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Hop and Medicinal Plants, Year XXVIII, No. 1-2, 2020
ISSN 2360–0179 print, ISSN 2360–0187 electronic

CABBAGE (*BRASSICA OLERACEA* L.). OVERVIEW OF THE HEALTH BENEFITS AND THERAPEUTICAL USES

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Abstract: One of the oldest vegetables known and widely distributed over the world among cultivated plants, *Brassica oleracea* was cultivated from ancient times and used like food and in herbal medicine. From the time of ancient cultures including Greeks, Romans and Egyptians, it has been well known that cabbage juice can reduce constipation and has also been used as a laxative, as an antidote to mushroom poisoning, or a treatment for hangovers and headaches. In fact, cabbage has historically been used to stop sunstroke, or to relieve fevers. The leaves were also used to soothe swollen feet and to treat childhood croup. Brassica vegetables have also anti-inflamatory activity that has been known from a long time ago and have been used to different irritations of the human body. While the specific modes of action have not yet been defined, phytochemical research and pharmacological experiments performed over the past few decades on white cabbage juice or extract offer fair evidence for its numerous conventional uses. Study on the phytochemicals of white cabbage has been based on the well-known health promotion of components such as glucosinolates, polyphenols, and various vitamins correlated with anticarcinogenic and antioxidant activities.

Keywords**:** biochemistry, *Brassica oleracea*, cabbage juice, medicine, pharmaceutic.

Introduction

Botanical Description of Cabbage

White cabbage (*Brassica oleracea* var. *capitata* f. *alba*) is one of the most widely grown vegetables in the world, it is a cruciferous vegetable used as a food supplement and in herbal medicine (Šamec *et al.*, 2017).

It belongs to the *Brassica* genus and the *Brassicaceae* family of mustards (*Cruciferae*). *Brassicaceae* is a monophyletic group of 338 recognized genera and approximately 3,700 species, with the exception of Antarctica, distributed around the world (Al-Shehbaz *et al*., 2006).

The mustard family (*Brassicaceae* or *Cruciferae*) belongs to the Brassicales order and is easily differentiated by a cruciform (cross-shaped) corolla, six stamens (two stamens short and four stamens long), a capsule with a septum and a peppery watery sap (Franzke *et al*., 2011). The fruit is silica that opens to expose the brown or black, round seeds at maturity. Insects cross-pollinate the flowers. The root system of cultivated plants is fibrous and superficial (Šamec *et al*., 2017).

As Dixon (2007) described, a thin root and heart-shaped cotyledons are present in cabbage seedlings. The first leaves, with a lobed petiole, are egg-shaped. A rosette shape is formed by the original leaves, then a new cabbage leaves grow with shorter petioles and the leaves start to cup into to form the head. Cabbage heads normally vary from 0.5 to 4 kilograms, and in colour they can be green or pale green to white.

Brasica oleracea contains numerous varieties (Figure 1), like cabbage (var. *capitata*) the main variety, broccoli (var. *italica*), cauliflower (var. *botrytis*), kale (var. *acephala*), kohlrabi (var. *gongylodes*), Brussels sprouts (var. *gemmifera*) and many others (Table 1).

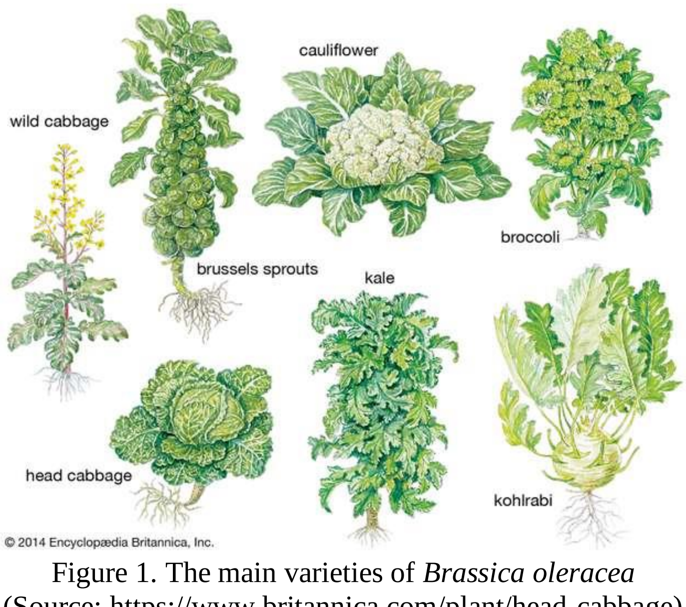

Figure 1. The main varieties of *Brassica oleracea*
(Source: https://www.britannica.com/plant/head-cabbage)

White cabbage belongs to the variety of *capitata,* whose name comes from the Latin word ‘capita’ which means ‘head’. Leaves are shaped, as the word means, into distinctive cabbage heads that can vary in shape, colour and texture of the leaves, resulting in a wide number of cabbage cultivars with cultivation potential under different climatic conditions (Björkman *et al.*, 2011). The *capitata* variety presents 4 forms: *alba* (white cabbage), *rubra* (red cabbage), *sabauda* (savoy cabbage) and *acuta* (cone cabbage).

Table 1

Existing cultivars of *Brassica oleracea* specie

No.	Popular name	Latin name
1	Wild cabbage	*Brassica oleracea var.* oleracea
2	Cabbage	*Brassica oleracea var.* capitata f. alba
3	Savoy Cabbage	*Brassica oleracea var.* capitata f. sabauda
4	Red Cabbage	*Brassica oleracea var.* capitata f. rubra
5	Cone Cabbage	*Brassica oleracea var.* capitata f. acuta
6	Ornamental kale	*Brassica oleracea var.* acephala
7	Brussels sprout	*Brassica oleracea var.* gemmifera
8	Broccoli	*Brassica oleracea var.* italica
9	Kohlrabi	*Brassica oleracea var.* gongylodes
10	Cauliflower	*Brassica oleracea var.* botrytis
11	Gai Ian	*Brassica oleracea* var. *alboglabra*
12	Collard greens	*Brassica oleracea var.* viridis
13	Jersey cabbage	*Brassica oleracea var.* longata
14	Kale	*Brassica oleracea var.* sabellica
15	Lacinato kale	*Brassica oleracea var.* palmifolia
16	Perpetual kale	*Brassica oleracea var.* ramosa
17	Marrow cabbage	*Brassica oleracea var.* medullosa
18	Tronchuda kale	*Brassica oleracea var.* costata
19	Broccoflower	*Brassica oleracea var.* botrytis *x italica*
20	Broccolini	*Brassica oleracea var.* italica × *alboglabra*
21	Kalette	*Brassica oleracea var.* viridis *x gemmifera*

(Source: https://en.wikipedia.org/wiki/Brassica_oleracea)

History of Cabbage

White cabbage is one of the oldest vegetables known and widely distributed commercially by cultivated plants (Figure 2). *B. oleracea* was cultivated in ancient times. The precise past of cabbage is difficult to track.

Crops of the genus *Brassica* were used in India as far back as 3,000 BC, according to Sanskrit texts. The *Brassicaceae* appeared in the Iranian-Turanian region as a tropical-subtropical genus around 37 million years ago (Eocene), as the supposed ancestral region of the family (Franzke *et al.*, 2011).

Figure 2. Harvesting cabbage, Tacuinum Sanitatis, 15th century.
(Source: https://en.wikipedia.org/wiki/Cabbage)

Some data suggests that current cultivars of head cabbage come from the wild non-heading specie of *Brassica* expanding on the eastern Mediterranean and Baltic coasts (Balkaya *et al.*, 2005). Some of the wild representatives that grow naturally on the Adriatic seaside have been described as stenoendemics (Jasprica, 2015).

The Iranian-Turanian region (nearly 900 species), North and Central America (973 species), and the Mediterranean region are the areas with the largest diversity of native species in the *Brassicaceae* family (630 species). The Saharo-Sindian area contains other smaller centres (180 species) including South America along the Andes (367 species), South Africa (almost 110 species) Australia and New Zealand (about 120 species) (Šamec *et al*., 2017).

Today, white cabbage is an economically important crop cultivated in over 90 nations around the world. There are several types of white cabbage that vary in morphological features, nutritional qualities, phytochemical composition and resistance to abiotic and biotic stresses that are cultivated across the world. Numerous techniques such as morphological feature analysis, seed protein, isozymes, cytological and biochemical properties, phytochemical composition and different forms of DNA-based molecular markers can explore crop germplasm diversity (Šamec *et al.*, 2017).

Traditional Medicine and Chemical Composition of Cabbage

The white cabbage was traditionally used as a medicinal herb for a number of health benefits, in addition to its normal purpose as a comestible vegetable. From the time of ancient cultures including Greeks, Romans and Egyptians, it has been well known that cabbage juice can reduce constipation and has also been used as a laxative (Hatfield, 2004).

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 fact, cabbage has historically been used to stop sunstroke, or to relieve fevers. The leaves were also used to soothe swollen feet and to treat childhood croup. Treatments for sore throat, rheumatism, colic, hoarseness, and melancholy are other medical uses reported in European folk medicine (Hatfield, 2004). *Brassica* vegetable has also anti-inflamatory activity that has known a long time ago and it has been used to different irritations of the human body.

The widespread use of white cabbage, in a raw or prepared form, to avoid or cure different inflammations has been documented in traditional medicine. White cabbage leaves were used in folk medicine to cure bedsores and irritation of the skin and joints in Scandinavian countries. As a result, the Norwegian community examined white cabbage polysaccharides with immunostimulatory activity as a marker using the complement-fixing test (Westereng *et al*., 2006). More than that, cabbage leaf compresses have been used usually by breastfeeding woman for the treatment of swelling, as protection of breast inflammation (Ayers, 2000).

There are numerous *Brassica* species, including wild *Brassica oleracea*, reported to be against neuralgia and rheumatic diseases in conventional information in Lebanon (Nelly *et al.*, 2008). White cabbage has historically been used in Italy for the treatment of contusions, rheumatic pains and cuts, as well as for scurvy (Passalacqua *et al*., 2007).

The white cabbage represents an essential source of phytonutrients in the human diet because of its common abundance in local markets, affordability, and customer demand (Šamec *et al.*, 2017). Moreover, owing to the richness of phytochemicals such as polyphenolics, glucosinolates, carotenoids and vitamins that have shown antioxidant, anticancer properties

(Podsędek, 2007; Park *et al.*, 2014a, b) and significant anti-obesity properties, this vegetable has become more common in people's life and medicine uses (Williams *et al.*, 2013).

Metabolomics, a fairly modern area of study, is characterized in a given biological system as the global or local profiling of metabolites, with a large presence of various types of metabolites. Plant metabolomics has found applications in a particularly large range of fields of plant science, where the total number of metabolites present in the plant kingdom is measured at 200,000 or more, such as fingerprinting of ecotypes for phylogenetic or biochemical reasons, correlation of mutants and transgenic plants with their wild species, external stimulation effects of the metabolite profile, plant-herbivore relationships, evolutionary mechanisms, quality management of medicinal herbs and determination of medicinal plant activity (Ernst *et al.*, 2014).

Through using mass spectrometry and nuclear magnetic resonance spectroscopy, researchers analysed metabolites in various Brassica plants and confirmed mass signals representing 63 different metabolites. In addition, Kim *et al*. (2013), in two white cabbage F1 hybrids with gas chromatography time-of-flight mass spectrometry (GC-QToF), profiled 46 metabolites, including 19 amino acids, 15 organic acids, 8 carbohydrates, 3 sugar alcohols, and 1 amine. So, we should just assume that these techniques would also be used for the analysis of white cabbage in the coming years and will provide more precise knowledge about the exact amount of its metabolites as well as about the elemental composition of metabolites inside of plant parts.

Glucosinolates

The majority of studies on Brassica phytochemicals have focused on the glucosinolates. Because of the potent flavours and tastes they induce in cabbage, broccoli, and other Brassica vegetables, glucosinolates, often known as mustard oil glucosides, have been part of human life for thousands of years (Halkier and Gershenzon, 2006). They are generally classified as aliphatic, aromatic and indolic glucosinolates. Figure 3 shows the central structure and some of the most important glucosinolates present in white cabbage (Šamec *et al.*, 2017).

The total glucosinolate content in white cabbage was found in the range between 1.05 and 70.56 μmol/g dry weights, based on the results of different authors. The highest value of glucosinolates was 340 μmol/100 g fresh weights found in 'Bartolo' white cabbage (Volden *et al.*, 2008).

For a long time, the activation of glucosinolates against plant damage and the biological properties of their hydrolysis products have shown that the key role of these compounds in plants is to protect against herbivores and pathogens (Halkier and Gershenzon, 2006).

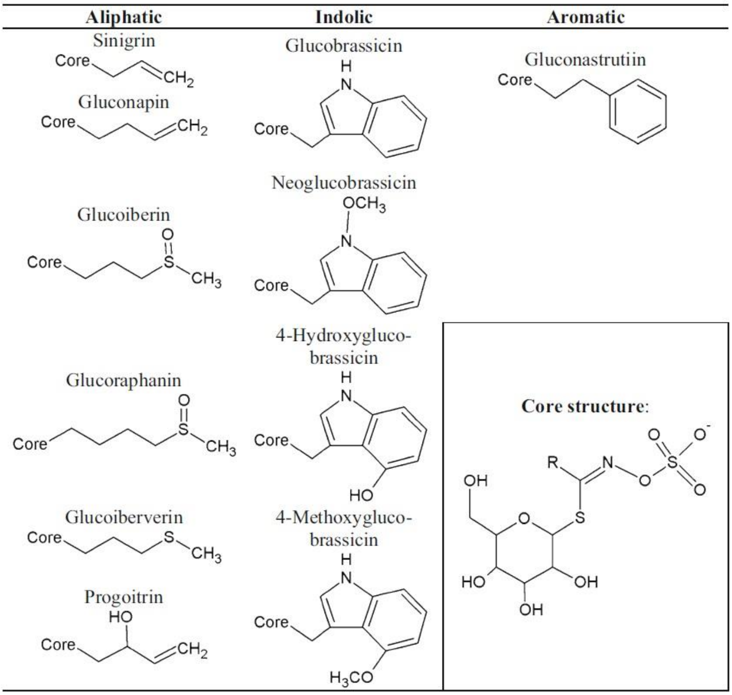

Figure 3. Glucosinolate's core structure and the individual glucosinolates in the white cabbage found (Source: Šamec *et al*., 2017)

The biochemical role of glucosinolates in the family of Brassicaceae is accomplished through the mechanism of glucosinolates/myrosinase (Martinez-Ballesta and Carvajal, 2015). Myrosinase is confined to the cell vacuoles in plant tissue. Myrosinase is released from vacuoles after tissue damage and initiates glucosinolates hydrolysis (Agerbirk *et al*., 2009). Hydrolysis reaction breakdown products are important for human health and are capable for many pharmacological activities of vegetable-containing glucosinolates. Thermal, microwave or chemical glucosinolate degradation could also appear during vegetable processing, including enzymatic hydrolysis (Nugrahedi *et al*., 2015).

Polyphenols

Researchers have been particularly involved in polyphenols and their quantities in various fruit and plant-based foods over the last 20 years. Recognition of the antioxidant effects of polyphenols and their possible function in the prevention of multiple diseases associated with oxidative stress, such as cancer, cardiovascular and neurodegenerative diseases is the key explanation for this interest. White cabbage has also been identified as a good source of phenolic compounds, in comparison to glucosinolates and their derivatives (Šamec *et al*., 2017).

The most common and complex group of polyphenols in *Brassica* species are the flavonoids (mainly flavonols) and the hydroxycinnamic acids, according to the review paper by Cartea *et al*. (2011).

Folin-Ciocalteu is the most commonly used method for determining the total content of polyphenols (Singleton and Rossi, 1965). For precise identification of polyphenol compounds, more advanced hyphenation techniques such as high-performance liquid chromatography with photodiode array detection (HPLC-PDA) or capillary electrophoresis mass spectrometry (CE-MS) seem to be more reasonable and generally appreciated.

Quercetin and kaempferol, mostly found in glycoside forms, were the most identified flavonoids using hyphenated methods (Kim *et al*., 2004; Park *et al*., 2014 a). There have also been reports the presence of apigenin and rutin flavonoids in white cabbage (Ghasemzadeh *et al*., 2012). The total flavonoid content in European white cabbage cultivars tends to vary between 1.18 and 1.82 mg CE/g dry weight, as reported by Kusznierewicz *et al*. (2008), while the total flavanol content ranges from 2.03 to 4.06 μg CE/g dry weight.

The polyphenolic content of cabbage food is affected by raw cabbage processing. In addition to fresh vegetables, Ciska *et al*. (2005) reported that sauerkraut has a higher overall phenolic content. The same authors verified that fermentation of white cabbage also affects individual phenolic constituents by doing HPLC analysis.

Carotenoids and vitamins

The important compounds that enhance human nutrition are vitamins and carotenoids, which are responsible for the specific functioning of human metabolism and immune system. Cruciferous vegetables are high in bioactive compounds and are a great option for RDA nutrients (recommended dietary allowance) (Šamec *et al*., 2017). In conformity with the USDA National Nutrient Database for Standard Reference and dietary intake recommendations for adults, the white cabbage represents about 72% of the recommended daily value (DV) for vitamin K, 44% of DV for vitamin C, 11% of DV for folate and 10% of DV for vitamin B6.

Associated with vitamin C, carotenoids and tocopherols (vitamin E analogs) are compounds with demonstrated antioxidant activity to be part of the health benefits of white cabbage (Podsędek, 2007). In addition to antioxidant properties, vitamin A precursors like α-carotene and β-carotene are needed for healthy skin, bones, gastrointestinal and respiratory systems. While vitamin E which has neurological functions, regulates enzyme activity and gene expression, vitamin C has a role to play in enhancing the immune system (Combs, 2012).

The spectrophotometric methods (El-Din *et al.*, 2013; Šamec *et al.*, 2014) or the HPLC method combined with a range of detectors and the analysis of individual carotenoids, tocopherols and ascorbic acid can be used to evaluate the carotenoid and vitamin contents of the white cabbage.

The measured β-carotene content varies in the range between 10 and 130 μg/100 g usable parts of many cabbage cultivars. Ascorbic acid has been measured in the range of concentrations between 5 and 51.15 mg/100 g fresh weight, while tocopherols are the most abundant source of α-tocopherol in the range of concentrations between 0.03 and 0.509 mg/100 g fresh weight (Singh *et al.*, 2007; Peñas *et al.*, 2011; Park *et al.*, 2014b).

Many of the above mentioned phytochemicals can be lost due to deterioration during the processing of cabbage (Lešková *et al.*, 2006); for example, cabbage boiling and microwave heating decrease β-carotene levels up to 30%, and ascorbic acid up to 70% (El-Din *et al.*, 2013).

Pharmacology of Cabbage

Anticancer activity

Epidemiological and multiple in vitro and in vivo studies indicate that the consumption of cruciferous vegetables can reduce the overall risk of cancer and provide protection at all stages of cancer progression (Kristal and Lampe, 2002; Wang *et al.*, 2004; Gasper *et al.*, 2007). In order to evaluate their possible cancer therapeutic activities, white cabbage extracts have been used in many in vitro studies. Compared to other traditional vegetables, cabbage extracts were tested in all studies listed in Table 2 and results demonstrate very strong antiproliferative activities against neoplastic cell lines.

According to Komatsu *et al.* (1998), the effects of the cabbage extract were investigated on the tumour necrosis factor development and its implications for the treatment of antitumours, both *in vivo* and *in vitro*. Whole cabbage extract stimulated rat spleen cells to develop tumour necrosis factor and demonstrated cytotoxic activity in the rat ascite hepatoma cell line (AH109A) when hepatoma cells were cultured with spleen cells stimulated by cabbage.

In association with lipopolysaccharide injection, when the extract was administered orally to AH109A-bearing rats, the hepatoma weight was reduced to one-half of the vehicle control. Komatsu concluded that cabbage extract with the macrophage-stimulating components and that by stimulating the cytotoxicity of tumour-infiltrating macrophages, the antitumor effect can be achieved.

Table 2

Antiproliferative activity of the white cabbage extracts

Extract type	Used cell lines	Activity	Method used
80% Acetone extract	Hepatocellular carcinoma, HepG2	Very high	MTS assay
Cabbage juice	Promyelocytic leukemia cells, HL-60)	Very high	Trypan blue assay
	Stomach adenocarcinoma, AGS mammary gland adenocarcinoma, MCF-7 pancreatic carcinoma, Panc-1 prostatic adenocarcinoma, PC-3 lung carcinoma, A549 medulloblastoma, Daoy glioblastoma, U-87 MG renal carcinoma, Caki-2 normal human dermal fibroblasts	Very high	WST-1 assay
100 % Methanol extract	Pulmonary carcinoma, Calu-6 gastric carcinoma, SNU-601	Very high	MTT assay
Sulphur aglycone compounds fraction	Human lung cancer, A-549	Very high	MTT assay

(Source: Šamec *et al*., 2017)

Other essential and really well studied glucosinolate's hydrolysis products like sulforaphane and indol-3-carbinol, they are also present in white cabbage (Sivakumar *et al*., 2007; Park *et al*., 2013). From the hydrolysis of glucoraphanin under the control of myrosinase enzymes is formed sulforaphane. This isothiocyanate, sulforaphane, is capable of targeting many cancer growth steps and is an extremely impressive nutritional chemoprevention and therapeutic tool (Clarke *et al*., 2009). Indole-3-carbinol could spontaneously develop ascorbigen in the presence of vitamin C, it is a compound that responds greatly to antitumor functions of *Brassica oleracea* (Wagner and Rimbach, 2009) and it is a primary glucosinolate hydrolysis agent in fermented cabbage (Martinez-Villaluenga *et al*., 2012).

There is growing evidence that the additive and synergistic effects of some phytochemicals are the basis of the chemopreventive properties of vegetables. In addition to glucosinolates, other potent anticarcinogenic phytochemicals contained in white cabbage must be listed as flavonoids, especially quercetin and kaempferol (Gibellini *et al*., 2011; Calderon-Montano *et al*., 2011).

Antioxidant activities

Consumption of food or nutritional supplements rich in antioxidants improves the pathways of defences against free radicals and reactive oxygen species (ROS) and thereby helps to protect against chronic diseases. The presence of biological activities with confirmed antioxidant capacity, like vitamin C, carotenoids, polyphenolics, flavonoids, glucosinolates, hydrolysis products, etc., has been predominantly associated with the health benefits of *Brassica* vegetable (Figure 4) (Podsędek, 2007; Singh *et al*., 2007; Cartea *et al*., 2011).

		Mean concentration (mg/100 g FW ± SD; *n* = 3)				
Vegetable	**Cultivar**	**Dry weight (%)**	**Total phenolics[a]**	**Ascorbic acid**	**α-Tocopherol**	**Total carotenoids[b]**
Red cabbage	Kissendrup	11.48 ± 0.58	171.36 ± 13.77	62.00 ± 2.74	0.061 ± 0.003	0.016 ± 0.002
	Koda	10.42 ± 0.21	134.73 ± 3.35	72.56 ± 7.99	0.111 ± 0.008	0.013 ± 0.001
Brussels sprouts	Ajax	18.10 ± 0.04	140.13 ± 5.67	127.77 ± 7.82	0.545 ± 0.010	1.090 ± 0.050
	Filemon	20.64 ± 0.25	133.46 ± 6.43	129.27 ± 2.96	0.823 ± 0.011	1.160 ± 0.030
White cabbage	Almanag	8.09 ± 0.10	29.70 ± 0.66	25.46 ± 0.98	0.008 ± 0.001	0.042 ± 0.001
	Tukana	6.51 ± 0.14	20.81 ± 0.79	18.00 ± 0.60	0.009 ± 0.003	0.051 ± 0.003
	Vestri	7.99 ± 0.29	23.32 ± 0.47	35.64 ± 0.57	0.022 ± 0.005	0.009 ± 0.001
Savoy cabbage	Langedijker	10.90 ± 0.13	54.31 ± 1.60	51.66 ± 0.31	0.782 ± 0.091	0.048 ± 0.003
	60F/100	10.23 ± 0.10	47.62 ± 0.70	49.81 ± 0.88	0.011 ± 0.004	0.122 ± 0.008

[a]Total phenolics value is expressed as gallic acid.
[b]Total carotenoids value is expressed as β-carotene.

Figure 4. The natural antioxidants of *Brassica* vegetables
(Source: Podsędek *et al*., 2006)

The antioxidant potential of white cabbage has been calculated using various methods in multiple tests. Scientists have recommended the ORAC (Oxygen Radical Absorbance Capacity) method for measuring antioxidant capacity. The total ORAC for fresh weight of cabbage is between 498 and 1784 μmol TE/100 g, which grades *B. oleracea* var. *capitata* as a vegetable with medium antioxidant activity, according to the USDA ORAC Database (Haytowitz and Bhagwat, 2010).

According to Jacob *et al*. (2011), the extract of white cabbage could be O_2^-, OH^- radicals function as free radical scavengers and fix free-radical damage caused by radical guanosine. In aerobic species, cellular biomembranes are the primary tasks of ROS, resulting in lipid peroxide formation. White cabbage water extract has been shown to be capable of preventing lipid peroxidation and reducing lipid peroxide production (Podsędek, 2007).

Glucosinolates under the complete hydrolysis through fermentation of the white cabbage create a variety of health-promoting compounds that have a high antioxidant activity, and indeed fermentation boosts the white cabbage's antioxidant property. Due to global accessibility and daily use, the white cabbage will contribute substantially to the total utilization of antioxidant phytonutrients in human dietary (Singh *et al*., 2006).

Gastrointestinal activity

While treating multiple stomach conditions, white cabbage has a long tradition about gastrointestinal problems. Cavender (2006) documented the use of boiled or fried cabbage, cabbage juice and kraut in the treatment of disturbed stomach and clean intestines of native populations of the southern Appalachian region in the United States in ethnobotanical studies. For gastrointestinal wellness, many modern herbal alternative therapies and natural therapies suggest cabbage these days (Meletis and Zabriskie, 2008).

The first scientific data was published by Cheney (1949) on the positive effects of consumption of cabbage juice on the intestinal system, especially in the recovery of peptic ulcers. In order to validate ethnobotanical arguments about the use of cabbage in gastric disorders, several other groups subsequently researched the antiulcerative effect of cabbage (Figure 5).

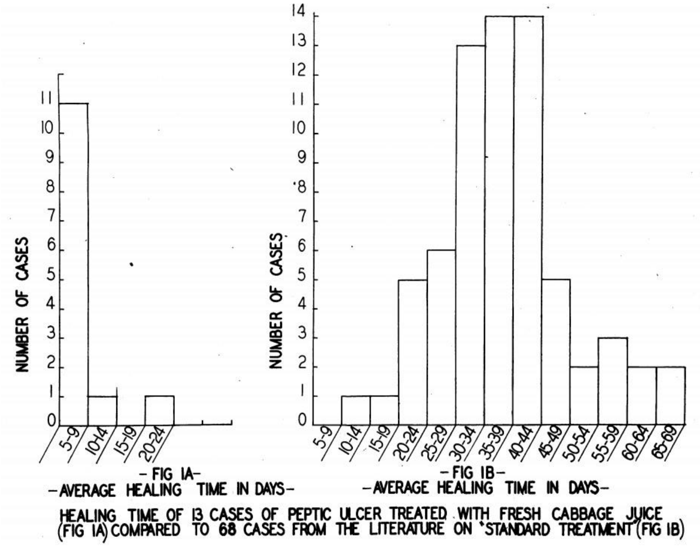

Figure 5. The graphics of proven fast healing peptic ulcer with cabbage juice (Source: Cheney, 1949)

In the animal study, Carvalho *et al*. (2011) tested the anti-ulcerogenic aqueous extracts of white cabbage. Acute gastric ulcers were caused by oral administration of aspirin in rodents, and they observed how gastric healing or injury was affected by cabbage therapy.

The extraction of cabbage greatly prevents the production of ulcers caused by a chemical agent, and the findings explain the health benefits of this vegetable in the treatment of gastric disorders. In related animal experiments, this outcome was confirmed later (Enye *et a*l., 2013; Oguwike *et al*., 2014).

Antiobesity, hypolipidemic and hypoglycemic effect

Brassica oleracea var. *capitata* is an important vegetable used in many conventional and marketing diet programs because of its low caloric level and a wide range of phytochemicals (Greenly, 2004).

The effects of a canned blended green vegetable and fruit beverage containing broccoli and cabbage on serum lipid levels in hypercholesterolemic patients were tested in a clinical research by Suido *et al*. (2002). Thirty-one adults were offered two canned beverages (160 g/can) a day for 3 weeks, and their serum total cholesterol and low-density lipoprotein cholesterol levels decreased substantially. In several other animal studies, the anticholesterol, hypoglycemic and anticoagulant effects of white cabbage were examined.

In a Pakistani research (Waqar and Mahmood, 2010), the antihypercholesterolemic effect of cabbage was also reported. Evidence of association exists between blood lipids and measures for coagulation.

Recently, by using rabbits as an experimental model, Khan *et al.* (2015) investigated the anticoagulant activity of Brassica vegetable methyl alcohol extract in vivo. Biochemical studies have shown that the activated partial thromboplastin, fibrinogen and thrombin duration of rabbits given cabbage extraction at a dose of 500 mg/kg for 30 days has improved. High cholesterol has been shown to raise coagulation factors concentration, while decreasing the level of cholesterol can avoid the formation of clots.

In additional to hypolipidemic, Assad *et al.* (2014) examined hypoglycemic function of white cabbage methanol extract in alloxan-induced diabetic rabbits in addition to hypolipidemic. Blood glucose, total cholesterol and low density lipoprotein were substantially reduced in diabetic rats given cabbage methanol extract, whereas high-density lipoprotein levels improved relative to control levels.

Another research (Asadujjaman *et al.*, 2011) also investigated the impact of cabbage extract on blood sugar level control. The various fractions of the cabbage extract were applied intraperitoneal injection to alloxan and glucose induced diabetic rats at a single dose of 150 mg/kg. Cabbage extract substantially lowered the level of blood glucose, significantly reduced the quantity of liver glycogen and increased glucose tolerance in rats.

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. White cabbage *(Brassica oleracea* var. *capitata* f. *alba*), which has often been used for decades in traditional medicine, is among the most widely eaten.

While the specific modes of action have not yet been defined, phytochemical research and pharmacological experiments performed over the past few decades on white cabbage juice or extract offer fair evidence for its numerous conventional uses. Study on the phytochemicals of white cabbage has been based on the well-known health promotion of components such as glucosinolates, polyphenols, and various vitamins correlated with anticarcinogenic and antioxidant activities.

It was also important to carry out more studies on bioavailability, absorption, metabolism, pharmacology and biotransformation of white cabbage health supporting compounds of activity in order to provide compelling evidence for the potential usage of white cabbage in medicinal or nutritional care.

To come with a conclusion, the medication with cabbage juice or extracts is above everyone's expectations because it is hard to believe that many injuries and health diseases could be cured by cabbage compounds and it is preferably to research moreover the biochemistry of white cabbage because it is definitely a source of health.

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