https://doi.org/10.53964/jmab.2022008

https://www.innovationforever.com

Journal of
Modern Agriculture and Biotechnology

ISSN 2788-810X (Online)

Open Access

Review

The Nutritional and Functional Aspects of White Vegetables

Neeru Bhatt[1*]

[1]Motinagar, Tarsali, Baroda, Gujarat, India

***Correspondence to:** Neeru Bhatt, Tarsali 390009, Baroda, India; Email: neerubhatt60@yahoo.co.in

Received: December 6, 2021 **Revised:** January 17, 2022 **Accepted:** January 26, 2022 **Published:** April 8, 2022

Abstract

Vegetables have an imperative role in human nutrition and make up a significant portion of daily diet. Vegetables are grouped into many categories such as green, red, yellow, white etc. White vegetables are higjh in carbohydrates, proteins, minerals, vitamins, dietary fibres, and other bioactive compounds. They are nutritionally equivalent to any other coloured veggies. The bright or rainbow-colored foods have traditionally enticed and motivated humans when choosing meals, particularly vegetables. Though colour is thought a good indicator of a plant's antioxidant capacity, that doesn't mean that white vegetables aren't rich in antioxidants. Due to the presence of glucosinolates, cauliflower and turnip have long been known to have anti-carcinogenic properties. Similarly, white onion and garlic have beneficial properties and aid in disease prevention. It is believed that mushrooms can reduce the risk of developing health conditions such as Alzheimer's disease, heart ailment, cancer, and diabetes. Potatoes contribute important nutrients including potassium, vitamin C, and dietary fiber to the human diet and have been a mainstay of human diets for centuries. Potato also contains a number of bioactive components that extend disease prevention capacity. A variety of nutritional and functional benefits can be associated with white vegetables and should be incorporated into diet.

Keywords: white vegetables, health, nutritional activity, antioxidants, functional activity

Citation: Bhatt N. The Nutritional and Functional Aspects of White Vegetables. *J Mod Agric Biotechnol*, 2022; 1(2): 8. DOI: 10.53964/jmab.2022008.

1 INTRODUCTION

Vegetables impart a significant role in nutrition and comprise a considerable share of human diet. They are a wonderful supplier of phytochemicals, vitamins (C, A, B1, B6, B9, E), minerals, and particularly dietary fibre. A ray of studies have found that phytochemicals have the capacity to lower down the pathogenesis of chronic diseases by nullifying the harmful effects of free radicals[1-4], altering metabolic pathways, cleansing carcinogens from the body and modifying the process of tumor development. Inclusion[2,4-6] of vegetables in daily diet improves nutritional adequacy and is highly recommended for their various health boosting properties. They are known to improve gastrointestinal health and vision, reduced risk for some forms of cancers, heart diseases, cardiovascular diseases, diabetes[7], anaemia, gastric ulcer, rheumatoid arthritis, and other chronic diseases, though[8-12], the mechanism is not completely understood by physicians and scientists. However, according to Dias low vegetable intakes may exert negative effects on human heart functioning and are responsible for about 31% of ischaemic heart disease and 11% of stroke globally. The three main classes of phytochemicals[13] present in plants: the carotenoids abundant in yellow and red coloured plant produce, chlorophylls in green plants, and anthocyanins in blue, purple, and red fruits and vegetable. Anthocyanins

are a class of flavonoids, and the majority of which are not coloured. Anthoxanthins, which include flavones, flavonols, and flavonones, are pigments frequently found in white vegetables. These pigments can range from dazzling white to yellow. Some of them, like kaempferol, quercetin, and rutin, are particularly powerful antioxidants[14-15].

2 COLOUR VS WHITE

Colours as one of the most important senses of vision and can influence the mood, behaviour and well-being of human, however the human eye can only see through a small window (390-765nm) of the electromagnetic spectrum. Many[16] vital nutrients, such as vitamin C, have no absorption in the visible range of the electromagnetic spectrum. As a result, the human eye is unable to detect the vitamin C level of a food directly. Potassium, dietary fibre, calcium, and vitamin D are some other known nutrients for which colour is not an appropriate indicator. Human[16] is more attracted and motivated by food with more reddish nuances and bright colours. Colours can be used as an indicator of food quality, grade and also linked to the antioxidant capacity. For phytochemicals[17], colour may be a measure of antioxidant capacity, but it's not necessarily true for all plants. The nutritionists and scientists and the dietary guidelines around the globe, often advocate the importance on eating colourful foods, however Weaver and Marr argued that the colour-based dietary dietary guidelines is not a perfect approach. Though colour is thought a good indicator of a plant's antioxidant capacity[18], that doesn't mean that white vegetables aren't rich in antioxidants.

White vegetables are underrated, despite they are superbly packed with vital nutrients. They are an excellent source of dietary fibre and high dietary fibre intake is inversely associated with several chronic diseases including cancer, cardiovascular disease, diabetes and high blood pressure. Some white vegetables such as cauliflowers and turnips contain glucosinolates, which have been proved as potent anticancer agents[19]. Additionally, white vegetables are rich in resistant starch, vitamins minerals, flavonoids and other phytochemicals and should be included in the diet to achieve the recommended daily vegetable requirement of the Dietary Guidelines. Though, in recent years the white vegetables are gaining momentum and the pandemic caused due to COVID 19 has actually heightened the value of neglected food categories especially ginger, onion and garlic. Many white vegetables such as cauliflower, reddish, garlic, onion, turnips, potato, mushroom, white beans, leeks and parsnips are present in nature. This review article will throw light on some white vegetables with valuable attributes.

2.1 Cauliflower (Brassica oleracea L var, Botrytis)

Cauliflower is a valuable member of the Cruciferae (Brassicaceae) family of vegetables. Cauliflower is suitable to all climatic zones and grown worldwide. Cauliflower is not only used as a vegetable, but also used in the preparation of salads, soups, biryani, pulao and pickles. According to one estimate in 2016, the global production of cauliflowers and broccoli together was 25.2million tonnes. China topped the producing countries constituting 73% of the world total production, followed by India.. The United States, Spain, Mexico and Italy produced about 0.4-1.3million tonnes annually[20].

Cauliflower includes head of aborted floral meristems about 6-7 inches diameters (white curd) stalk and surrounding thick, green leaves. Only curd is consumed by human and stalk and leaves are discarded as waste and used mainly for cattle feed, though, such leftovers are found to be rich in iron and β-carotene, hence, can be used in various value-added products. Because of the higher water contents[24], cauliflowers are low in energy, carbohydrates, proteins and fats, but a good source of fibre (Table 1). Cauliflower[21-23] comprises good concentration of mineral especially Ca and P. Low concentration of sodium and higher concentration of potassium make cauliflower a good candidate for the people suffering with high blood pressure and hypertension (Table 1)[21-23]. Additionally, it is high in vitamin C, folic acid, vitamin B6, Vitamin B5, and small amounts of other B group vitamins (like B1, B2 and B3). Glucosinolates[25], a class of phytochemicals are abundantly found in cauliflower. They are involved in slowing down the growth of mutated cancerous cells and its metabolite isothiocyanates are known for their anti-cancer activity. This qualifies cauliflower a promising plant to prevent cancer as well as alleviate the re-occurrences of cancer in human[19]. Glucosinolates[26] is also responsible for the peculiar smell of cruciferous vegetables like cauliflower, cabbage and sprouts when they are cooked. Several cooking and processing techniques like blanching, boiling, microwaving, and stir-frying influence the status of phytochemicals in cauliflower. Water boiling and blanching significantly decreases dry matter, protein, mineral, and phytochemical contents as well as diphenyl-1-picrylhydrazyl (DPPH) scavenging capacity. However, steam treatments (blanching and cooking), stir-frying, and microwaving did little change in the nutritional profile of cauliflower[21].

Another bioactive compound sulforaphane is also widely distributed in cauliflower. Sulforaphane is a powerful Phase II enzyme inducer and can avert incidences of several inherited cancers. The group of induced enzymes includes NAD(P)H: NQO1 (quinone reductase) and the family of glutathione-S-transferases (GSTs). Both the enzymes are needed to clear up the toxic effects of steroids and benzo(a) pyrene, a ubiquitous environmental toxin. The initiation[27-29] of detoxification enzymes by sulforaphane may significantly contribute to the anticarcinogenic activity. Research[30] states that including cauliflower in diet is negatively associated with the occurrence of several types of cancers such as breast, lung, liver, colon and stomach cancers[31].

Table 1. Proximate and Mineral Composition of Cauliflower

Constituents	Value[21-23]
Moisture (%)	87.93-90.62
Ash (%)	0.62-1.10
Crude protein (%)	1.98-2.75
Fats (%)	0.20-0.31
Crude fibre (%)	3.77-11.57
Carbohydrates (%)	4.42-4.74
Dietary fibre (%)	2.03
Ca (mg/100g)	28.9-41.16
P (mg/100g)	26.92-329.0
Fe (mg/100g)	2.15-26.2
Na (mg/100g)	176-392
K (mg/100g)	1.68-3657
Mg (mg/100g)	0.67-450

Cauliflower is considered as heart supporting vegetable. It is rich in folic acid and vitamin B6 which are central components of homocysteine metabolism. The elevated homocysteine concentration in blood is associated with the risk of cardiovascular disease. Apart from that cauliflower is also known to contain omega-3 essential fatty acids, the alpha-linolenic acid is helpful in reducing biomarkers of cardiovascular disease. Dietary supplementation of alpha linolenic acid is inversely related to the incidences of heart disease. Free radicals destroy the skin's elasticity and attack elastin and collagens, which are the main substances that support the skin's structure. Cauliflower has the ability to repair oxidative damage mainly[32] due to the presence of high vitamin C content.

The antioxidants and anti-inflammatory compounds present in cauliflower help to lower down oxidative damage and hence, chronic diseases. Cauliflower consists of considerable amount of beta-carotene and vitamin K which are potent anti-inflammatory agents. Beta-carotene is a pro-vitamin which converts into vitamin A in the body and protects body from free radicals. Researches have shown that the anti-inflammatory attribute of vitamin K extends protection against heart disease, as well as osteoporosis. Vitamin B5[33-34], important B vitamin present in cauliflower helps bodies to utilize the food to rebuild muscles, organs and tissues. It plays an important role in digestion and nutrient extraction; digestive difficulties can be a sign of a severe vitamin B5 deficiency. Cauliflower is a good source of vitamin B6, which is needed for the production of neurotransmitters in the brain. Neurotransmitters carry signals from one nerve cell to another, are essential for processing thought and healthy brain development and are also responsible for sending bodies signals to produce hormones that influence mood and the body's sleep cycles. Cauliflower[35-36] consists of moderate amount of minerals which help to reduce inflammation[21-22]. Low amount of magnesium is related with high stress. Stress, as most of us know, can cause cravings for foods such as chocolate or other refined carbohydrates. Stress also changes level of dopamine in the brain, and dopamine is actually a magnesium-dependent neurotransmitter.

2.2 Garlic (Allium sativum L.)

Traditionally garlic is one of the most viable species of the Allium genus and belongs to family Alliaceae. It is a globular perennial food plant[37] that is widely distributed in Europe, Asia, North America and North Africa. It is one of nature's best kept secrets[38].

Garlic is used as raw and cooked as well. It is widely used as a condiment and flavouring agent in cooking, pickle making, preparation of baked goods, puddings, gravies, soups, stew, meat products, non-alcoholic beverages and soft candy. Additionally, garlic is used in sauces and dressings as chopped, grated, fine paste, or in the form of a boiled extract. Garlic's inherent pungent, spicy flavour is softened and sweetened by cooking[39-40].

The proximate and mineral composition of garlic (from different sources) is presented in Table 2. Garlic contains about 4 to 8% moisture, 3-4% ash, 15-20% crude protein, 1% fat and 2% crude fibre, respectively. A considerable amount of minerals is also found in garlic bulbs (Table 2). Garlic is traditionally[41-43] used to treat plethora of ailments such as aches and pains, leprosy, deafness, diarrhoea, constipation, parasitic infection and fever and to lessen stomach ache. It is evident from the literature[44] that garlic was allegedly provided to the athletes participated in the earliest Olympic games organised in Greece, to increase their stamina. The antibacterial property[45] of garlic was noticed long back in 1958 by Pasteur. The use of garlic as an antiseptic helped to treat wounded soldiers during world war I and II. The sulfur-containing compounds[46],

Table 2. Proximate and Mineral Composition of Garlic

Constituents	Value[41-43]
Moisture (%)	4.55-7.80
Ash (%)	3.14-4.08
Crude protein (%)	15.33-19.75
Fats (%)	0 .19-0.57
Crude fibre (%)	1.73-2.10
Carbohydrates (%)	66.36- 73.22
Dietary fibre (%)	-
Ca (mg/100g)	26.30-7146
P (mg/100g)	10.19
Fe (mg/100g)	0.06-5.29
Na (mg/100g)	4.10
K (mg/100g)	54.00-95.49
Mg (mg/100g)	2.51-6.11

generally found in garlic, stimulate the production of certain beneficial enzymes to protect human body from different biotic and abiotic agents. The antibiotic properties[47] of garlic make it a perfect candidate for mild to moderate home remedies including sore throat[48]. Additionally, garlic stimulates the lymphatic system to accelerate removal of waste materials from the body. It also serves as an effective antioxidant to protect body cells from the harmful effects of free radicals, produced continuously in the body[48].

Garlic is predominantly rich source of organosulfur compounds, which are assumed to be responsible for its flavour and aroma, in addition to its potential health benefits. Garlic[49] is concentrated with sulfur containing compounds thiosulfinates, which include allicin. Allicin is present in garlic bulbs and released only after the raw garlic is chopped, crushed, or chewed. It is formed from alliin, a sulfur-containing amino acid, in the presence of the enzyme alliinase. Many meta-analyses studies have revealed noteworthy reduction in total cholesterol levels, low-density lipoproteins and triglyceride levels compared with placebo. In one study allicin[50-53] efficaciously scavenged hydroxyl radicals (exogenously generated) in a dose-dependent manner, although heating to 100°C for 20 minutes lowered their efficiency by around 10%. In addition[54], S-allyl cysteine, another sulfur compounds present in garlic showed strong antioxidant properties in fresh garlic almost 1000 times more powerful than crude, aged garlic extract. Several human[54] trials have revealed garlic consumption can increase fibrinolytic activity in both healthy people and patients with acute myocardial infarction. In rabbits[55], garlic pre-treatment reduced intracellular Ca2+ mobilisation, thromboxane-A2 (a potent platelet aggregator) production, and protected against thrombocytopenia produced by collagen or arachidonate. Platelet aggregation is inhibited by the aged garlic extract due to an increase in cAMP and blockage of the GPIIb/IIIa receptor. Furthermore[56], regular garlic consumption lowers the risk of peripheral arterial occlusive diseases, plasma viscosity, and unstable angina while increasing blood vessel elasticity and capillary perfusion. Garlic intake[57] has been shown to reduce blood pressure, prevent atherosclerosis, cut serum cholesterol and triglyceride levels, inhibit platelet aggregation, and increase ibrinolytic activity. Garlic's antihypertensive properties[58] could be related to prostaglandin-like effects[59].

Many bioactive components present in garlic are known for their potential anti-cancer activity, largely allylsulfide derivatives and are capable to modulate molecular processes in carcinogenesis, such as DNA adduct formation, mutagenesis, scavenging of free radicals, cell proliferation and differentiation as well as angiogenesis. Garlic slows the growth of cancer cells by blocking cell cycle progression in the G2/M phase. Garlic feeding[60] has been shown in both rat and human trials to suppress the formation of tumors in the liver, colon[61], prostate[62], bladder[63], mammary gland[64], oesophagus[65], lung[66], skin[67], and stomach[68]. Although experimental investigations have shown that garlic has a distinct hypoglycemic impact[69], the effect of garlic on human blood glucose levels is still debatable. Garlic has been shown to be effective against a wide range of bacteria, including gram-positive, gram-negative, and acid-fast. Salmonella, Escherichia coli, Pseudomonas[70], Proteus, Staphylococcus aureus, Escherichia coli, Salmonella, Klebsiella[71], Micrococcus[72], Bacillus subtulis, Clostridium[73], Mycobacterium[74] and Helicobacter[75] are among them[76].

2.3 Mushroom

Mushrooms eating has been practised since ancient times, when wild edible mushrooms were gathered and devoured. Mushrooms are not a plantor animal meal, but rather a type of fungus that belongs to the saprophyte a class of living organisms that exist by consumption of dead

matter. More than 10,000 different kinds of mushrooms are grown around the world, and are one of the most delicious delicacies. China and the U.S. are two of the top five mushroom producers in the world[77-79]. Mushrooms have long been used as a dietary supplement in many civilizations, and they are cultivated and consumed as a delicacy.

The proximate composition of mushrooms varies widely within the species. It is evident from Table 3 that moisture contain varies from 2-92%, and likewise the other nutrients. Mushrooms are good source of several essential minerals as well (Table 3). Mushrooms[80-82] are big fruiting bodies with a wide range of pharmacological properties that are beneficial to human health. Mushrooms are usually low in calory, an excellent source of polysaccharides, indoles, polyphenols, and carotenoids and have antioxidant, anti-inflammatory, and anticancer properties. Proteins, vitamins, fats, carbohydrates, amino acids and minerals are all found in mushrooms. Mushrooms[83] have a dry matter content of about 16.5%, with 7.4% crude fibre, 14.6% crude protein and 4.48%fat and oil. Edible[84] mushrooms have a significant nutritional value, particularly in terms of protein and carbohydrates. The Pleurotus sajor-caju powder had a high concentration of carbohydrate (60.47g/100g), resulting in 451.60 cal/100g. Mushrooms[85] contain both digestible (trehalose, mannitol, glycogen, and glucose) and non-digestible carbohydrate (mannans, chitin, and β-glucan). Mushrooms[85] also contain a lot of dietary fibre, chitin and β-glucans. Auricularia[86] species have a protein level of 4 to 9%, while Agaricus species have a protein content of 24% to 44%. Mushrooms have double the protein content of asparagus and potatoes, four times the protein content of tomatoes and carrots, and six times the protein content of oranges. All vital amino acids are found in mushrooms. Many minerals together with phosphorus[83], magnesium, selenium, copper, and potassium are found in mushrooms. Mushrooms[87-90] are high in vitamins such as vitamin B and vitamin D. Mushrooms[86-90,91] include a substance referred to as ergosterol, that has a structure comparable to cholesterol in animals. Mushrooms are rich in vitamins like riboflavin, biotin and thiamine. When exposed to ultraviolet radiation[92], Ergosterol can be converted to vitamin D.

Despite the fact that mushrooms are an unappreciated food, humans have consumed them for ages for a variety of reasons, including nutrition[93-94], taste and healing capabilities. Polysaccharides[95], proteins, fats, minerals, glycosides, alkaloids, volatile oils, terpenoids, tocopherols, phenolics, flavonoids, carotenoids, folates, lectins, enzymes, ascorbic, and organic acids, are abundant in mushrooms and have a variety of pharmacological properties including antioxidant, anticancer, antidiabetic, antiallergic, immunomodulating, cardiovascular protector, anticholesterolemic, antiviral, antibacterial, antiparasitic, antifungal, detoxification, and hepatoprotective effects. Mushrooms also contribute to prevent the growth of tumours and inflammation. Polysaccharides[96-98] are the most significant in modern medicine, with β-glucan being the most well-known and adaptable metabolite with a broad range of biological action. Mushrooms[96-97,99-100] also aid in decreasing the hazard of Parkinson's, Alzheimer's diseases[101].

2.4 Potato (Solanum tuberosum)

Potatoes are cultivated in 149 countries and are one of the most vital food crops after wheat and rice. Potato[102] produces more food energy than cereals on the basis of per-hectare and per-day. It is not only rich in carbohydrates but also in amino acids, minerals and many other plant biotics.

The proximate and mineral composition of potatoes present in Table 4. The carbohydrate content of potatoes varies from 13 to 17% (Table 4)[103-105]. Potatoes are frequently categorised as high glycemic index (GI) foods, and it is widely assumed that eating potatoes leads to obesity[103-105], probably due to the greater carbohydrate content. However, according to one study, potato intake can be helpful in shedding weight quickly and effectively. Actually[106], the GI of potatoes depends on numerous factors such as varieties, geographical conditions of cultivation, cooking methods, way of consumption (hot, chilled or frozen), eaten as boiled and mashed or cubed or whole and with what it is consumed. Moreover[106], potatoes comprise exceptional amount of resistant starch, which is not digested by stomach or small intestinal enzymes and reaches directly to the large intestine and attribute to many health benefits. Studies have shown that the resistant starch provides defence against colon cancer, improves glucose tolerance and insulin sensitivity, lowers plasma cholesterol and triglyceride concentrations, increases satiety, and possibly even reduces fat storage. Cooling after cooking enhances resistant starch significantly. According to one study in cooked potatoes, resistant starch was 7 percent, which reached up to 13 percent upon cooling[107-109]. The protein content in potatoes is low (less than 6%, Table 4)[110], but has a high biological value. In a very recent study Williams et al found more than 8% crude protein in Irish potato cultivars (Table 4). Moreover[103], many human feeding studies have found that potatoes are rich in essential amino acids. Potato protein, therefore is considered high-quality protein[111-113] and the best protein from vegetable sources of protein. Potato is a good source of minerals (Table 4). and vitamins[103-105]. A 150g potato including the skin offers 27mg of vitamin C (45% of the daily allowance), 0.2mg vitamin B6 (10% of daily allowance), 620 mg of potassium (18% of daily allowance), 0.5 to 2.8mg/kg α- tocopherol, 0.13 to 0.6mg/kg lutein, and 1 mg/kg β-carotene[114] and traces of thiamine, riboflavin, niacin, magnesium, phosphorus, iron, and zinc. Potato may provide about 0.01mg/kg selenium and 0.35mg/kgfolate to the human diet. The fibre content of a potato with skin (2g) is comparable with whole grain breads, pastas, and cereals[115].

https://doi.org/10.53964/jmab.2022008

Table 3. Proximate and Mineral Composition of Mushroom

Constituents	Value[80-82]
Moisture (%)	2.51-92.02
Ash (%)	4.12-15.73
Crude protein (%)	12.02-37.0
Fats (%)	0.1-2.58
Crude fiber (%)	2.0-21.97
Carbohydrates (%)	4.82-68.0
Dietary fiber (%)	-
Ca (mg/100g)	31-607.0
P (mg/100g)	0.2-364
Fe (mg/100g)	16.3-1230
Na (mg/100g)	0.2-858.4
K (mg/100g)	2.2-1369.1
Mg (mg/100g)	12-1537

Table 4. Proximate and Mineral Composition of Potato

Constituents	Value[103-105]
Moisture (%)	69.35-80.88
Ash (%)	1.01-2.83
Crude protein (%)	3.16-8.65
Fats (%)	0.05-2.80
Crude fiber (%)	1.0-1.22
Carbohydrates (%)	13.60-19.74
Dietary fiber (%)	2.18-3.45
Ca (mg/100g)	37-204.68
P (mg/100g)	132- 207
Fe (mg/100g)	2.55-4.54
Na (mg/100g)	25.65-322
K (mg/100g)	697-2082
Mg (mg/100g)	53.23-153

Potatoes contain considerable amount of phytochemicals predominantly carotenoids and phenols being[116-117] the chief contributor of vegetable phenols including phenolics, phytoalexins, flavonoids, tannins. Besides, alkaloids and protease inhibitors are also found in potatoes. Total phenolics in potato ranges from 0.5 to 1.7g/kg. About 90%[118-119] of phenolics is comprised by chlorogenic acid. Other phenolics are 4-O-caffeoylquinic acid (crypto-chlorogenic acid), 5-O-caffeoylquinic (neo-chlorogenic acid), 3,4-dicaffeoylquinic and 3,5-dicaffeoylquinic acids. The peel[120] and adjoining tissue account for about 50% of the total phenolic compounds in potato and the composition decreases towards the canter. Potatoes[121-122] can be used to manage hypertension and high blood pressure. The higher concentration of potassium and lower concentration of sodium make it a perfect food for people suffering from high blood pressure. The raw potato slices[123] or juice is often used as home remedy for burns, rashes and cuts and possess anti-irritating, soothing and de-congesting properties. Raw potato juice[123-125] is also used to treat gastritis, colitis, gastric and intestinal ulcers. Inclusion of potatoes in the diet can positively alter the antioxidant concentrations in blood and other tissues, and save vital nutrients such as lipids, proteins, enzymes and DNA from oxidative stress. Oxidative stress is one of the culprits of the pathogenesis of a number of chronic diseases including cancer or cardiovascular disease. The bioactive components[126-128] in potatoes extend several notable pharmacological activities such as activity anti-diabetic and cholesterol trimming property, antimicrobial activity, antiulcer activity, anti-oxidative property, anti-diarrheic activity, phagocytic activity, cytotoxic activity etc[129].

2.5 Turnip (*Brassica rapa*)

Historically, turnip is one of the oldest grown vegetable crops known to human. Turnip has been eaten as a

https://doi.org/10.53964/jmab.2022008

Table 5. Proximate and Mineral Composition of Turnip

Constituents	Value[132,134-137]
Moisture (%)	88.9-91.28
Ash (%)	0.15-1.46
Crude protein (%)	0.90-1.12
Fats (%)	0.10-0.21
Crude fiber (%)	1.65-3.14
Carbohydrates (%)	5.81-8.55
Dietary fiber (%)	-
Ca (mg/100gm)	39-114.57
P (mg/100gm)	27
Fe (mg/100gm)	0.3-44.53
Na (mg/100gm)	67-272.1
K (mg/100gm)	191-520.5
Mg (mg/100gm)	11-143.87

vegetable since the prehistoric times, and has medicinal values along with a conventional healing agent. It's a member of the cruciferous family[130-132] of vegetables. It is generally known as field mustard or turnip mustard, and is mostly cultivated as a root vegetable, a leaf vegetable, and an oil seed. Turnip is completely edible with its leaves, inflorescence, root, stem, and seeds. Turnips have slow respiration rate and a long shelf-life, longer than potatoes[133].

Table 5 shows that turnips contain a good amount of water (88-92 %). The ash content ranged from 0.15-1.5 %, crude protein nearly 1%, fats 0.1-0.2%. crude fibre 1.8-3.0% and carbohydrates approximately 6-9%, respectively (Table 5). Major minerals[132,134-137] such as Ca, P, Fe, Mg, Na and Kare also found in significant amount (Table 5). Turnip is a natural source of glucocinolates[132,134-137], isothocyanates (3-butenly, 4-pentenyl, and β-phenylethyl isothiocyanate) including sulforaphane. The range of the total content of glucosinolates in different parts of the turnip (peeled root, peeling, and leaf) is from 147 to 151µmol/100g. A large number of the phenolic[138-140] compounds like 3-p-coumaroylquinic acid, caffeic acid, ferulic acid, sinapic acid, kaempferol 3-O-sophoroside-7-O-glucoside, kaempferol 3-O-sophoroside-7-O-sophoroside, kaempferol 3-O-(feruloyl/caffeoyl)-sophoroside-7-O-glucoside, kaempferol 3,7-O-diglucoside, isorhamnetin 3,7-O-diglucoside, kaempferol 3-O-sophoroside, 1,2-disinapoylgentiobiose, 1,20 -disinapoyl2-feruloylgentiobiose, kaempferol 3-O-glucoside, and isorhamnetin 3-O-glucoside are also present in turnips. The turnip phenolic compounds have displayed a high level (about 18g/kg), two times those in Brassica oleracea L. var. acephala. Likewise[130,141] flavonoid contents are also high in turnips (about 119.2–138.85 mg/100g), which is about 3–10 times than other Brassica family members. The contents of hydroxycinnamic derivatives were found at the level of 5.77–52.54mg/100g. Besides, the organic acids namely malic acid, aconitic acid, citric acid, ketoglutaric acid, shikimic acid, and fumaric acid are also abundant in turnips especially in leaves, stems, and flower buds[130,141].

Turnip extract can help to reduce uric acid levels and can dissolve kidney stones. Consumption of ethanol extracts of turnip roots reduced cisplatin-induced nephrotoxicity by reducing oxidative stress[142]. It is used to treat night blindness by increasing visual acuity. The syrup improves memory, and the peelings of the roots contain a natural pesticide. It is known for its antiseptic[143-144], appetite stimulant, antirheumatic, diaphoretic, diuretic activities and also aids in irregular menstruation. Turnips, an excellent source of vitamin C, are a powerful immune booster, helpful for stomach disorders and are also considered to be very effective in cases of sore throat and indigestion. Studies[145] have revealed that several members of cruciferous family exert anticancer activity owing to the presence of glucosinolates. Various[138,146-147] parts of turnip plants are successfully used in home remedies. The poultice derived from crushed ripe seeds is effectively used on burns, root boiled with lard is used for breast tumours and an organic lotion made from turnip flowers is used against skin cancer. The methanolic[148] extracts of turnip have been found to hinder the growth of gram-positive bacteria (Bacillus cereus, B. subtilis, and Sarcina lutea) and Gram-negative bacteria (Escherichia coli, Pseudomonas aeruginosa, Salmonella Paratyphi, S. Typhi, S. dysenteriae, and Vibrio parahemolyticus), signifying an effective antimicrobial activity of turnip. Turnip[149] root has traditionally been used as remedy of hypoxia by Tibetan people residing in Qinghai-Tibet Plateau. The Tibetan turnip intake for seven consecutive days significantly improved human hypoxia tolerance[150-151], subsequently promoting both oxygen absorption in red blood corpuscles and oxygen transportation by haemoglobin. Several[151]

studies recommended that polysaccharides, p-coumaric acid, and p-coumaric acid-β-D-glucopyranoside in turnip are potentially active components contributing to the anti-hypoxia. The turnip root[150,152-153] enhances the glucose and liquid metabolism, thus exerting an antidiabetic effect in type 2 diabetic mice. The ethanol extracts of turnip root enhanced glucose transportation and ameliorated insulin resistance by reducing glycosylated haemoglobin, plasma insulin, C-peptide, and glucagon in type 2 diabetic db/db mice along with augmentation of the insulin/glucagon ratio and hepatic glycogen content by the promotion of hepatic glucose regulating enzyme activity). Other extracts[154] such as ethyl acetate extracts and butanol extracts of turnip effectively inhibited α-glucosidase activity. The aqueous[154] extracts of turnip leaves, stems, and flower buds have shown higher antioxidative capacity, compared to turnip roots. Conversely other study reported higher DPPH radical scavenging activity of aqueous extracts of turnip roots compared to the aqueous extracts of turnip greens. Turnip[155] also possess hepatoprotective activity. The bioactive components present in turnip offer protection against hepatic injury in people with diabetes[156].

3 CONCLUSION

It is a common perspective that colored fruits and vegetables provide significant amount of bioactive compounds and protect human from various pathogenesis. Several studies have shown that white vegetables are no less than their colored counterparts in terms of nutrients and phytonutrients. They are abundant in carbohydrates, proteins, dietary fibre, minerals, and vitamins, which are essential nutrients for proper growth, development and maintenance. Besides, white vegetables such as potatoes, mushrooms and garlics are an excellent source of phenolic acids. Potatoes are also rich in resistant starch and dietary fibres. Resistant starch is needed to maintain good gut health. Precisely gut health includes normal bowel function, effective absorption of nutrients and subsequent adequate nutritional status, absence of GI illnesses, normal and stable intestinal microbiota and effective immune status. The high concentration of sulfur containing compounds like allicin (diallyl thiosulfinate or diallyldisulfide), alliin (Sallylcysteine sulfoxide), present in garlic can inhibit and kill bacteria, fungi, lower down blood pressure, blood cholesterol and blood sugar, prevent blood coagulation, boost immunity and have anti-tumor properties. Studies have shown that mushrooms are high in phenolic and flavonoid compounds that are beneficial to human health. Cauliflower and turnips are an upscale resource of glucosinolates, isothocyanates (3-butenly, 4-pentenyl, and β-phenylethyl isothiocyanate) including sulforaphane, phenolic compounds, organic acids, flavonoids, sulfur compounds, and volatiles, which exert different health-beneficial effects.

Acknowledgements

All the researchers and scientists, referred and cited are duly acknowledged.

Conflicts of Interest

Author declares no conflict of interest.

Author Contribution

Bhatt N planned for the idea, made the revision of the review article, collected the data required for writing draft of review article, adjusted the article according journal formatting, and approved the final version.

Abbreviation List

Ca, Calcium
Cal/g, Calory/gram
cAMP, Cyclic adenosine monophosphate
COVID 19, Corona virus disease-19
DNA, Deoxy ribonucleic acid
Fe , Ferrous/ iron
G, Gram
GPIIB/IIIA, Glycoprotein IIB/IIIA
K, Potassium
Kg, Kilogram
Mg, Milligram
Mg, Magnesium
NAD(P)H, Nicotinamide adenine dinucleotide, (phosphate)
P, Phosphorus
^{0}C, Degree centigrade
β, Beta

References

[1] Quebedeaux B, Eisa HM. Horticulture and Human Health: Contributions of Fruits and Vegetables. Proceedings of the 2nd International Symposium Horticulture and Human Health. Hort Science, 1990; 25: 1474. DOI: 10.21273/HORTSCI.25.12.1474

[2] Winston C, Beck L. Phytochemicals: health protective effects. *Canad J Diet Practi Rese*, 1999; 60: 78-84.

[3] Wargovich MJ. Anticancer Properties of Fruits and Vegetables. *HortSci*, 2000; 35: 573-575. DOI: 10.21273/hortsci.35.4.573

[4] Dias JS, Ryder E. World Vegetable Industry: Production, Breeding, Trends. *Hort Rev*, 2011; 38: 299-356.

[5] Southon S. Increased Fruit and Vegetable Consumption within the EU: Potential Health Benefits. *Food Res Intl*, 2000; 33: 211-217. DOI: 10.1016/S0963-9969(00)00036-3

[6] Herrera E, Jimenez R, Aruoma OI et al. Aspects of antioxidant foods and supplements in health and disease. *Nutri Rev*, 2009; 67: S140-S144. DOI: 10.1111/j.1753-4887.2009. 00177.x

[7] Mullie P, Clarys P. Association between Cardiovascular Disease Risk Factor Knowledge and Lifestyle. *Food Nutr Sci*, 2011; 2: 1048-1053. DOI: 10.4236/fns.2011.210140

[8] Prior RL, Cao G. Antioxidant Phytochemicals in Fruit and Vegetables: Diet and Health Implications. *HortSci*, 2000; 35: 588-592.

[9] Hyson D. The Health Benefits of Fruit and Vegetables: A Scientific Overview for Health Professionals. Wilmington, DE: Produce for Better Health Foundation, 2002.

[10] Golberg G. Plants: diet and health the Report of a British

Nutrition Foundation Task Force. Blackwell Science: Oxford, UK, 2003; 152-163.

[11] IFAVA. Fruit, Vegetables and Health: A Scientific Overview, 2006.

[12] Keatinge JDH, Waliyar F, Jammadass RH et al. Re-Learning Old Lessons for the Future of Food: By Bread Alone No Longer-Diversifying Diets with Fruit and Vegetables. *Crop Sci*, 2010; 50: 51-62. DOI: 10.2135/cropsci2009.09.0528

[13] Dias JS. World Importance, Marketing and Trading of Vegetables. *Acta Horti*, 2011; 921: 153-169. DOI: 10.17660/ActaHortic.2011.921.18

[14] David AVA, Arulmoli R, Parasuraman S. Overviews of biological importance of quercetin: a bioactive flavonoid. *Pharmacogn Rev*, 2016; 10: 84-89. DOI: 10.4103/0973-7847.194044

[15] Enogieru AB, Haylett W, Hiss DC et al. Rutin as a potent antioxidant: implications for neurodegenerative disorders. *Oxid Med Cell Longev*, 2018; 2018: 6241017. DOI: 10.1155/2018/6241017

[16] McGuire S. US department of agriculture and US department of health and human services, dietary guidelines for Americans, 2010. Washington, DC: US government printing office, January 2011. *Adv Nutr*, 2011; 2: 293-294. DOI: 10.3945/an.111.000430

[17] Cömert ED, Mogol BA, Gökmen V. Relationship between color and antioxidant capacity of fruits and vegetables. *Curr Res Food Sci*, 2020; 2: 1-10. DOI: 10.1016/j.crfs.2019.11.001

[18] Weaver C, Marr ET. White Vegetables: A Forgotten Source of Nutrients: Purdue Roundtable Executive Summary. American Society for Nutrition. *Adv Nutr*, 2013; 4: 318S-326S. DOI: 10.3945/an.112.003566

[19] Wang X, Pasqua AJD, Govind S. Selective depletion of mutant p53 by cancer hemopreventive isothiocyanates and their structure-activity relationships. *J Med Chem*, 2011; 54: 809-816. DOI: 10.1021/jm101199t

[20] FAOSTAT. Production/Crops, Quantities by Country for Cauliflowers and Broccoli for 2016. Food and Agricultural Organization of the United Nations, Statistics Division, 2016.

[21] Baloch AB, Xiaodong X, Saghir AS. Proximate and mineral compositions of dried cauliflower (Brassica Oleracea L.) grown in Sindh, Pakistan. *J Food Nutri Res*, 2015; 3: 213-219. DOI: 10.12691/jfnr-3-3-14

[22] Ahmed FA, Ali RFM. Bioactive compounds and antioxidant activity of fresh and processed white cauliflower. *BioMed Res Int*, 2013; 2013: 367819. DOI: 10.1155/2013/367819

[23] Ogbede SC, Saidu AN, Kabiru AY et al. Nutrient and anti-nutrient compositions of Brassica oleracae Var. Capitata L. *IOSR J Pharmacy*, 2015; 3: 19-25.

[24] Kowsalya S, Mohandas S. Acceptability and nutrient profile of cauliflower leaves (Brassica oleraceae var Botrytis). *Ind J Nutrit Dietetics*, 1999; 36: 332-338.

[25] World Health Organization. Requirements of Vitamin A, Iron, Folate, and Vitamin B12: Report of a Joint FAO/WHO Expert Consultation. Food & Agriculture Org: Rome, Itlay, 1988.

[26] Murillo G, Mehta RG. Cruciferous vegetables and cancer prevention. *Nutr Cancer*, 2001; 41: 17-28. DOI: 10.1080/01635581.2001.9680607

[27] Singletary K, MacDonald C. Inhibition of benzo[a]pyrene- and 1,6-dinitropyrene-DNA adduct formation in human mammary epithelial cells bydibenzoylmethane and sulforaphane. *Cancer Lett*, 2000; 155: 47-54. DOI: 10.1016/S0304-3835(00)00412-2

[28] Cavalieri EL, Rogan EG. Depurinating estrogen-DNA adducts in the etiology and prevention of breast and other human cancers. *Future Oncol*, 2010; 6: 75-91. DOI: 10.2217/fon.09.137

[29] Madureira DJ, Weiss FT, Van Midwoud P et al. Systems toxicology approach to understand the kinetics of benzo(a) pyrene uptake, biotransformation, and DNA adduct formation in a liver cell model. *Chem Rese Toxicolo*, 2014; 27: 443-453. DOI: 10.1021/tx400446q

[30] Zhang Y, Talalay P, Cho CG et al. A major inducer of anticarcinogenic protective enzymes from broccoli: Isolation and elucidation of structure. *Proc Natl Acad Sci USA*, 1992; 89: 2399-2403. DOI: 10.1073/pnas.89.6.2399

[31] Li L, Luo Y, Lu M et al. Cruciferous vegetable consumption and the risk of pancreatic cancer: a meta-analysis. *World J Surg Oncol*, 2015; 13: 1-8. DOI: 10.1186/s12957-015-0454-4

[32] Schagen SK, Zampeli VA, Makrantonaki E et al. Discovering the link between nutrition and skin aging. *Dermato-endocrinol*, 2012; 4: 298-307. DOI: 10.4161/derm.22876

[33] Ohsaki Y, Shirakawa H, Miura A et al. Vitamin K suppresses the lipopolysaccharide-induced expression of inflammatory cytokines in cultured macrophage-like cells via the inhibition of the activation of nuclear factor κB through the repression of IKKα/β phosphorylation. *J Nutr Biochem*, 2010; 21: 1120-126. DOI: 10.1016/j.jnutbio.2009.09.011

[34] Shea MK, Booth SL, Massaro JM et al. Vitamin K and vitamin D status: associations with inflammatory markers in the Framingham Offspring Study. *Am J Epidemiol,* 2008; 167: 313-320. DOI: 10.1093/aje/kwm306

[35] Ebadi M. Regulation and function of pyridoxal phosphate in CNS. *Neurochem Int*, 1981; 3: 181-205. DOI: 10.1016/0197-0186(81)90001-2

[36] Lehmann M, Regland B, Blennow K et al. Vitamin B12-B6-folate treatment improves blood-brain barrier function in patients with hyperhomocysteinaemia and mild cognitive impairment. *Dement Geriatr Cogn Disord*, 2003; 16: 145-150. DOI: 10.1159/000071002

[37] Huzaifa U, Labaran AB. Bello AU et al. Phytochemical screening of aqueous extract of garlic (allium sativum) bulbs. *Rep Opin*, 2014; 6: 1-4.

[38] Ozturk M, Gucel S, Altay V et al. Alliums, an underutilized genetic resource in the east Mediterranean. *Acta Hortic*, 2012; 969: 303-309. DOI: 10.17660/ActaHortic.2012.969.39

[39] Macrae R, Robinson RK, Sadler MJ. Encyclopedia of food science, food technology and nutrition, 2nd ed. Academic Press: London, UK, 2002; 3358-3362.

[40] Purseglove JW. Tropical crops: Monocotyledons. 1st ed. Longman group Limited: London, UK, 1972; 52-54.

[41] Islam D, Lina NN, Roy RK et al. Relative proximate composition and mineral analysis of three garlic varieties available in Bangladesh. *Eur J Med Plants*, 2020; 31: 1-9.

[42] Otunola GA, Oloyede OB, Oladiji AT et al. Comparative

analysis of the chemical composition of three spices-Allium sativum L. Zingiber officinale Rosc. and Capsicum frutescens L. commonly consumed in Nigeria. *Afr J Biotechn*, 2010; 9: 6927-6931. DOI: 10.5897/AJB10.183

[43] Mariam MBB, Devi UC. Chemical and shelf-life analysis of dry garlic powder: A golden herb. *Int J Agric Food Sci Technol*, 2016; 7: 1-6.

[44] Tattelman E. Health effects of garlic. *Am Fam Physician*, 2005; 72: 103-106.

[45] Lawson LD. Garlic: a review of its medicinal effects and indicated active compounds. In: Lawson LD, Bauer R, eds. Phytomedicines of Europe: Chemistry and Biological Activity. American Chemical Society: Washington D. C. , USA, 1998; 176-209. DOI: 10.1021/bk-1998-0691.ch014

[46] Murray MT. The healing power of herbs: the enlightened person's guide to the wonders of medicinal plants, 2d ed. Prima: Rocklin, CA, 1995.

[47] Mansell P, Reckless JP. Garlic. *BMJ-Brit Med J*, 1991; 303: 379-380. DOI: 10.1136/bmj.303.6799.379

[48] Gebreyohannes G, Gebreyohannes M. Medicinal values of garlic: A review. *Int J Med Med Sci*, 2013; 5: 401-408.

[49] Block E. The chemistry of garlic and onions. *Sci Am*, 1985; 252: 114-119.

[50] Neil HAW, Silagy CA, Lancaster T et al. Garlic powder in the treatment of moderate hyperlipidaemia: a controlled trial and metanalyses. *J R Coll Physicians Lond*, 1996; 30: 329-334.

[51] Isaacsohn JL, Moser M, Stein EA et al. Garlic powder and plasma lipids and lipoproteins: a multicenter, randomized, placebo-controlled trial. *Arch Intern Med*, 1998; 158: 1189-1194. DOI: 10.1001/archinte.158.11.1189

[52] Stevinson C, Pittler MH, Ernst E. Garlic for treating hypercholesterolemia. A meta-analysis of randomized clinical trials. *Ann Intern Med*, 2000; 133: 420-429. DOI: 10.7326/0003-4819-133-6-200009190-00009

[53] Ackermann RT, Mulrow CD, Ramirez G et al. Garlic shows promise for improving some cardiovascular risk factors. *Arch Intern Med*, 2001; 161: 813-824. DOI: 10.1001/archinte.161.6.813

[54] Torok B, Belagyi J, RietzB et al. Effectiveness of garlic on the radical activity in radical generating systems. *Arzneimittel-Forsch*, 1994; 44: 608-611.

[55] Bordia A. Effect of garlic on blood lipids in patients with coronary heart disease. *Am J Clin Nutr*, 1981; 34: 2100-2103.

[56] Allison GL, Lowe GM, Rahman K. Aged garlic extract inhibits platelet activation by increasing intracellular cAMP and reducing the interaction of GPIIb/IIIa receptor with fibrinogen. *Life Sci*, 2012; 91(25-26): 1275-1280. DOI: 10.1016/j.lfs.2012.09.019

[57] Sumiyoshi H, Wargovich MJ. Chemoprevention of 1,2-dimethylhydrazine-rnduced colon cancer in mice by naturally occurring organosulfur compounds. *Cancer Res*, 1990; 50: 5084-5087.

[58] Chan JYY, Yuen AC, Chan RY et al. A review of the cardiovascular benefits and antioxidant properties of allicin. *Phytother Res*, 2013; 27: 637-646. DOI: 10.1002/ptr.4796

[59] Rashid A, Khan HH. The mechanism of hypotensive effect of garlic extract. *J Pak Med Assoc*, 1985; 35: 357-362.

[60] Capasso A. Antioxidant action and therapeutic efficacy of Allium sativum L. *Molecules*, 2013; 18: 690-700. DOI: 10.3390/molecules18010690

[61] Kweon S, Park KA, Choi H. Chemopreventive effect of garlicpowder diet in diethylnitrosamineinduced rat hepatocarcinogenesis. *Life Sci*, 2003; 73: 2515-2526. DOI: 10.1016/S0024-3205(03)00660-X

[62] Knowles LM, Milner JA. Diallyl disulfide induces ERK phosphorylation and alters gene expression profiles in human colon tumor cells. *J Nutr*, 2003; 133: 2901-2906. DOI: 10.1093/jn/133.9.2901

[63] Hsing AW, Chokkalingam AP, Gao YT et al. Allium vegetables and risk of prostate cancer: a populat~onbased study. *J Natl Cancer Inst*, 2002; 94: 1648-1651. DOI: 10.1093/jnci/94.21.1648

[64] Lau BH, Woolley JL, Marsh CL et al. Superiority of intralesional immunotherapy with Corynebacterium parvum and Allium sativum in control of murine transitional cell carcinoma. *J Urol*, 1986; 136: 701-705. DOI: 10.1016/S0022-5347(17)45031-2

[65] Amagase H, Milner JA. Impact of varioussources of garlic and their constituents on 7,12- dimethylbenz[a]anthracene binding to mammary cell DNA. *Carcinogenesis*, 1993; 14: 1627-1631. DOI: 10.1093/carcin/14.8.1627

[66] Wattenberg LW, Sparnins VL, Barany G. Inhibition of N-nitrosodiethylamine carcinogenesis in mice by naturally occurring organosulfur compounds and monoterpenes. *Cancer Res*, 1989; 49: 2689-2692.

[67] Sparnins VL, Mott AW, Barany G. Effects of allyl methyl trisulfide onglutathione S-transferase activity and BP-induced neoplasia in the mouse. *Nutr Cancer*, 1986; 8: 211-215. DOI: 10.1080/01635588609513895

[68] Nishino H, IwashimaA, Isaura Y et al. Antitumorpromoting activity of garlic extracts. *Oncology*, 1986; 46: 277-280. DOI: 10.1159/000226731

[69] Weber ND, Andersen DO, North JA et al. In vitro virucidal effects of Allium sativum (garlic) extract and compounds. *Planta Med*, 1992; 58: 417-423. DOI: 10.1055/s-2006-961504

[70] Adler BB, Bechet LR. Death of Salmonella, Escherichia coli0157:H7, and Listeria monocytogenes in garlic butteras affected bystorage temperature. *J Food Prot*, 2002; 65: 1976-1980.

[71] Johnson MG, Vaughn RH. Death of Escherichia coli in the presence of freshly reconstituted dehydrated garlic and onion. *Appl Microbiol*, 1969; 17: 903-905.

[72] Jezowa L, Rafinski T, Wrocinski T. Investigations on the antibiotic activity of Allium sativum L. *Herba Pol*, 1966; 12: 3-13.

[73] Sharma VD, Sethi MS, Kumar A et al. Antibacterial property of Allium sativum Linn.: in vivo & in vitro studies. *Indian J Exp Biol*, 1977; 15: 466-468.

[74] De Witt JC, Notermans S, Gorin N et al. Effect of garlic oil or onion oil on toxin production by Clostridium botulinum in meat slurry. *J Food Protect*, 1979; 42: 222-224.

[75] Delaha EC, Garagusi VF. Inhibition of mycobacteria by garlic extracts (Allium sativum). *Antimicrob Agents Ch*, 1985; 27: 485-486. DOI: 10.1128/AAC.27.4.485

[76] O'Gara EA, Hill DJ, Maslin DJ. Activities of garlic oil, garlic powder, and their diallylconstituents against Helicobacter pylori. *Appl Environ Microbiol*, 2000; 66: 2269-2273. DOI: 10.1128/AEM.66.5.2269-2273.2000

[77] Panda MK, Tayung K. Documentation and ethnomedical knowledge on wild edible mushrooms among ethnic tribes of Northern Odisha, India. *Asian J Pharm Clini Res*, 2015; 8:139 -143.

[78] Hussein J, Tibuhwa DD. Edible mushroom in Tanzania: enlightening human health and improved livelihood. *Int Res J Biol Sci*, 2020; 9: 33-39.

[79] Kinge TR, Goldman G, Jacobs A et al. A first checklist of macrofungi for South Africa. *MycoKeys*, 2020; 63: 1-48. DOI: 10.3897/mycokeys.63.36566

[80] Manjunathan J, Subbulakshmi N, Shanmugapriya R et al. Proximate and mineral composition of four edible mushroom species from South India. *Int J Biodive Consern*, 2011; 3: 386-388. DOI: 10.5897/IJBC.9000117

[81] Okoro IO, Achuba FI. Proximate and mineral analysis of some wild edible mushrooms. *Afr J Biotech*, 2011; 11: 7720-7724. DOI: 10.5897/AJB11.590

[82] Adejumo TO, Awosanya OB. Proximate and mineral composition of four edible mushroom species from South Western Nigeria. *Afr J Biotech*, 2005; 4: 1084-1088.

[83] Jiskani MM. Energy potential of mushrooms. *DAWN Econ Bus Rev*, 2001; 4: 15-21.

[84] Ogundana SK, Fagade O. The nutritive value of some Nigerian edible mushrooms. In: Mushroom Science XI, Proceedings of the Eleventh International Scientific Congress on the Cultivation of Edible Fungi, Australia, 1981, 123-131.

[85] Samsudin NIP, Abdullah N. Edible mushrooms from Malaysia; a literature review on their nutritional and medicinal properties. *Int Food Res J*, 2019; 26: 11-31.

[86] Feeney MJ, Dwyer J, Hasler-Lewis CM et al. Mushrooms and health summit proceedings. *The J Nutri*, 2014; 144: 1128S-1136S. DOI: 10.3945/ jn.114.190728

[87] Mallikarjuna SE, Ranjini A, Haware DJ et al. Mineral composition of four edible mushrooms. *J Che*, 2013; 2013: 1-5. DOI: 10.1155/ 2013/805284

[88] Buigut SK. Mushroom production in sustainable small-scale farming system-opportunities and constraints: a survey of Uasin Gishu district. In: Proceedings of the Holticulture seminar on Sustainable Horticultural Production in the Tropics at Jomo Kenyatta University of Agriculture & Technology, Juja, Kenya, 3-6 October 2001.

[89] Kayode RMO, Olakulehin TF, Adedeji BS et al. Evaluation of amino acid and fatty acid profiles of commercially cultivated oyster mushroom (Pleurotussajor-caju) grown on gmelina wood waste. *Nigeri Food J*, 2015; 33: 18-21. DOI: 10.1016/j.nifoj.2015.04.001

[90] Han NS, Ahmad WANW, Ishak WRW. Quality characteristics of Pleurotussajor-caju powder: Study on nutritional compositions, functional properties and storage stability. *Sains Malays*, 2016; 45: 1617-1623.

[91] Kalaras MD, Beelman RB, Elias RJ. Effects of postharvest pulsed UV light treatment of white button mushrooms (Agaricusbisporus) on vitamin D2 content and quality attributes. *J Agri Food Che*, 2012; 60: 220-225. DOI: 10.1021/jf203825e

[92] Chang ST, Buswell JA. Mushroom Nutriceuticals. *World J Microbio Biotech*, 1996; 12: 473-476. DOI: 10.1007/BF00419460

[93] Manjunathan J, Kaviyarasan V. Nutrient composition in wild and cultivated edible mushroom, Lentinus tuberregium (Fr.) Tamil Nadu, India. *Int Food Res J*, 2011; 18: 809-811.

[94] Leo VV, Passari AK, Mishra VK et al. Antimicrobial potential, identification and phylogenetic affiliation of wild mushrooms from two sub-tropical semi-evergreen Indian Forest ecosystems. *PLoS One*, 2016; 11: e0166368. DOI: 10.1371/journal.pone.0166368

[95] Ma G, Yang W, Zhao L et al. A critical review on the health promoting effects of mushrooms nutraceuticals. *Food Sci Hum Well*, 2018; 7: 125-133. DOI: 10.1016/j.fshw.2018.05.002

[96] Patel S, Goyal A. Recent developments in mushrooms as anticancer therapeutics: a review. 2012; 2: 1-15. DOI: 10.1007/s13205-011-0036-2

[97] Chang ST, Wasser SP. The role of culinary-medicinal mushrooms on human welfare with a pyramid model for human health. 2012; 14: 95-134. DOI: 10.1615/IntJMedMushr.v14.i2.10

[98] Zhang L, Fan C, Liu S et al. Chemical composition and antitumor activity of polysaccharide from. 2011; 5: 1251-1260. DOI: 10.5897/JMPR.9000346

[99] Finimundy TC, Gambato G, Fontana R et al. Aqueous extracts of and Pleurotus-exhibit high antioxidant capability and promising antitumor activity. 2013; 33: 76-84. DOI: 10.1016/j.nutres.2012.11.005

[100] Chen J, Seviour R. Medicinal importance of fungal -(1→3), (1→6)-glucans. 2007; 11: 635-652. DOI: 10.1016/j.mycres.2007.02.011

[101] Valverde ME, Hernández-Pérez T, Paredes-López O. Edible mushrooms: improving human health and promoting quality life. *Int J Microbiol*, 2015; 99: 376387. DOI: 10.1155/2015/376387

[102] JE Bradshaw ed. Roots and tubers. Springer: London, UK, 2010.

[103] Williams ET, Danladi NN, Timothy N. Phytochemical, elemental, proximate and anti- nutrients composition of Irish potato (Solanum tuberosum) obtained in Kwaja, Mubi south local government area of Adamawa state. *Int J Innova Sci EngTech*, 2020; 7: 258-268.

[105] Abong GO, Okoth MW, Karuri EG et al. Nutrient contents of raw and processed products from Kenyan potato cultivars. *J Appl Biosci*, 2009; 16: 877-886.

[106] Tan DPC. Proximate analysis of fibre, protein, lipid and carbohydrate in potatoes (Solanum Tuberosum). Universiti Malaysia Sabah: Negeri Sabah, Malaysia, 2007.

[107] Fernandes G, Velangi A, Wolever TMS. Glycemic Index of Potatoes Commonly Consumed in North America. *J Am Diete Assoc*, 2005; 105: 557-562. DOI: 10.1016/j.jada.2005.01.003

[108] Raben A, Tagliabue A, Christensen NJ et al. Resistant Starch: The Effect on Postprandial Glycemia, Hormonal Response, and Satiety. *Am J Clin Nutri*, 1994; 60: 544-551. DOI: 10.1093/ajcn/60.4.544

[109] Cummings JHE, Beatty R, Kingman SM et al. Digestion and Physiological Properties of Resistant Starch in the Human Large Bowel. *Brit J Nutri*, 1996; 75: 733-747. DOI:10.1079/BJN19960177

[110] Hylla S, Gostner A, Dusel DG. Effects of Resistant Starch on the Colon in Healthy Volunteers: Possible Implications for Cancer Prevention. *Am J Clin Nutri*, 1998; 67: 136-142. DOI: 10.1093/ajcn/67.1.136

[111] Englyst HN, Kingman SM, Cummings JH. Classification and Measurement of Nutritionally Important Starch Fractions. *Europ J Clinl Nutrit*, 1992; 46: S33-S50.

[112] Okeyo JA, Kushad MM. Composition of Four Potato Cultivars in Relation to Cold Storage and Reconditioning. *Hort Tech*, 1995; 5: 250-253.

[113] Friedman M. Nutricional Value of Proteins from Different Food Sources: A Review. *J Agri Food Chem*, 1996; 44: 6-29. DOI: 10.1021/jf9400167

[114] McCay CM, McCay JB, Smith O. Nutritive Value of Potato. In: Talburt WF, Smith O ed. Potato Processing, Westport: Connecticut, USA, 1987; 287-331.

[115] Lachman J, Hamouz JK, Orsak M et al. Potato Tubers as a Significant Source of Antioxidants in Human Nutrition. *Rostlinná Výroba*, 2000; 46: 231-236.

[116] DjujicI, Djuric B, Trajkovic L. Dietary Intake of Selenium in Serbia: Confrence Selenium. Nauc Skup Srp Akad Nauk Umet, 1995; 81-87.

[117] Brown CR. Breeding for phytonutrient enhancement of potato. *Am J Potato Res*, 2008; 85: 298-307. DOI: 10.1007/s12230-008-9028-0

[118] Liu RH. Health-promoting components of fruits and vegetables in the diet. *Adv Nutr*, 2013; 4: 384S-392S. DOI: 10.3945/an.112.003517

[119] Reeve RM, Hautala E, Weaver ML. Anatomy and Compositional Variation within Potatoes II. Phenolics, Enzymes and Other Minor Components. *Am J Potato Res*, 1969; 46: 374-386. DOI:10.1007/BF02869558

[120] Thomas P, Joshi MR. Prevention of After-Cooking Darkening of Irradiated Potatoes. *Potato Res*, 1977; 20: 77-84. DOI: 10.1007/BF02362302

[121] Friedman M. Chemistry, Biochemistry and Detary Role of Potato Polyphenols: A Review. *J Agri Food Che*, 1997; 45: 1523-1540. DOI:10.1021/jf960900s

[122] Al-Saikhan MS, Howard LR, Miller JC. Antioxidant Activity and Total Phenolics in Different Genotypes of Potato (Solanum tuberosum, L.). *J Food Sci*, 1995; 60: 341-344. DOI: 10.1111/j.1365-2621.1995.tb05668.x

[123] Hasegawa D, Johnson RM, Gould WA. Changes during Storage, Effect of Cold Storage on Chlorogenic Acid Content of Potatoes. *J Agr Food Che*, 1996; 14: 165-169. DOI:10.1021/jf60144a020

[124] Subrahmanyam M. Honey dressing versus boiled potato peel in the treatment of burns: a prospective randomized study. *Burns*, 1996; 22: 491-493. DOI: 10.1016/0305-4179(96)00007-1

[125] Dattatreya RM, Nuijen S, Swaaij AC et al. Evaluation of boiled potato peel as a wound dressing. *Burns*, 1991; 17: 323-328. DOI: 10.1016/0305-4179(91)90049-M

[126] Keswani MH, Vartak AM, Patil A et al. Histological and bacteriological studies of burn wounds treated with boiled potato peel dressings. *Burns*, 1990; 16: 137-143. DOI: 10.1016/0305-4179(90)90175-V

[127] Tsao R. Phytochemical profiles of potato and their roles in human health and wellness. *Food*, 2009; 3: 125-135.

[128] Akyol H, Riciputi Y, Capanoglu E et al. Phenolic Compounds in the Potato and Its Byproducts: An Overview. *Int J Mol Sci*, 2016; 17: 835. DOI: 10.3390/ijms17060835.

[129] McGill CR, Kurilich AC, Davignon J. The role of potatoes and potato components in cardiometabolic health: A review. *Ann Med*, 2013; 45: 467-473. DOI: 10.3109/07853890.2013.813633

[130] Das N, Mukherjee M. Cultivation of Pleurotus ostreatus on weed plants. *Bioresource Technol*, 2007; 98: 2723-2726. DOI: 10.1016/j.biortech.2006.09.061

[131] Fernandes F, Valentão P, Sousa C et al. Chemical and antioxidative assessment of dietary turnip (brassica rapa var. rapa L.). *Food Chem*, 2007; 105: 1003-1010.

[132] PaulS, Geng CA, Yang TH et al. Phytochemical and health-beneficial progress of turnip (brassica rapa). *J Food Sci*, 2019; 84: 19-30. DOI: 10.1111/1750-3841.14417

[133] Nayik GA, Gull A ed. Antioxidants in Vegetables and Nuts-Properties and Health Benefits. Springer Nature Ltd, 2020.

[134] Lepage M. Identification and composition of turnip root lipids. Lipids, 1967; 2: 244-250. DOI: 10.1007/BF02532563

[135] Azam A, Khan I, Mahmood A et al. Yield, chemical composition and nutritional quality responses of carrot, radish and turnip to elevated atmospheric carbon dioxide. *J Sci Food Agr*, 2013; 93: 3237-3244. DOI: 10.1002/jsfa.6165

[136] Yadav K, Dubey RP. Management of micronutrient deficiencies in adolescent girls: An interventional approach. *Plant Arch*, 2017; 17: 973-976.

[137] Saeed MK, Anjum S, Ahmad I et al. Nutritional Facts and Free Radical Scavenging Activity of Turnip (Brassica rapa) From Pakistan. *World Appl Sci J*, 2012; 19: 370-375, DOI: 10.5829/idosi.wasj.2012.19.03.691

[138] Sheikh SA, Shar AS, Panhwar AA et al. Effect of processing treatments on the nutritive composition and consumer acceptance of red and white turnip vegetables with green tops. *Pak J Agr Engg Vet Sci*, 2018; 34: 31-39.

[139] Hong E, Kim GH. Anticancer and antimicrobial activities of BETA-phenylethyl isothiocyanate in Brassica rapa L. *Food Sci Techn Res*, 2008; 14: 377-382. DOI: 10.3136/fstr.14.377

[140] Xue YL, Han HT, Liu CJ et al. Multivariate analyses of the volatile components in fresh and dried turnip (Brassica rapa L.) chips via HS-SPME-GC-MS. *J Food Sci Tech*, 2020; 57: 3390-3399. DOI: 10.1007/s13197-020-04372-y

[141] Taveira M, Fernandes F, Guedes de Pinho P et al. Evolution of Brassica rapa var. rapa L. volatile composition by HS-SPME and GC/IT-MS. *Microchem J*, 2009; 93: 140-146. DOI: 10.1016/j.microc.2009.05.011

[142] Sousa C, Taveira M, Valentao P et al. Inflorescences of Brassicacea species as source of bioactive compounds: a comparative study. *Food Chem*, 2008; 110: 953-691. DOI: 10.1016/j.foodchem.2008.02.087

[143] Kim YH, Kim YW, Oh YJ et al. Protective effect of the ethanol

extract of the roots of Brassica rapa on cisplatin-induced nephrotoxicity in LLC-PK1 cells and rats. *Biol Pharm Bull*, 2006; 29: 2436-2441. DOI: 10.1248/bpb.29.2436

[144] Foster S, Duke JA. A Field Guide to Medicinal Plants. Eastern and Central North America. The Peterson field guide series (USA), 1990.

[145] Allardice P. A-Z of Companion Planting. Cassell Publishers Ltd, 1993.

[146] Choudhary K, Singh M, Pillai U. Ethnobotanical Survey of Rajasthan-An Update. *Am-Eurasi J Bot*, 2008; 54:1342-1346. DOI: 10.1021/jf052629x

[147] Higdon JV, Delage B, Williams DE et al. Cruciferous vegetables and human cancer risk: epidemiologic evidence and mechanistic basis. *Pharmacol Res*, 2007; 55: 224-36. DOI: 10.1016/j.phrs.2007.01.009

[148] Wu X, Zhou QH, Xu K. Are isothiocyanates potential anti-cancer drugs? *Acta Pharmacol Sin*, 2009; 30: 501-512. DOI: 10.1038/aps.2009.50

[149] El-Sherbeny SE, Hendawy SF, Youssef AA et al. Response of turnip (Brassica rapa) plants to minerals or organic fertilizers treatments. *J Appl Sci Res*, 2012; 8: 628-634.

[150] Rahman MS, Jahan N, Khatun M et al. Chemical and biological assays of Brassica rapa subsp. chinensis (L.) Hanelt. *Bangl J Bot*, 2018; 44: 327-332. DOI: 10.3329/bjb.v44i2.38525

[151] Xie Y, Jiang S, Su D et al. Composition analysis and anti-hypoxia activity of polysaccharide from Brassica rapa L. *Int J Biol Macromol*, 2010; 47: 528-533. DOI: 10.1016/j.ijbiomac.2010.07.008

[152] Chu B, Chen C, Li J et al. Effects of Tibetan turnip (Brassica rapa L.) on promoting hypoxia-tolerance in healthy humans. *J Ethnopharmacol*, 2017; 195: 246-254. DOI:10.1016/j.jep.2016.11.028

[153] Li Y, Han J, Chen Y et al. *p*-Coumaric acid as a prophylactic measure against normobaric hypoxiainduced pulmonary edema in mice. *Life Sci*, 2018; 211: 215-223. DOI: 10.1016/j.lfs.2018.09.039

[154] Li Y, Han J, Zhang Y et al. Prophylactic effect and mechanism of p-coumaric acid against hypoxic cerebral edema in mice. *Respir Physiol Neurobiol*, 2019; 260: 95-104. DOI: 10.1016/j.resp.2018.11.004

[155] Jung UJ, Baek NI, Chung HG et al. Effects of the ethanol extract of the roots of Brassica rapa on glucose and lipid metabolism in C57BL/KsJ-db/db mice. *Clin Nutr*, 2008; 27: 158-67. DOI: 10.1016/J.CLNU.2007.09.009

[156] Beltagy AM. Investigation of new antimicrobial and antioxidant activities of Brassica rapa. L. *Int J Pharm Pharm Sci*, 2014; 6: 19-25.

[157] Javed A, Ahmad A, Nouman M, et al. Turnip (Brassica Rapus L.): a natural health tonic. *Braz J Food Technol*, 2019, 22. DOI: 10.1590/1981-6723.25318