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MINI REVIEW

Functional properties of Okra *Abelmoschus esculentus* L. (Moench): traditional claims and scientific evidences

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Abstract

Okra, *Abelmoschus esculentus* L. (Moench) is an important vegetable crop cultivated in tropical, subtropical and warm temperate regions around the world. Besides the nutritional benefit, the different parts of the plant are used extensively in traditional medicine (antidiabetic, antipyretic, diuretic, antispasmodic, etc) around the world. This review critically assesses the nutritional values, phytochemistry, preclinical pharmacological properties and the possible future application of the okra. Effort is made to correlate the traditional claims in the context of experimental evidences.

Keywords: okra; traditional use; antidiabetic; antihyperlipidemic; dysentery; diarrhoea.

Introduction

Okra, *Abelmoschus esculentus* L. (Moench) commonly known as ladies finger and in several other vernacular names is cultivated as an important vegetable crop in tropical, subtropical and warm temperate regions around the world with total trade estimated to over $5 billion (Oyenuga, 1969; Chauhan, 1972; Lamont, 1999; Oyelade, Ade-Omowaye, & Adeomi, 2003; Siemonsma & Kouame, 2000; Ndunguru & Rajabu, 2004; NRC, 2006; Kumar *et al.*, 2010; Benchasri, 2012; Lim, 2012). Okra is an annual or perennial tall (around 2 meters) dicotyledonous plant related to species such as cotton, cocoa and *Hibiscus*. The plant grows preferably in well-drained humus rich fertile soil in full sun with pH ranging from 6 to 6.7, but it can tolerate a wide range of soil types and pH from 5.5 to 8.0 (N. Jain, R. Jain, V. Jain, & S. Jain, 2012). The leaves are long-petioled, orbicular or orbicular-ovate around 10–20 cm long, broad and rough, palmately lobed with 5–7 lobes. Flowers of this plant are axillary and solitary, 4–8 cm in diameter having five white to yellow petals, often with a red or purple spot at the base of each petal. Fruit is elongated, 10 to 25 cm long, 1.5 to 3 cm in diameter, tapering to a blunt point and containing rows of rounded, and kidney shaped seeds (Fig. 1). Depending on the cultivar, fruits of Okra mature after 60-180 days of sowing (alternatively can also be counted 5-10 days after flowering of plant). Fruits are detached from the stacks by applying slight twist (Tindall, 1986). Irritating hairs are sometimes present on leaves, stems and on the fruit surface.

Immature fresh and green seed pods are consumed as vegetable. It offers mucilaginous consistency after cooking. Often the extract obtained from the fruit is added to different recipes like soups, stews and sauces to increase the consistency. The immature pods are also used in making pickle. The entire plant is edible and is used to have several food (Babu & Srinivasan, 1995; Madison, 2008; Lim, 2012; Jain *et al.*, 2012; Maramag, 2013) and non food applications (Camciuc, Deplagne, Vilarem, & Gaset, 1998). Okra leaves are to some extent edible and are used as salad when fresh or cooked for edible purposes as the greens of beets or dandelions.

Okra seeds are source of oil and protein. It can be used as non-caffeinated substitute for coffee. Okra seeds may be roasted and ground to form a caffeine-free substitute for coffee (Martin, 1982; Calisir, Ozcan, Haciseferogullari, & Yildiz, 2005). Okra seed powder is used as a substitute for aluminium salts in water purification (Vaidya & Nanoti, 1989). Okra root mucilage has almost the same chemical composition as that of medicinal plant common marshmallow *Althaea officinalis* (Tomoda, Shimuzu, &

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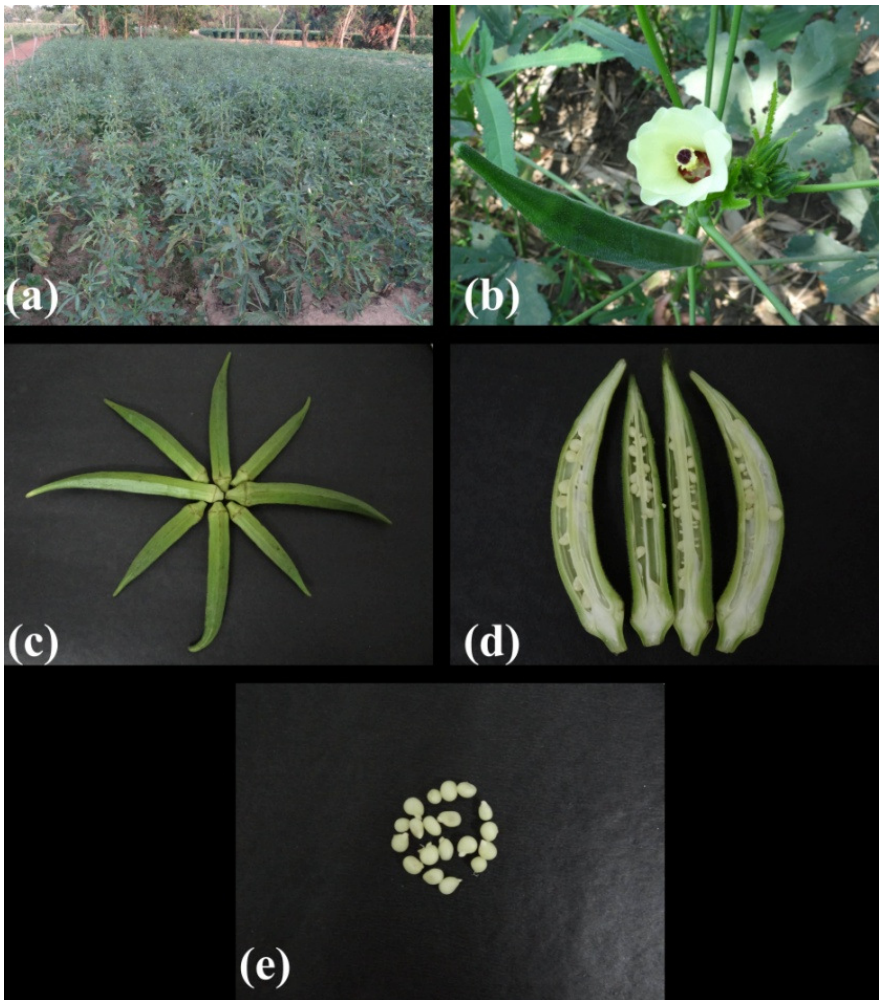

Fig 1. Different parts of okra (a) Okra in field (b) Okra fruit and flower (c) Okra fruit (d) Cross sectional view (e) Okra seed.

Gonda, 1985).

Other non-food applications include use of the root and stem of okra for cleaning the cane juice from which Jaggary (gur or brown sugar) is prepared (Chauhan, 1972). Mature fruits and stems containing crude fiber are used in the paper industry (Martin, 1982). It can also be used for sacks and ropes (Watt, 1908), biogas and fuel (Dahiya & Vasudevan, 1987).

Okra is widely used in ethno medicine in diverse cultures (Table 1). In Ayruveda, okra is used as an edible infusion and in different preparation for diuretic effect (Maramag, 2013). An infusion of the fruit mucilage is also used to treat dysentery and diarrhoea in acute inflammation and irritation of the stomach, bowels, and kidneys catarrhal infections, ardour urinae, dysuria and gonorrhoea. Seeds are used as antispasmodic, cordial and stimulant (Lim, 2012, pp. 160-169). Leaves and root extracts are served as demulcent and emollient poultice (Babu & Srinivasan, 1995).

Although some reviews are available describing medicinal properties okra (Kumar *et al*., 2010; Indah Mohd, 2011; Fong, Toh, Rajen, & Rao, 2011; Jain *et al*., 2012; Nwachukwu, Nulit & Rusea, 2014), but no specific review are present describing nutritional values, phytochemistry, preclinical pharmacological properties and the possible future application of the okra. This review is focused to draw a correlation between traditional ethno-medicinal claims of okra with the established scientific evidences. Besides discussion are drawn on the future prospect on the different ways of applying this nutraceutical in food and medicinal matrices.

Nutritive and phytochemical profiling of different parts of okra (*A. esculentus*)

Okra pods are mucilaginous, low in calories but nutritionally rich and a good source of edible fiber. Studies have shown that the okra pod contains important bioactive compounds such as carotene, folic acid, thiamine, riboflavin, niacin, vitamin C, oxalic acid and amino acids.

Pods are low in saturated fat, very low in cholesterol and offers sufficient amount of minerals (Table 2) (U.S

Table 1. Okra in Ethnomedicine

Parts	Form	Name of the Medicinal system where it is used	Used for	References
Fruit	Infusion of the fruit mucilage	Indian ethnomedicine	For treating dysentery and diarrhoea in acute inflammation and irritation of the stomach, bowels, and kidneys catarrhal infections, ardour urinae, dysuria, diuret ic, plasma replacement and gonorrhoeaa.	Odedra, & Nathabhai, 2009; Lim, 2012; Maramag, 2013; Smit, Neeraj, & Preeti, 2013; Sayana *et al.*, 2014
	Infusion of the fruit mucilage	Indian ethnomedicine	Antipyretic and plasma replacement.	
	A decoction of the immature fruit	Indian ethnomedicine	Demulcent and emollient poultice.	
Leaves	Extract of leaves and roots	Indian ethnomedicine	Demulcent, though less so than that of okra fruit.	Babu & Srinivasan, 1995; Odedra, & Nathabhai, 2009
	Extract of leaves	Indian ethnomedicine	Extract of leaves mixed with egg albumin and applied on hair which makes black and silky hair.	
	Leaves	Latin America	Remedies for tumour	
Root	Extract of roots	Indian ethnomedicine	Demulcent and emollient poultice.	Barrett, 1994; Yesilada *et al.,* 1951; Babu, & Srinivasan, 1995; Odedra, & Nathabhai, 2009; Lim, 2012
	The juice of the roots	Nepal	To treat cuts, wounds and boils.	
	An infusion of the roots	Indian ethnomedicine, Malaya	Treatment of syphilis.	
	Infusion of the roots	Traditional medicine of Nicoragua's Atlantic Coast and Turkey	Used as stomachic, to treat diabetes, ulcer, used as laxative and treatment of jaundice.	
Seed	Seeds	Indian ethnomedicine	Antispasmodic, cordial and stimulant.	Crossley & Hilditch, 1952; Martin, 1982; Vaidya & Nanoti, 1989; Calisir *et al.*, 2005; Jarret *et al.*, 2011; Lim, 2012 pp. 160-167; Aslan, Sezik, Yesilada, 2003; Smit *et al*., 2013
	Infusion of the roasted seeds	Indian ethnomedicine	Has sudorific properties	
	Okra seed	Indian ethnomedicine	Treatment of spermatorrhoea	
	Okra seed	Turkish folk medicine	In managing increased blood glucose concentration	
	Seeds	Latin America	Remedies for tumour	
	Infusion of roasted okra seeds	Turkey	Diabetes mellitus therapy.	
Flower	The decoction of the leaves and flowers	Indian ethnomedicine	Used for the treatment of bronchitis and pneumonia.	Lim, 2012; Marwat *et al.,* 2011.

Department of Agriculture, Agricultural Research Service 2010, Lim, 2012).

Random coil polysaccharides consisting of galactose, rhamnose, and galacturonic acid are in the structural form of okra gum (Fig. 2). α (1-2)-rhamnose and α (1-4)-galacturonic acid residues with disaccharide side chains and a degree of acetylation (DA = 58) are the repeating unit of gum (Alamri, Mohamed, Hussain, & Xu,

2012; Zaharuddin, Noordin, & Kadivar, 2014). Besides this plant is also the treasure house of polyphenolic compounds. Presence of hyperoside, quercetin, coumarin scopoletin, uridine, and phenylalanine is reported by several authors (Bandyukova & Ligai, 1987; Lu, Huanfen, & Linlin, 2011). Shui & Peng (2004) have reported that quercetin derivatives and (−)-epigallocatechin as major antioxidant compounds in okra. 70% of the total antioxidant activity comes due to the quercetin derivatives (quercetin 3-O-xylosyl (1"→2") glucoside, quercetin 3-O-glucosyl (1"→6") glucoside, quercetin 3-O-glucoside and quercetin 3-O- (6"-O-malonyl)- glucoside). Liao, Dong, Shi, Liu, & Yuan, (2012) reported a new flavonol glycoside named 5, 7, 3', 4'-tetrahydroxy-4"-O-methyl flavonol-3-O-β-D- glucopyranoside with another pre reported compound 5, 7, 3', 4'-tetrahydroxy flavonol -3-O-[β-D-glucopyranosyl- (1→6)]-β-D-glucopyranoside.

Table 2. The proximate value per 100g edible portion of okra

Item	Quantity
Water	90.17 g
Energy	31 kcal (129 kJ)
Protein	2.00 g
Total lipid	0.10 g
Ash	0.70 g
Carbohydrate	7.03g
Total dietary fibre	3.2 g
Total sugars	1.2 g
Sucrose	0.40 g
Glucose	0.13 g
Fructose	0.21 g
Starch	0.34 g
Minerals	
Ca	81 mg
Fe	0.8 mg
Mg	57 mg
P	63 mg
K	303 mg
Na	8 g
Zn	0.60 mg
Cu	0.094 mg
Mn	0.990 mg,
Se	0.7 m g
Amino acids	
Tryptophan	0.017 g
Threonine	0.065 g
Isoleucine	0.069 g
leucine	0.105 g
lysine	0.081 g
methionine	0.021 g
Cystine	0.019 g
Phenylalanine	0.065 g
Tyrosine	0.087 g
Valine	0.091 g
Histidine	0.031 g
alanine	0.073 g
Aspartic acid	0.145 g
Glutamic acid	0.271 g
Glycine	0.044 g
Proline	0.045 g
Serine	0.044 g
Lutein + zeaxanthin	516 m g
Arginine	0.084 g
Lipid	
Total Saturated fatty acids	0.026 g
Palmitic acid (16:0)	0.022 g
Stearic acid (18:0)	0.003 g
Total mono-unsaturated fatty acids	0.017 g
Oleic acid (18:1)	0.016 g
Total polyunsaturated fatty acids	0.027 g,
Undifferentiated (linoleic acid; 18:2)	0.026 g
Undifferentiated (linolenic acid; 18:3)	0.001 g
Phytosterols	24 mg
Vitamin	
Vitamin C	21.1 mg
Thiamine	0.0.2 mg
Riboflavin	0.060 mg
Niacin	1.0 mg
Pantothenic acid	0.245 mg
Vitamin B-	6 0.215 mg
Total folate	88 m g
Total choline	12.3 mg
ß-carotene	225 m g
Vitamin A	375 IU
Vitamin A RAE	19 m g
Vitamin E (a-tocopherol)	0.36 mg
Vitamin K (phylloquinone)	53 m g

Mature seeds are used for oil production and, when ground, as a substitute for coffee. Whole seeds and kernels of okra are rich in protein as well as fat. Major portion of protein and fat of the seed is accumulated in the kernel while crude fibre is concentrated in the seed coat or hull. It is rich in essential amino acids, has trypsin activity and chemical score of 67 (Rao, 1985). Okra seed oil is rich in palmitic, oleic, and linoleic acids (Crossley & Hilditch, 1951; Chisholm, & Hopkins, 1957; Steyn *et al.*, 2014). The value of palmitic acid in *A. esculentus* was in the range of 10.3%-36.35%, where as values of linoleic acid was from 23.6 to 50.65% (Jarret, Wang, & Levy, 2011).

Root mucilage of this plant poses similar chemical composition as that of medicinal plant *Althaea officinalis*. It was composed of partially acetylated acidic polysaccharide

(molecular weight about 1700000 Da. The polysaccharide was composed of L-rhamnose : D-galactose : D-galacturonic acid : D-glucuronic acid : O-acetyl groups in the molar ratio of 1.1 : 1.9 : 1.0 : 1.0 : 2.0 (Tomoda, Shimizu, & Gonda, 1985). The phytochemical study of the root extract confirmed presence of carbohydrate, fixed oils, mucilage and flavanoid glycosides (Tomoda *et al.*, 1987) and offers antioxidant potential (Sunilson, Jayaraj, Mohan, Kumari, Varatharajan , 2008).

According to the analytical study of the leaves of *A. esculentus* (Nwachukwu *et al.*, 2014, pp. 16-19; Idris, Yisa, & Itodo, 2009), the proximate and mineral composition were 82.53±1.60% moisture, 18.48±0.03% ash, 7.63 ±0.06% crude protein, 12.98±0.03% crude lipid and 27.54±0.27% available carbohydrate. Dominant mineral elements found in leaves were K (2107.50±0.03 mg/100g) and Mg (75.85±0.02 mg/100mg) where as appreciable concentrations of Na (37.50±0.83 mg/100g), Ca (57.03±0.12 mg/100g), P (7.33±0.04 mg/100g), Cu (3.22±0.02 mg/100g), Fe (20.78±0.15 mg/100g), Mn (17.25±0.22 mg/100g) and Zn (8.64±0.04 mg/100g) were also found. Hedin, Lamar, Thompson, & Minyard (1968) identified 11 flavonol glycosides *i.e.* quercetin 4'-glucoside, quercetin 7-glucoside, quercetin 5-glucoside, quercetin 3-diglucoside, quercetin 4'-diglucoside, quercetin 3-triglucoside, quercetin 5-rhamnoglucoside, gossypetin 8-glucoside, gossypetin 8-rhamnoglucoside, gossypetin 3-glucosido-8-rhamnoglucoside, and the anthocyanins were cyanidin 4'-glucoside and cyaniding 3-glucosido-4' glucoside and two anthocyanins from the flower petal of this plant.

Validated pharmacological properties of the okra

Antioxidant activity and prevention of cellular damage related diseases

Reactive oxygen species (ROS) *i.e.* superoxide anion (O_2^-), hydrogen peroxide (H_2O_2), and the hydroxyl radical (OH^-) and reactive nitrogen species (RNS) *i.e.* nitric oxide (NO), peroxynitrite ($ONOO^-$) when produced in excess, cause cell dysfunction and ultimately death. This happens due to alteration of metabolic pathway activity (Newsholme, Keane, Welters, & Morgan, 2007; Newsholme *et al.*, 2009) and/or the structure of cellular membranes, DNA, or proteins (Chandra, Samali, & Orrenius, 2000; Limon-Pacheco, & Gonsebatt, 2009; Newsholme *et al.*, 2012). Many medicinal plants, fruits and their products, fermented food, etc are proved to have sufficient antioxidant to scavenge these free radicals and to prevent the ensuing damage (Sánchez-Moreno, Larrauri, & Saura-Calixto, 1999; Alia *et al.*, 2008; Krishnaiah, Sarbatly, & Nithyanandam, 2011; Roy *et al.,* 2012a; Roy, Khanra, Mishra, & Bhattacharyya, 2012b; Roy, Khanra, Mishra, Bhattacharya, & Bhattacharyya, 2012c; Zhou, Zhang, Sun, Yan, & Wang, 2014).

With regard to Okra, several studies have been conducted on the antioxidant activity with different parts of the plant. Atawodi *et al.* (2009) has reported *in vitro* antioxidant assay of methanol extract of okra fruits. They have done antioxidant/radical scavenging activities by xanthine oxidase and 2-deoxyguanosine methods and reported 50% inhibitory concentration values of 25 and 43 ml. According to Khomsug, Thongjaroenbuangam, Pakdeenarong, Suttajit, & Chantiratikul (2010), total phenolic content of pulped and seeds of okra extracts as 10.75±0.02mg GAE/100g extract and 142.48±0.02mg GAE/100g extract which corresponds with scavenging activities. Besides they have also found procycanidin B2 as predominant phenolic compound followed by procycanidin B1 and rutin in seeds. In pulped seed catechin, procycanidin B2, epicatechin and rutin are reported to be present. It is quite important to the see that roasting (1600°C for 10–60 minutes) increased the nutrient composition and antioxidant activity of the seeds (Adelakun, Ade-Omowaye, Adeyemi, & Van De Venter, 2010) whereas pre-treatment (soaking and blanching) increased the nutrient composition, but decreases antioxidant activity (Adelakun *et al*., 2009). Ansari, Houlihan, Hussain, & Pieroni (2005) reported Okra extract as *in vitro* non-enzymatic inhibitior of lipid peroxidation in liposomes. *A. esculentus* peel and seed powder contains significant *in vivo* antioxidant property in streptozotocin-induced diabetic rats.

Administration of different doses of peel and seed powder significantly increased liver, kidney and pancreas superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), reduced glutathione (GSH) levels and decreased thiobarbituric acid reactive substances (TBARS) ($P < 0.001$) levels in diabetic rats compared to diabetic control rats. Liao, Liu, & Yuan, (2012) has done a comparative analysis of total phenolics and total flavonoids and antioxidant ability of different organs (flower, fruit, leaf, and seed) and different enrichment fractions of water extracts of the *A. esculentus* plant. They confirmed fruitful presence of total phenolics and total flavonoids related to antioxidant ability in all the extracts of the plant organs although percentage varied. In flower of okra highest amount of total phenolics and total flavonoids were found (Liao *et al*., 2012).

This data suggests Okra as a good contributor to the antioxidant status and promising chemopreventive agent as described in several traditional medicines for human race.

Okra as antidiabetic and antihyperlipidemic and related disease prevention

In traditional medicine Okra seeds are reported to have ability in managing increased blood glucose concentration. Modern research has correlated this traditional claim with

scientific evidences.

Tomoda *et al*. (1989) reported that okra polysaccharide possesses anticomplementary and hypoglycemic activity in normal mice. *A. esculentus* was found to have hypolipidemic activity in *in vivo* tested rat model (Trinh, Nguyen, Tran, & Nguyen 2008) and in mice (Ngoc, Ngo, Van, & Phung, 2008). Okra polysaccharide lowers the cholesterol level in blood and may prevent cancer by its ability to bind bile acids (Kahlon, Chapman & Smith, 2007).

Cholesterol levels decreased 56.45%, 55.65%, 41.13%, 40.50% and 53.63% respectively in mice groups orally administered with dichloromethane okra plant extract, methanol okra plant extract, dichloromethane okra fruit extract, methanol okra fruit extract and simvastatin as compared to the tyloxapol injected group (Ngoc *et al*., 2008). The effects of crude extracts of *A. esculentus* on albumin and total bilirubin levels of diabetic albino rats were reported to have a significant ($P<0.05$) increase (82%) in total bilirubin levels in diabetic control group over the normal control (Uraku, Ajah, Okak, Ibiam, & Onu, 2010). Ramachandran, Sandeep, Srinivas, & Dhanaraju, 2010 reported anti-diabetic activity of okra on alloxan-induced diabetic rats. Sabitha, Ramachandran, Naveen, & Panneerselvam Sabita *et al*., (2012, 2013) has reported antidiabetic and antihyperlipidemic potential of okra peel and seed powder in streptozotocin (STZ)-induced diabetic rats. Administration of peel and seed powder at 100 and 200 mg/kg dose in diabetic rats showed significant ($P < 0.001$) reduction in blood glucose level and increase in body weight than diabetic control rats. Water-soluble fraction of the fruits of Okra was studied to check the absorption of oral glucose as well as metformin from the gastrointestinal tract in the Long Evans rats. It showed significant reduction in absorption of glucose as studied in the 24 hours fasting rats (Khatun, Rahman, Biswas, & Islam, 2011). Thanakosai & Phuwapraisirisan, (2013) has reported, the presence of two major flavonol glucosides named isoquercetin (2) and quercetin-3-O-beta-glucopyranosyl- (1"→6")-glucoside (3) in okra seeds which are α-glucosidase inhibitors. These two compounds selectively inhibited rat intestinal maltase and sucrase, in which isoquercetin (2) was 6-10 times more potent than its related diglucoside 3. Subrahmanyam *et al*., (2011) has reported antidiabetic activity of okra fruit extract.

The effects of *A. esculentus* fruits on alkaline phosphatase (ALP), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities on diabetic albino rats were also investigated. Serum glucose levels and activities of enzymes *viz.* ALP, AST and ALT decreased significantly after administration of the extracts (Uraku, Onuoha, Offor, Ogbanshi, & Ndidi, 2011). Hypoglycemic effect of ethanolic and aqueous extract of *A. esculentus* fruit was studied. Results revealed that aqueous extract of powdered drug had maximum effect (Saha, Jain, & Jain, 2011). Recent study reported that the extract of okra lowers blood glucose and serum lipids in high-fat diet-induced obese C57BL/6 mice. Ethanol extract of okra (EO) and its major flavonoids isoquercitrin and quercetin 3-O-gentiobioside reduced blood glucose and serum insulin levels and improved glucose tolerance in obese mice (Fan *et al*., 2014).

For treating dysentery and diarrhoea in acute inflammation and irritation of the stomach, bowels

In Asia and African traditional medicine, okra fruits are served as mucilaginous food as a dietary meal in the treatment of gastric irritations and inflammative diseases. Scientific explanation of such use came in recent years. Lengsfeld, Titgemeyer, Faller, & Hensel (2004) pre-treated *Helicobacter pylori* with a fresh juice of okra that completely inhibited adhesion in an *in situ* adhesion model on sections of human gastric mucosa. The anti-adhesive qualities of okra were assumed to be due to a combination of glycoproteins and highly acidic sugar compounds making up a complex three-dimensional structure that is fully developed only in the fresh juice of the fruit. That is due to the blocking capacity of specific *Helicobacter* surface receptors that coordinate the interaction between host and bacterium. According to Messing *et al*., 2014, it supported the previous claims and showed that the effectiveness in treating gastric irritations and inflammative diseases is due to polysaccharides that inhibit the adhesion of *H. pylori* to stomach tissue.

Recent trends and future prospect

Okra extract is used as a key ingredient in several commercially important products of food and medicine. The rheological behaviour (Kontogiorgosa, Margeloua, Georgiadisb, & Ritzoulisb 2013), properties of forming oil water emulsion (Georgiadisa *et al*., 2011) and ability to stabilize acidic emulsion (Alba, Ritzoulis, Georgiadis, & Kontogiorgos 2013) of okra can potentially be used as future value addition applications like composite materials (Dimopoulou & Ritzoulis, 2014) and food foam productions (Laporte *et al*., 2014) .

In last decade, extensive efforts have been given in developing of several nanoscale-carriers in to improve the drug delivery systems (Roy *et al*., 2012a, 2012b; Mandal *et al*., 2014). Okra may play a leading role in improved drug delivery system. Several reports came using okra polysaccharide as drug release agent. Okra gum as a mini-matrix for furosemide and diclofenac sodium tablets showed prolonged release of furosemide and diclofenac sodium from the compressed tablets (Ofoefule & Chukwu, 2001). Besides it is now used as a medium for several other drug deliveries. Bakre and Jaiyeoba *(*2009) used it as metronidazole tablet formulation. Sharma, Kulkarni, & Sharma, (2013a) used it in the development mucoadhesive

gel for nasal delivery of rizatriptan benzoate. Recently this same research group (Sharma, Kulkarni, Sharma, Bhatnagar, & Kumar, 2013b) have prepared and evaluated of mucoadhesive microspheres, using okra polysaccharide as a novel carrier for safe and effective delivery of rizatriptan benzoate into nasal cavity. It is also used to study the sustaining release of drug (Zaharuddin *et al*., 2014). Besides colon specific drug delivery studies also been carried out (Rajkumari, Sarma, Ilango, Devi, & Rajak, 2012). If drug release is the present hunk of okra research, the future might come as a medium of probiotic, nutraceutical delivery. Several new formulation might come like edible coating, preservative carrier etc. So more application oriented research might be carried out to get the full utilization of this novel natural gift.

Conclusion

From previous discussion it can be concluded that traditional ethnomedicinal claims of Okra (*A. esculentus*) has a strong scientific evidences. Traditionally claimed pharmacological properties of okra attributed to the presence of various phyto-compounds reported. The strong scientific evidence of *in vitro* and *in vivo* biological activity confirms the doubt of its traditional use. Detailed investigations for its myriad beneficial effects may enlighten the future of medicinal exploitation. However further research should be focused to find out the mechanism of action of the pharmacological activities at the molecular level. This can solve several unanswered questions of origin, development and cure of diseases. Besides, being nontoxic in nature, this fruit can be easily tried for human trials rather than animal models. Okra based anti-diabetic food, antioxidant rich food formulation can be thus easily be tried avoiding complicated medical trials. It would get go for better value addition and commercialization in near future not being confined only in kitchen.

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