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A Review On Biochemical, Nutritional and Medicinal Properties of Okra

Shiva Basnet[1*], Pratikshya Lamichane[2], Aman Meheta[3], Yogesh Rajbanshi[4]

Institute of Agriculture and Animal Science, Lamjung Campus, Nepal. *
Institute of Agriculture and Animal Science, Mahandra Ratna Multiple Campus, Ilam, Nepal.[2]
Faculty of Agriculture, Agriculture and Forestry, University, Rampur, Chitwan, Nepal.[3]
Institute of Agriculture and Animal Science, Lamjung Campus, Nepal.[4]

Abstract

Abelmoschus esculentus, commonly known as Bhindi, is a multi-usable vegetable crop whose whole part including roots can be consumed very effectively as a vegetable, fruit, juice and medicine. Almost 33k\al of energy can be gained on 100 gm consumption of okra. Due to the antioxidant, antidiabetic, antineoplastic, antitumor, antimicrobial and antiulcerogenic characteristics of the mucilage extract of okra, it has been extensively used in medical field. Sunsari is the biggest okra producing district followed by Dhanusha and Jhapa in terms of area and production per hectare. Being a high value vegetable crop, it hasn't been in popular in cultivation and use due to the lack of appreciate knowledge. Nepalese farmers are still on lack of information about the medicinal as well as dietary values of okra. If we use the cultivation practices in efficient way, it is pretty sure that a good prospect must be wait for our country.

Introduction

Okra (*Abelmoschus esculentus)*, commonly known as bhindi, is a mercantile vegetable crop that has been cultivated in different countries of the world. (Ambrose, 1956) Okra *(Abelmoschus esculentus*), a vegetable crop of Malvaceous family have many significant benefits.. It is grown widely in tropical, subtropical and warmer temperate regions including West Africa, South Asia, Southern Europe and North America (Gong et al., 2019). The optimum temperature for growth and development of okra is 24-28°C and it is very sensitive to drought, water logging, frost and cold (Das et al., 2018). When planting the temperature of soil should be warm enough for proper germination of seedling. Okra is cultivated commercially in USA, Japan, Thailand, India, Bangladesh, Turkey, Malaysia, Ethiopia, Pakistan, Myanmar, Brazil, etc. (Sorapong, 2012). It is an annual herb having slightly curved, six chambered pod of fibrous textured, 10-25 cm long fruit whose seeds are rich in protein and oil (Thoele et al., 2015). The leaves of the okra are polymorphous; heart shaped and three to five lobed and petioles upto 15 cm long. Flowers are attractive, yellow with crimson center (Islam, 2019). Different parts of the okra plant such as fresh leaves, buds, flowers, pods, stem, seeds and fruits can be use six-chambered board for several purpose (Durazzo et al., 2019). The fruits of okra are mostly consumed as vegetables, while some people use it to make salad, soup and stewed with meat. In food emulsion system Okra plant can be used as emulsifying agent (Ahmad & Norizzah, 2015). The mucilage of okra has medicinal properties like: antioxidant, antidiabetic, antineoplastic, antitumor, antimicrobial, antiulcerogenic capacities, binding cholesterol and bile acids and removing toxins from liver (Jha et al., 2018). Okra fruit is a good source of mineral, protein, fiber, folate, calcium, phosphorous, magnesium along with vitamin A, B, C and K1 (Tiamiyu et al., 2012)

Origin And Geographic Distribution

Okra is a trading crop owned by the Malvaceous family and its origin is supposed to be Ethiopia and other different Northeast African countries. (D S Kumar et al., 2013) was grown by the early Egyptian peoples by the 12th century (Singh, Chauhan, Tiwari, Singh Chauhan, et al., 2014) .Its distribution can be found all over the world with all the climatic regions(Singh, Chauhan, Tiwari, Chauhan, et al., 2014). In Nepal, it is seldom cultivated as a commercial crop but in some regions, such as Dhankuta, Bhairahawa, Pokhara, and Kathmandu District where okra is grown as a common vegetable up to 1400MASL. Because of high nutritive value species *A.esculantus* is vigorously cultivated all over the world, another one species i.e., *A.moschutus* is mainly grown for horticultural point of view i.e., mainly for aromatic seed production as well as grown as ornamental plants though its existence is in wild form (Keatinge et al., 2011)

Composition and Uses

Okra has been consumed in various ways throughout the history. Its fruits and leaves are consumed by human and could be fed to farm animals as a means of forage, respectively. Similarly, Okra is used as fuel, mucilage, paper pulp, coffee substitute, source of curd and oil and protein source.

- Leaves: In regions where a variety of leafy greens are included in the diet (such as western Africa and Southeast Asia), the soft leaves of okra are frequently eaten as a vegetable (Lamont, 1999). Along with the leaves, the delicate shoots, flower buds, and calyxes are frequently consumed (Irvine, 1952).

- Fruits: The pods have a distinctive flavor and mucilaginous texture when they are boiled, added to soups or cut up and fried. Boiling dried pods or okra powder makes them quickly palatable. Okra is predominantly consumed in the United States as food in its fresh and processed forms (canned, in ready-to-eat soups, frozen, and dehydrated as a powder). Okra's young, soft pods are great in soups and stews and are frequently used in creole cooking. They can be cooked, baked, or fried. Rapid cooking is desirable regardless of the technique since it maintains flavor and keeps the food from becoming mucilaginous.
- Fuel and Mucilage use: Okra stems that have been completely dried can be burned as a cheap fuel. It burns quickly and generates a lot of heat; however, it does not last long. Similarly, the pod turns extremely mucilaginous when it is boiled. Okra mucilage is the term for the thick, slimy substance that can be found in both fresh and dried pods. Potential applications for okra mucilage include food, non-food goods, and pharmaceuticals. Applications in food include using it to beat up reconstituted egg whites, as an ingredient in the creation of flour-based adhesives, and in India, to clarify sugarcane juice. In Malaysia, this mucilage has been utilized as a spreading agent in the production of paper. As a preventative food additive against irritative and inflammatory stomach disorders, Okra mucilage is utilized in Asian medicine (Lengsfeld et al., 2004).
- Oil and Protein source: Linoleic acid, a polyunsaturated fatty acid required for human nutrition, is abundant in Okra seed oil (S. Kumar et al., 2010). Okra seeds have a high (70%) amount of unsaturated fatty acids, particularly linoleic and oleic acids. Although the oil has a poor keeping quality, it may easily be hydrogenated to create a solid shortening that can be used as margarine. Also, okra contains a lot of protein—between i.e., 18% to 27%. Okra seed protein is comparable to many cereals (apart from wheat) in terms of protein efficiency ratio (PER) and net protein utilization (NPU), and its oil output is comparable to most oil seed crops, with the exception of oil palm and soybean (Onakpa, 2013).
- Paper Pulp: Okra plant fiber, like that of other members of the Malvaceous family, is ideal for use in the production of paper. The woody cores of okra stems have longer fibers than those of most other dicotyledonous plants (Nelson et al., 1961). The stems are used to produce a fiber that is used in place of jute. In addition, it is used to create textiles and paper. The fibers are 2.4mm length on average. The leaves are pulled off and the stems are heated till the fibers can be stripped off when used to make paper. The stems are harvested in late summer or autumn after the edible seedpods have been harvested. The fibers are lye-cooked for two hours before being ground for three hours in a ball mill (A. Kumar et al., 2013).
- Biopolymer: Natural binder called Abelmoschus esculentus can be used to create an inexpensive, ecologically sound biopolymer for the green pathway technique of silver nanoparticle production producing spherical silver nanoparticles. The green approach method for synthesizing nano silver material shown good antibacterial effectiveness against Candida, Staphylococcus aureus, and Escherichia coli (Pande, 2014).
- Livelihood Enhancement: Okra has enormous potential to improve livelihoods for many stakeholders, both in urban and rural regions. It provides a potential path to prosperity for both small- and large-scale farmers, as well as everyone else involved in the okra value chain, especially female farmers and traders. It provides nutritional and food security through high amount of dietary fiber, rich in vitamin B6, folic acid, A and C. Similarly, Okra can be value added; dried, mound and stored for long period unlike other perishable vegetables. Besides, it's potential for non-vegetable use are- paper pulp, bio-film etc

Nutritional Component of Okra

Okra provides vitamins and carbohydrates (Dilruba et al., 2009) and young, immature okra pods can be eaten in a variety of ways and are crucial to consume as fresh fruits (Ndunguru& Rajabu, 2004). Fruit of okra can be fried, boiled, or cooked (Akintoye et al., 2011). The primary elements included in okra pods are K, Na, Mg, and Ca which have a seed content of 17%. Fe, Zn, and Mn are present and Ni has also been mentioned (Moyin-Jesu, 2007). Fresh pods provide little calories (20 per 100 g), almost no fat, and almost no sodium, high in fiber, and include a number of essential nutrients, comprising around 30% of the advised levels of 10 to 20% of folate (46 to 88 g), and vitamin C (16 to 29 mg). Moreover, 5% of vitamin A (14 to 20 RAE) (Council, 2006). The seeds and pod skin (mesocarp) are both great sources of (80 g/g) zinc (Cook et al., 2000). Okra seeds and pods are abundant in phenolic compounds with significant biological effects, such as hydroxycinnamic derivatives, quartering derivatives, and catechin oligomers (Arapitsas, 2008). These qualities, combined with the high levels of proteins, carbohydrates, glycol-proteins, and other nutritional components, increase the significance of this meal in the human diet (Manach et al., 2005). The best vegetable source of viscous fiber, a crucial nutrient for lowering cholesterol, is found in fresh okra pods (Kendall & Jenkins, 2004). Fresh okra pods that are seven days old have the highest concentration of nutrients (Agbo et al., 2008).Okra stems and roots are used to clarify sugarcane juice, which is used to make gur or brown sugar (Kacha & Patel, 2015).

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Table 1. Nutritional value of raw Okra per 100g, Source:(A. Kumar *et al*., 2013)

Energy	33Kcal
Carbohydrate	7.45g
Sugar	1.48g
Dietary Fiber	3.2g
Fat	0.19g
Protein	2g
Water	90.19g
Vitamin A	36 µg (7%)
Thiamine(B1)	0.2 mg (17%)
Riboflavin(B2)	0.06mg (5%)
Niacin(B3)	1mg (7%)
Vitamin C	23 mg (28%)
Vitamin E	0.2 mg (2%)
Vitamin K	31.3 µg (30%)
Calcium	82 mg (8%)
Iron	0.62 mg (5%)
Magnesium	57 mg (16%)
POTASSIUM	299 mg (6%)
Zinc	0.58 mg (6%)

Chemical Composition of Okra

Okra pods contain 88.6 g of water, 144.00 kJ (36 kcal) of energy, 2.10 g of protein, 8.20 g of carbohydrate, 0.20 g of fat, 1.70 g of fiber, 185.00 g of beta-carotene, 0.08 mcg of riboflavin, 0.04 mcg of thiamin, 0.60 mcg of niacin and ascorbic acid 47.00 mg (Fekadu Gemede, 2014). Okra is rich in protein, carbohydrates, and vitamin C and is an essential part of the human diet (Saifullah & Rabbani, 2009). Okra fruit is primarily eaten raw or cooked, and it is a significant source of the vitamins A, B, and C, as well as minerals like iron and iodine and viscous fiber from vegetables. However, it is also said to be low in salt, saturated fat, and cholesterol (Kendall & Jenkins, 2004). Okra leaves contain the following nutrients per 100 g of edible portion: 81.50 g of water, 4.40 g of protein, 0.60 g of fat, 11.30 g of carbohydrate, 2.10 g of fiber, 532.00 mg of calcium, 70.00 mg of phosphorus, 0.70 mg of iron, 59.00 mg of ascorbic acid, 385.00 g of -carotene and 0.25 mg of thiamin (Gopalan et al., 2007). The majority of the carbohydrates are found as mucilage (R. Kumar et al., 2009). (Liao et al., 2012) observed that *Abelmoschus esculentus* L has a high usage value based on its high total phenolic and total flavonoid content and excellent antioxidant activity. The nutritional benefit of some chemical characteristics, such as crude protein, crude oil, and crude fiber, led to the importance of okra in human health (Çalışır et al., 2005).

Table 2. Chemical composition of okra seeds: Source:(Çalışır*et al*., 2005)

Properties	Values
Moisture (%)	6.35
Crude Protein (%)	19.10
Crude Oil (%)	8.21
Crude Fiber (%)	26.34
Ash %	4.63
Crude Energy (kcal/g)	25.4
Water soluble extract (%)	2.6
Ether-soluble extract (%)	8.7
Non–soluble HCL acid ash (%)	$0.41*10^{-2}$

Health Benefits of Okra

In recent years, people have become more aware about their health consciousness and preferred to live a healthy lifestyle with food enriched with high amounts of nutrients, vitamins, antioxidants and fibers. High consumption of plant products is linked to a lower risk of several chronic diseases, including atherosclerosis and heart disease (Gosslau& Chen, 2004). The chemicals with antioxidant activity have been partially responsible for these positive benefits. Okra is widely accepted as a healthy food because it is a source of calcium and potassium which also contains folate vitamin C and high dietary fiber. Carotenoids, and phenolic chemicals, especially flavonoids, vitamins C and E, are the main antioxidants found in vegetables especially okra (Oyelade*et al*., 2003). These antioxidants eliminate free radicals which prevent the start of chains, or stop chains from spreading

(the second defense line) (Fekadu Gemede, 2014). Carotenoids and vitamin E quench singlet oxygen, adding to the first line of defense against oxidative stress (Krinsky, 2001). Okra has been nicknamed "the perfect villager's vegetable" due to its hardiness, nutritional fiber, and unique seed protein balance of both lysine and tryptophan amino acids (unlike the proteins of grains and pulses) (Holser & Bost, 2004).
Okra seeds are well known for having a high concentration of high-quality protein, especially when compared to other plant protein sources due to their higher concentration of key amino acids (Oyelade et al., 2003). As a result, it is crucial to human diet (Farinde et al., 2007). Okra seed protein's amino acid profile is similar to that of soybean protein's, and it has a higher PER (Adetuyi et al., 2012). Similarly, the protein's amino acid composition makes it a suitable addition to diets based on legumes or grains (Ndangui et al., 2010). Protein and unsaturated fatty acids like linoleic acid are abundant in okra seeds. The thick, slimy polysaccharides found in okra pods are used to thicken soups and stews, as an alternative to egg whites, and as a fat substitute in chocolate bar cookies and frozen dairy desserts with chocolate (Sengkhamparn*et al*., 2009).

Medicinal Uses of Okra

Okra is an antispasmodic, diuretic, emollient, stimulant, demulcent, diaphoretic, and vulnerary food. Okra's medicinal benefits have reportedly included treating ulcers and providing relief from hemorrhoids (McCullough et al., 2002). Okra is renowned for having significant antioxidant activity with diverse portions of the plant (Shui & Peng, 2004).
The roots of okra have a potent demulcent effect due to their high mucilage content (Kumar *et al*., 2010) which can be used as plasma replacement. An infusion of the roots is used in the treatment of syphilis. Similarly, the juice of the roots is used external to treat cuts, wounds and boils in Nepal. The seeds are soothing, stimulating, and antispasmodic. The roasted seeds can be infused to have sudorific effects (Martin, 1982). Okra proves effective for lowering blood sugar levels in the body, helping with diabetes, due to fiber and other nutrients. The fiber also aids in maintaining stable blood sugar levels by delaying the absorption of sugar via the intestines (Ngoc et al., 2008). Okra contains a significant amount of folic acid, which is essential for the development of the neural tube in the baby between the fourth and the 12th week of pregnancy (Zaharuddin et al., 2014) Through the utilization of foliate, a crucial component for a healthy pregnancy, and critical B vitamins for forming and sustaining new cells, okra helps to support a healthy pregnancy.Okra is used to stabilize blood sugar by regulating the rate at which sugar is absorbed from the intestinal tract. Okra normalizes blood sugar and cholesterol levels in addition to being beneficial for asthma sufferers (Sengkhamparn et al., 2009). Polysaccharide of okra reduces blood cholesterol levels and may prevent cancer because of its capacity to bind bile acids (Lengsfeld et al., 2004). Furthermore, okra seeds have effects on diabetics' lipid profiles and blood glucose levels that normalize them (Sabitha et al., 2011) .

Cytogenetic Relationship

Regarding cytological evidences about the origin of cultivated okra, the statement says that A. esculentus (2n=130) is an amphidiploid of *A. tuberculatus* (2n=58) and an unknown species (2n=72), in all probability, most likely source of complementary genome has much acceptance.(Joshi & Hardas, 1956)and (Joshi & Hardas, 1956) studied chromosome homology during meiotic event of hybrids between *A. esculen*tus and A. tuberculatus concluded that out of 65 chromosomes of *A. esculentus* (n=65), 29 had complete homology with 29 of *A. tuberculatus* (n=29) and remaining 36 appeared considerable but incomplete pairing with 36 of *A. ficulneu*s (n=36). They suggested that one of the parents of A. esculentus (n=65) should have been *A. tuberculatus* (n=29) and among of the two Indian species, namely *A. ficulneus* and *A. moschatus* possibly show a role of complementary genome, yet to be established.

Production Status and Marketing in Nepal

For easy and maximum production of Okra in subsistence farming, the sack cultivation is most reliable in terai region of Neal during summer and spring days(Kandel & Puri, 2020). Though onion production technique had been satisfiable with new mechanization in different areas of Nepal, the daily vegetable consumption rate along with onion is very low (i.e., 56 gm) as compared to suggested amount (i.e., 300gm)(AVRDC, 1998).
According to the report of Nepalese Agriculture 2076/77(2019/20), the Okra production status in different districts of Nepal could be visualized as Table 3.
Thus, from the above statistical information, it could be claimed that the maximum production of Okra per hectare is in Lalitpur (20.10) and the minimum production per hectare is in Sarlahi (4.65).
Similarly, the Okra production of different provincial area of Nepal as per the report of Staatistical Information of Nepalese Agriculture 2077/78(2020/21) could be tabulated as Table 4.

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Table 3. The Okra production status in different districts of Nepal

S.N.	Districts	Area	Production	Yield
1	Taplejung	18	245	13.61
2	Sankhuwasabha	105.10	1167.0	11.10
3	Solukhumbu	4.5	23.00	5.11
4	Panchthar	28	209	7.46
5	Ilam	0	-	-
6	Terahthum	16.5	139.40	8.45
7	Dhankuta	23	119	5.17
8	Bhojpur	6	57	9.5
9	Khotang	4	38	9.5
10	Okhaldhunga	6	56	9.33
11	Udaypur	90	1080	12
12	Jhapa	575	8625	15
13	Morang	306	3367	11
14	Sunsari	715	8575	11.99
15	Saptari	325.25	4422.09	13.60
16	Siraha	93.05	1214.17	13.05
17	Dhanusa	606	5500.61	9.08
18	Mahottari	453	5174.72	11.42
19	Sarlahi	254.11	1181.67	4.65
20	Rautahat	49.81	478.37	9.6
21	Bara	458.11	6711.05	14.65
22	Persa	312	3726.19	11.94
23	Dolakha	6.5	52	8
24	Sindhupalchowk	41	477	11.63
25	Rasuwa	11	83	7.55
26	Ramechp	14	168	12
27	Sindhuli	130	870	6.69
28	Kavrepalanchowk	151	2273	15.05
29	Bhaktapur	-	-	-
30	Lalitpur	13.07	262.60	20.10
31	Kathmandu	15.08	129.28	8.58
32	Nuwakot	102	1338	13.12
33	Dharding	168	1512	9
34	Makwanpur	125	2750	22

Area on hectares, the production in metric tons and yield is on metric tons per hectare.

Table 4. the Okra production of different provincial area of Nepal as per the report of Staatistical Information of Nepalese Agriculture

S.N.	Province	Area	Production	Yield
1	Province 1	1914	25842	13.50
2	Madhesh	2566	29107	11.34
3	Baagmati	1135	14668	12.93
4	Gandaki	759	7335	9.66
5	Lumbini	1860	16941	9.11
6	Karnali	336	3833	11.41
7	Sudurpaschim	1013	12840	12.67

Area on hectares, the production in metric tons and yield is on metric tons per hectare.

Thus, from the above information, it could be concluded that the maximum Okra production in recent case is in Province 1 followed by Bagmati province. Meanwhile, the minimum Okra production is seen on Lumbini province followed by Gandaki province(Ministry of Agricultural Development, 2013).

Seed production of different vegetables including Okra could be the major source of economic and life quality upgrading phenomena among farmers(*Aggg2.Pdf*, n.d.), the seed production of okra and also other different spring vegetables are practiced in mid hills and high hills of Nepal due to favorable cool climate. Meanwhile, there exists lacking of roper research, mechanization and agricultural extension system in these areas(Timsina & Shivakoti, 2018).

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Conclusions

Okra (*Abelmoschus spp)* is a multipurpose vegetable crop whose whole parts from head of plant to the bottom i.e., (leaves, flower, stem, fruit, seed) can be used very effectively in different purpose such as vegetable, fruit, medicine, beauty and cosmetics, fiber industry, etc. Okra is very effective reagent in medical sector as it can perform as an antispasmatic, antidieuratic, emollient, stimulant, demulcent, diphoretic agent also useful in treating ulcer disease. The nutritional value of okra is also satisfactory, only 100 gm of okra fruit can give upto 33 k Cal of energy. But being a multipurpose vegetable crop Okra cultivation has not been so practical in context of our country, if we use the cultivation practices in efficient way, it is pretty sure that a good prospect must be wait for our country.

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