International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 31 No. 1 February 2022, pp. 276-281

Okra (Abelmoschus Esculentus L.) as Foodstuff and Its Bioactivity

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Abstract – Okra (*Abelmoschus esculentus*, Malvaceae) has long been used as a vegetable and traditional medicine. This study aims to explain the botany and use of okra as a food ingredient and its bioactivity. The method used is library research from Google Scholar by using the keywords *A. esculentus*, secondary metabolites of *A. esculentus*, and uses *A. esculentus*. The immature okra fruit, which is consumed as a vegetable, can be used in salads, soups and stews, fresh or dried, fried or boiled. Its medicinal uses have been reported in traditional medicine systems such as Ayurveda, Siddha and Unani. The mineral content of okra carbohydrates, vitamins (B3, B6, C, E) and minerals (K, P, Mg, Cu, Na, Zn, Ca). The bioactivity of okra includes anti-diabetes mellitus, anti-oxidants, improves nerve function, anti-ulcer and anti-microbial. Phenolic compounds, flavonoids and phenolics are bioactive components in okra fruit that function as antioxidants and diabetes mellitus. Okra has the potential to be developed as a nutraceutical to treat diabetes mellitus.

Keywords – *Abelmoschus Esculentus*; Anti Diabetes Mellitus, Flavonoid, Okra

I. Introduction

Abelmoschus esculentus L. (okra) is one type of vegetable that is widely used recently in Indonesia and has been traded in traditional markets (Silalahi et al 2021). This plant is easily recognizable from the shape of the fruit that resembles a finger so it is often referred to as the finger lady. Okra is thought to have originated in Ethiopia and is widely distributed throughout the tropics, subtropics and in the world (Benchasri 2012). Although okra is native to Africa (dos Santos et al 2013), it has been widely cultivated in Asia, including Indonesia. When compared to other types of vegetables such as cabbage, the selling price of okra is more expensive, this is thought to be related to its limited supply, therefore it has the potential to be developed as an economic commodity. Almost all okra organs are utilized such as fresh leaves, shoots, flowers, pods, stems and seeds. Immature okra fruit, consumed as vegetables, salads, soups and stews, fresh or dried, fried or boiled (Gemede et al 2015).

One of the main characteristics of okra fruit is that it produces mucus when soaked with water (Sengkhamparn et al 2009) and is believed to have properties to treat various diseases such as diabetes mellitus (Lu et al 2016; Huang et al 2017) and is rich in minerals (Gemede et al 2016). The use of okra as a traditional medicine has been reported in medicinal systems such as Ayurveda, Siddha and Unani (Kumar et al 2013). Okra plays an important role in the human diet by providing fat, protein, carbohydrates, minerals and vitamins (Benchasri 2012). Okra pods contain large amounts of essential nutrients such as protein, fiber, calcium, iron, and zinc and are low in antinutrients (Gemede et al 2016). The bioactivity of okra is thought to be related to the content of its secondary metabolites. Okra fruit powder extracted with ethanol and water contains carbohydrates, gums and mucus, proteins, phytosterols, flavonoids, tannins, phenolic compounds and essential oils (Saha et al 2011).

As a traditional medicine okra is used as a diuretic agent, for the treatment of dental diseases and to reduce/prevent gastric irritation (Sengkhamparn et al 2009). Okra seed extract has promising antioxidant, antistress, and nootropic activities supporting its medicinal value as a vegetable (Doreddula et al 2014). The average mineral concentrations in raw and cooked okra (in mg/100 g), were: 366 to 325 (Ca); 0.102 to 0.052 (Cu); 267 to 97.7 (K); 45.3 to 18.3 (Mg); 18.3 to 7.00 (Na); 44.5 to 25.8 (P); and 0.233 to 0.094 (Zn) (dos Santos et al 2013). This study aims to explain the use of okra as an ingredient in traditional food and medicine and its bioactivity so that its potential can be developed in nutraceuticals.

II. Methods

The method used in this study is library research obtained online from Google Scholar using the keywords *A. esculentus*, secondary metabolites of *A. esculentus*, and uses *A. esculentus*. The results obtained were reviewed so that comprehensive information was obtained about the use of okra as food, traditional medicine and its bioactivity.

III. Result And Discussion

3.1. Botany of *Abelmoschus esculentus* (L.)

The taxonomy of *Abelmoschus* is complicated, which was initially cultivated and the wild species were included in the genera *Hibiscus*, and was later appointed to a different genus as *Abelmoschus* by Medikus (1787 (Omonhinmin et al 2005). Subsequently, okra was included in the genera *Abelmoschus* and distinguished from the genera *Hibiscus* based on the characteristic's calyx, spatula, with five short teeth, similar to the crown and caduceus after flowering (Abdulrahaman et al 2015). The genera *Abelmoschus* (L.) Moench consists of ten species and four of which are extensively cultivated species namely *A. esculentus* (L.) Moench, *A. caillei* (A. Chev.) Stevels, *A. manihot* and *A. moschatus* (Essilfie et al 2010).

Description: an annual shrub 0.5-1 m high in the wild and up to 1.5-1.75 m tall when cultivated. Stem terete, green with light purple irregular spots with short internodes. Alternating leaf arrangement. Petiole measuring 12.5 - 15.5 cm long, purplish upper surface with stipules. The lamina is heart-shaped with 5-7 lobes measuring 10-12 cm (length) and 16-18 cm (width). Palmatisect upper leaves with a size of 6.5 cm and 8.5 cm. The petals are 5, free, regular, ovate, generally yellow, sometimes white, with rhomboid purple eye base. The stamina tube is creamy white; anthers reniform, yellow or white; filaments up to 1 mm long. Inflorescence a raceme with a size of 30-40cm long. Epicalyx numbered 9-12 subequal bracteoles. Sepal 5, segmented. Carpel 5, united; stigma red, with very fine lobes. Fruit capsule, 5-7.5 cm long and 2 cm broad, narrow oval with a pointed apex, slightly obtuse (Fig. 1A). Seeds round, black (cream colored when young) about 3 mm in diameter round hilum, dark brown (Figs 1B; 1C) (Pal et al 1952).

Figure 1. Fruit of okra (*Abelmoschus esculentus* L.). A. Fruit; B. Cross section with seeds; C. Longitudinal section with seeds.

3.2. Foodstuff

Plants used as food are plants that contain nutrients, vitamins or minerals. The types of plants that can be used as food are actually very many, but empirically looks like the exclusivity of certain foodstuffs. Immature okra fruit, which is consumed as a vegetable, can be used in salads, soups and stews, fresh or dried, fried or boiled (Gemede et al 2015). This is thought to be related to the use of which is only known by certain circles or the supply is very limited (Silalahi et al 2021). Okra is consumed as a vegetable by people in Africa and Asia (Sami et al 2014; Benchasri 2012) including Indonesia. However, the supply of okra in various markets is still very limited and the price is relatively more expensive than other vegetables such as cabbage and beans (Silalahi et al 2021).

Gemede et al (2016) stated that the development and consumption of vegetables can help reduce food insecurity and malnutrition in developing countries. This is related to the nutritional content of okra which is rich in carbohydrates, vitamins and minerals, but the content varies depending on the processing process (dos Santos et al 2013; Sami et al 2014). Okra quality assessment was carried out on the basis of protein, ascorbic acid and fiber content. Maximum retention of protein, ascorbic acid and fiber content was found in 2 cm long slices dried at 60 °C (Pendre et al 2012). Okra seeds are a potential source of oil, with concentrations varying from 20% to 40%, consisting of linoleic acid up to 47.4%. Okra seed oil is also a rich source of linoleic acid, a polyunsaturated fatty acid essential for human nutrition (Gemede et al 2015).

Average minerals for raw and cooked okra (in mg/100 g), were: 366 - 325 (Ca); 0.102 - 0.052 (Cu); 267 - 97.7 (K); 45.3 -18.3 (Mg); 18.3 - 7.00 (Na); 44.5 - 25.8 (F); and 0.233 - 0.094 (Zn). Minerals that varied greatly between raw and cooked samples were: K, P, Mg, Cu, Na and Zn, with a small contribution from Ca (dos Santos et al 2013). Okra pods (every 100 g) contained the highest vitamin B6 (49.81 g) and E (1.47 mg) but the lowest vitamin B3 (1.42 g) the lowest vitamin C (11.60 mg) vitamin B3 (22.70 g), B12 (91.20 g) (Sami et al 2014). The composition of okra fruit (g/100 g dry matter) is crude protein (10.25-26.16), crude fat (0.56-2.49), crude fiber (11.97–29.93), crude ash (5.37-11.30), carbohydrates (36.66–50.97) with energy content (197.26–245.55 kcal/100 g). Okra fruit contains calcium, iron, potassium, zinc, phosphorus, and sodium based on dry weight. The ranges of phytate, tannin, and oxalate content (mg/100 g) for Okra pods were as follows: 0.83–0.87, 4.93–9.90, and 0.04–0.53, respectively (Gemede et al 2016).

3.3. Traditional medicine and its bioactivity

Various types of food plants besides having nutritional content also have bioactive compounds that have medicinal properties so they are grouped as nutraceutical. Nutraceutical as a traditional medicinal ingredient has advantages compared to other medicinal plants because its toxicity has been tested so that it is safe for consumption in the long term. Its medicinal use has been reported in traditional medicine systems such as Ayurveda, Siddha and Unani (Kumar et al 2013). Okra is a medicinal plant that is widely used in traditional Turkish medicine to treat diseases such as ulcers and gastritis (Ortac et al 2018). The use of okra as a traditional medicine is related to its bioactivity. The following will explain further the bioactivity of okra as anti-diabetes mellitus, anti-cholesterol, improve nerve function, antioxidant, and anti-gastritis.

3.3.1. Anti-Diabetes Mellitus

Diabetes mellitus (DM) is a metabolic disorder that results in above normal blood glucose levels resulting in hormonal imbalance (Saha et al 2011). Various commercial drugs have been used to treat DM such as Glibenclamide, but its use in a relatively long time can result in various side effects, therefore the exploration of natural ingredients, including okra, continues to be carried out. The bioactivity of okra as anti-DM is more prominent than other bioactivities and has been reported by Saha et al (2011), Sabitha et al (2012), Thanakosai and Phuwapraisirisan (2013), Lu et al (2016), and Liao et al (2019).

Plants used as anti-DM are plants that produce secondary metabolites that can inhibit the breakdown of carbohydrates such asα -glucosidase (Thanakosai and Phuwapraisirisan 2013; Lu et al 2016) and α-amylase (Lu et al 2016) or stimulate the pancreas to produce insulin. which is known as a plant that has a hypoglycemic effect. Okra powder water extract has the same maximal effect as Glibenclamide (standard drug for DM) (Saha et al 2011). Administration of okra seed extract also significantly increased levels of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), reduced glutathione (GSH) and decreased levels of TBARS in liver, kidney and pancreas in diabetic rats in diabetic rats (Sabitha, et al. et al 2012). Dipeptidyl peptidase-4 (DPP-4) inhibitors are stated to be useful tools in the treatment of type 2 DM (Huang et al 2017).

Thanakosai and Phuwapraisirisan (2013) reported that the hypoglycemic effect of okra seed extract was related to the content of secondary metabolites that were able to inhibit intestinal α-glucosidase activity. It was further reported that isoquercetin and quercetin-3-O-β-glucopyranosyl-(1→6)-glucoside compounds selectively inhibit rat intestinal maltase and sucrase, where isoquercetin is 6-10 times more potent than diglucoside (Thanakosai and Phuwapraisirisan 2013). Abelmoschus esculentus showed -amylase and -glucosidase inhibitory activity. Fractionation of raw okra seed extract produces oligomeric proanthocyanidins (Lu et al 2016). Okra fruit powder extracted with ethanol and water extracts contains carbohydrates, gums and mucus, proteins, phytosterols, flavonoids, tannins, phenolic compounds and essential oils (Saha et al 2011). Polysaccharides extracted from okra are traditional functional foods, biologically active substances reported to have hypoglycemic properties (Liao et al 2019). Administration of okra extract increased liver glycogen and liver fibrosis in type 2 DM rats. Polysaccharides isolated from okra exert anti-T2DM effects in part by modulating oxidative stress via the PI3K/AKT/GSK3 drug transport pathway (Liao et al 2019).

3.3.2. Anti-Cholesterol

Cholesterol is a type of fat that is generally divided into high density lipoprotein (HDL) and low density lipoprotein (LDL). If the blood cholesterol level is above normal, it can cause various metabolic disorders and is known as hyperlipidemia. Simvastatin is one type of commercial drug that is used to treat blood cholesterol disorders. Okra mucus binds to cholesterol and carriers of toxic bile acids that are excreted into it by the liver (Gemede et al 2015). The activity of okra to overcome hierlipediam has been reported by Ngoc et al (2008), Gemede et al (2015) and Doreddula et al (2014). In an experiment in the laboratory, hyperlipidemia in mice was induced by intraperitoneal injection of tyloxapol (Ngoc et al 2008).

The bioactivity of okra in lowering blood cholesterol levels is influenced by various factors, including the substances used in the extraction. The hyperlipidemic rats (induced with tyloxapol) given extracts of dichloromethane (AE1), methanol (AE2), dichloromethane (AE3) and methanol (AE4) of okra fruit orally and simvastatin showed a decrease in cholesterol levels by 56.45%, 55.65%, 41.13%, 40.50% and 53.63% respectively. Triglyceride levels in the treatment group did not have a significant difference compared to the simvastatin group except for the AE4 treatment group (Ngoc et al 2008). Eight weeks of okra administration (200, 400 mg/kg bw) significantly reduced symptoms, with an increase in blood glucose, triglycerides, total cholesterol and LDL cholesterol, and reduced HDL cholesterol. lipoprotein cholesterol (HDL-C), body weight, food, and water consumption (Liao et al 2019).

3.3.3. Improving Nerve Function

The nervous system has a very important function in receiving, processing, and conveying stimuli from all organs of the body. Various factors lead to a decline in the nervous system, including age and chemicals that enter the body. Exploration of natural ingredients to suppress damage to the nervous system continues, including okra. Although reports of okra bioactivity to improve nerve function are still few, but this is a new alternative source that needs to be developed. Administration of dexamethasone, a synthetic glucocorticoid receptor agonist, causes death in the CA3 layer of the hippocampus, which has been associated with impaired learning and memory. Okra extract and its derivatives (quercetin and rutin) to protect neuronal function and improve learning and memory deficits in rats undergoing dexamethasone treatment (Tongjaroenbuangam et al 2011).

3.3.4. Antioxidant

Antioxidants are compounds that have a function to combat the negative effects that come from free radicals. Phenolic compounds (Shen et al 2019), flavonoids and phenolics (Liao et al 2012) are considered to be the main bioactive components in okra fruit that function as antioxidants (Shen et al 2019; Liao et al 2012). All different parts of okra and different enrichment fractions of A. esculentus aqueous extract contained phenolics and flavonoids (Liao et al 2012). Phenolic compounds, including quercetin-3-O-gentiobioside, quercetin-3-O-glucoside (isoquercetin), rutin, quercetin derivatives, protocatechuic acid, and their catechin derivatives, were identified as major compounds in okra fruit. Okra fruit at different ripening stages exerts extraordinary antioxidant capacity and inhibitory effects on pancreatic lipase, α-glucosidase, and a-amylase. The compound quercetin-3-O-gentiobioside is one of the main contributors to its antioxidant capacity and inhibitory effect on digestive enzymes (Shen et al 2019). The water extract fraction in A. esculentus has the effect of counteracting free radicals. The main components of antioxidant activity are flavonoids and phenolics so that their bioactivity as antioxidants is directly proportional to flavonoids and phenolics (Liao et al 2012). Fermented okra seeds contain significantly higher phenolic compounds, vitamin C, flavonoids and non-flavonoids and show greater antioxidant activity than unfermented okra seeds (Adetuyi and Ibrahim 2014).

3.3.5. Anti-Microbial

Pathogenic microorganisms are the main cause of infectious diseases in humans, especially in gastrointestinal, respiratory and skin infections. Plants used as antimicrobials are plants that produce compounds that can inhibit growth or cause microbial death. Okra fruit in traditional Asian and African medicine is used as a mucilaginous food to treat gastritis because of its polysaccharides which inhibit the adhesion of *Helicobacter pylori* to intestinal tissue (Messing et al 2014). Standardized aqueous extract of okra fruit dose dependent (0.2 to 2 mg/mL) inhibited the binding of *H. pylori* to cells. The non-specific interaction between the high molecular compounds of okra fruit and the surface of *H. pylori* causes a strong antiadhesive effect (Messing et al 2014). Okra has a gastroprotective effect against ethanol and can reduce gastric ulcers seen from biochemical and histopathological results in vivo (Ortac et al 2018).

IV. Conclusions

Okra has been used as a vegetable because it contains carbohydrate minerals, vitamins (B3, B6, C, E) and minerals (K, P, Mg, Cu, Na, Zn, Ca). The bioactivity of okra includes anti-diabetes mellitus, anti-oxidants, improves nerve function, anti-ulcer and anti-microbial. Phenolic compounds, flavonoids and phenolics are bioactive components in okra fruit that function as antioxidants and diabetes mellitus.

Conflicts Of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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