



Brassicaceae - A Classical Review on Its Pharmacological Activities

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ABSTRACT

Brassicaceae, a mustard family includes about 338 genera and more than 3,700 species that are most commonly consumed a group of plants all over the world. Regular consumption of Brassicaceae vegetables provides a good source of bioactive compounds and different levels of nutrients in the everyday diet. It consists of many numbers of mineral, fiber, vitamin and phytochemical content thereby it is considered to be the staple food in various parts of the world. After soybean and palm, Brassica oilseed crops serves as the third most significant source with 14% of the world's edible vegetable oil. Not only the edible oil, the phytochemicals from the different parts of these plants provide a great source for medicinal and agronomic purposes. Around worldwide it is estimated that most frequently consuming vegetables include cauliflower, cabbage, turnip, broccoli and kohlrabi because of the presence of several useful dietary health attributes and also presence of several antioxidant phytochemical like carotenoids, ascorbic acid, and phenolic compounds, it involves in controlling various diseases related to cancer, heart and degenerative diseases. This paper communicates the pharmacological importance of medicinal plants from the family Brassicaceae (Cruciferae) or mustard family.

Keywords: Brassicaceae, Cruciferae, Mustard family, Medicinal plants, Pharmacological activities, Traditional uses.

INTRODUCTION

The World Health Organisation (WHO) says that about 80% of the world population in developing countries, mostly relies on locally available plant resources for their primary healthcare when compared to western pharmaceuticals.¹ Brassicaceae are commonly named as the "mustard" (from the Latin *mustum ardens*) plant family due to the sharp, potent flavor attributable to their main metabolites, the glucosinolates (GLSs), which contain sulfur.⁵¹ The members of the mustard are the earliest cultivated plants in the Brassicaceae family.² Among 338 genera, more than 3,700 species belong to the wide range of family Brassicaceae which is also known to be crucifers.^{3,4} Since 1500 BC oldest cultivated plants known to humans are said to be *Brassica* plants.³ For the discovery of the new drugs, medicinal plants provide a good source either as a pure compound or as an extract.⁵ A person consumes Brassica vegetables of about 6.3 kg person annum.⁶ Cruciferous are the vegetables that belong to the family *Brassicaceae* which are commonly referred to as *crucifera*. Broccoli, brussels sprouts, kale, mustard, cabbage, turnips, cauliflower, boy Choy and Chinese cabbage are some of the commonly consumed vegetables of Cruciferae which has high phytochemical constituents and a rich source of vitamin C.⁷ They are also grown and used all over the world by various cultures due to its great environmental adaptation. Numerous species used in traditional medicine and culinary belongs to the family Brassicaceae and these are also recognized as the functional food.²¹

Brassica vegetables exhibit biological activities like antibacterial, anticancer activity, antiviral and for the innate immune response system these vegetables act as a

potent modulator.⁷ In the traditional systems of medicines like Chinese and Unani, the crude extracts of medicinal plants are widely used at a domestic level in rustic areas.⁸ From ancient times, most of the cruciferous plants are cultured. Mediterranean basin is the native for these plants and there has high consumption in local markets.⁵⁰ All over the world, many areas consume Brassicaceae vegetables as stable food and it considered to be a good source of amino acids, minerals, carbohydrates, vitamins, different groups of phytochemicals.⁹ To improve the phytochemicals with good health benefits and to tolerate herbicides, insects, soil pests and diseases, these plants are incorporated in extensive breeding programs as a source of value-added traits of agronomic interest.⁴⁹ Various epidemiological and meta-analysis recommended that different types of cancers and chronic disease can be prevented by the intake of cruciferous vegetables.²¹ For their health care system, about 64% of the total global population relay on traditional medicine. Whereas in India 85% of the rural population rely on plants for treating various disease.¹⁰ Medicinal plants are those that contain active constituents which are used in the treatment of various diseases. In other words, plants with healing properties are termed as medicinal plants.¹¹ In recent years, brassica has added interest as trap crops. To attract and catch the targeted insects, these trap crops are positioned, thereby decreasing the loss of main crops from insects.⁵² In the study of evolutionary and polyploidy, the Cruciferae family serves as a model as it considers to be economically significant.¹² These family members are widely distributed all over the world and also it includes economically important edible and industrial oilseed.¹² *Brassica* spp. are found in all the parts of Italy but mostly



in northern Veneto, Lazio, Calabria, Puglia and Campania, the center-south region of Italy. The most commonly available Brassica spp. in Italy are Cavolo Nero (*Brassica oleracea acephala* L. convar. *Acephala* (DC.) Alef. var. *sabellica* L. and *Broccolo Fiolarodi Creazzo* (*Brassica oleracea* L. convar. *Italica botrytis* L. Alef. var. *cymose Duch.*).⁵⁰ Over the last few years, Cruciferous are used like sprouts in their germinating stage as a new culinary trend. Fried, baked, fermented, salad, fresh or dried as a spice, cooked are the other forms of Cruciferous used.²¹ Most of the mustard or Cruciferae family contains various economically significant species such as vegetables, fodder crop, industrial oil and edible seed.¹³ The cover crops of Brassicaceae are said to play a vital role in nematodes, weeds, fungi and diseases controlling by discharging the chemical compounds from decomposing residues.⁵²

Parkin *et al.* reported that Brassica species and *Arabidopsis thaliana* are considered as the “model organisms” for genomic studies in Brassicaceae family and Capsella and Arabis are recently proposed model species.¹³ In nature exstipulate leaves, spiral, hermaphroditic herbs and shrubs are found in Brassicaceae (mustard family).¹⁴ As a high number of species found in Brassicaceae which have the ability to hyper-accumulation of heavy metals like cadmium, zinc and nickel. Approximately 25% of the Cruciferae family are known to be hyper-accumulators.¹⁴ Some of the plants like *Brassica oleracea* L, *Brassica juncea* (L.) Czern., *Brassica nigra* Koch and *Brassica napus* L., from Brassicaceae family with higher growth rates are capable to tolerate and aggregates the heavy metals.¹⁴ As vegetables available in the Brassicaceae family contains vitamins, catalase, superoxide dismutase and peroxidase

so these vegetables are a prominent source for antioxidants activity.¹⁵ Oxidative stress, the risk of cancer, carcinogenic mutations and proliferation of cancer cells are prevented by the phytochemicals present in the Brassica vegetables.¹⁵ For the biofumigation process, brassicas used as biocontrol agents.⁵² Brassicaceae vegetables are considered as the important food crops in China, Japan, India, and European countries and worldwide it was consumed as the human diet.¹⁶ In experiments, the administration of broccoli juice or cauliflower in the animal models found the antimutagenic properties of cruciferous food plants.⁴⁹

In Brassicaceae family, all glucosinolate-containing vegetables are found to contain Myrosinase enzyme which enhances the hydrolysis of glucosinolates into aglycone and D-glucose and further aglycones are converted into indoles or isothiocyanates. Various health benefits are found in the active forms of glucosinolates.²¹ The current study in plant biology, Brassicaceae family plants are used as a model plant and some of them are *Arabidopsis halleri* in hyperaccumulation study *Cardamine hirsuta* in plant architecture, *Diplotaxis* spp. In mating system changes and *Lepidium* spp. in seed physiology.¹⁷ Several studies reported that the highest diversity of Brassicaceae sp. was found to be in the Irano-Turanian region which could serve as a possible site of origin for the family Brassicaceae. The age of the family is not clear yet. Estimation of Brassicaceae ages depends upon the timing of duplication of the genome in *Arabidopsis* yielded ages ranging from 24 to 40mya.¹⁷ In this review paper, our study mainly focused on the information about Pharmacological activities of Plants from Brassicaceae family.

Table 1: List of Plants from Brassicaceae family with Pharmacological activities

S.No	Botanical name	Common name	Parts used	Pharmacological activity	References
1.	<i>Brassica rupestris</i> L.	Brown mustard	Whole plant	Anticancer and antioxidant activity	¹
2.	<i>Brassica tournefortii</i> Gouan	Asian mustard	Whole plant	Anticancer and antioxidant activity	¹
3.	<i>Brassica napus</i> L.	Rapeseed	Whole plant	Anticancer, antioxidant, analgesic, diuretic and Anti-catarrhal activity, Diuretic, anti-scurvy, anti-inflammatory of bladder and anti-goat	^{1,2,22}
4.	<i>Brassica</i> L. var. <i>perviridis</i>	Mustard spinach	Whole plant	Anticancer and antioxidant activity	¹
5.	<i>Brassica rapa</i> L. var. <i>rapifera</i>	Turnips	Whole plant	Anticancer and antioxidant activity	¹
6.	<i>Brassica rapa</i> L. var. <i>chinensis</i>	Bokchoy	Whole plant	Anticancer and antioxidant activity	¹
7.	<i>Brassica rapa</i> L. var. <i>pekinensis</i>	Chinese cabbage	Whole plant	Anticancer and antioxidant activity	¹
8.	<i>Brassica oleracea</i>	Cauliflower	Leaves	Antibacterial activity	²³
9.	<i>Brassica carinata</i> A. Braun.	Ethiopian or Abyssinian mustard	Whole plant	Used as bio-fumigant, to suppress soil-borne pests and	^{2,24}



				pathogens Potential as new edible oil/protein crops	
10.	<i>Malcolmia africana</i> (L.) R.Br.	African mustard	spices	Antioxidant activity and phenol content	25
11.	<i>Brassica oleracea</i> L. var. <i>capitata</i>	Cabbage	Raw and processed Cabbage	Antioxidant, anti-inflammatory and antibacterial properties	6,23
12.	<i>Brassica rapa</i> L.	Broccoli raab	Vegetables	Anticancer, diuretic, analgesic, anti-gout potential, aphrodisiac activity, anti-inflammatory and anthelmintic activity Improve insulin resistance in type 2 diabetic patients	1,26,27
13.	<i>Brassica oleracea</i> var. <i>capitata</i> f. <i>rubra</i>	Red cabbage	Leaves	Anti-diabetic, antioxidant, hypolipidemic, antihyperglycemic, cardioprotective and anti-cancer activity	7
14.	<i>Brassica juncea</i> L.	Mustard	Seed Leaves Dried leaf and flower Total plant	Anticancer, anti-diabetic, diuretic, analgesic, emetic activity and rubefacient Antihyperglycemic, antioxidant, antiatherogenic, antifungal activity, allergenicity and antitumor activity Antiatherogenic effect, antioxidant and fungicidal activity Used to treat dengue fever, splenic disorders and dyspepsia	1,2,28–30
15.	<i>Brassica campestris</i> Linn.	Sarson	Seed Oil	Used to remove dandruff from hair, Used as Ointment in skin diseases masses, laxative and hair tonic	31
16.	<i>Raphanus sativus</i>	Radish	Leaves and seeds Underground parts	Antimicrobial activity Treatment of intestinal parasites, asthma and chest pain.	23,32,33
17.	<i>Lepidium Sativum</i> L.	Garden cress	Seeds	Used in treating dysentery and bone fracture Healing in human and migraine Used as a saag and anthelmintic Anti-arthritic activity Useful in the treatment of asthma, cough with expectoration, poultices for sprains, leprosy, skin disease, dysentery, diarrhoea, splenomegaly, dyspepsia, lumbago, leucorrhoea, scurvy and seminal weakness	34–37
18.	<i>Nasturtium Officinale</i> R.BR.	Watercress	Vegetative shoot	Used as pot herb and salad, its decoction and "Saag" is used as appet as appetizer, stomach, anticobic, diuretic and also used in chest problem.	34
19.	<i>Sisymbrium Irio</i> L.	London rocket	Leaves and seeds	Antipyretic, anti-vomiting, diarrhea and cough.	34,38

			Whole plant	A tonic herb with a mustard-like aroma. It has laxative, diuretic, and expectorant effect, and benefits the digestion, internally used for bronchitis, coughs, laryngitis and bronchial catarrh.	
20.	<i>Brassica nigra</i>	Black mustard	Seeds	Anticancer, anti-diabetic, diuretic, stimulant activity, activity in cold and flu, anti-catarrhal, emetic, antibacterial activity and laxative. Anti-spasmodic, aphrodisiac activity, appetizing, digestive and aperitif activity Used against alopecia, Anti-dandruff activity, Used in neuralgia Used for common cold and arthritis	1,2,39,40
21.	<i>Armoracia rusticana</i>	Horseradish	Roots and leaves	Anti-lipase and antioxidant activity	41
22.	<i>Calepina irregularis</i>	White ball mustard	Mustard extracts	Analgesic activity	2
23.	<i>Lepidium meyenii</i>	Maca	Leaves	Restores the levels of testosterone in the males Hypoglycaemic and anti-obesity effect	42
24.	<i>Brassica indica</i>	-	Whole plant	Used in fertility regulation	43
25.	<i>Anastatica hierochuntica</i> Linn.	Rose of Jericho	Whole plant	Used in fertility regulation	43
26.	<i>Capsella bursa-pastoris</i> Moench	Bambaisa	Whole plant Seeds	Used in fertility regulation Astringent	20,43
27.	<i>Cheirantus Cheiri</i> L.	Wallflower	Flower and seed	Diuretic, aphrodisiac, jaundice, tumors	43,54
28.	<i>Aethionema oppositifolium</i> Pers. & Hedge	Opposite-leaf candytuft	Spices	Antioxidant activity	25
29.	<i>Cardamine hirsuta</i> Linn.	Hairy bittercress	Whole plant	Used for indigestion	44
30.	<i>Rorippa indica</i> (Linn.) Hiern	Indian yellow cress	Whole plant	Used for a toothache, sore throat, rheumatic arthritis, hepatitis, abdominal and blood disorders	44
31.	<i>Descurainia Sophia</i> (L.) Webb.	Skhabootay	Flowers and leaves Seeds	Antiscorbic Used as Cardiotonic, demulcent, diuretic, expectorant, febrifuge, laxative	20,45
32.	<i>Nasturtium officinale</i> R.Br.	Talmeera	Shoot Leaves	Purgative, emetic Effective in cough	20,46
33.	<i>Alliaria petiolata</i> (M.Bieb.)	Garlic mustard	Leaves	Antimicrobial activities Used as an antiseptic in ulcers and cuts, as a disinfectant, a diuretic and to heal wounds and bronchial complications	2,47
34.	<i>Raphanus sativus</i> var. <i>longipinnatus</i>	White radius	Leaves	Antimicrobial activities	48
35.	<i>Brassica alba</i> Boiss.	White or yellow mustard	Seedling leaves Seeds	Used to purify and strengthen the blood, It has strong disinfectant properties and is used to preserve foods, Used for the treatment of cold, cough and sore throats	2



36.	<i>Sisymbrium officinale</i> L. Scop.	English watercress	Whole plant	Treatment of sore throat and as an expectorant to treat common cold and asthma	2
37.	<i>Nesliapaniculata</i>	Ball mustard	Whole plant	Used as fodder for both monogastric and ruminant livestock, skin disorders.	2
38.	<i>Sisymbriumerysimoides</i>	Smooth mustard	Whole plant	Used to treat bronchitis and has Anti-inflammatory activity	2
39.	<i>Sisymbriumorientale</i>	Asian hedge mustard	Whole plant	Used to treat bronchitis	2
40.	<i>Sisymbrium officinale</i>	Hedge mustard	Whole plant	Used to treat bronchitis and Snake bite antidote Anti-asthmatic, Anti-spasmodic and Anti- addiction activity	2
41.	<i>Camelina sativa</i>	Camelina	Whole plant	Potential in the food, animal feed, nutraceutical, paint, dye, cosmetic, and biofuel industries Potential as new edible oil/protein crops	24
42.	<i>Crambeabyssinica</i>	Crambe	Whole plant	Use as erucamide Potential as new edible oil/protein crops	24
43.	<i>E. vesicaria</i>	Rocket	Seed oil	Used as an illuminant, lubricant, hair oil, vesicant, and for massage and pickling. Potential as new edible oil/protein crops	24
44.	<i>Aethionema grandiflorum</i>	Persian stonecress	Whole plant	Used to treat meningitis, bacterial infections and typhoid	33
45.	<i>Erysimumkotschyan</i>	Wallflower	Spices	Antioxidant activity	25
46.	<i>Sterigmostemumincanum</i>	-	Spices	Antioxidant activity	25
47.	<i>Aethionemadumanii</i>	-	Spices	Antioxidant activity	25
48.	<i>Brassica hirta</i>	White mustard	extracts	Anti-microbial activity	2
49.	<i>Eruca sativa</i>	Rocket salad	Leaves whole plant	Used as Astringent, diuretic, digestive, emollient, depurative, laxative, rubefacient, tonic, stomachic Antiinflammatory, Antibacterial activity, Hair tonic, antidandruff and antioxidant activity antidiabetic activity	18–20 53

CONCLUSION

Many new types of therapeutic can be developed from the natural products that are commonly derived from the medicinal plants. Person's healthcare system can be improved by the Brassicaceae family through its fiber, vitamin and phytochemical content that are in the Brassicaceae order. Brassicaceae vegetable stands unique due to the presence of high sulfur-containing compounds in their bioactive metabolites. Effects on genetic pathways can be improved by those nutrients which are helpful to boost immunity, enable bone health and also have anti-inflammatory and anticancer activity. Thereby intake of these plant extracts by humans and animals has the advantage to put off *in vivo* oxidative damage linked with diseases and illnesses. Thereby consumption of Brassicaceae family leaves signifying naturally available food with potential antimicrobial activity. The compounds

present in this family as several beneficial effects due to their peculiar chemical features and physiological actions in it. Further *in vitro* or *in vivo* pharmacological studies for the scheduled bioactive compounds from Brassica vegetables have exhibited a wide spectrum of biological activities, including antimicrobial, anticancer, antimutagenic, anti-inflammatory, neuroprotective and antioxidative activity and also some may act as the anti-nutritive effects on the human body. The family signifies to be an outstanding source of health-promoting phytochemicals and nutrients that would pay beneficial dietary importance of these food crops against certain types of diseases. Thus, this review provides an enormous amount of facts about the nutritional value present and pharmacological activities associated with the Brassica vegetables in which it eventually directs the people to healthier food choices.



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