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A Panoramic View on Pharmacognostical and Pharmacological Attributes of Brassica Oleracecea Var.Botrytis: A Comprehensive Review

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KEYWORDS
Cauliflower, Brassica oleracecea, Brassicaceae, Phytoconstituents and Pharmacological.

ABSTRACT:
Brassica oleracea var. botrytis (Brassicaceae), a variety of cauliflower from the *Brassica oleracea* genus. Brassicaceae (Cruciferae) is referred to as the "mustard" plant family from the Latin "mustum ardens" because of the sulfur-containing glucosinolates (GLSs), which are their major metabolites and give the plant family its distinctive flavour. Different species of Brassica are cultivated throughout the world such as *Brassica oleracea, B. napus, B. rapa, and B. juncea* for the use as vegetables, animal feed, or oilseeds. In India, cauliflower is grown throughout the country. The plant is said to contain various class of phytoconstituents such as phenolics, flavonoids, ascorbic acid (Vitamin C), glucosinolates, astaxanthin etc., Cauliflower has various role in diabetes, cancer, other illnesses, etc., This current review focusses on phytochemical composition and pharmacological characteristics of the plant *Brassica oleracea* var. botrytis.

1.Introduction

Brassica oleracea var.botrytis, a variety of cauliflower from the *Brassica oleracea* genus.The Latin terms "Caulis" (stalk) and "Floris"(flower) are the origin of the word "cauliflower"[1].It contains significant amounts of dietary fiber, flavonoids, proteins, minerals, and the vitamins C, K, A, and folic acid [2].*Brassicaceae* (Cruciferae) is referred to as the "mustard" plant family from the Latin "mustum ardens" because of the sulfur-containing glucosinolates (GLSs), which are their major metabolites and give the plant family its distinctive flavor [3].*Brassica* vegetables have biological properties such as antibacterial, anticancer and antiviral activity. They also operate as a powerful modulator of the innate immune response system [4]. The *brassicaceae* family's mustard species are among the earliest cultivated plants.Their seeds are among the earliest known spices, having been used and grown for more than 5000 years [5]. It is also referred to as "Phoolgobhi" and was first introduced to India in 1822 by Dr. Jemson, who was in charge of the botanical garden in Saharanpur, Uttar Pradesh. It was derived from wild cabbage (*Brassica oleracea* var. sylvestris) [6]. The world cultivates *Brassica oleracea, B. napus, B. rapa, and B. juncea* from its approximately 350 genera and 3500 species for use as vegetables, animal feed, or oilseeds [7]. The edible portion of the cauliflower is called botanically as the prefloral fleshy apical meristem, blooming primordial, or immature inflorescence [8].The central and basal portions of the midrib were both cut off because these components. In order to evaluate the midrib's fiber content, the middle and basal portions were both removed [9]. The phytochemical composition and pharmacological characteristics of the plant *Brassica oleracea* var. botrytis are the main topics of this review.

2.Plant profile

Scientific name: *Brassica oleracea* var. Botrytis

Family: Brassicaceae

Genus: *Brassica*

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***Brassica oleracea* var. botrytis**

3.Taxonomical classification [10]

Synonym: *Brassica cretica convar*. Botrytis

Kingdom: Plantae

Phylum: Magnoliophyta

Division: Angiosperms

Subdivision: Spermatophytin

Class: Magnoliopsida (Dicot)

Order: Brassicales, Papaverales

Family: Brassicaceae (Cruciferae)

Genus: Brassica

Species: *Brassica oleracea* var. botrytis

4.Vernacular name[10]

Bengali: Phulakapi

Hindi: Phoolgobhi

Kannada: Hukosu,elekosu

Malayalam: Vyaakhyaanam,arutham

Assamese: Bandha kobi

Sanskrit: Kapikam

Tamil: Muttai-k-kocu, Pookosu

Telugu: Kosu

Urdu: Ghobi

5.History

Cole crops are widely grown worldwide, especially in tropical, subtropical, and temperate locations. They have one of the longest histories of any European vegetable.Since 600 BC, cauliflower has been grown throughout the Middle East and the Mediterranean. Three kinds that were introduced from Syria, where it had been grown for thousands of years, were described in Spain in the 12th century. Around 1490, it arrived in Italy; around the 16th century, it reached France and other nations in Europe. Cauliflower was mentioned in the 16th century in Turkey and Egypt. Cauliflower was known as "Cyprus coleworts" in England in 1586, implying that it had recently been imported from Cyprus. Late in the 17th century, cauliflower was first grown in North America. A botanist from Kew introduced it to India [11].

6.Distribution

Cauliflower is thought to be domesticated in the Mediterranean region. It originated in the island of Cyprus from where it moved to other areas like Syria, Turkey, Egypt, Italy, Spain and north western Europe [12].

Towards the beginning of the 20th century, due to the large European and especially Italian migration, they became more and more popular in the United States. Nowadays, the US is the third largest producer of broccoli and cauliflower in the world. India is the largest producer of cauliflower in the world. Other important cauliflower growing countries include China, France, Italy, United Kingdom, Spain, Germany, Poland and Oceania. Development of Indian cauliflower types, tolerant to high temperature, made it possible to grow cauliflower in tropical and sub-tropical parts of the world [13].

In India, cauliflower is grown throughout the country. Area wise, Bihar, Odisha and West Bengal rank first, second and third whereas production wise, Bihar, West Bengal and Uttar Pradesh rank first, second and third respectively. The other important cauliflower growing states are Assam, Madhya Pradesh, Gujarat, Haryana, Punjab, Maharashtra, Karnataka, Uttarakhand and Himachal Pradesh [11].

7.Habitat

The trick to growing cauliflower is consistently cool temperatures, which is why almost three fourth of commercial cauliflower is grown in the coastal valleys of California. All variety of *Brassica oleraceae* originated in Asia and Europe [14].

Cauliflower is grown as both seasonal and offseasonal vegetable. It is grown during cool summer months in higher elevations and can be successfully grown in winter in the tropical regions [10].

The taxa of section Brassica are chasmophytic and they usually occur in maritime cliffs of limestone substrates,

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although occurrences on other substrates. Most Brassica plants are found in the so called step-crevice community of large shelves and cracks, often in more or less steep and shady positions, but in situations protected from grazing some plants can be found below the cliffs in screen and among shrubs. In particular, may also inhabit small, rocky islets, which are not influenced by grazing. This species have been repeatedly found growing in habitats influenced by human activities, for instance quarries, roadsides and building grounds [15].

8.Botanical description

Cauliflower, a cruciferous vegetable, is in the same plant family as broccoli, kale, cabbage and collards. Surrounding the curd are ribbed, coarse green leaves that protect it from sunlight, impeding the development of chlorophyll. The flowers are attached to a central stalk. Seeds are head shaped. The head of a cauliflower, also called a "curd," is a group of tightly packed flower buds that have not fully developed. The buds are attached to fleshy stalks where most of the nutrients for their growth are stored. The taxonomical position of cauliflower is as follows: The family cruciferae is characterized by 4 petals, standing opposite to each other in square cross, 6 stamens of which 2 are short and 4 long and a special kind of pod called siliqua. Cauliflower is a monogenomic species whose genomic constitution is C and chromosome number is 2n=18 [12].

Leaves alternate, usually shallowly lobed; upper ones usually enclosing inflorescence; rachises of young inflorescences and pedicels incrassate forming a dense yellowish white head with abortive flowers and buds [16].

Sepals erect, oblong, obtuse, 812 x 2-3 mm. Petals obovate, clawed, 15-20 x 4-6 cm. Stamens erect, fruits erect or on erectopatent pedicels, 6-10 cm long including 1-2 cm long; seed often 1- beaked,

Reticulate [17].

Leaves: Leaves are large entire with wavy margin.

Flowers: Inflorescence is a Raceme,Flowers are complete and bisexual.

Calyx: 4 sepals

Corolla: 4 petals

Androecium: Tetradynamous.6 stamens (4 long and 2short).

Gynoecium: Superior ovary of two joined carpels with a single short stled. Ovules are numerous. Partial placentation but ovary is divided into two chambers and the development of false septum.

Fruit: Siliqua.The siliqua is typically long, slender and smooth with short conical beak.Seeds are grayish brown in colour [18].

9.Traditional uses

From the time of ancient cultures including Greeks, Romans and Egyptians, it has been well known that cauliflower juice can reduce constipation and has also been used as a laxative. It has been used as an antidote to mushroom poisoning, as an antidote to drunkenness to avoid the adverse effects of drinking, and as a treatment for hangovers and headaches. In folk medicine in the southern United States, it has a reputation for helping to cure a hangover just as in Britain. During World War I they were similarly used to treat "trench foot". In Wales, they have been used for a great variety of ailments, including the treatment of sprains. The water in which brassica leaves have been cooked has been used to treat rheumatism. In Ireland, burns have been treated with fresh macerated leaves, and cabbage leaves tied around the throat have been recommended for a sore throat. Hoarseness has been treated in England with the mixture of cauliflower juice with honey [19].

Intake of cauliflowers might be beneficial for heart health. Cruciferous vegetables might have promising results in preventing the risk of heart disease. Type 2 diabetes is a condition that is common across the world. High blood glucose levels cause the development of diabetes. Cauliflower might stop the enzymes that are responsible for diabetes. According to a laboratory study the consumption of cauliflower might help you prevent the early stages of diabetes [20].

10.Medicinal uses

Numerous therapeutic plants belong to the cruciferaceae family. It has more than 3000 species spread across more than 300 taxa globally [21].

Direct and indirect research evidences demonstrates the benefits of cruciferous vegetables in prevention of metabolic disorders, asthma and Alzheimer's disease, along with antimicrobial activity against number of pathogens. Among the metabolic syndromes, the role of isothiocyanates in diabetics is well demonstrated [22].

Many *Brassica* species, particularly wild *Brassica oleracea*, have been known to be harmful. In Lebanon's traditional medical literature, neuralgia and rheumatic disorders are discussed [23].

Various traditional medicines use mustard seeds as an aperitif, digestive aid, and appetizer, gastrointestinal, respiratory, and antiseptic conditions using a stimulant, laxative, expectorant, and skin conditions, arthritis, rheumatism, foot pain, and lumbago [24].

Brassicaceae cover crops are thought to be crucial in the control of nematodes, weeds, fungus, and combating infections by releasing chemical chemicals from rotting leftovers [4].

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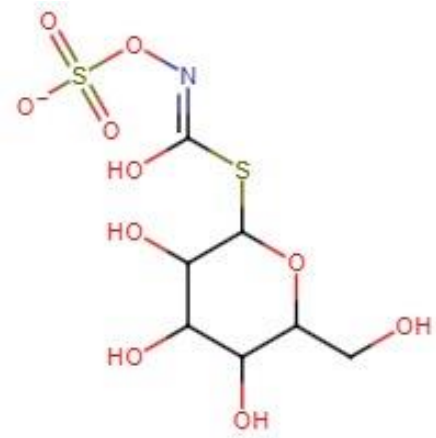
11.Phytoconstituents

Phenolics, flavonoids, ascorbic acid (Vitamin C), glucosinolates, and astaxanthin are the main phytochemical components quantitatively evaluated in several species of Brassica. Tocopherols additionally, it contains a number of phytochemicals, such as phenolics, flavonoids, phenolic acids, carotenoids (zeaxanthin, lutein, and alpha-carotene), polyphenols and alkaloids, phytosterols, chlorophyll, Terpenoids, and glycosides are only a few examples [25].

Secondary plant metabolites called glucosinolates (GSLs) are widely distributed in plant species. There has been substantial research on Brassicales, GSL, and its breakdown products with regards to benefits to agriculture and medicine.Around 130 GSL structures, the variety of side-chains presently recognized and confirmed, in addition to their widespread occurrence in Brassica plants. These metabolites are very interesting for biochemistry, natural product chemistry, and biology [26].



Core Structure [27]

QUERCETIN

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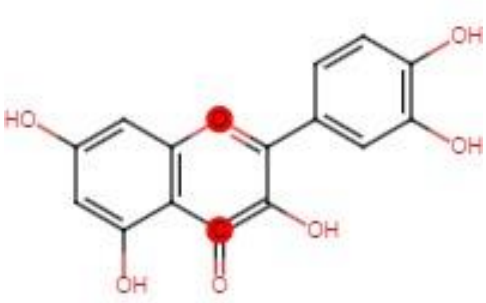

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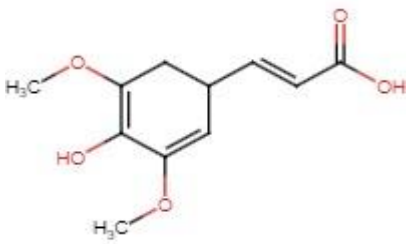
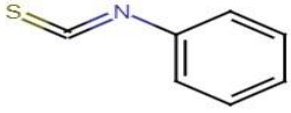


SINAPIC ACID



ALLYL ISOTHIOCYANATE

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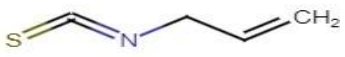
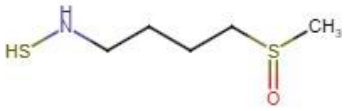
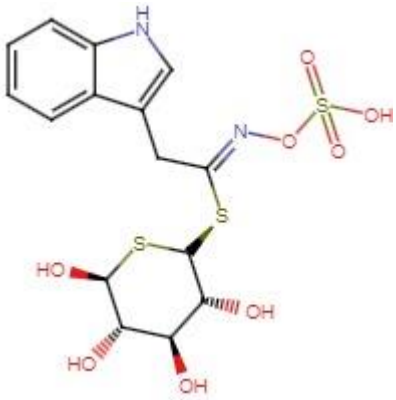


2- PHENYL ISOTHIOCYANATE

3-BUTENYL ISOTHIOCYANATE



3-METHYL THIO PROPYL ISO THIOCYANATE



GLUCOBRASSICIN

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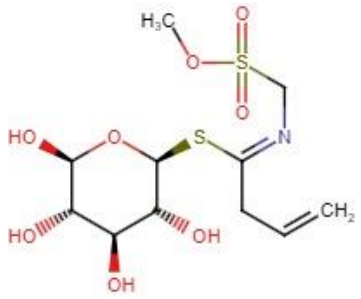
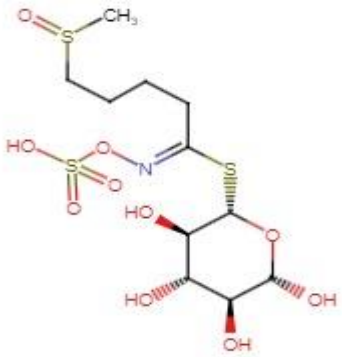
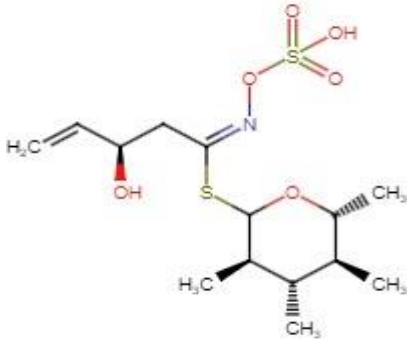


GLUCORAPHANIN



PROGOITRIN



SINAGRIN

They contain isothiocyanates, glucoraphane, sulforaphane, selenium, and are high in dietary fiber [28].

Researchers have focused in particular on polyphenols and the amount of them in different fruits and cuisines based on plants throughout the previous 20 years. Understanding the antioxidant properties of the potential role of polyphenols in the prevention of numerous diseases linked to the problem is oxidative stress, which causes conditions including cancer, cardiovascular disease, and neurological illnesses provide an explanation for this interest [27].

Many fruits and vegetables, such as onions, apples, tea, cabbage, cauliflower, berries, and almonds, naturally contain flavonoids that give us quercetin, a potent natural antioxidant and a cytotoxic substance. Under its health benefits, cauliflower has been described as having has a role in diabetes, cancer, and other illnesses. The majority of the components used in the treatment of cancer or the phytochemicals found in cauliflower, including indole-3carbinol, isothiocyanates, and brassinin have been shown to be genuinely advantageous. Even the trace element selenium is crucial for cancer avoidance. Other phytochemicals cause the antioxidant activity of cauliflower to occur

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such as sulforaphane, glucoraphin, and glucosinolates [28].

12.Pharmacological activity

12.1.Anti oxidant activity

The presence of various antioxidants, including DPPH, FRAP, SOD, and total antioxidant contents, was examined in an effort to investigate the possible advantages of these leaves, which the majority of people completely disregard. When compared to an inorganic sample, the concentration of cauliflower leaves was increasing, indicating increased DPPH activity in the organically grown sample.The FRAP concentration of inorganic cauliflower greens is 21 mg/g, while organic cauliflower green extract has 23 mg/g. The organic

extracts have a higher antioxidant concentration, according to these comparison data. Using standard ascorbic acid, the mg/g of total antioxidant was determined by spectrophotometrically measuring the total antioxidant capacity of both organic and inorganic cauliflower at 695 nm. When comparing the organic and inorganic forms of cauliflower greens, superoxide free radicals demonstrated the greatest inhibition in the former. The study's findings show that, when compared to inorganically grown cauliflower greens, organically grown cauliflower extract has higher antioxidant levels of DPPH, FRAP, SOD, and total antioxidants [29].

Using the DPPH radical scavenging technique, the antioxidant activity of raw and processed cauliflower were ascertained. In the DPPH scavenging assay, the antioxidant activity was quantified by measuring the absorbance drop that occurred when the DPPH radical converted from a stable diamagnetic molecule to an electron or hydrogen radical derived from an antioxidant chemical. The raw and processed cauliflower extracts showed DPPH radical-scavenging activity ranging from 35.13% to 68.91% inhibition. The fresh cauliflower methanolic extract exhibited the highest DPPH radical-scavenging activity (68.91%), with the extracts from steam-blanched, steam-boiled, stir-fried, and microwaved cauliflower following closely behind at 61.83%, 59.15%, 58.93%, and 58.24%, respectively. These results suggest that the amount of antioxidant activity lost during processing is influenced by the contact area and processing time of the vegetables. It was observed that the contact surfaces during the operations of steaming and stir-frying were significantly less than those during boiling, resulting in comparatively minimal loss of antioxidant compounds. The active ingredients of the cooked tissue are preserved by microwave cooking. Due to the fact that baking, griddling, and microwave heating do not encourage the release of ascorbic acid or other antioxidants from cooked tissue, the activity of vegetables cooked in a microwave oven was often higher than that of vegetables cooked in boiling water. The lowest scavenging activity, however, was demonstrated by the extracts of water-blanched and water-boiled cauliflower, at 35.13% and 48.13%, respectively. Many of the antioxidant chemicals leaked into the boiling medium after the process of boiling, reducing their antioxidant capabilities. Vegetable cooking can affect the antioxidant activity of the veggies due to quality changes, antioxidant breakdown, and leaching into surrounding water. Blanching, boiling, microwaving, and stir-frying white cauliflower all have an impact on its composition, phytochemical contents, antioxidant activity, and phenolic profiles, as this study has demonstrated. Significant losses in dry matter, protein, mineral, and phytochemical contents were experienced during the boiling and blanching of water, as well as radical DPPH scavenging. However, stir-frying, microwaving, and steam treatments (blanching and cooking) resulted in minimal losses and the highest retention of nutrients and phytochemicals [30].

To assess their potential value as a natural ingredient for meals or cosmetic applications, water and ethanol extracts of cauliflower (*Brassica oleracea* L.) were tested for their possible antioxidant activity. Total antioxidant activity, reducing activity using the Fe+3-Fe+2 transformation and CUPRAC assays, hydrogen peroxide (H2O2) scavenging, and ferrous metal chelating were all used to measure antioxidant activity in this study. The antioxidant effects of the cauliflower water extract (WEC) and ethanol extract (EEC) prevented linoleic acid emulsion from becoming peroxidized. Due to the presence of antioxidant phytochemicals, particularly the, brassica vegetables are known to have antioxidant characteristics.The potential antioxidant qualities of WEC and EEC were shown in this investigation. When compared to the standard antioxidant compounds α-tocopherol (a natural antioxidant) and trolox (the water-soluble analogue of tocopherol), the presented data indicated that WEC and EEC were effective antioxidants in various in vitro assays, such as the ferric thiocyanate method, Fe3+-Fe2+ and Cu2+-Cu+ reducing power assays, DPPH• scavenging, ABTS•+ scavenging, DMPD•+ scavenging, superoxide anion radical scavenging, hydrogen peroxide scavenging, and metal chelating activity. The study's findings demonstrate that both plant extracts have strong antioxidant activity against a variety of antioxidant systems in vitro [31].

12.2.Anti inflammatory activity

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A growing body of research has shown that purified elements of the *Brassicaceae* family and extracts from those plants have anti-inflammatory activities. All things considered, the outcomes of the several tests show that Brassicaceae can raise the levels of anti-inflammatory cytokines (like IL-10) and decrease the production of pro-inflammatory cytokines (like IL-1β, IL-6, and TNF-α). However, a number of factors, including the particular stimulus, the kind of cell, and the experimental model employed, can affect the effects of Brassicaceae. [32].

A stronger anti-inflammatory impact than carrot and cucumber seeds has been documented for Brassica seeds, in addition to the qualities already described. Extracts from the *Brassicaceae* family may have anti-inflammatory properties naturally. In fact, it has been noted that the primary ingredient of the Western herbal medication (or STW 5) that is mostly used to treat IBD is fresh plant extract (or STW 6) [24].

12.3.Anti-microbial activity

When compared to the inorganic cauliflower sample, organic cauliflower greens had a higher zone of inhibition, according to the antibacterial activity. None of the extracts in the current investigation exhibit any antifungal action, and both exhibit antibacterial activity with the exception of K.pneumoniae [33].

Brassicaceae plant family leaves were collected, dried, and pulverized. The powdered substance was extracted using a soxhlet method with a variety of solvents, then allowed to evaporate. The so-obtained crude extracts were put to use for additional research on phytochemical and antibacterial activity. According to the findings, phytometabolites were present, and they significantly inhibited the growth of the pathogens *Escherichia coli, Bacillus subtilis, Staphylococcus aureus, Salmonella typhimurium, Salmonella paratyphi,* and *Staphylococcus epidermis.* The ethanol extracts from these samples had the highest concentration of secondary metabolites [34].

Because of their exceptional antibacterial properties and varied modes of action, antimicrobial proteins and peptides, or APPs, are increasingly being isolated from the seeds of Brassica species. These organic compounds are being researched as antibiotics. According to these research findings, Brassica seeds and the substances they produce, including as functional peptides, GLS, and sulforaphane, may be used as natural antimicrobials in the food and pharmaceutical industries. Furthermore, it has been documented that broccoli seed extracts including ethanol, methanol, and water exhibited an inhibitory effect on Gram-positive and Gram-negative bacteria, including Salmonella typhimurium and Escherichia coli, as well as Staphylococcus aureus and Bacillus subtilis. All things considered, the research data point to the possibility of using Brassica seeds and the substances generated from them (such as sulforaphane, GLS, and functional peptides) as natural antimicrobials in the food and pharmaceutical industries [24].

Using Listeria monocytogenes at several concentrations [0–15]% (w/v) and incubation temperatures [5-22] °C, the antibacterial potential of cauliflower by-product was evaluated in reference medium. At concentration levels of ≥5% (w/v), the cauliflower by-product demonstrated its bactericidal action across all investigated temperatures. The lowering levels of the initial L. monocytogenes infection were significantly ($p \leq 0.05$) impacted by temperature and the concentration of cauliflower by-product. The current study suggests using a quantitative method to evaluate the antibacterial capability of cauliflower, a vegetable by-product, against a foodborne disease that public health officials and scientists are most concerned about [35].

The Kirby-Bauer agar diffusion method was utilized to ascertain the phytochemical leaf extracts' antibacterial properties in compliance with NCCLS guidelines. Using the spread plate method, 0.1 cc of each bacterium's 24-hour broth culture was injected onto MHA plates under sterile conditions. 50µl of concentrated leaf extracts was added to each well after sterilized cork borer was used to create the wells. The zone of inhibition for each extract sample was found after a 24-hour incubation period. The average zone of inhibition was computed after the experiment was run in duplicate. As controls, solvents were utilized to look for any zones of inhibition. A variety of solvent extracts were used in an antimicrobial experiment against pathogenic bacteria, including Pseudomonas aeruginosa, Escherichia coli, and Staphylococcus aureus. For the extraction, methanol, ethanol, chloroform, and diethylether were the various solvents used. Every sample's ethanolic extract shown a zone of inhibition against each of the three pathogenic microbes. The highest zone of inhibition against E. coli was demonstrated by the methanolic extract of cauliflower leaves. The growth of E. coli was maximally suppressed by the cauliflower chloroform extract. There was a maximum zone of inhibition between the diethyl ether extract of cauliflower leaves and P.aeruginosa. Of the samples extracted using chloroform or solvents such as diethyl ether, methanol, and ethanol, the cauliflower extract exhibited the largest zone of inhibition, measuring 34 mm in diameter [36].

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12.4.Anti-fungal activity

The antifungal activity of fresh, aqueous Brassica oleracea var. botrytis juice against Candida albicans and other pathogenic fungi was investigated. The juice was found to be effective both in inhibiting the growth of blastoconidia and reducing the appearance of C. albicans germ tubes. Furthermore, the juice inhibited the growth of some pathogenic, filamentous fungi. C. albicans and other filamentous fungus cannot develop when the crude aqueous juice of *B. oleracea* var. botrytis leaves is added to the culture medium. Additionally, after 2 hours of exposure, some cultivars were able to lessen the visibility of germ tubes without impairing cell proliferation [37].

When applied at a dose of 2 µM, the isolated peptide γ-thionin (BoT) from B. oleracea seeds was found to be a strong antifungal agent against Aspergillus niger and Aspergillus flavus, while at 0.12 µM, it killed the insects Tribolium castaneum and Sitophilus oryzae [24].

Using Soxhlet's apparatus, the stems and flowers of cauliflower were extracted for 6 hours using 125mL of ethanol and water. For testing antifungal activity, Mueller Hinton agar and Sabouraud's dextrose agar medium were utilized. A modified Kirby-Bauer disk diffusion method was used to assess the antifungal properties of each cauliflower, broccoli stem, and blossom extract. Positive controls for the study were standard antibiotics, gentamicin (25 g/mL), and fluconazole (25 g/mL). Antifungal activity of cauliflower, broccoli parts such as flowers, and seeds extracts were analyzed against fungal microbes like C. albicans, A. niger by the disk diffusion method using fluconazole as a standard drug. The zone of inhibition of water and ethanol extracts at various concentrations of 100 µg/mL was measured in millimeters [38].

12.5.Anti-bacterial activity

Antibacterial activity of cauliflower parts such as flowers and seed extracts was analyzed against Gram-negative microbes like E. coli, P. aeruginosa, B. subtilis, S. aureus by the disk diffusion method using gentamicin as a standard drug. The zone of inhibition of water and ethanol extracts at concentrations of 100 µg/ml was measured in millimeters [38].

It was discovered that the cauliflower leaf juice had antimicrobial properties. The well diffusion method was used to measure the sample's antibacterial activity against the microorganisms. The bacterial culture (E. coli, S. aureus, P. aeruginosa, K. pneumoniae, and B. subtilis) was swabbed with a cotton swab in 70 µl of Mueller hinton agar (39g in 1000 ml), and a well was created with a cork borer before the sample (cauliflower greens) was added in 50 µl. The plate was incubated at 370°C for 24 hours with an antibiotic disc (30 mcg of cefazolin) as the positive control and distilled water as the negative control. Based on the zone, the sample's antibacterial activity was validated upon incubation. The results highlighted that the tested extracts of Brassica oleraceae var. botrytis showed potential antibacterial activity against Bacillus sp, Escherichia coli, Staphylococcus aureus, Klebsiella sp, and Pseudomonas sp [29].

12.6.Anti-diabetic activity

Diabetes has emerged as a serious issue on a global scale that is becoming more prevalent every day and has significant acute and chronic effects [39].

One of the leading causes of morbidity and mortality in the globe is diabetes. Numerous studies have shown that seeds from the Brassica genus may have a hypoglycemic effect. Animals and in vitro testing of brassica seed extracts have both been done [24].

Based on our current findings BOvG significantly reduced FBG to normal levels and alleviated diabetes related complications. We suggest that the phytomolecules in BOvG have the potential to form a multi-component drug to target diabetes and its related complications.

Aqueous extracts reduced insulin levels whereas ethanol and aqueous extracts improved lipid profiles. For each of the three extract kinds, there was a decrease in transfer delay. In an experiment for lipid peroxidation, the administration of 400 mg/kg of ethanol extract exhibited the highest percentage inhibition. Furthermore, the levels of glycosylated hemoglobin, interleukin-6, and tumor necrosis factor-α were significantly decreased by the ethanol extract and aqueous treatment. High doses of extracts mitigated the damage caused by type 2 diabetes mellitus in several organs and bones, according to histological studies. Drawing conclusions from the findings of this investigation, B. oleracea may be able to mitigate type 2 diabetes mellitus [40].

12.7.Neuroprotective activity

In vitro and human studies have demonstrated the neuroprotective advantages of Brassica seeds and their derivatives. Brassicalkaloid A, a newly discovered nitrogenous chemical, and coixspirolactam C, a well-known alkaloid, were extracted and demonstrated an antineuroinflammatory action by inhibiting the nitric oxide (NO) production produced by lipopolysaccharide (LPS) in BV-2 cells . A recent clinical study on autism spectrum disorder (ASD) children revealed that the consumption of high-sulforaphane broccoli seed and

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sprout tablets improved their behavior and social responsiveness and identified changes in urinary metabolites correlated with clinical improvements. Consequently, sulforaphane's neuroprotective effect probably stemmed from transcription factor (Nrf2) activation [24].

12.8.Anti-cancer activity

It has been suggested that isothiocyanates, which are abundant in cruciferous vegetables, reduce the chance of developing numerous cancers, including lung cancer. Evidence from long-term studies of populations with a comparatively high intake of cruciferous vegetables, however, is scarce. Consuming cruciferous vegetables is linked to a reduced risk of numerous cancers, including bladder and colorectal cancer [41].

On cancerous cells, such as those found in breast, lung, gastric, ovarian, colorectal, and hepatic malignancies, flavonoids shown remarkable inhibitory actions [42].

Caco-2 (intestinal carcinoma cell lines as a model of the intestinal epithelial barrier), HCT116 (colon cancer), and Hep G2 (human hepatocellular carcinoma). Mammalian cell lines were used to investigate cell lines. Growth inhibition was observed to increase in a dose-dependent way. These findings showed that cauliflower had the greatest inhibitory effect on human hepatocellular carcinoma and colon cancer cell lines. The observed suppression effect of cauliflower could be related to the antioxidant properties and amount of phenolic substances. A growing body of research indicates that flavonoids may be able to inhibit the growth of tumor cells and may be useful as chemopreventive medicines to stop the development of human cancer. Numerous investigations have demonstrated the potent cytotoxic and anticancer properties of flavonoids [43].

Researchers in China carried out a study in which geftinib and quercetin nanoparticles were created in order to investigate the potential of quercetin as an anticancer agent against lung cancer. Both invitro- and in vivo-based antitumor activity was carried out [39].

In this work, SFN, a bioactive substance isolated from cauliflower, was used to examine the mechanism of action of SFN in the prevention of breast cancer. Using rotary evaporation and silica gel chromatography, SFN was isolated from cauliflower for this purpose. The extracted SFN was then utilized in both in vitro and in vivo investigations. The outcomes demonstrated that SFN was successful in decreasing the size and volume of tumors, enhancing the pathological state of tumor tissues, and preventing the expression of MMP-9 and NF-κB in the model mice. This study proved that SFN is a successful treatment for breast cancer. Furthermore, by controlling the expression of the NF-κB/MMP-9 signaling pathway, SFN can treat breast cancer by preventing the development, multiplication, and activity of breast cancer cells [44].

13.Conclusions

Brassica vegetables have been known for a long time as excellent sources of wellness and nutrition, such as broccoli, cauliflower, cabbage, kale, kohlrabi and Brussel sprouts. Cauliflower (*Brassica oleracea* var. botrytis), which has often been used for decades in traditional medicine, is among the most widely eaten. *Brassica oleracea* var. botrytis, is an herbaceous annual or biennial vegetable plant in the family *Brassicaceae* grown for its edible head. It is wide spread all over the world. This comprehensive review highlights the information on *Brassica olereacea* var. botrytis for phytoconstituents and pharmacological properties. The plant is a potential source of glycosides, terpenoids, phenols, etc.,and it is used in the treatment of cancer, inflammation, diabetes, obesity and stroke and the various phytoconstituents responsible for it have been reported.

14. References

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