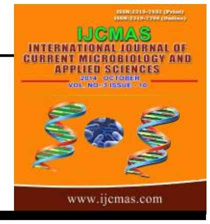

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Original Research Article

Evaluation of Phytochemical and Nutritional Composition of Bhindi (*Abelmoschus esculentus*)

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A B S T R A C T

Although, Bhindi (*Abelmoschus esculentus* (L.) Moench) plant is cultivated in tropical and warm temperate region around the world but the species is still poorly studied. Therefore, in the present study we aimed for evaluation of phytochemical and nutritional composition of Bhindi available in local vegetable market. Bhindi procured from local vegetable market was subjected to successive solvent extraction by continuous hot extraction (Soxhlet) with double distilled water, and evaluated for phytochemical screening. Furthermore, nutritional composition of Bhindi were assessed using standard analytical methods. Results depicted that aqueous (*aq.*) Bhindi extract composed of phytochemicals like alkaloids, flavonoids, glycosides, phenolic compounds, tannins, and terpenoids. The nutrient composition of Bhindi procured from local vegetable market composed of 79.80% moisture, 0.18% fat, 1.49% protein, 1.28% crude fiber, 17.93% carbohydrate, and 0.6% ash. In conclusion, Bhindi procured from local vegetable market contain appreciable amount of nutrients sufficient to meet daily human requirements. The phytochemical composition of Bhindi could be cheaper substitute for conventional drugs since they are easily available from vegetable source of Bhindi.

Keywords

Bhindi, Phytochemicals, Nutrients, Carbohydrate, Proteins, Fat, Fiber, Moisture

Introduction

For the sustainable food security of ever-growing world's population, there is an urgent need of diversifying the food supplying plant species. Underutilized indigenous crops often excel in terms of low input requirements, adaptability in the environmental and convenient harvesting characteristics. Many of them can also provide a good source of protein, minerals, and vitamins to alleviate micronutrient malnutrition that affects about half of the world's population.[1] Furthermore, in recent years, increasing attention has been paid to the role of diet in human health.[2]

The presence of chemical constituents in plants is important for consuming as nutrition and treatment against several diseases. The high intake of plant product is associated with reduced risk of a number of chronic diseases such as atherosclerosis and cancer.[3]

Bhindi (*Abelmoschus esculentus* (L.) Moench) is one of the important vegetables having better dietary value with medicinal and industrial importance (Figure 1). It is one of the most widely known and utilized species of the family Malvaceae,[4] and an economically important vegetable crop grown in tropical and sub-tropical parts of the world,[5] and it is a flowering plant in the mallow family.[6]

Okra known by different names such as lady's fingers in English speaking countries, asbamia in the Middle East and Bhindi in India, belongs to the family malvaceae and genus *Abelmoschus*. Bhindi is cultivated in tropical, subtropical and warm temperate regions of the world for its tender green pods and leaves which are cooked and commonly consumed as boiled vegetables.[7]

Bhindi can be grown on diverse variety of soils, however, at well drained soils with adequate organic matter high yields can be obtained.[8] Fruits and vegetables such as Bhindi have basic useful properties in providing excellent health and nutritional qualities as these are rich in vitamins and enzymes necessary for proper body function and prevention of chronic diseases.

Though Bhindi is a traditional vegetable, rich in nutrients and with high economical potential, yet it has so far been considered as a minor crop and a little attention is being paid to its improvement in the international research program.[6,9] With this scenario, in the current study we aimed to evaluate phytochemical and nutritional composition of Bhindi available in local vegetable market.

Materials and Methods

Collection Bhindi

The Bhindi were procured from local vegetable market, and thoroughly washed with running tap water to remove the dirt particles and wiped off, and sprayed with ethanol, and then shade dried.

The dried Bhindi were crushed to fine powder with help of electric grinder and stored in airtight containers for further analysis.[10]

Extraction

Approximately 50 g of dried and coarsely powdered Bhindi was subjected to successive solvent extraction by continuous hot extraction (Soxhlet) with 500 mL of double distilled water.

The extracts were concentrated by distilling the solvents in a rotary flash evaporator and dried at 40ºC. The extract was preserved in airtight containers and stored at room temperature until further use.[10]

Phytochemical Screening

Phytochemical screening was carried out on the aqueous (*aq.*) Bhindi extract by using standard procedures to detect phytoconstituents as described by Sofora,[11] Trease and Evans[12] and Herborne.[13]

Test for alkaloids

Approximately 0.2g of *aq.*Bhindi extract was warmed with 2% H_2SO_4 (2.0 mL) for two minutes. The reaction mixture was filtered and few drops of Dragendrof's reagent was added to the filtrate. Orange red precipitation showed the presence of alkaloids moiety.

Test for tannins and phenolic compounds

The *aq.* Bhindi extract in **s**mall quantity was mixed with water and heated on water bath and filtered. To the filtrate, few drops of ferric chloride ($FeCl_3$) was added. A dark green colouration indicate the presence of tannins and phenolic compounds.

Test for glycosides

About 0.6g of *aq.* Bhindi extract was hydrolyzed with HCl and neutralized with NaOH solution and few drops of Fehling's solution A and B were added. Formation of red precipitate indicates the presence of glycosides.

Test for saponins

About 0.2g of *aq.* Bhindi extract was shaken with 5 mL of distilled water and then heated to boil. Frothing (appearance of creamy miss of small bubbles) showed the presence of saponins.

Test for flavonoids

0.2g of *aq.* Bhindi was dissolved in diluted 10%NaOH and few drops of 2M HCl was added. A yellow solution that turns into colorless indicate the presence of flavonoids.

Test for steroids

2 mL of acetic anhydride was added to 0.5g of *aq.* Bhindi extract and then added 2 mL of H_2SO_4. The change of color from violet to blue or green or red showed the presence of steroids.

Test for terpenoids

0.3g of *aq.* Bhindi extract was mixed with 2 mL of chloroform ($CHCl_3$) and 3 mL of concentrated 6M H_2SO_4 was carefully added to form a layer. Formation of reddish-brown coloration at the interface indicates positive results for the presence of terpenoids.

Quantitative Estimation of Phytochemicals

Total phenolics

The concentration of total phenolics in the *aq.* Bhindi extract was determined by the Folin-Ciocalteu assay that involves reduction of the reagent by phenolic compounds, with concomitant formation of a blue complex, and its intensity at 725nm increases linearly with the concentration of phenolics in the reaction medium.[14] The phenolic content of the *aq.*

Bhindi extract was determined from calibration curve which was made by preparing gallic acid solution (0-0.8 mg/ml) in distilled water and was expressed in mg gallic acid equivalent (GAE)/g of extract powder (mgGAE/g).

Total flavonoids

Aluminum chloride colorimetric method was used for flavonoids determination in *aq.* Bhindi extract.[15] The flavonoid content was determined from extrapolation of calibration curve which was made by preparing quercetin solution (0-0.8 mg/ml) in distilled water. The concentration of flavonoid was expressed in terms of mg quercetin equivalent (QE)/g of extract powder (mgQE/g).

Nutrient Characteristics Analysis

Moisture content determination

The moisture content of the Bhindi was determined as per the method described in Association of Official Analytical Chemists (AOAC, 2000).[16]

$$\text{Moisture content (\%)} = \frac{(w_2 - w_1) - (w_2 - w_3) \times 100}{(w_2 - w_1)}$$

Where,

W1: Initial weight of the empty petridish (g)

W2: Weight of the petridish + Bhindi sample before drying (g)

W3: Weight of the petridish + Bhindi sample after drying (g)

Crude fat content determination

The crude fat content of the Bhindi was determined as per the method described in Association of Official Analytical Chemists (AOAC, 2000).[16] Soxhlet apparatus was used to determine crude fat content of the Bhindi samples. The crude fat (%) was calculated using the following formula:

Crude fat (%) = Weight of ether extract (g)/Weight of sample (g) X 100

Protein content determination

The protein content of the Bhindi sample was determined as per the method described in Association of Official Analytical Chemists (AOAC, 2000).[16]

- ✓ Place the samples of Bhindi (0.5-1.0 g) in digestion flask.
- ✓ Add 5 g Kjedahl catalyst and 200 ml of conc. H_2SO_4.
- ✓ Prepare a tube containing the above chemical except sample as blank. Place flasks in inclined position and heat gently until frothing ceases. Boil briskly until solution clears.
- ✓ Cool and add 60 ml of distilled water cautiously.
- ✓ Immediately connect flask to digestion bulb on condenser and with tip of condenser immersed in standard acid and 5-7 drops of mix indicator in receiver. Rotate flask to mix content thoroughly; then heat until all NH_3 is distilled.
- ✓ Remove receiver, wash tip of condenser and titrate excess standard acid distilled with standard NaOH solution.

Percentage of nitrogen and protein was calculated by the following equations:

Nitrogen (%) = T_S*-*T_Bx *Normality of acid* x *0.014)/ Weight of sample (g) X 100*

Where,

T_S - Titre volume of the sample (ml)

T_B - Titre volume of Blank (ml),

0.014-M eq. of N

Protein (%) = Nitrogen x *6.25*

Where,

6.25-The protein-nitrogen conversation factor

Crude fibre content determination

The crude fibre content of the Bhindi sample was determined as per the method described in Association of Official Analytical Chemists (AOAC, 2000).[16] The crude fibre (g) was calculated using the following formula:

Crude fibre (%) = (100-(moisture + fat))x A x 100/W1

Where;

W1 = Weight of the Bhindi samples

W2 = Weight of the crucible + Bhindi samples before heating at 600°C

W3 = Weight of the crucible + Bhindi sample after heating at 600°C

W2–W3 = A = Weight of crude fibre

Ash content determination

The ash content of the four different varieties of Bhindi was determined as per the method described in Association of Official Analytical Chemists (AOAC, 2000).[16] Drying the Bhindi samples (5g) at 100°C and churned over an electric heater. It was then ashes in muffle furnace at 550°C for 5 hrs. Ash content was calculated using the following formula:

Ash content (%) = Weight of ash (g)/Weight of sample (g) X 100

Total carbohydrate

The total carbohydrate content in the Bhindi sample was determined as total carbohydrate by difference, calculated by subtracting the measured protein, fat, ash and moisture from 100.[16]

Results and Discussion

The major phytochemicals in *aq.* Bhindi extract were found to be alkaloids, flavonoids, glycosides, phenolic compounds, tannins, and terpenoids. Whereas, phytochemicals such as saponins and steroids were found to be absent in *aq.*Bhindi extract (Table 1). The results of quantitative estimation of phytochemicals in *aq.* Bhindi was represented in Table 2. Results implied that total phenolics and flavonoids were found to be present in small quantities. Total phenolic quantity was found to be higher (1.46 mgGAE/g extract) in *aq.* extract of Bhindi when compared with total flavonoid quantities (0.54 mgQE/g extract).

The nutrient composition of Bhindi sample procured from local vegetable market composed of 79.80% moisture, 0.18% fat, 1.49% protein, 1.28% crude fiber, 17.93% carbohydrate, and 0.6% ash (Table 3 and Figure 1).

The term phytochemical is usually used to those chemicals that may have biological significance but are not established as important nutrients. But in narrower sense the term phytochemical describes the number of secondary metabolic compounds found in plants. The scientists estimate that approximately 10,000 different phytochemicals having the potential therapeutic effects on various ailments. Bhindi seed consists of tannins, terpenoids and glycosides.[17] Bhindi plays an important role in the human diet by supplying carbohydrate, minerals and vitamins.[18]Bhindi seeds could serve as alternate rich sources of protein, fat, and sugar.[19] The natural phenolic content of Bhindi seeds has been reported.[17] Hence in the present study we aimed to screen for phytochemicals present in *aq.* Bhindi extract and nutritional composition of Bhindi available in local vegetable market. In our study *aq.* Bhindi extract composed of phytochemicals like alkaloids, flavonoids, glycosides, phenolic compounds, tannins, and terpenoids. Total phenolics (1.46 mgGAE/g extract) and flavonoids (0.54 mgQE/g extract) were found to be present in small quantities. The nutrient composition of Bhindi sample procured from local vegetable market composed of 79.80% moisture, 0.18% fat, 1.49% protein, 1.28% crude fiber, 17.93% carbohydrate, and 0.6% ash. The consumption of Bhindi seeds can provide the necessary energy to the body and can boost the immune system of body, as well as against diseases.[19,20] Its ripe seeds are roasted, ground and used as a substitute for coffee in some countries.[21]

Table.1 Photochemical screening of *aq*.Bhindi extract

Phytochemical Components	*Aq.* Extract of Bhindi
Alkaloids	+
Flavonoids	+
Glycosides	+
Saponins	-
Steroids	-
Phenolic compounds	+
Tannins	+
Terpenoids	+

+: Present; -: Absent;

Table.2 Quantitative estimation of phytochemicals in *aq*. extract of Bhindi

Phytochemicals	*Aq.* Extract of Bhindi
Total Phenolics	1.46 mgGAE/g extract
Total flavonoids	0.54 mgQE/g extract

Values are expressed mean; n=3

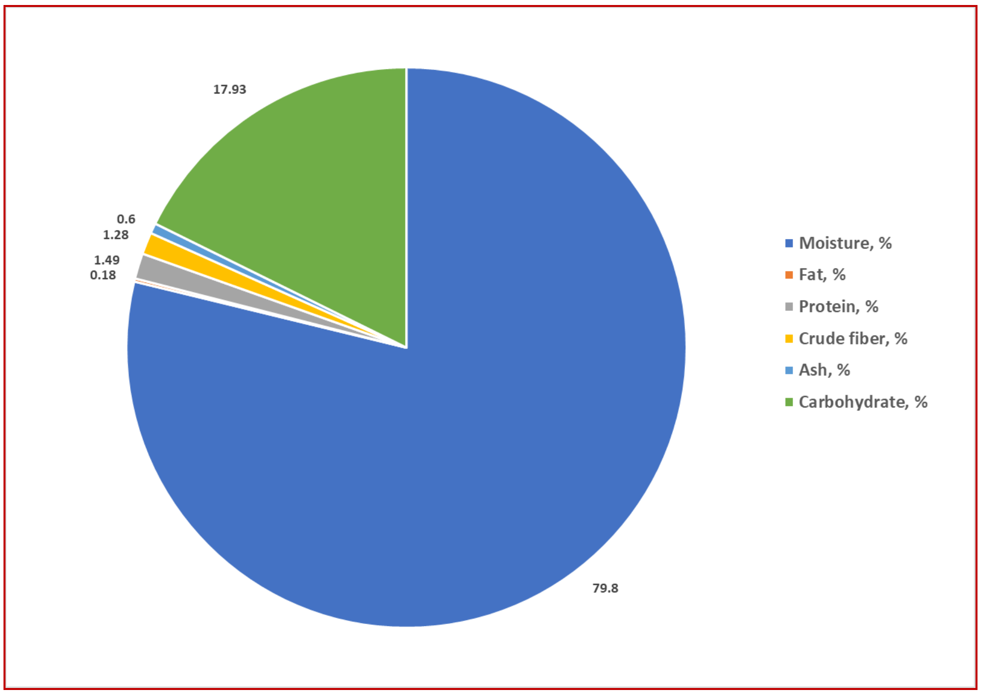
Table.3 Nutrient composition of *aq*. extract of Bhindi

Nutrient Composition	*Aq.* Extract of Bhindi
Moisture, %	79.80
Fat, %	0.18
Protein, %	1.49
Crude fiber, %	1.28
Ash, %	0.60
Carbohydrate, %	17.93

Values are expressed mean; n=3

Figure.1 Showing Bhindi (*Abelmoschus esculentus*) procured in local vegetable market

Figure.2 Nutrient composition of *aq.* extract of Bhindi



Literature reports evidenced that Bhindi provides an important source of carbohydrates and proteins which are often lacking in the diet in developing countries.[22-24] Carbohydrates in Bhindi are mainly present in the form of mucilage.[25,26] The immature Bhindi pods can be eaten raw or as a cooked vegetable and can also be pickled. Due to high contents of proteins and oil in Bhindi seeds,[27,28] the potential for wide cultivation of Bhindi for production of edible oil and cake is very high.[29]

Mature fruits and stems containing crude fibre are used in the paper industry and are also used for clarification of sugarcane juice from which gur or brown sugar is prepared.[30] Greenish-yellow edible Bhindi oil has a pleasant taste and odor and is high in unsaturated fatty acids such as oleic acid and linoleic acid.[31] Bhindi oil has also been reported to have potential hypocholesterolemic effect.[32]

Bhind is an important nutritive vegetable crop that finds several pharmacological applications. This preliminary study revealed that Bhindi procured from local vegetable market contain appreciable amount of nutrients sufficient to meet daily human requirements. The phytochemical composition of Bhindi could be cheaper substitute for conventional drugs since they are easily available from vegetable source of Bhindi.

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