Okra

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Okra (*Abelmoschus esculentus* L.) is a popular vegetable crop with good nutritional significance, along with certain therapeutic values, which makes it a potential candidate in the use of a variety of nutraceuticals.

okra phytotherapy

1. Introduction

Okra (Abelmoschus esculentus L.), belonging to the family Malvaceae, is commonly known as Lady's finger, as well as by several vernacular names, including okra, bhindi, okura, quimgombo, bamia, gombo, and lai long ma, in the different geographical regions of its cultivation 1. Okra is believed to have originated around Ethiopia, where it was frequently cultivated by the Egyptians during the 12th century, and thereafter spread throughout the Middle East and North Africa ^{[2][3]}. Okra is an annual shrub that is cultivated mostly within tropical and subtropical regions across the globe and represents a popular garden crop, as well as a farm crop. It is a widely cultivated food crop and is globally known for its palatability. The immature green pods of okra are usually consumed as vegetables, while the extract of the pods also serves as a thickening agent in numerous recipes for soups, as well as sauces, to augment their viscosity [4][5]. Another noteworthy application of okra fruit is their wide use in the pickle industry. The polysaccharides present in okra are used in sweetened frozen foods such as icecreams, as well as bakery products, due to their health benefits and longer shelf-lives 6 ZIB. Anatomically, the fruits, stem, and leaves of okra are covered with minute soft, hairy structures. Although the flowering of the okra plant is perennial, it is highly dependent on various biotic and abiotic factors. The leaves of okra are polymorphous, characterized by hairy upper and lower surfaces, whereas the petioles are around 15 cmlong. The flowers of okra can be easily recognized due to their slight yellowish color with a crimson center. The edible part of okra or its capsule (pod) measures approximately 15–20 cm in length and has a pyramidal-oblong, pentagonal, hispid appearance. Historically, okra pods were utilized for various purposes, such as in food, appetite boosters, astringents, and as an aphrodisiac. Furthermore, okra pods have also been recommended to cure dysentery, gonorrhea, and urinary complications ^[9]. Extracts of young okra pods have also been reported to display moisturizing and diuretic properties, whereas the seeds of this plant have been reported to possess anticancer and fungicidal properties ^[10].

2. Formulation and Development of Okra-Based Nutraceuticals

Nutraceuticals are broadly described as food or parts of food that provide incremental health benefits. Okra-based nutraceuticals represent popular health foods, owing to its intrinsic nutritional and other bioactive components,

which show health-associated beneficial properties (Figure 1) [11]. Several efforts are being made to improve the well-known hypoglycemic outcomes of okra fruit by formulating different proportions of seeds and peels of Exmaradi Okra fruit in the ratio of (10:90, 20:80, 30:70, 40:60, 50:50%, and so on), which is subsequently followed by investigating the antidiabetic and antioxidant efficacy of these formulations in vitro. Recent findings have led to the conclusion that seeds and peels at the ratio of 10:90% are the most efficient in exhibiting substantial in vitro antidiabetic and antioxidant efficacy [12][13]. Subsequently, it was recommended that the nutraceutical formulation of peel and Ex-maradi okra seeds in the ratio (10:90) exhibits substantial hypoglycemic and hypolipidemic activity in alloxan models of diabetes (rodents) and was thus appropriate for further improvements for the formulation of okrabased nutraceutical interventions in diabetes mellitus ^[13]. On the other hand, okra polysaccharides have also been reported to inhibit human cancer cell proliferation [14]. This possibly indicates their potential usage as anticancer nutraceutical formulations. However, an individual's susceptibility to any disease also largely depends upon genetic predisposition and lifestyle habits, such as smoking and high alcohol consumption. Therefore, the efficacy of nutraceuticals can vary from person to person. Nutraceuticals have proven health benefits, and their consumption (within their acceptable recommended dietary intakes) may help in the prevention of disease and allow humans to maintain overall good health. Therefore, since various parts of okra (fruit, seed, pulp, and mucilage) carry several therapeutic purposes, it can be considered to be an important vegetable crop for nutraceutical purposes.



Figure 1. Illustrative representation of the okra-mediated beneficial effects that have been scientifically established to date.

3. Global Okra Production and Possible Nutraceutical Market

Okra, being an inexpensive popular vegetable crop, is consumed by several populations globally and is a local staple food in low-income countries. Nowadays, due to its nutritional and health benefits, there is a growing demand for okra, and different okra products are available for purchase on online marketplaces. Recently, the agency Market Research Future estimated that the global okra seed market could earn a revenue of USD 352.7 million and register a 9.8% compound annual growth rate during the period 2018–2023 ^[15]. Globally, the market of okra seeds is geographically largely divided into Europe, Asia-Pacific, and North America, followed by the remaining countries. In 2018, the largest accreditation for the contribution of the okra market share (63.77%) was recorded by the Asia-Pacific region. It is estimated that the okra-based nutraceutical market will reach a worth of 222.9 million USD by the end of the year 2023. Small-scale manufacturers are a major cause for the disintegration of the okra market in the Asia-Pacific region. Pakistan, Malaysia, India, and the Philippines are regarded as the dominant producers of okra seeds [16][15][17][18]. In recent times, India has been the prominent producer of okra globally, followed by the remaining countries mentioned above. Since 2018, these remaining countries have held a 33.0% share of the global okra market. This enhanced expansion within the local market is attributed to increased cultivation, as well as the development of genetically modified (GM) seeds. Furthermore, the acceptance of hybrid and disorder-resistant seeds within the region has also facilitated the noticeable expansion of the okra market. Africa is now predicted to globally dominate the market for the consumption of okra seeds. It represents approximately 69% of the territorial market share due to increased accessibility to more arable croplands within the country. On the other hand, during 2017, North America accounted for only 2.2% of the okra market share, whereas Europe accounted for only 1.0%. At the same time, Mexico is known to be a dominant producer of okra in North America because of the high cultivation of okra within the country ^[19]. The global okra seed-mediated market (OSM) is divided categorically and regionally. Based on the category, the OSM is further divided into conventional and organic seeds of okra plants. The conventional OSM (cOSM) is more prominent, with a market share of 90.5% since 2018. The market dominance of cOSM could be attributed to the exploitation of different varieties, namely open-pollinated and traditional. In contrast, organic OSM is estimated to show a high growth rate of 10.7%, which could be attributed to a shift in consumer awareness resulting in an increased preference for organic plant produce ^[20]. Thus, the high production of okra the world over should be utilized to some extent in the large-scale production of okra-based nutraceuticals, which could also be used to alleviate the problem of malnutrition in underdeveloped countries.

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