COMPARATIVE ANALYSES ON ANTIOXIDATIVE PROPERTIES OF LOCALLY FOUND LEAFY AND ROOT VEGETABLES - A REVIEW

[*1]Debasree Ghosh, [2]Baisakhi Mondal

[1]Assistant Professor, Department of Food and Nutrition
[2]M.Sc student, Department of Food and Nutrition
Barrackpore Rastraguru Surendranath College
West Bengal, India

***Abstract*: Dietary plant antioxidants have been considered beneficial to human health. Antioxidants can eliminate free radicals and prevent many health related disease. Vegetables are rich in phytochemicals. This review paper highlights the pharmacological properties of *Ipomoea sp., Colocasia sp., Beta sp., Daucus sp., B. oleracea var. capitata, B. oleracea var. italica, S. oleracea* and their medicinal values. This vegetables are beneficial in the prevention of chronic diseases through its antioxidant, anti-inflammatory, antimicrobial activities. The phytochemicals such as flavonoids, terpenoids, cyanidin, peonidin, carotenoids, polyphenols, β-cryptoxanthin, lycopene, and zeaxanthin etc. are present in high amount in these vegetables. These vegetables are economically affordable. This paper reviews on the scientific approach and pharmacological activity of these vegetables.**

Keywords: Anti-carcinogenic, Anti-inflammatory, Anti-diabetic, Anti-microbial properties, Phytochemicals, *Colocasia* sp.

INTRODUCTION

Free radicals are reactive oxygen molecules produced by the oxidation reduction process. Free radicals damage the cell and formed various diseases such as tumors, diabetes, cardiovascular disease, joint inflammation etc. [1]. Antioxidant means, "Against oxidation." Antioxidant is a substance that prevents oxidation and helps to remove free radicals and protect the body against toxic effect of free radicals [2]. Antioxidants are two groups. These are enzymatic antioxidants and non-enzymatic antioxidants. Superoxide dismutase, catalase , glutathione peroxidase are enzymatic antioxidants and vitamin C (ascorbic acid), vitamin E (tocopherol), carotenoids, flavonoids are non-enzymatic antioxidants [3,4].

Vegetables are the good source of antioxidants. Green leafy vegetables and yellow orange vegetables are rich in carotenoids and flavonoids. Mullar investigated that 22 species of vegetables like spinach, broccoli, carrot were very rich in carotenoids (over 10mg/100gm edible portion) [5].

Red beet root (*Beta vulgaris rubra*) leaves and roots are rich in phenolic compounds. Red beet root contains betalains which is nitrogen containing water soluble pigments derived from betalamic acid.Red beet roots are used for a long time for their beneficial health effects, mainly protection of kidney, liver, gut and immune systems from toxic compounds [6]. Red Cabbage (*Brassica oleracea var. capitata f. rubra*) and purple sweet potato (*Ipomoea batatas*(L.) Lam) Contain red or purple colour due to the presence of anthocyanins pigment. Anthocyanins possess antioxidant, anti-inflammatory, antimicrobial and anti-carcinogenesis properties. Different colour of the vegetables depends on the different PH of the soil. Reddish leaves cabbage grow in acidic soil, purple or red leaves grow in nutral soil and greenish yellow coloured leaves grow in alkaline soil [7, 8]. Colocasia (*Colocasia esculenta*) contain high amount of phytochemicals that are used as the base of modern drugs that cure various diseases. Colocasia have many medicinal importance due to presence of chemical components like alkaloids, glycosides, resins, volatile oils, gums, tannins etc. *Colocasia esculenta* is rich in easily digestible carbohydrates , micronutrients and vitamins (A, B complex, C) and contain antinutrient factors such as oxalate, phytate etc. [9].

AIMS AND OBJECTIVES

- The aim of this review is to find out the various antioxidative properties of vegetables like cabbage, spinach, broccoli, carrot, sweet potato, colocasia, beet-root etc.
- To gain knowledge about medicinal importance of these vegetables.
- To express the health benefits of these vegetables.

FINDINGS OF THIS STUDY

Sweet potato, colocasia, beet-root, carrot, cabbage, broccoli, spinach vegetables are represent an important part of the human diet worldwide are consumed by people all over the world. These vegetables contain phytochemicals and rich source of antioxidants. The bioactive compounds of these vegetables help to prevent many diseases. Summary of the phytochemicals properties and medicinal importance of these vegetables are described through the following tables.

Table 1. Summary of the Phytochemicals Properties of the Vegetables

Vegetables name	Scientific name	Nomenclature	Phytochemical properties
Sweet potato	*Ipomoea batatas (L.)Lam*	Kingdom: Plantae Division: Magnoliophyta Class: Magnoliopsida Order: Solanales Family: Convolvulaceae Genus*: Ipomoea* Species*: I. batatas*	The major phytochemicals that are present in sweet potato are flavonoids, terpenoids, tannins, saponins, glycosides, alkaloids, steroids and phenolic acids.[10] Some phytochemicals are responsible for the colour variation of sweet potato such as orange varieties are rich in Beta carotene and anthocyanins are responsible for the red, purple and blue pigments. Peonidin and cyanidin are example of anthocyanin present in purple sweet potato.[11] Phenolic acids such as chlorogenic, isochlorogenic, caffeic, cinammic acid hydroxycinammic are present in sweet potato.[12] High performance liquid 19 individual phenolic compounds such as 3, 5-di-o-caffeoylquinic acid, astragalin and cyanidin were the predominant phenolic acid.[13] A 100g tuber provides 14187 IU of vitamin A and 8509µg of β-carotene.[11]
Colocasia	*Colocasia esculenta* (L.)	Kingdom: Plantae Division: Magnoliophyta Class: Liliopsida Order: Arales Family: Araceae Genus*: Colocasia* Species*: C. esculenta*	Anthocyaninsperlargonidin 3-glucoside, cyaniding 3-glucoside, cyaniding 3-rhamnoside, alkaloids, ascorbic acid, saponins, terpernes, anthraquinones Flavonids.[12] A study reported that pour colocasia based cropping system find out that the high concentration of phenolics 0.966+0.009mg gallic acid equivalent/100mg fresh weight and anthocyanin 4.29+0.04mg/100mg freshweight.[13] Hydroxycinnamic acid derivatives (Caffeoylghecaric acid, D-Glucaric acid, glucosylsinapic acid, caffeic acid, p-coumaric acid, dihydro caffeoylquinic acid). Flavonoids (c-glycosylflavone, o-glycosyl-c-glycosylflavone, luteolin, apigenin, orientin, isoorientin).[14, 15]
Beet root	*Beta vulgaris*	Kingdom: Plantae Division: Tracheophyta Class: Magnoliopsida Order: Caryophyllales Family: Amaranthaceae Genus*: Beta* Species*: B.vulgaris*	Beetroot rich in glycine, betaine, saponins, polyphenols and flavonoids.[16] Betalain is a nitrogen pigment, which contributes antioxidant property of red beetroot.[17] Betalains are two types,these are betacyanins and Betaxanthins.The range of betacyanins in reddish purple pigment beetroot is 0.44 to 0.60g/kg and the range of betaxanthins in yellow pigment beetroot is 0.32 to 0.42g/kg.[18] Triterpenes, sesquiter penoids, coumarins, falavonoids(tiliroside,

			astragaline, rhamnocitrin, rhamnetin, kaempferol).[19]
Carrot	*Daucus Carota*	Kingdom: Plantae Division: Magnoliophyta Class: Mangnoliopsida Order: Apiales Family: Apiaceae Genus*: Daucus* Species*: D.carota*	Carrots are rich sources of carotene, phenolic compounds such as flavonoids, tannins, lignans, stilbenoids, curcuminoids.[20] Two types of carotenoids present in carrot, carotene and xanthophylls.The major carotenoids in carrot roots are β-carotene(75%), α-carotene(23%), lutein(1.9%) and β-cryptoxanthin, lycopene, and zeaxanthin.[21] Carrot contain terpenoids and *p*-cymene, linonene, β-mycrene, sabinene, terpinolene, γ-terpinene, β-caryophylene, β-bisabolene, γ-bisabolene, α-humulene, and α-pinene that provide aroma to the root.[22]
Cabbage	*Brassica oleracea var. capitata*	Kingdom: Plantae Division: Magnoliophyta Class: Magnoliopsida Order: Brassicales Family: Brassicaceae Genus*: Brassica* Species*: B.oleracea*	Cyanidin 3-sophoroside-5-glucoside, cyanidin 3-sophoroside-5-glucoside acylated, sinapic acid, ferulic acid, p-coumaric, malonic acid, glucoraphanin sinigrin, glucoiberin.1,6-di-O-sinapoylglucose, 1-O-caffeoylgentiobiose, 12, 60-tri-O-sinapoylgentiobiose.[23, 24] Main phytochemical components of cabbage are alkaloids, gylcosides, steroids, flavonoids (flavonols, anthocyanins). Flavonols are quercetin and kaempferol.[25, 26]
Broccoli	*Brassica oleracea var. italica*	Kingdom: Plantae Division: Magnoliophyta Class: Magnoliopsida Order: Brassicales Family: Brassicaceae Genus*: Brassica* Species*: B.oleracea*	The phytochemicals of broccoli are glucosinolates (glucoraphanin, glucobrassicin, neoglucobrassin), tocopherols and carotenoids (lutein , zeaxanthin, β carotene), dithiolthiones, s-methyl cysteine sulfoxide, isothiocyanates and indole-3-carbinol.[27, 28] The flavonols of broccoli are quercetin-3-O-sophorotrioside-7-O-glucoside, quercetin-3-O-sohoroside-7-O-glucoside, kaempferol-3-O-sophorotrioside-7-O-glucoside, 3-p-coumaroylquinic acid, sinapic acid, kaempferol 3-O-sophoroside. [29, 30]
Spinach	*Spinacia oleracea*	Kingdom: Plantae Division: Magnoliophyta Class: Magnoliopsida Order: Caryophyllales Family: Amaranthaceae Genus*: Spinacia* Species*: S.oleracea*	The extracts of spinacia oleracea contain phenolic compounds (ortho-coumaric acid, paracoumaric acid, ferulic acid), various flavonoids isolated from this plan are apigenin, glucuronide, flavone, jaceidin, kaempferol, myricetin, quercetin, patuletin, methoxyflavone, spinacetin and carotenoids are lutein, β-carotene, violaxanthin , neoxanthin, tannins, saponins, anthraquinines.[31, 32]

Table 2. Health benefits of the vegetables

Biological properties	Species name	Findings	Reference no
Antioxidant activity	*Ipomoea batatas (L.)Lam*	Recent research has shown the skin of sweet potato contain different concentration of anthocyanin which have antioxidant properties.	[33]
		Total phenolic content has been found in highest amount in the stem end of the roots of the sweet potato.	
		The total antioxidant strength of raw sweet potato measured the oxygen radical absorbance capacity is 902µmol Trolox Equivalent/100g.	[34]
		One study shows that the antioxidant activity of purple fleshed sweet potato is higher than the white fleshed sweet potato.	
	C. esculenta	*C. esculenta* contain high amount of phenolic acid which have antioxidant properties.	[10]
		Many phytochemicals found in this root vegetables to reduce oxidative stress.	
	Colocasia esculenta (L.)	The H-ORAC (Hydroxyl Radical Antioxidant Capacity), ABTS (2,2'-Azino-bis[3-ethylbenzoline-6-sulfonic acid] diammonium salt), FRAP(ferric reducing antioxidant power)and DPPH (2,2'-diphenyl-1-picrylhy-drazyl radical assay) methods are used to evaluate the TAC of colocasia extracts.	[35] [15, 36]
	Beta vulgaris	Red Beet is a good source of natural antioxidant.	
		Beetroot contain high amount of Betalain that have free radicals scavenhing activity.	
		B.vulgaris contain phenolics compound such as rutin, epicatechin and caffeic acid which are also known as excellent antioxidants.	[37]
		The presence of high concentration of antioxidants carotenoids mainly β-carotene have antioxidants properties which can remove the free radicals.	
		Total phenolics in peel is 78.3mg GAE/100g determined by the Folin-ciocalteu assay.	[38]
	Daucus carota	The total antioxidant capacity of cabbage extracts is 0.025 mmol Torolox /g determined by the Trolox equivalent antioxidant activity assay.	[39]
	Brassica oleracea var. capitata	Anthocyanins which are present in highly amount in red cabbage to diminish platelet activation by antioxidative activity.	[40]
		Antioxidant activity determind by FRAP (Ferric Reducing Antioxidant Power) from broccoli extracts is 2.06 to 3.56 µ mol Trolox/g.	[41]

	Brassica oleracea var. italica	Broccoli sprouts rich in phytochemicals such as flavonoids, phenolic acid which have antioxidant properties.	[42]
		Spinach oleraceae plan leaves extract contain phytochemicals mainly tannin flavonoid, tereponoid with highly antioxidant properties.	[43]
	Spinacia oleracea		[44]
Anti-cancer	*Ipomoea batatas (L.)Lam*	Different parts of sweet potato extracts inhibits cell proliferation and induces apoptosis in prostate cancer cells.	[45]
		A recent study reported that purple fleshed sweet potato extract have inhibitory effect on the growth of MCF-7 (breast cancer) and SNU-1 (gastric cancer) cancer cell.	[46]
	Colocasia esculenta (L.)	Root and tuber phytochemicals have demonstrated anticancer effects in several types of carcinoma cell lines.	[13]
	Daucus carota	A studies shown that the consumption of carrots can reduce the risk of lung cancer, breast cancer and colon cancer because carrots are rich in poly-acetylene antioxidant, falcarinol, which destroy cancer cell in the tumors.	[47]
		Red cabbage color extract shown to inhibit adenoma and carcinoma formation in rats treated with 1,2 dimethylhydrazine.	
	Brassica oleracea var. capitata	Broccoli sprouts are a rich source of isothiocyanates that are known as cancer chemopreventive agents by suppressing tumor growth.	[48]
	Brassica oleracea var. italica		[49]
	Spinacia oleracea	Spinach extract contain various carotenoids and lipophilic active compounds such as neoxanthin, lutein, zeaxanthin and chlorophylls which have anti-cancer effects against ovarian, lung, breast, colon cancer.	[50]
		Glycoglycerolipids which are present in spinach to inhibit cancer cell growth.	
Anti-diabetic	*Ipomoea batatas (L.)Lam*	A human studies shown different forms of sweet potato have maintaining blood sugar levels and lowering insulin resistance.	[8,51]
		"Caiapo" is a dietary supplement and a crude extract of white skinned sweet potato which has been consumed for a long time in Japan as a remedy for diabetes.	
	Colocasia esculenta (L.)	Methanol extract of *C.esculenta* leaves have anti-diabetic activity and decrease the blood glucose level.	[52]
	Beta vulgaris	According to a study, 10% Beetroot contained 9808.0mg GAE/100ml ofpolyphenols and 8334.0mg QE/100ml of flavonoids. Administration of beetroot juice for six weeks led to significantly	[19]

		reduced blood glucose levels from 76.1mg/dl to 49.8mg/dl.	
	Brassica oleracea var. capitata	Red cabbage have protective effect on destruction of pancreatic β cell and inhibite the formation of glycated hemoglobin.	[26]
	Brassica oleracea var. italica	Broccoli sprouts are known to improve insulin resistance in type-2 diabetic patients. Broccoli contain sulforaphane which is supplementary treatment in type-2 diabetes.	[53]
Anti-inflammatory activity	*Ipomoea batatas (L.)Lam*	Purple sweet potato extract inhibit the inflammatory brain diseases by suppressing lipopolysacharide (LPS) induce inflammatory responses.	[54, 55]
	Spinacia oleracea	Ethanolic and aqueous extracts of spinach leaves express a dose level of 1100mg/kg have shown anti-inflammatory activity compare to standard drug, Indomethacin,(20mg/kg) in rat.	[56]
	Brassica oleracea var. capitata	The methanolic extract of red cabbage shown anti-inflammatory activity by reducing formaldehyde induced paw oedema in rats	[57]
Anti-microbial activity	*Ipomoea batatas (L.)Lam*	Adsul et al reported that acetone and ethanol extract of sweet potato leaves and root showed antimicrobial activity against *Salmonella typhimurium* and *Pseudomonas aeruginosa.*	[58]
	Daucus carota	The essential oil obtained from aerial parts of the carrot showed inhibitory action against the enteropathogen *Campylobacter jejuni.* Phenylpropanoids such as methylisoeugenol and elemicin essential oil have antimicrobial effect against Campylobacter.	[59] [60]
	Spinacia oleracea	Spinach extract can be used as a natural antibiotic and preservative in food industries and pharmaceuticals.	[61]
		Spinach rich in flavonoids(querecetin, myricetin,kampeferol) and polyphenols paracoumaric, ferulic acid that have anti-bacterial activity.	[33, 62]

DISCUSSION

Colorful vegetables can offer a range of antioxidants. Antioxidants can protect against the cell damage that free radicals cause, known as oxidative stress.

Activities and processes that can lead to oxidative stress include the followings:

- mitochondrial activity
- excessive exercise
- tissue trauma, due to inflammation and injury
- ischemia and reperfusion damage
- consumption of certain foods, especially refined and processed foods, trans fats, artificial sweeteners, and certain dyes and additives

- smoking
- environmental pollution
- radiation
- exposure to chemicals, such as pesticides and drugs, including chemotherapy
- industrial solvent

Such activities and exposures can result in cell damage. This, in turn, may lead to

- an excessive release of free iron or copper ions
- an activation of phagocytes, a type of white blood cell with a role in fighting infection
- an increase in enzymes that generate free radicals
- a disruption of electron transport chains

The damage caused by oxidative stress has been linked to cancer, atherosclerosis, and vision loss. It is thought that the free radicals cause changes in the cells that lead to these and possibly other conditions. An intake of antioxidants is believed to reduce these risks. According to one study Trusted Source, "Antioxidants act as radical scavenger, hydrogen donor, electron donor, peroxide decomposer, singlet oxygen quencher, enzyme inhibitor, synergist, and metal-chelating agents. However, there is a lack of evidence that a higher intake of specific antioxidants can reduce the risk of disease. In most cases, results have tended to show no benefit, or a detrimental effect, or they have been conflicting. There are thought to be hundreds and possibly thousands of substances that can act as antioxidants. Each has its own role and can interact with others to help the body work effectively. "Antioxidant" is not really the name of a substance, but rather it describes what a range of substances can do.

Flavonoids, flavones, catechins, polyphenols, and phytoestrogens are all types of antioxidants and phytonutrients, and they are all found in plant-based foods.Each antioxidant serves a different function and is not interchangeable with another. The best sources of antioxidants are plant-based foods, especially fruits and vegetables.Foods that are particularly high in antioxidants are often referred to as a "superfood" or "functional food. *D. carota* contain Phenylpropanoids such as methylisoeugenol and elemicin essential oil have antimicrobial effect against Campylobacter. *I. batatas* leaves and root showed antimicrobial activity against *Salmonella typhimurium* and *Pseudomonas aeruginosa. S. oleracea* is rich source of antioxidant, antimicrobial properties due to the presence of querecetin, myricetin,kampeferol and polyphenols, paracoumaric, ferulic acid have anti bacterial activity. *I batatas contain high concentration of anthocyanin and B. vulgaris contain high* amount of betalain phenolics compound(rutin, epicatechin and caffeic acid) which have antioxidant properties. *S. oleracea* neoxanthin, lutein, zeaxanthin and chlorophylls which have anti-cancer effects against ovarian, lung, breast, colon cancer.

CONCLUSION

This review paper highlights the all benefits of these root and leafy vegetables (*I. batatas, C. esculenta, B. vulgaris, D. carota, B. oleracea var. capitata, B. oleracea var. italica, S. oleracea)* and their phytochemical properties. These vegetables are locally available or eco-friendly and have high nutritive and medicinal values. The phytochemical properties of these vegetables help to prevent health related disease like diabetes , cancer, other degenerative disease. These vegetables are selected for this review work because these are rich in antioxidant and flavonoids, glycosides, phenolic acids etc. and these are economically affordable.

ACKNOWLEDGEMENT

We acknowledge our college authority to carry on this review work without any interruption in this pandemic condition.

REFERENCES

[1] Biesiada, A., Tomczak, A. (2012). Biotic and abiotic factors affecting the content of the chosen antioxidant compounds in vegetables. *Vegetable crops research bulletin 76*: 55-78.

[2] Atta, M. E., Mohamed, H. N., Abdelgawad, A. M. A.(2017). Antioxidants: An overview on the natural and synthetic types. *Natural and synthetic antioxidants*. *6*(8), 365-375.

[3] Ravimannan, N., Nisansala, A. (2017).Study on antioxidant activity in fruits and vegetables-A Review. *International Journal of Advanced Research in Biological Sciences*, *4*(3) 93-101.

[4] Mates, M. J., Jimenez, S. F. (1999). Antioxidant enzymes and their implication in pathophysiologic processes. *Antioxidant defence and human diseases.* D339-345.

[5] Shetty, A. A., Magadum, S.,Kalmesh, M.,(2013). Vegetables as sources of antioxidants. *Journal of Food & Nutritional Disorders. 2*(1), 1-5.

[6] Kavalcova, P., Bystricka, J., Tamas, J., Karovicova, J., Kovarovic, J., Lenkova, M., (2015). *Potravinarstvo Scientific Journal for Food Industry*.*9*(1), 77-83.

[7] Fernandes, L. D., Hedge, K., Shabaraya, AR., (2019). Scientific approaches on red cabbage: A Review. *International Journal of Pharma And Chemical Research*. *5*(3), 123-130.

[8] Ayeleso, B. T., Ramachela, K., Mukwevho, E., (2016). A Review of therapeutic potentials of sweet potato: Pharmacological activities and influence of the cultivar. *Tropical Journal of Pharmaceutical Research*. *15* (12), 2751-2761.

[9] Krishnapriya, V.T., Suganthi, A.,(2017). Biochemical and phytochemical analysis of *Colocasia esculenta* (L.) Schott tubers. *International Journal of Research in Pharmacy and Pharmaceutical Sciences*, *2*(3), 21-25.

[10] Makori, I. S., Mu, H. T., Sun, N.H.,(2015). Total polyphenol content, antioxidant activity, and individual phenolic composition of different edible parts of sweet potato cultivars. *Natural Product communications*. 15(7), 1-12.

[11] Mohanraj, R., Sivasankar,S.,(2014). Sweet potato(*Ipomoea batatas* [L.] Lam)- A Valuable Medicinal Food: A Review. *Journal of medicinal food*. 17(7),733-741.

[12] Rashmi, D.R., Gopenath,TS., Palanisamy, P., Bakthavatchalam,P., Karthikeyan, M., Gnanasekaran, A., Ranjith,MS., Chandrashekrappa, GK., Basalingappa,M.K.,(2018).Taro(Colocasia esculenta): An Review. *Journal of Medicinal Plants Studies.* 6(4), 156-161.
[13] Tutid, D.M., Pal, S. R., Kumar, A. R., Bisht, K. J., Bhatt,C. J.,(2015). Colocasia based system affects the antioxidant properties and productivity of colocasia[*Colocasia esculenta* (L.) Schott] tuber. *An International Quarterly Journal of Life Science.* 10(1), 117-123.
[14] Chanda, S., Rakholiya, K., Dholakia, K., Baravalia, Y., (2013). Antimicrobial, antioxidant, and synergistic properties of two nutraceutical plants: *Terminalia catappa* L. and *Colocasia esculenta* L.. *Turkish Journal of Biology*.37, 81-91.
[15] Gupta, K., Kumar, A., Tomer, V., Kumar, V., Saini, M., (2019). Potential of *Colocasia* leaves in human nutrition: Review on nutritional and phytochemical properties. *Journal of Food Biochemistry*.
[16] Chauhan, S., Chamoli, K., Sharma, S., (2020). Beetroot-A review paper. *Journal of Pharmacognosy and Phytochemistry.* 9(2), 424-427.
[17] Chhikara, N., Kushwaha, K., Sharma, P., Gat, Y., Panghal, A., (2018). Bioactive compounds of beetroot and utilization in food processing industry: A review. *Food Chemistry. 272*(2019), 192-200.
[18] Masih, D., Singh, N., Singh, A.,(2019). Red Beetroot: A source of natural colorant and antioxidant: A review. *Journal of Pharmacognosy and Phytochemistry*. 8(4), 162-166.
[19] Ceclu, L., Nistor, V.O.,(2020). Red Beetroot: Composition and Health Effects-A Review. *Journal of Nutritional Medicine and Diet Care .6*(1), 1-9.
[20] Raees-ul, H., Prasad, K.,(2015). Nutritional and processing aspects of carrot(*Daucus carota)*- A review. *South Asian J. Food Technol. Environ.1*(1), 1-14.
[21] Ahmad, T., Cawood, M., Iqbal, Q., Arino, A., Batool, A., Tariq, S.M.R., Azam,M., Akhtar,S., (2019). Phytochemicals in *Daucus carota* and their health benefits- Review article. 8,424.
[22] Susiloningsih, B.K.E., Sarofa, U., Sholihah, I. F.,(2016). Antioxidant activity and sensory properties carrot (*Daucus carota)* soyghurt. MATEC Web of Conference 58, 01002.
[23] Soengas, P., Sotelo, T., Velasco, P., Cartea, E.M., (2011). Antioxidant properties of brassica vegetables. *Functional Plant Science and Biotechnology.*5(2), 43-55.
[24] Leja, M., Kaminska, I., Kolton, A., (2010). Phenolic compounds as the major antioxidants in red cabbage. *Polish Society For Horticultural Science.*22(1), 19-24.
[25] Podsedek, A., (2005). Natural antioxidants and antioxidant capacity of Brassica vegetable: A review. *Swiss Society of Food Science and Technology.40*, 1-11.
[26] Seong, G., Hwang, I., chung, S., (2015). Antioxidant capacities and polyphenols of Chinese cabbage leaves. *Food Chemistry*. 199, 612-618.
[27] Ravikumar, C., (2015). Therapeutic potential of *Brassica oleracea* (Broccoli)-A review. *International Journal of Drug Development and Research.* 7(2), 9-10.
[28] Bhandari,R.S., Kwak,H.J., (2014). Seasonal variation in phytochemicals and antioxidant activities in different tissues of various Broccoli cultivars. *African Journal of Biotechnology*. 13(4),604-615.
[29] Jahan, A.I., Mostafa, M., Nimmi, I., Hossain, H.M., Ahsan, M., Chowdhury, U. J., (2010). Chemical and antioxidant properties of Broccoli growing in Bangladesh. *Journal of Pharmaceutical sciences.* 9(1), 31-37.
[30] Jeffery,E. H., Brown, F.A., Kurilich, C. A., Keck,S. A., Mutusheski,N., Klein, P.B., Juvik, A.J., (2003). Variation in content of bioactive components in broccoli. *Journal of Food Composition and Analysis*. 16, 323-330.
[31] Lomnitski, L., Bergman, M., Nyska,A., Ben-Shaul, V., Grossman,S., (2003). Composition, efficacy, and safety of Spinach extracts. *Nutrition and cancer*.46(2), 222-231.
[32] Olasupo, AD., Aborisade, AB., Olagoke,OV., (2018). Phytochemical analysis and antibacterial activities of Spinach leaf. *American Journal of Phytomedicine and Clinical Therapeutics.* 6(2), 1-4.
[33] Teow,C.C., Truong,V., McFeeters F. R., Thompson, L.R., Pecota, V. K., Yencho, C.G.,(2007). Antioxidant activities, phenolic and β-carotene contents of sweet potato genotypes with varying flesh colours. *Food Chemistry. 103*, 829-838.
[34] Johnson, M., Pace, D. R., (2016). Sweet potato leaves: properties and synergistic interactions that promote health and prevent disease. *Nutrition Reviews.68*(10),604-615.
[35] Pereria, R. P., Mattos, E., Correa,A., Vericimo, M., Paschoalin, V., Anticancer and immunomodulatory benefits of taro corms , an underexploited tuber crop. *Inernational Journal of Molecular Sciences.22*, 265.
[36] Gupta, K., Kumar, A., Tomer, V., Kumar, V., Saini, M., (2019). Potential of *Colocasia* leaves in human nutrition: Review on nutritional and phytochemical properties. *Journal of Food Biochemistry*. 43 (7).
[37] Slosar, M., Kopta, T., Hegedus, O., Hegedusova, A., Mezeyova,I., Timoracka, M., Mezey,J., (2020). Yield parameters, antioxidant activity, polyphenol and total soluble solids content of beetroot cultivars with different flesh colours.32(2),351-362.
[38] Masih, D., Singh, N., Singh, A.,(2019). Red beetroot: A source of natural colourant and antioxidants : A review. *Journal of Pharmacognosy and Phytochemistry.*8(4), 162-166.
[39] Yadav,P., (2020). A Review on different types of carrot and its chemical compositions. *IOSR Journal of Pharmacy.10* (5), 32-39.
[40] Zhang, D., Hamauzu, Y., (2004). Phenolic compounds and their antioxidany properties in different tissues of carrots*(Daucus carota* L.). 2(1).
[41] Ciska, E., Karamac, M., Kosinska, A., (2005). Antioxidant activity of white cabbage and sauerkraut. *Polish Journal of Food And Nutrition Science.14/55* (4), 367-373.

[42] Fernandes, L. D., Hedge, K., Shabaraya, AR., (2019). Scientific approaches on red cabbage: A Review. *International Journal of Pharma And Chemical Research*. *5*(3), 123-130
[43] Kumar, K., (2006). Variations in antioxidant activity in Broccoli *(Brassica oleracea* L.) cultivars. *Journal of Food Biochemistry*.31,621-638.
[44] Lomnitski, L., Bergman, M., Nyska, A., Ben- Shaul, V., Grossman, S., (2003). Composition, efficacy, and Safety of Spinach Extracts. *Nutrition and cancer.46* (2), 222-231.
[45] Cornago, D., Rumbaoa, R., Geronime, I., (2011). Philippine Yam tubers phenolic content and antioxidant capacity. *Phillippine Journal of science. 140*(2), 145-152.
[46] Ayeleso, B. T., Ramachela, K., Mukwevho, E., (2016). A Review of therapeutic potentials of sweet potato: Pharmacological activities and influence of the cultivar. *Tropical Journal of Pharmaceutical Research.15* (12), 2751-2761.
[47] Que,F., Hou, X., Wang, G., Xu, Z., Tan, G., Wang, Y., (2019). Advances in research on the carrot, an important root vegetable in the Apiaceae family. *Horticulture Research. 6,69*.
[48] Leja, M., Kaminska, I., Kolton, A., (2010). Phenolic compounds as the major antioxidants in red cabbage.*Folia Horticulturae.*22 (1), 1119-24.
[49] Ravikumar, C., Therapeutic potential of *Brassica oleracea* (Broccoli)- A Review. *International Journal of Drug Development and Research.7(2),009-010.*
[50] Roughani, A., Miri, M. S., (2019). Spinach: An important green leafy vegetable and medicinal herb. *International conference on medicinal plants organic farming, natural and pharmaceutical ingredients.*
[51] Rumbaoa, R., Cornago, F. D., Geronimo, M. I., (2009). Phenolic content and antioxidant capacity of Philippine sweet potato (*Ipomoea batatas)* varieties. *Food Chemistry. 113*, 1133-1138.
[52] Karthikeyan, M., Gnanasekaran, A., Ranjith Ms., Basalingappa, K., Chandrashekrappa, GK., Rashmi DR, Gopenath TS,Bakthavatchalam,P.,(2018). Taro *(Colocasia esculenta). Journal of Medicinal Plants Studies.6* (4), 156-161.
[53] Sousa, C., Valentao, P., Pereira, M. D., Taveiraa, M., Ferreres, F., Pereira, A. J., Bento, A., Seabra, M. R., Andrade, B. P., Phytochemical and antioxidant characterization of *Brassica oleracea* Var. *Costata* extracts. *Standardization of Herbal/Ayurvedic Formulations.24* ,312-339.
[54] Cornago, F.D., Rumbaoa, R., Geronimo, I., (2011). Philippine yam (*Dioscorea* spp) tubers phenolic content and antioxidant capacity. *Philippine Journal of Science.140*(2),145-152.
[55] Milind, P., Monika,(2015). Sweet potato as a super food. *International Journal of Research In Ayurveda &Pharmacy.6*(4), 557-562.
[56] Metha, D., Belemkar,S., (2014). Pharmacological activity of Spinacia oleracea Linn.-a complete overview. *Asian Journal of Pharmaceutical Research and Development.2*(1),83-93.
[57] Rokayya, S., Li,J. C., Zhao, Y., Li, Y., Sun, H.C., (2013). Cabbage (*Brassica oleracea* L. var. capitata) Phytochemicals with antioxidant and anti-inflammatory potential. *Asian Pacific Journal of Cancer Prevention.* 14. 6657-6661.
[58] Leite, C., Porcu, O., C, A., (2020). Sweet potato (*Ipomoea batatas* L. Lam) nutritional potential and social relevance: a review. *International Journal of Engineering Research and Applications. 10*(6), 23-40.
[59] Kartika, E., Zulharmita, Chandra, B., Rivai, H., (2021). Phytochemical and pharmacological review of carrot (*Daucus carota* L.). *International Journal of Pharmaceutical Sciences and Medicine.6*(1), 75-82.
[60] Bahrami R., Ghobadi ,A., Behnoud, N., Akhtari, E., (2018). Medicinal properties of *Daucus carota* in traditional persian medicine and modern phytotherapy. *Journal of Biochemical Technology.*(2), 107-114.
[61] Tewani, R., Sharma, K. J., Rao, S., (2016). Spinach (Palak) Natural Laxative. *International Journal of Applied Research and Technology.1* (2),140-148.
[62] Miano, F.T., (2016). Nutritional value of Spinacia oleraecea spinach-an overview. *International Journal of Life Sciences and Review*. *2*(12), 172-174.