

Radish (*Raphanus Sativus*): Potential Antioxidant role of Bioactive Compounds extracted from radish leaves - A review

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ABSTRACT

Radish (*Raphanus Sativus*) used against many toxicants as a natural drug, is a worldwide grown cruciferous root crop with root part the main edible organ and leave part, which in dried form are effective as functional foods. Radish (*Raphanus Sativus*) that exhibits variety of colors has rich content of vitamins, phenolic compounds, dietary fiber and Phyto-anthocyanin. Based on physico-chemical, nutritional, antioxidant and microbiological properties radish leaves are more nutritionally rich than roots. Leaves are premier source of phenol, flavonoid and have free radical hunting ability. The antioxidant biomarker compound Rutin has been identified only in radish leaves. Therefore the inclusion of Radish leaves in the human diet could have higher bioactive compounds especially flavonoid availability than roots.

Conclusion: Consumption of radish leaves mostly discarded may present nutritional and medicinal value to human health especially due to their Antioxidant Activity. Moreover to develop novel functional products more exploration is required to approximate other bioactive compounds from the radish leaves.

Keywords: Radish (*Raphanus Sativus*), bioactive compounds Antioxidants and Skin

INTRODUCTION

Radish (*Raphanus Sativus*)¹ is a worldwide grown cruciferous root crop^{2,3,4} a vegetable that exhibits variety of colors due to Phyto-anthocyanins⁵ having different economic importance⁶ and significance from nutritional and pharmaceutical aspects across the globe⁷. Also commonly grown and used vegetable by Asians⁸. Based on anthocyanin accumulation, it can have different colors like white, green or red. Green and red radishes are consumed fresh but also as pickles⁹. The different edible parts of Radish include the petiole, root peel and root flesh. These different parts show difference in bioactive and Antioxidant effects with lower contents found in flesh. Higher levels of proanthocyanidins, Carotenoids and chlorophylls contents found in green radish than those in red radish while vitamin C, anthocyanins and total phenolic contents found higher in red radish than in green radish. The bioactive compounds contents and antioxidant capacities have shown significant differences among edible parts and species of radish¹⁰. Substantial amount of anthocyanins¹¹ accumulate in both the skin and flesh of Red radishes¹². Since ancient times it has been used against many toxicants as a natural drug in folk medicine¹³. It has root part that is main edible organ¹⁴ and leave part, which in dried form are effective as functional foods¹⁵. The Major nutritional components as g/100 g "fresh weight" and Micronutrients as µg/g of fresh weight of Radish are shown in Table 1¹⁶. Cruciferous vegetables have numerous nutritional components and biologically active molecules and their usage has several health benefits. Phase-II enzymes activation and apoptosis induction is the Key mechanism by which cruciferous vegetables results in health benefits. Cruciferous vegetables Production with optimal content of bioactive molecules through Biotechnological and agricultural approaches may be of great utility^{16,17}.

Bioactive Compounds: Secondary plant metabolites that can elicit pharmacological or toxicological effects in man and animals are known as Bioactive Compounds. Since ancient time plants based products and drinks have been used globally for different purposes. Leafy vegetables based products have beneficial effects in treating many human ailments¹⁸⁻²⁰. These have high content of secondary metabolites with extra nutritional effects²¹. These Bioactive Compounds have effects against viruses, bacteria, allergic conditions inflammation and as Antioxidant due to its Antioxidant properties^{22,23}. So used in pharmaceutical, food and chemical industries²⁴.

Phytochemicals mainly found in Radish Leaves and Roots:

According to a systematic review the reported Phytochemicals like alkaloids, phenols, and flavonoid compounds were mainly found in *R. Sativus* leaves (RSLs) and roots (RSR) with Flavonoid compounds being the most important of these Phytochemicals known for their Nutraceutical and pharmacological properties. The highest 38.8% of reported data were flavonoids. Other reported compounds were non-flavonoid polyphenols 8.4%, Terpenes and derivatives 8.2%, fat and fatty related compounds 6.4% and glucosinolates and breakdown products 5.6%^{4,25,26,27}. A specific aliphatic glucosinolate (GSL), Glucoraphasatin (GRH) is that is only abundant in radish. Other compounds found in high concentration in leaves includes macronutrients fiber calcium, potassium, sodium and non-flavonoid polyphenols²⁸. The total phenolic and flavonoid found more in leaves comparative to roots (Table 2)²⁹.

Natural Antioxidants: An antioxidant is a substance that prevents the oxidation of other substance.³⁰ Antioxidants counteract the harmful effects of free radicals and protect the key cell components. Balance of oxidation and anti-oxidation is normally maintained by human body antioxidant system to prevent DNA damage and proteins, lipid oxidation in the cells by scavenging "reactive oxygen species and reactive nitrogen species (superoxide, hydroxyl, and nitric oxide radicals)". According to their properties they can be classified into natural antioxidants and endogenous antioxidants^{30,31,32}. Defense mechanisms of cells are performed by Natural antioxidants that hunt reactive species and have a major role in the health promotion through preventing oxidative stress. Study has shown that increase of exogenous antioxidants intake would decrease the oxidative stress^{33,34} caused damage through inhibition of commencement or transmission of oxidative chain reaction by extinguishing quenchers of singlet oxygen, scavenger of free radical and reducing agents³⁵. Main sources of exogenous antioxidants includes food and medicinal plants such as fruits, vegetables³⁶, cereals, mushrooms, beverages, flowers, spices and traditional medicinal herbs. Prime exogenous antioxidants include polyphenols (phenolic acids, flavonoids, anthocyanins, lignans and stilbenes), Carotenoids (xanthophylls and carotenes) and vitamins (vitamin E and C). These natural antioxidants, especially polyphenols and Carotenoids demonstrate effects against inflammation, bacteria, viral infections, aging, and cancer^{37,38}. Due to its antioxidant defensive mechanism enhancing and free radicals accumulation reduction effect³⁹ can be beneficial in Diabetics affecting the hormonal induced glucose hemostasis⁴⁰. A study has shown that F2, a fraction of radish leaves extracts has antioxidant effect and

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can be used for protecting the oxidative lung damage by attenuating the reactive oxygen species level and restoring mitochondrial membrane potential. Medical Research Council cell strain 5 apoptosis induced by H₂O₂ alleviated by F2 pretreatment preliminary mechanism of protective effect includes F2 induced down-regulation of the pro-apoptosis protein (Bax) and up-regulation of the anti-apoptosis protein (Bcl-2)⁴¹. Radish bioactive compounds have been used to treat several diseases. *Raphanus Sativus* (radish) roots and leave also have high nutritional and phytochemical potential especially anthocyanins from Flavonoids have been the most studied and reported compounds with health benefits. So leaves mostly discarded can be recommended as part of a healthy diet⁴². Study has shown that the leaves mostly discarded part of Radish has higher Polyunsaturated Fatty Acids, Phenols and Flavonoids, the natural valuable nutrients and safe Bioactive Compounds valuable for good health of human^{43,44}. Antioxidants help fight the signs of aging, acne Sunburn and skin tone darkening by preventing damage caused by free radical reducing oxidative stress and inflammation⁴⁵.

Radish leaves as part of a healthy diet: Radish (*Raphanus Sativus*) shows high nutritional value due to its rich content of vitamins, phenolic compounds, and dietary fiber showing antioxidant and anti carcinogenic effects, significant biological functions^{10,46}. Study has shown radish (*Raphanus Sativus*). Leaves had bioactive compounds from phenolic group having Antibacterial activity against *Escherichia coli* and its chemical compounds⁴⁷. In another study, radish has shown the higher bioaccessibility of antioxidant bioactive compounds and minerals⁴⁸. In another study from 21 anthocyanins, on the basis of their oxygen radical absorbing capacity models with 3-dimensional quantitative structure activity relationship (3D-QSAR) were built⁴⁹ and were utilized to envision radish anthocyanins for their Oxygen

Radical Absorbance Capacity values⁵⁰. Environmental stresses like, Ultraviolet radiation, Plant injuries, pathogens and insects attack lead to the maximum antiproliferative effectiveness against all cell lines, 217–453 µg/mL IC₅₀ values has been shown by RSLs^{29,51}. Radish has shown the higher bioaccessibility of Antioxidant bioactive compounds and minerals^{48,49,50}. Secondary metabolites synthesized by plants as a result of Environmental stresses are phenolic compounds which have the metals chelating, can hunt free radicals and inhibition of lipid peroxidation. High levels of these phenolic compounds found in mostly discarded leaves^{52,29,33}. Based on physico-chemical, nutritional, antioxidant and microbiological properties radish leaves far exceeds the in nutritional value than roots. Calcium with a value of 752.64 mg/100g, protein, ash and crude fiber levels were again higher in Leaves than roots. The Ascorbic acid level 38.69 mg/100g and Total phenolic levels (695.07 mg GAE/100g d.m.) were twice greater than for roots. While total flavonoid levels (1042.73 mg Quercetin/100g d.m.) were four times than for roots. Antioxidant activities of leaves were 39.48 mmol much higher than 11.09 mmol of leaves Table 3³³. Another study has shown highest phenol and flavonoid element with the maximum free radical hunting ability found in leaves²⁹. High performance thin layer chromatography in reversed-phase has shown common dietary flavonoid⁵³ Rutin (5.2 µg/mg)⁵⁴ with antimicrobial, anti-inflammatory, anticancer, anti-diabetic property⁵⁵ was identified only in radish leaves²⁹.

Polyphenolic bioflavonoid compound Rutin, antioxidant biomarker compound has low skin⁵⁶ permeation so it is associated to liposomal vesicles, such as ethosomes to perform its antioxidant activity onto the skin⁵⁷ in dermocosmetic formulation⁵⁸. Therefore the inclusion of Radish leaves in the human diet as superior source of bioactive compounds, especially flavonoids than roots could have higher flavonoid compounds availability.

Table 1: Radish Major nutritional components: g/100 g fresh weight

Protein		Fiber		Fat		Carbohydrates			
0.68		37.40		0.08		3.45			
Radish Micronutrients (µg/g of fresh weight)									
Phosphorus	Potassium	Magnesium	Sodium	Calcium	Iron	Selenium	Copper	Manganese	Zink
0.23	2.277	0.16	0.21	0.27	4.10	0.007	1.20	0.30	1.50

Table 2

	Leaves RSLs	Roots RSRs
Total phenolic content	125.3 mg of Gallic acid equivalent [GAE]/g	95.8 of GAE/g
Flavonoid content	44.5 mg of Quercetin equivalent [QE]/g	24.4 of QE/g)."

Table 3: The Antioxidant activities of Radish Leaves and Roots

Leaves	Roots
39.48 mmol TE/100g	11.09 mmol TE/100g

CONCLUSION

Consumption of radish leaves mostly discarded may present nutritional and medicinal value to human health especially due to their Antioxidant Activity. Moreover to develop novel functional products more exploration is required to approximate other bioactive compounds from the radish leaves.

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