A Phytopharmacological Review on *Abelmoschus esculentus* L. European Journal of Biomedical and Pharmaceutical Science. 2017; 4:775-780.
13. Odedra NK, Jadeja BA. Ethnobotany of Maher Tribe, 2012, 1-459.
14. Lim TK. Edible Medicinal and Non-Medicinal Plants. Springer Science + Business Media, Berlin. 2012; 3:160.
15. Maramag RP. Diuretic Potential of Capsicum frutescens L., Corchorus oliturius L. and Abelmoschus esculentus *L.* Asian Journal of Natural and Applied Science. 2013; 2:60-69.
16. Smit R, Neeraj K, Preeti K. Traditional Medicinal Plants Used for the Treatment of Diabetes. International Journal of Pharmaceutical and Phyto-Pharmacological Research. 2013; 3:171-175.
17. Sayana SB, Khanwelkar CK. Evaluation of Diuretic Activity of Alcoholic Extract of Roots of *Cissampelos pareira* in Albino Rats. Journal of Clinical and Diagnostic Research. 2014; 8:1-4.
18. Babu PS, Srinivasan K. Influence of Dietary Curcumin and Cholesterol on the Progression of Experimentally Induced Diabetes in Albino Rat. Molecular and Cellular Biochemistry. 1995; 152:13-21.
19. Barrett B. Medicinal Plants of Nicaragua's Atlantic Coast. Economic Botany. 1994; 481:8-20.
20. Crossley A, Hilditch TP. The Fatty Acids and Glycerides of Okra Seed Oil. Journal of the Science of Food and Agriculture. 1951; 2:251-255.
21. Martin FW. Okra, Potential Multiple-Purpose Crop for the Temperate Zones and Tropics. Economic Botany. 1982; 36:340-345.
22. Vaidya MV, Nanoti MV. Bhindi Seed Powder as Coagulant in Removal of Turbidity from Water. Indian Journal of Environmental Health. 1989; 31:43-48.
23. Calisir S, Ozcan M, Haciseferogullari H, Yildiz MU. A Study on Some Physico-Chemical Properties of Turkey Okra (Hibiscus esculentus) Seeds. Journal of Food Engineering. 2005; 68:73-78.
24. Jarret RL, Wang ML, Levy IJ. Seed Oil and Fatty Acid Content in Okra (Abelmoschus esculentus) and Related Species. Journal of Agricultural and Food Chemistry. 2011; 59:19-24.
25. Marwat SK, Rehman FR, Khan MA. Medicinal Folk Recipes Used as Traditional Used as Traditional Phytotherapies. Journal of Botany. 2011; 43:1453-1462.
26. Saravanan S, Pandikumar P. Hepatoprotective Role of *Abelmoschus esculentus* (L.) Moench., on Carbon Tetrachloride-Induced Liver Injury. Toxicology Mechanism and Methods. 2013; 23:528-536.
27. Solomon S, Muruganantham N, Senthamilselvi MM. Anticancer Activity of *Abelmoschus esculentus* (Flowers) against Human Liver Cancer. International Journal of Pharmacy and Biological Science. 2016; 6:154-157.
28. Ngoc TH, Ngoc QN, Van ATT, Phung NV. Hypolipidemic effect of extracts from Abelmoschus esculentus L. (Malvaceae) on Tyloxapol-induced hyperlipidemia in mice. Mahidol University Journal of Pharmaceutical Sciences. 2008; 35:42-46.
29. Sabitha V, Ramachandran S, Naveen KR, Panneerselvam K. Antidiabetic and antihyperlipidemic potential of *Abelmoschus esculentus* (L.) Moench. in streptozotocin-induced diabetic rats. Journal of Pharmacy & Bioallied Sciences. 2011; 3:397-402.
30. de Carvalho CCCR, Cruz PA, da Fonseca MR, Xavier-Filho L. Antibacterial properties of the extract of *Abelmoschus esculentus*. Biotechnology and Bioprocess Engineering. 2011; 16:971-977.
31. Ortaç D, Cemek M, Karaca T, Büyükokuroğlu ME, Özdemir ZÖ, Kocaman AT, *et al*. *In vivo* anti-ulcerogenic effect of okra (Abelmoschus esculentus) on ethanol-induced acute gastric mucosal lesions. Pharmaceutical Biology. 2018; 56:165-175.
32. Xia F, Zhong Y, Li M, Chang Q. Anti-Oxidant and Anti-Fatigue Constituents of Okra. Nutrients. 2015; 7:8846-8858.
33. Vindika S, Kuruwitaarachchige D, Inoka U, Sirimal P, Jayantha W. Cardio Protective Activity of *Abelmoschus esculentus* (Okra). International Journal of Food Science and Nutrition. 2018; 3:39-43.

34. Mairuae N, Cheepsunthorn P, Cheepsunthorn CL. Tongjaroenbuangam W. Okra (*Abelmoschus esculentus* Linn) Inhibits Lipopolysaccharide-Induced Inflammatory Mediators in BV2 Microglial Cells. Tropical Journal of Pharmaceutical Research. 2017; 16:1285-1292.
35. Chen H. *In vitro* and *in vivo* Immunomodulatory Activity of Okra (*Abelmoschus esculentus* L.) Polysaccharides. Journal of Medicinal Food. 2016; 19:253-265.
36. Farooq U, Malviya R, Sharma PK. Extraction and Characterization of Okra Mucilage as Pharmaceutical Excipient. Academic Journal of Plant Science. 2013; 6:168-172.
37. Messing J, Thole C, Niehues M, Shevtsova A. Antiadhesive Properties of *Abelmoschus esculentus* (Okra) Immature Fruit Extract against *Helicobacter pylori* Adhesion. PLoS ONE. 2014; 9:e84836.
38. Doreddula SK, Bonam SR, Gaddam DP, Desu BS, Ramarao N, Pandy V, *et al*. Phytochemical analysis, antioxidant, antistress, and nootropic activities of aqueous and methanolic seed extracts of ladies finger (*Abelmoschus esculentus* L.) in mice. Scientific World Journal. 2014, 519848.