



# From Natural Compounds to Disease Treatment and Control: A Review of Nutraceuticals Vegetable Crops and their Roles in Disease Control

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## Abstract

In recent times, conventional medicine has become less accessible to more people either due to affordability or lack of well-equipped health facilities. Foods, and vegetables inclusive contain naturally occurring prophylactics and therapeutics with different means of preparation and accessibility but not enough reports are available on them to educate especially the poor masses on how to turn normal foods into potential drugs to save them a lot of time and money. Malnutrition and starvation with associated health problems have become a global threat and there is a need to review and create more awareness on possible access to naturally grown foods that are loaded with biologically potential active nutrients. Nutraceuticals are a group of biochemicals that are found in food substances and provide potential physiological benefits. This group of compounds presents little or no side effects due to their natural ability compared to synthetic products. This topic is aimed to investigate the various active nutraceuticals that are obtainable in vegetable crop plants. It will also expound on the disease prevention and health benefits as well as the enhancement of the overall human wellness potentials provided by vegetable crops and nutraceuticals.

**Keywords:** Nutraceuticals; Inflammation; Anti-cancer; Bio-enhancement; Phytonutrients.

## 1. Introduction

There are health benefits associated with diversified eating style and diets which include fruits, vegetables, legumes, whole grains, nuts, seeds and olive oil. These foods contain active phytoconstituents and nutraceutical compounds that result in low-risk potentials of developing certain chronic diseases in humans that consumes them. [1]. Vegetables are soft but edible shoot, leaves, fruits or roots of a plant which can be eaten raw or cooked. It can also be used as a food supplement. Vegetable crops can be categorized based on life cycle that is annual, biennial and perennial. They can also be classified based on the part usable. This classification is presented as below:

- a) Root: carrot, beet, turnip etc.
- b) Tuber: potatoes, taro etc.
- c) Bulb: onion, garlic, leeks etc.
- d) Leaves: spinach, mallow, fenugreek leaves, cabbage, valerian etc.
- e) Flower: broccoli, artichoke, cauliflower etc.
- f) Fruits: cucumber, okra, tomato, eggplant etc.
- g) Seed: peas, lentils, soybean etc.
- h) Stem: asparagus, celery, kohirabi etc.

Vegetable plants have formed a major part of human diet because of their safety of consumption, low calorie levels, potential therapeutic value and ability to give desired results in the provision of essential daily nutrient requirement. They are loaded with functional phyto-nutrients needed for categories of disease prevention and cure [2, 3]. Malnutrition is a concern, especially in children of developing countries and the pack of health benefits presented by vegetable crops has been under-utilized because several health problems like cancer, scurvy, hemorrhagic disorders, metabolic and digestion and cardiovascular diseases are associated with low consumption of vegetables [4-6]. Adequate exposure to vegetable diets can increasingly improve health, prevent diseases especially abnormal cellular growth and enhance growth and developmental process by varying encouraging percentages thereby abolishing malnutrition [4]. In order to make the vast of potential nutraceuticals present in vegetables more available for consumers, some bio-enhancement processes have been proposed by Parulekar, *et al.* [4]. Type 2 diabetes is very rampant lately and it has been linked to obesity and other risk factors. This is one of the diseases that confers economic burden on individuals, their families and the society at large [7-9].

There are many substances which contain vitamins, minerals and other natural compounds which when eaten or drunk are used for various therapeutic purposes. These substances are referred to as traditional medicine [10]. The first point of call in the treatment of various diseases before western medicine came was the use of different plant parts and this has proven effective against many diseases. This method is not only effective, it is affordable, easily accessible and acceptable widely among various cultural and religious settings [11, 12].

Reports from various interdisciplinary perspectives were collated by Durazzo, *et al.* [13] and the correlation between food and herbal products was published in order to have scientific clue about the potential health benefits of the food, fruits and spices that we consume daily. There is need to establish the relationship between dietary/food supplements (especially vegetables) and herbal medicinal products from various perspectives and earlier reports and that is what this research write-up is about.

## 2. What Are Nutraceuticals?

There are different compounds already recovered from food and dietary substances, some with pure mineral and developmental nutrient supply while others can deliver great health benefits. There are a group of substances recently discovered from food products that can supply both nutrient and therapeutic values, they are called 'Nutraceuticals or Bioceuticals'. This is a combination of both nutritional and pharmaceutical potential obtainable from naturally occurring biochemicals. Gupta, *et al.* [14], reported that nutraceuticals can be isolated and purified from food product but commercialized as drugs or supplements and they supply effectiveness for disease prevention and control. Nutraceuticals are of different categories based on sources and properties. For example, there are potential and established dietary fibers, probiotics, prebiotics, poly-unsaturated fats, polyphenols, vitamins and spices etc. [15, 16]. Nutraceuticals can be accessed in their crude natural forms and can also be in the fortified form. Some provide pure nutrients (micro and macro nutrients) and different types of vitamins and minerals that are aimed at targeted effects while others can be administered in the form of botanicals and phytochemical concentrates or supplements. They are reportedly used for the prevention or treatment of diseases like inflammation, obesity, cancer, heart disease and vision problems, but they are also projected as potential cure for diseases like Alzheimer's, Parkinson's, eye, immunological, diabetes, inflammatory and chronic cardiovascular diseases [9, 16-18].

Nutraceuticals are contained as functional ingredients in different food matrixes and serve as potential prophylactics. They can be consumed directly from the food or packaged as a supplement or drug in order to deliver their potential health benefits [19]. Nutraceuticals are supposedly safer to consume since they are isolated from natural sources and portray less side effects than conventional drugs. However, they can be expensive, lack good quality standard of control, less potent, encounters seasonal compositional changes and differential quality delivery [19]. Another challenge that nutraceutical product might face is that of proper pharmacokinetic/pharmacodynamic studies to ascertain their safety and mode of activities especially in human and animal cells [20]. Nutraceuticals are gaining scientific attention recently and there is an increase in research and development leading to the discovery of more nutraceuticals in food products. Although, the mechanism of actions have not been fully understood, but definitely it is easy to predict that variety of biological, physiological and genetic expression pathways are involved [9].

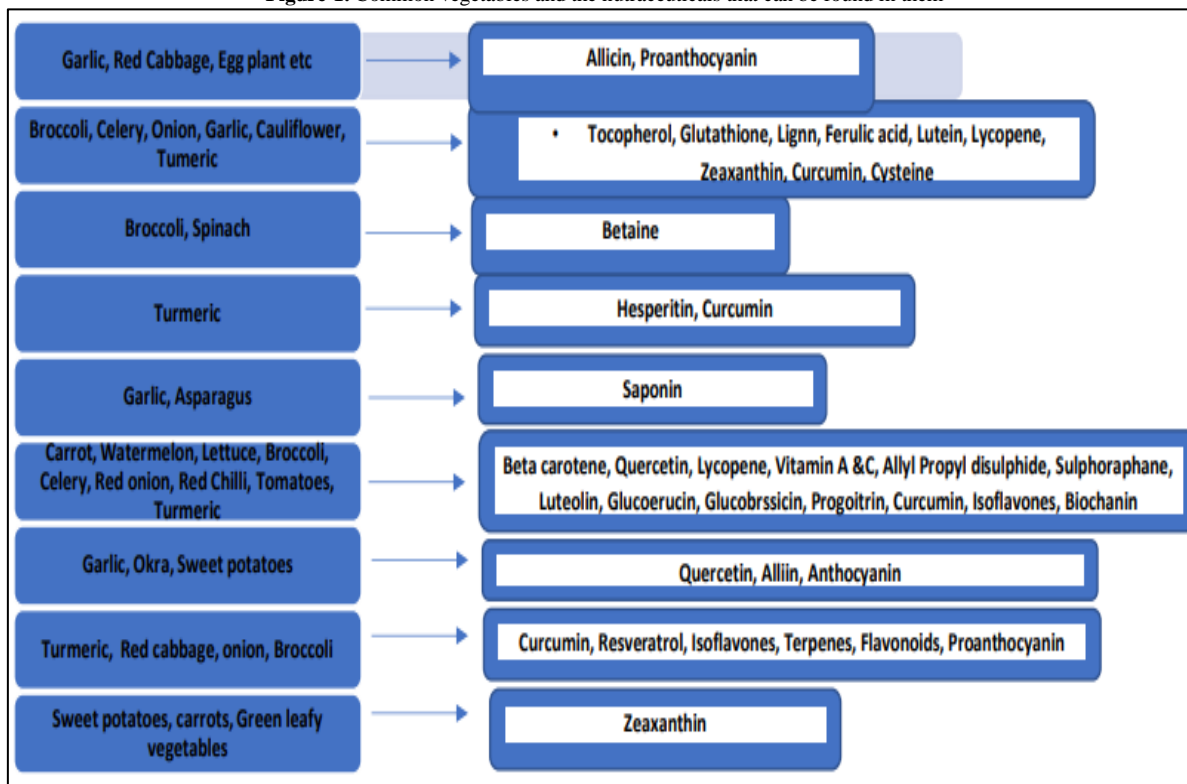
### 2.1. Various Nutraceuticals Contained in Vegetable Crops

A spicy vegetable like ginger is used all over the world to serve culinary purposes in both humans and animals and it contain phytoconstituents that makes it as an effective therapeutic agent [21]. According to Arya, *et al.* [2] and Parulekar, *et al.* [4], various phytochemical compounds with established therapeutic and nutraceutical benefits have been obtained from variety of vegetable crops and reported. Allicin, a thiosulphinates and proanthocyanin, a chemical compound isolated from garlic/onion and red cabbage or egg plants respectively have been found to serve as antimicrobial agents. Antioxidant agents include; tocopherol, glutathione, allicin, lignan and ferulic acid which can be obtained from vegetables like broccoli, celery, onion, garlic, cabbage, cauliflower, turnip etc. There are other phyto-nutrient agents like betaine which acts as an anti-toxin agent, hesperitin which is an anti-inflammatory agent, saponin for the reduction of blood cholesterol. Beta carotene, quercetin, lycopene, Vit. C, Vit. A, Allyl propyl disulfide, Luteolin, glucoerucin, Glucobrassicin, Progoitrin, Gluconasturtiin, Resveratrol, fisetin, capsaicin and sulphoraphane have anti-cancer properties and can be isolated from carrot, water melon, lettuce, broccoli, celery, red onion, red chili, spinach among others. Anti-diabetic bioceuticals include; Quercetin, Alliin and anthocyanin which are presented in garlic, okra and sweet potatoes. The following nutraceuticals are also reported; silymarin, apigenin, isoflavonoids, kaempferol, myricetin, lysine, chlorogenic acid, caffeinic acid, nasunin, progoitrin, glucoraphanin, rutin, patuletin, genistein, Daidzein, natto kinase, salicylic, oleanolic etc. which have been found to have effect against a range of human diseases. Colon cancer particularly have been found to be healed by the consumption of certain class of carotenoids such as  $\beta$ -carotene,  $\alpha$ -carotene, lycopene and oxy-carotenoids which can be found in tomatoes, carrots, bell peppers and so on. Other carotenoids like lutein, lycopene and zeaxanthin as well as phenols, lipoic acid and anthocyanins have anti-oxidative properties but phenols particularly and flavonoids have a broader range of disease curative effect [22].

Cancer prevention potentials of vegetables has gained increase attention because of the presence of nutraceuticals like curcumin (derived from a root vegetable, turmeric), carotenoids, biochanin, isoflavones, genistein, polyphenols and flavonoids [9, 23, 24]. Curcumin also has antioxidative and anti-inflammatory properties [25]. High consumption of cruciferous vegetables can help to lower the risk of certain types of cancer. Curcuminoids from turmeric also can help to modulate continuous irregular immunological inflammation and consequent pain [26]. Other compounds contained in vegetable crops and have antioxidative potentials are cysteine, glutathione, selenium

and Vit. C and E [9, 27]. Sweet potatoes, carrots, tomatoes and some leafy greens are potential sources of lutein and zeaxanthin (forms of fatty acids) which are nutraceuticals that are used for the treatment of eye disorders [28]. Natural nutraceuticals like curcumin, resveratrol, isoflavones, proanthocyanins, flavonoids, saponins, terpenes and other biomolecules have reportedly shown antiangiogenic activity by inhibiting the formation of new blood vessels that cancerous cells need to increase [29, 30].

Figure-1. Common vegetables and the nutraceuticals that can be found in them



## 2.2. Isolation and Bio-Enhancement of Potential Nutraceuticals from Vegetables

Developing countries are still finding it difficult to eradicate malnutrition especially in children. This is as a result of insufficient or exclusive access to nutrients which usually result in impeded growth and developmental process [31]. Malnutrition can result in underweight and even death, therefore, it is imperative that urgent intervention methods that can make more nutritive value of food to be accessible to the masses be employed [32]. Although, vegetables have been reported to contain rich phytochemical compounds that can provide robust health and nutrient benefits, natural bio-enhancement methods are being proposed in order to make these valuable phytoconstituents more readily and abundantly available humans. Vegetable crops can be biofortified through agronomical methods, conventional breeding methods and use of transgenic techniques [4]. Agronomic methods such as treatment of seeds or foliar/direct application with organic and inorganic manures as well as the introduction of microbial inoculants have been found to be simple and cost-effective methods that have improved the nutritional value of vegetables [33, 34]. Valuable nutraceuticals discovered from scarce varieties of plant can be isolated and incorporated into common varieties in order to produce a new but abundant variety with enhanced nutraceutical content. This can be achieved either by conventional breeding or transgenic techniques and the main focus of both methods is to develop improved crop varieties [35-37]. The conventional plant breeding approach has been found to be more sustainable and easily practiced than the transgenic method in the improvement of vegetable genetic contents but transgenic crop cultivars also provide healthy and more nutritious food crops [22].

## 2.3. Conventional and Herbal Use of Vegetable Crops Nutraceuticals

Herbal nutraceuticals are active ingredients that have effect against acute and chronic health problems that are induced by lack of adequate nutrition. They can help in the maintenance of qualitative optimal health and long-life span [38]. Herbal products have successfully served as storage means for potential remedies for the treatment of acute and chronic diseases. And these herbal medicines have nutraceuticals from vegetables and other food products as important components Dureja, *et al.* [39]. Many herbal vegetables have proven to be effective against type 2 diabetes in preclinical testing [40]. Eshaifol, *et al.* [41], have reported the potency, safety and effectiveness of nutraceuticals and herbs in the management and cure for diabetes and any possible vascular complications that might follow. The common features of nutraceuticals and herbal drugs are the fact that they have multiple target and channels property thereby delivering synergistic ability especially because one natural product will usually contain various constituents. These nutraceuticals can also be combined as a strategy to intervene in the course of various diseases including Alzheimer's disease (AD) [42].

Vegetable crops like ginger, rhubarb, garlic, turmeric, soybean, bitter melon, milk thistle, fenugreek leaves, and chili pepper have reportedly been investigated for their remarkable anti-diabetic potentials [41]. Curcumin, a naturally occurring bioactive compound present in turmeric has proven to show remarkable efficacy against COVID-19 during the pandemic [43]. Fenugreek is another herbal vegetable that has great traditional importance. It is used for wound healing, also as an aphrodisiac, lactation promoter, antidiabetic agent, hepatoprotector, antibacterial and so on. Considering its safety and potential therapeutic abilities, lot of phytochemicals and minerals that can serve as nutraceuticals have been isolated from fenugreek [44]. A review study conducted by Gharibpour, *et al.* [45] has also revealed nutraceutical compounds isolated from various vegetables have oral anti-candidal potentials considering the negative health impact that candida infection can cause. This is one of such studies to support the claim that natural bioactive compounds found in daily diets have antimicrobial effects and therefore can be incorporated into both conventional and herbal medicine [45]. Based on various records, varying nutraceuticals exist from vegetable to vegetable and from crop to crop (Table 1).

**Table-1.** A List of Vegetable Crops and the Nutraceuticals Found in Them for Medicinal Purpose

Vegetable crop	Commonname	Part used	Phyto-constituent	Therapeutic usage	Source
<i>Allium sativum</i> (Liliaceae) <i>Allium cepa L.</i> (Liliaceae)	Garlic Onion	Bulb Bulb	Alliin, Alicin, Methiin, Allyl propyl disulfide,	Anti-anxiety, anti-inflammatory, anti-diabetic, anti-bacterial, antifungal, treatment of artherosclerosis and hypertension. Anti-ageing, anti-cancer, hypotensive, fibrinolytic, anti-tumor, anti-oxidant	Baby, <i>et al.</i> [46]; Asdaq, <i>et al.</i> [47]; Risuleo and La Mesa [48]; Arya, <i>et al.</i> [2]; Parulekar, <i>et al.</i> [4]; and Dureja, <i>et al.</i> [39].
<i>Zingiber officinale</i> (Zingiberaceae)	Ginger	Rhizome	Zingiberene, gingerols	Stimulant, treatment of hyperglycemia, throat ache and chronic bronchitis, anti-inflammatory positive inotropic, treatment of dizziness. Anti-oxidant, anti-inflammatory, immunomodulatory, cardioprotective, anti-diabetic, neuroprotective	Baby, <i>et al.</i> [46]; Dureja, <i>et al.</i> [39]; Unuofin, <i>et al.</i> [49]; Srinivasan, <i>et al.</i> [21]; and Raj, <i>et al.</i> [50].
<i>Curcuma longa</i> (Zingiberaceae)	Turmeric	Rhizome	Curcumin	Prevention and treatment of inflammation, arthritis, cancer and diabetes. Anti-candidal	Baby, <i>et al.</i> [46]; Eshaifol, <i>et al.</i> [41]; Raj, <i>et al.</i> [50]; and Gharibpour, <i>et al.</i> [45].
<i>Valerianella locusta L.</i> <i>Valerianella officinalis</i> (Valerianaceae)	Valeriana	Root, Seeds, Leaves	Vit. A, B, C, Valerenic acid	Treatment of artherosclerosis and anemia, metabolic stimulant, mild sedative	Baby, <i>et al.</i> [46]; Dureja, <i>et al.</i> [39]; and Asif and Mohd [51].
<i>Cassia augustifolia</i> (Leguminosae)	Senna	Leaves	Sennosides	Purgatives	Baby, <i>et al.</i> [46].
<i>Ferula assafoetida L.</i> (Umbelliferae/Apiaceae)	assafoetida	Oleo gum resin	Ferulic acid, Umbellic acid	Stimulant, flatulence and cough relief	Baby, <i>et al.</i> [46].
<i>Daucus carota</i> (Apiaceae) <i>Curcubita spp</i> <i>Citrullus lanatus</i> (Curcubitaceae)	Carrots, pumpkins, winter squash, Watermelon.	Root Young leaves, fruit pulp and seed	Beta Carotene	Anti-ageing; anti-cancer; improvement of lung function; anti-diabetic complications	Sarvesh [52]; Ismael and Mustafa [53]; and Arya, <i>et al.</i> [2]
<i>Brassica oleracea</i> (Brassicaceae) <i>Daucus carota</i> (Apiaceae) <i>Apium graveolens</i> (Apiaceae) <i>Allium cepa</i> (Liliaceae)	Broccoli, Carrot Celery Onion	Leaves Root Leaves Root	Tocopherol	Anti-oxidant activity	Arya, <i>et al.</i> [2]; Mengpei, <i>et al.</i> [54]; and Jiyeon, <i>et al.</i> [55].
<i>Spinacea oleracea</i> (Amarathaceae) <i>Amaranthus spp</i> (Amaranthaceae)	Spinach Amaranth	Leaves Leaves	Betaine, Hesperitin, Patuletin and Spinacetin Vit. E, C, Folates	Prevention of damage to the arterial wall, blood clot and vessel blockage, anti-inflammatory, Weight loss, good eye sight Relief of constipation	Arya, <i>et al.</i> [2]; and Parulekar, <i>et al.</i> [4].
<i>Brassica oleracea var. italica, botrytis, capitata</i> (Brassicaceae)	Cruciferous vegetables (Broccoli Cauliflower Cabbage)	Stem, leaves and vegetative buds	Glutathione	Anti-oxidant, immune system boost	Arya, <i>et al.</i> [2]; and Raj, <i>et al.</i> [50].
<i>Allium cepa</i> (Liliaceae) <i>Brassica oleracea</i> <i>Brassica oleracea var.</i>	Onion Broccoli, Cabbage Lettuce,	Bulb Leaves Leaves Leaves	Quercetin	Treatment of Alzheimer's disease, anti-cancer, anti-cardiovascular disease, anti-diabetes, improvement of	Arya, <i>et al.</i> [2]; Raj, <i>et al.</i> [50]; and Sowmya [56].

<i>capitata</i> <i>Lactuca sativa</i> (Asteraceae) <i>Solanum lycopersicum</i> (Solanaceae) <i>Abelmoschus esculentus</i> (Malvaceae)	Tomato Okra	Fruits Fruits		vitality, anti-inflammatory	
<i>Brassica oleracea</i> var. <i>italica</i> (Brassicaceae)	Broccoli	Leaves	Lignan, Sulphoraphane, Glucobrassicin, Progoitrin, and Gluconasturtiin	Anti-aging, anti-oxidant, anti-cancer	Rodríguez-García, <i>et al.</i> [57]; Arya, <i>et al.</i> [2]; and Parulekar, <i>et al.</i> [4].
<i>Brassica oleracea</i> var. <i>botrytis</i> (Brassicaceae) <i>Apium graveolens</i> (Apiaceae) <i>Cynara cardunculus</i> var. <i>scolymus</i> (Asteraceae)	Cauliflower Celery Artichoke	Leaves	Luteoline	Improvement of eye sight and prevention of cataract, anti-cancer of the breast, anti-oxidant	Abdel-Aal, <i>et al.</i> [58]; Parulekar, <i>et al.</i> [4]; Raj, <i>et al.</i> [50]; Jain and Ramawat [59]
<i>Brassica rapa</i> (Brassicaceae) <i>Brassica napus</i> (Brassicaceae)	Turnip Rutabaga	Green leaves	Ferulic acid Glucorucin and Glucoraphanin	Anti-oxidant against skin damage, anti-diabetic, treatment of microbial infection, Cancer and heart diseases	Arya, <i>et al.</i> [2]; Cao, <i>et al.</i> [60]; and Parulekar, <i>et al.</i> [4].
<i>Brassica oleracea</i> var. <i>capitata</i> (Brassicaceae) <i>Solanum melongena</i> (Solanaceae)	Red Cabbage Egg plant	Leaves Fruits	Proanthocyanin	Treatment of urinary tract infections, anti-oxidant	Arya, <i>et al.</i> [2]; and Qianqian, <i>et al.</i> [61].
<i>Solanum lycopersicum</i> (Solanaceae) <i>Capsicum</i> spp. (Solanaceae) <i>Solanum melongena</i> (Solanaceae)	Tomato and other Solanaceous crops	Leaves Fruits	Lycopene	Ani-Cancer, Treatment of Cardio-vascular disease and arthritis, anti-oxidant	Parulekar, <i>et al.</i> [4]; and Raj, <i>et al.</i> [50].
<i>Cynara cardunculus</i> var. <i>scolymus</i> (Asteraceae)	Artichoke	Young flower buds	Silymarin	Prevention of liver diseases	Parulekar, <i>et al.</i> [4]; and Krepkova, <i>et al.</i> [62]
<i>Cichorium intybus</i> var. <i>foliosum</i> (Asteraceae) <i>Armoracia rusticana</i> (Brassicaceae)	Endive Horse Radish	Leaves, Bulbous base Root	Kaempferol, Myricetin, Fisetin	Inhibition of Low Density Lipids, anti-oxidant, anti-cancer	Parulekar, <i>et al.</i> [4]
<i>Solanum melongena</i> (Solanaceae)	Egg plant	Fruits	Caffeic acid, Chlorogenic Acid, and Nasunin	CVD skin blemishes	Parulekar, <i>et al.</i> [4].
<i>Glycine max</i> (Fabaceae)	Soybean	Seeds	Genistein Daidzein , and Nattokinase	Reduce LDL, coronary artery plaque, anti-diabetic, osteogenetic bone protective, anti-cancer	Parulekar, <i>et al.</i> [4]; Eshaifol, <i>et al.</i> [41].
<i>Beta vulgaris</i> (Amaranthaceae)	Beet root	Leaves	Ferulic Acid Betanin	Skin disease, anti-ageing	Parulekar, <i>et al.</i> [4].
<i>Ipomoea batatas</i> (Convolvulaceae)	Sweet Potato	Root	Anthocyanin, Chlorogenic Acid	Anti-diabetic anti-obesity	Parulekar, <i>et al.</i> [4]
<i>Capsicum annuum</i> (Solanaceae)	Red Chilli	Fruits	Capsaicin	Cancer, gastritis, headache, anti-inflammatory	Parulekar, <i>et al.</i> [4]; and Raj, <i>et al.</i> [50].
<i>Asparagus officinalis</i> (Asparagaceae) <i>Capsicum annuum</i> (Solanaceae)	Asparagus Green Chilli	Fruits	Rutin	Vericose Veins	Parulekar, <i>et al.</i> [4]
<i>Musa paradisiaca</i> (Musaceae)	Plantain	Fruits	Benzoic and chlorogenic acid; citric and ferulic acid; oleanolic, Salicylic acid	Antimicrobial, anti-inflammatory, antitusive, cardiac stimulant	Parulekar, <i>et al.</i> [4].
<i>Rheum palmatum</i> (Polygonaceae) <i>Rheum officinale</i>	Rhubarb	Leaves	Rutin	Diabetic nephropathy	Eshaifol, <i>et al.</i> [41]
<i>Apium graveolens</i> (Apiaceae)	Celery	Whole plant	Butylphthalide	Used in high blood pressure	Rai, <i>et al.</i> [63].
<i>Daucus carota</i> (Apiaceae) <i>Apium graveolens</i> (Apiaceae) <i>Brassica oleracea</i> var.	Carrot Celery Kale Lettuce	Root Stem Leaves Leaves	Lutein Zeaxanthin	Used for eye health and in age-related macular degeneration	Rai, <i>et al.</i> [63].

<i>sabellica</i> (Brassicaceae) <i>Lactuca sativa</i> (Asteraceae)					
<i>Brassica oleracea</i> var. <i>italica</i> <i>Brassica oleracea</i> var. <i>capitata</i> <i>Brassica oleracea</i> var. <i>botrytis</i> <i>Brassica nigra</i> <i>Armoracia rusticana</i> <i>Brassica oleracea</i> var. <i>sabellica</i> <i>Brassica oleracea</i> var. <i>gemmifera</i>  (Brassicaceae)	broccoli, cabbage, cauliflower, mustard, horseradish, kale, brussels sprouts	Whole plant Veg. buds Stem, leaves Seeds Roots Leaves Stem, leaves	Glucosinolates (indoles and isothiocyanates)	Anti-inflammation, anti-oxidant, antimicrobial	Bischoff [64]; and Rajasekaran, <i>et al.</i> [18].
<i>Glycine max</i> (Fabaceae) <i>Cicer arietinum</i>	Soybeans, chickpea	Seeds	Saponins	Anti-cancer, lower cholesterol	Jain and Ramawat [59]
<i>Petroselinum crispum</i> (Apiaceae) <i>Solanum lycopersicum</i> (Solanaceae)	Parsley tomato	Leaves Fruits	Apigenin	Anti-depressant, anti-cancer, anti-tumor, anti-inflammatory	
<i>Trigonella foenumgraecum</i> (Fabaceae)	Fenugreek	Leaves, whole dry or powdered seed		For the treatment of gastritis, hyper-cholesterol, diabetes, malnutrition, skin inflammation	Asif and Mohd [51].

## 2.4. Breeding, Bio-Enhancement and Quantification Prospects for Beneficial Vegetables and their Nutraceuticals

There are different types of breeding approaches that are applicable for the enhancement of nutraceuticals. In conventional breeding system, screening and selection of superior genotypes, back cross and mutation breeding can be incorporated whereas in molecular breeding approaches, marker assisted selection and introduction of transgenic crops could be a potential tool to exploit the nutraceutical properties of respected crops [4]. Some biotechnological/molecular methods such as multiplication and hybridization through tissue culture, molecular breeding and other genetic engineering approaches were proposed by Rai, *et al.* [63]. Vegetable varieties with certain natural qualities like resistance to pest and diseases, high yield capacity and in this case, presence of high-quality nutraceuticals can be hybridized through conventional methods in order to enhance food security and make naturally occurring biologicals readily available to consumers. These new approaches will also expand vegetable production at all levels [4, 63]. Owing to the increase in the number of reports on the importance and health improvement potentials of nutraceuticals as well as the usage of natural plant products for nutrithrapy, the focus of green biotechnology has included the system and process of enhancing the dietary and nutritional value of crops. The naturally occurring bioactive components found in these crops are thereby enhanced in return. Many of such biotechnological procedures include the conventional breeding and artificial selection process as well as transgenic crops and genetic modification as reviewed [65].

Recently, bio stimulants are also formulated to improve the quality and productivity of plants. Bio stimulant has been found to be eco-friendly and delivers high quality crops with improved health related potentials. They are used to stimulate increased production of phytonutrients in various plant organs [66]. Though, this is a new field but it is gradually gaining ground and it has proven to be a bio-enhancement procedure for the delivery of more nutraceuticals. Other crop enhancement biotechnological procedures that have effectively led to successful development of high quality metabolites and nutraceuticals are; fermentation technology, enzyme activity through genetic engineering and recombinant DNA [51].

As reported by Bernal, *et al.* [19], there are sophisticated conventional methods and analyzing tools which include HPLC, GC, MS, NMR, FID, QTOF, ESR, ELSC, GC-MS, UV-Vis, among others that are used for the analysis, isolation and quantification of nutraceuticals from various plant and animal matrices. Particularly, vegetable oils like squalene and tocopherols, carotenoids, lycopene, saponins, anthocyanins, curcuminoids, phenolics, lignans, sulfuraphane, phaeophytines, capsaicinoids and others which are found in vegetables.

## 3. Conclusion

This reviewed article has been able to collate the categories of common and easily grown vegetables that can be used as both food and medicine. They have been found to contain important bioactive ingredients that can control nutritional problems and possibly be used as disease cure. One long standing challenge in ethnopharmacology is the issue of diverse perspective on a subject matter like this Durazzo, *et al.* [13], it is therefore important that research articles that will synergize all opinions about such human health related topics should be highly considered.

Synthetic drugs mostly contain toxic component but nutraceutical products have been found to possess he efficacy to act against the negative effects of toxic materials from synthetic drugs [67]. Nutraceuticals derived from plants are of great importance in the global healthcare system, but more efforts are needed to improve on the system of quality control. This should include all aspects like the plant material used, process of manufacturing, target clients, safety, purity and dosage. The regulatory bodies that oversee the affair of nutraceuticals should be reinforced because of the nature of the products as food-medicine materials. They have reportedly been shown to play significant roles in the advancement of human health, therefore all hands must be on deck to ensure the advancement of nutraceutical and functional foods for more effective benefits to mankind.

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