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Bitter Gourd as the Potential Source of Various Bioactive Compounds and Its Use for Different Diseases: A Review

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Abstract

Bitter gourd (*Momordica charantia*) is an important and unique edible and medicinal vegetable-fruit. Bitter gourd is considered the most bitter among all plants, mainly because of the presence of three pentacyclic triterpenes, momordicinin, momordicin and momordicilin. Bitter gourd contains moisture, ash, lipids, fiber, protein, carbohydrates and energy. It consists of calcium, sodium, potassium, iron, manganese, copper, phosphorus and vitamins. It also contains phytochemicals, minerals, vitamins, antioxidants, and bioactive chemicals. It is helpful for different diseases such as inflammatory, leukemic, diabetic, mutagenic, mycobacterial, microbial, tumor, ulcer, aphrodisiac, viral, astringent, carminative, cytotoxic, hormonal, depurative, hypotensive, immuno-stimulant, etc. This article focuses on the review of benefits that bitter gourd offers in terms of its potential as a source of bioactive compounds and its role in the control of different diseases.



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Introduction

Bitter gourd (*Momordica charantia* L.) belongs to the Cucurbitaceae family and every part of bitter gourd plant is bitter [1]. Most common names of *Momordica charantia* are bitter gourd and bitter melon [2]. Bitter gourd is also known by some other names around the world like as Karella, Balsam pear, Goya, Ku gua, Ko guai, Kho qua, and Ampalaya [3]. Bitter gourd is the most important crop grown in tropical and sub-tropical regions of the world. The major producing countries of bitter gourd are China, Taiwan, Malaysia, Thailand, Vietnam, Indonesia, India and Africa [4]. Bitter gourd is a flowering vine and climbing perennial grows up to 5 m and contains elongated fruits with knobby surface. It is a vegetable and medicinal plant, good for human health and mostly used to control diabetes [5].

Types of bitter gourd

Different types of bitter gourds are present all over the world. These are the varieties of bitter gourd such as India long white, India long green and Hybrid India baby are available in India. Other famous varieties like Hong Kong green, Japan green spindle and green lover are present in Hong Kong, Japan and China, respectively. In Bangladesh, mainly two varieties are found, large size is called Korolla and small size is locally called Uche [6].

Nutritional value

Bitter gourd contains moisture, ash, lipids, fiber, protein, carbohydrates and energy. Bitter gourd is a medicinal vegetable, which has many valuable compounds, including phytochemicals, minerals, vitamins, antioxidants and bioactive chemicals helpful for the treatment of many diseases (Table 1). The bitter gourd fruit consists of the highest amount of vitamin C, vitamin A, vitamin E, vitamin B₁ (thiamine), vitamin B₂ (riboflavin), vitamin B₃ (niacin) and vitamin B₉. The caloric values for seed, fruit and leaf are 176.61, 241.66 and 213.26 kcal/100g, correspondingly [7]. Bitter gourd fruit contains a high amount of minerals such as potassium, zinc, phosphorus, calcium and iron (Table 2). Bitter melon is a good source of dietary fiber and amino acids (Table 3). The main reason for bitterness in bitter gourd or bitter melon is the presence of great amount of antioxidants, phenols, flavonoids, terpenes, glucosinolates and anthroquinones (Table 4 and Table 5) [8].

Therapeutic importance

Bitter gourd is traditionally famous due to its medicinal importance. It has anticancer, antiviral, antidiabetic, anti-inflammation and cholesterol reduction properties. Bitter melon contains many phenolic compounds, due to this reason, it has anti-mutagen and anti-oxidant properties [9]. Bitter gourd fruit, leaves, stem and roots all are used for the treatment of many diseases such as digestive disorders, hyperlipidaemia, microbial infection and menstrual problems [10]. Bitter gourd has the antiviral and anti-carcinogenic properties which can boost the immune system and activate the natural killer cell of the human body against white spot

Table 1 Proximate composition of bitter gourd fruit.

Component	Content	References
Moisture	93.20%	[23]
Ash	7.36%	[23]
Lipids	6.11%	[23]
Fiber	13.60%	[23]
Protein	27.88%	[23]
Carbohydrates	34.31%	[23]
Energy	241.66 kcal/100g	[23]
Vitamin c	96 mg/100g	[23]

Table 2 Mineral composition of bitter gourd fruit.

Minerals	Content	Reference
Calcium	20 mg/100g	[22]
Sodium	2.40 mg/100g	[22]
Potassium	171mg/100g	[22]
Iron	1.8 mg/100g	[22]
Manganese	0.08 mg/100g	[22]
Copper	0.19 mg/100g	[22]
Phosphorus	70 mg/100g	[22]

Table 3 Amino acids composition of bitter gourd fruit.

Amino acids	Content	References
Cystine	22.3 mg/g	[24]
Aspartic acid	93.8 mg/g	[24]
Threonine	25.2 mg/g	[24]
Serine	55.0 mg/g	[24]
Glutamic acid	96.0 mg/g	[24]
Proline	54.4 mg/g	[24]
Glycine	44.9 mg/g	[24]
Alanine	51.2 mg/g	[24]
Valine	42.2 mg/g	[24]
Isoleucine	30.8 mg/g	[24]
Leucine	64.9 mg/g	[24]
Tyrosine	59.4 mg/g	[24]
Phenylalanine	40.2 mg/g	[24]
Methione	47.6 mg/g	[24]
Histidine	72.8 mg/g	[24]
Lysine	101 mg/g	[24]
Arginine	45.6 mg/g	[24]

Table 4 Phenolic compound contents in different parts of bitter gourd (mg/g).

Compounds	Leaf	Stem	Green fruit	Ripe fruit	References
Tannic acid	2.13	2.40	1.08	1.41	[25]
p-Coumaric	0.36	6.72	0.56	0.16	[25]
Gallic acid	95.8	72.8	95.6	202	[25]
Caffeic acid	7.77	1.03	3.35	1.62	[25]
(+)-Catechin	4.39	4.68	3.95	4.54	[25]

syndrome virus, human immunodeficiency virus and cure breast cancer (Table 5) [11].

Anti-diabetic properties

The medicines obtained from the plants, mostly used all over the world to treat diabetes. Especially in developing countries, plant-based therapy is available to treat diabetic patients [12]. Some other traditional medicine systems and Ayurveda for the treatment of diabetes explained the number of plants that can be used as herbal drug. These medicines have fewer side effects and low cost. The bitter gourd is used to treat many diseases and has good medicinal values, but more emphasis is given to its anti-diabetic properties. Hyperglycemia involves the etiology of development of diabetic complications. The hyperglycemia herbs enhance the insulin secretions increase glucose uptake by muscles, adipose tissues and inhibit the production of glucose from the liver and glucose absorption from intestine [13]. Bitter gourd contains three active compounds, including charantin, vicine and an insulin-like compound polypeptide-p. These compounds reduce blood sugar levels by working together or individually. In addition, bitter gourd contains lectin which also reduce blood glucose level by affecting peripheral tissues and appetite. The lectin is a major factor of hypoglycemic effect [13].

Some other compounds present in bitter gourd also offer anti-diabetic properties. The important components of bitter gourd that have anti-diabetic effects are steroids, inorganic, triterpene, proteid, lipid and phenolic compounds. Some glycosides have been isolated from the bitter gourd fruit and stem and grouped under the genera of cucurbitane-type triterpenoids [14, 15]. Charantin is an important cucurbitane-type triterpenoid in bitter gourd that has anti-diabetic properties [16]. Vicine is another major compound that is isolated from the seed of bitter gourd and is used to treat hyperglycemia [17].

Table 5 Phytochemicals present in bitter gourd fruit.

Chemical compounds	References
Glycosides	[28]
Saponins	[28]
Alkaloids	[28]
Reducing sugars	[28]
Resins	[28]
Free acid	[28]
Fixed oil	[28]
Alkaloids	[28]
Charantin	[29]
Charine	[29]
Cryptoxanthin	[29]
Cucurbitins	[29]
Cucurbitacins	[29]
Cycloartenols	[29]
Diosgenin	[29]
Galacturonic acids	[29]
Guanylate cyclase	[29]
Momorcharins	[29]
Momordenol	[29]
Momordicilin	[29]
Momordicin	[29]
Momordin	[29]
Momordolo	[29]
Momordicosides	[29]
Oxalic acid	[29]
Oleanolic acid	[29]
Oleic acid	[29]
Linoleic acid	[29]

Other medicinal properties

Wound-healing activity

It was revealed that the bitter gourd extract has high amount of therapeutic compounds for the regeneration of tissues. It shows good wound healing properties that encouraged the proliferation of dermal fibroblasts of human [18]

Anti-HIV activity

Alpha- and beta-momorcharin proteins are present in seeds, leaves, and fruit of bitter gourd, those proteins expressed anti-HIV activity. Alpha- and beta-momorcharin proteins also could prohibit HIV-1 integrase (Table 6) [19].

Table 6 Biological benefits of unique proteins and enzymes present in bitter gourd.

Proteins/ enzyme names	Plant part	Biological benefits	References
Guanylate cyclase inhibitor	Fruits extract	Non- competitive inhibitor of guanylate cyclase activity	[26]
MAP30	Seeds	Anti-HIV activity	[19]
Ribonuclease	Seeds	Ribonuclease Activity	[19]
Protein P-B	Fruit Juice	Anti-cancer activity	[27]

Anticancer and antitumor properties

Different studies demonstrated that bitter gourd extract suppressed cancer cell growth and the development of liver cancer, mammary tumors, and leukemia in humans (Table 6) [20].

Bitter gourd products

In many countries, bitter gourd supplements and products are prepared by using the whole herb or vine powder and seed and fruit extracts. Different medicinal products such as Bitter Melon Extract-Solaray (500 mg capsule with 15% charantin) is used for hypoglycemic problems in the blood. Some bitter gourd products are Nature's Goodness Australia Bitter Melon, Puritan's Pride bitter melon capsules, Himalaya Bitter Melon capsule and Ampalaya Tea, etc. [21].

Conclusions

Bitter gourd is the most important medicinal plant; it has good therapeutic value. Bitter gourd has different medicinal properties such as anti-inflammatory, anti-diabetic, anti-tumor, anti-viral and immune-stimulant. Due to the presence of high bioactive compounds, bitter gourd is beneficial for the human health.

Conflict of interest

The authors have no conflict of interest.

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