

## REVIEW ARTICLE

**An Analytical Report of Phytochemical Constituents, Pharmacological Potential and Toxic Effects of Radish**ISHRAT YOUNUS<sup>1</sup>, AFSHAN SIDDIQ<sup>2</sup>, SADIA GOUSIA BAIG<sup>2</sup>, RAFIA SADAF<sup>3</sup>, TALHA BIN FAYYAZ<sup>4</sup>, NOOR UL AIN<sup>5</sup>, ZUBIA BEGUM<sup>6</sup>, ARSLAN AHMER<sup>7</sup><sup>1</sup>Department of Pharmacology, Faculty of Pharmacy, Hamdard University, Karachi-Pakistan.<sup>2</sup>Department of Pharmacology, Faculty of Pharmacy & Pharmaceutical Sciences, University of Karachi, Pakistan.<sup>3</sup>Jinnah College of Pharmacy, Sohail University, Karachi, Pakistan<sup>4</sup>Faculty of Pharmacy, Ziauddin University, Karachi, Pakistan<sup>5</sup>Institute of Pharmaceutical Sciences, Jinnah Sindh Medical University, Karachi, Pakistan<sup>6</sup>Faculty of Pharmacy, Jinnah University for Women, Karachi-Pakistan.<sup>7</sup>Faculty of Pharmacy, University of Sindh, Jamshoro, Pakistan.Correspondence to Dr. Afshan Siddiq, Email: [afshanpharma@uok.edu.pk](mailto:afshanpharma@uok.edu.pk)**ABSTRACT**

Vegetables have great significance and importance as they are not only useful as food but on the other hand, vegetables are a vital source in the treatment and prevention of various ailments, a powerful source of minerals, vitamins, antioxidants, fibers, and amino acids, therefore, help to buildup and heal the body. Mainly concerning cruciferous vegetables, have been famous for marked effects of cardio-protective, antimicrobial, and anti-carcinogenic. The environments of Pakistan are amicable for vegetable production. *Raphanus sativus* generally named radish is a widespread plant all over the world belongs to the Brassicaceae family. Edible *R. sativus* L. Var. *caudatus* are green color seed pods, utilized for properties attributed to *Raphanus*. Different chemical constituents are identified from radish. Various researches show that the whole radish plant has significant pharmacological activity. The current review expands on types, phytochemical components, and pharmacological potential and toxic outcomes of the radish plant

**Keywords:** Radish, varieties, constituents, pharmacology, uses, toxicity**INTRODUCTION**

Vegetables are an important source not only of food but on the other hand, they are also useful in the prevention and management of various ailments. Vegetables are powerful sources of antioxidants, minerals, fibers, vitamins, and amino acids therefore they can be helpful to boost and heal the body<sup>1,2</sup>. Cruciferous, commonly known for its antimicrobial, anti-carcinogenic, and cardio-protective activity. Pakistan's environment for the growth of vegetables is amicable. vegetables of various kinds are planted in the varied climate regions<sup>3</sup>.

In Pakistan, a large population consumes vegetables, but some are not fully aware of them and are usually used by elders in rural regions. These vegetables are usually unnoticed mainly by the young generation, due to a deficiency of awareness and technology. Overlooked native vegetables require scientific investigation<sup>4</sup> and *R. caudatus* is one of them.

*R. sativus* is found throughout the world and is commonly known as radish. The plant grows very fast. *Raphanus* derives from the Greek word that means "quick appearing". It belongs to the Brassicaceae family. Broccoli, turnip, cauliflower, etc. are the members of this family known for their certain smell attributed to sulfur comprising of isothiocyanate and glucosinolate constituents<sup>5,6</sup>.

**BACKGROUND**

Radish, a prehistoric plant has various geneses. They were first planted in China thousands of years ago, then in Egypt and Greece<sup>7</sup>. *Raphanus* was presented on the pyramid's walls about 4000 years old as described by ancient Greek historian Herodotus<sup>8</sup>. Approximately two thousand years back, it was planted in Japan, Southeast Asia, and in Central Asia<sup>9</sup>. It is assumed that radish was derived from Thailand and named the Thai rat-tailed. *R. caudatus* grow abundantly and consumed globally<sup>10</sup>.

**Varieties of radish:** Crisp<sup>11</sup> explained numerous types of radishes for example large-rooted daikon, European, seed pod and red radishes (Fig:1). According to Taxonomical classification radishes are divided into three classes:

- i. *Sativus*: palatable roots comprises of various types.
- ii. *Caudatus*: palatable pods/mougri/rat tailed.
- iii. *Oleifera*: fodder / oilseed<sup>12</sup>.

Figure 1: Various types of Radish



**RAPHANUS SATIVUS L. VAR. CAUDATUS:** Seed pods are used for its characteristic features refer to Radish. It grows annually as well as a biennial, height is around 30–90 cm grow from seed pods, it can grow up to 5 ft. and can expand 2 ft<sup>13</sup>. In Pakistan and India it is known as Sungraa and Mungraa. Seed pods are eatable and exist in Pakistan in the November till March (Fig. 2) and serve in different way<sup>14</sup>. Table 1 signifies taxonomy of *R. caudatus* L.

Table 1: Taxonomy of *Raphanus caudatus* L.

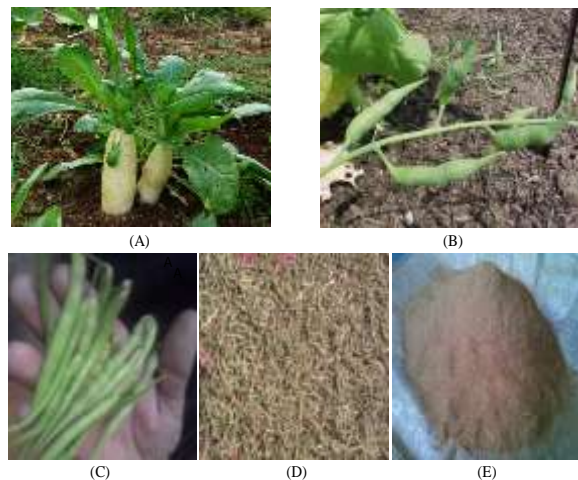
K i n g d o m	P l a n t a e
S u b k i n g d o m	T r a c h e o b i o n t a
S u p e r d i v i s i o n	S p e r m a t o p h y t a
D i v i s i o n	M a g n o l i o p h y t a
C l a s s	M a g n o l i o p s i d a
S u b - c l a s s	D i l l e n i i d a e
O r d e r	C a p p a r a l e s
F a m i l y	Brassicaceae / Cruciferae
G e n u s	R a p h a n u s L
S p e c i e s	R . c a u d a t u s L .

Source: The Plants Database. (<http://plants.usda.gov>)

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Figure 2: R. sativus L. (I) Roots(II), (III) Fresh Pods (IV) Dried pods (V) powder of Pods



**CHEMICAL COMPOSITION**

**Phenolic Compounds:** Radish is rich in flavonoids such as kaempferol, quercetin, myricetin, luteolin, and apigenin<sup>15</sup>. Various other researchers also prove the existence of phenolic content in R. sativus<sup>16,17</sup>. In various research, HPLC testing shown presence of catechin in aqueous extract while sinapic acid in ethyl acetate, methanol and hexane extracts<sup>18</sup>. In another research, R. caudatus, assessed for phenolic contents in various extracts which revealed the antioxidant activity of free radicals in FRAP assay<sup>19</sup>. Zhang et al 2020 reported several forms of flavonoids in six different colored radishes. There was a difference in flavonoid profile in different colored radishes. TA total of 133 flavonoids was found that are summarized as follows<sup>20</sup>:

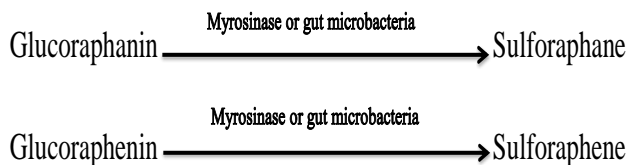
- 44 Flavones
- 16 Dihydroflavones
- 14 Flavonoids
- 28 Flavonols
- 09 Anthocyanins.

Table 2: Phenolic contents in R. sativus L<sup>21,22</sup>.

T	P a r t	Therapeutics effects
K a e m p f e r o l	Roots and leaves	Diuretic, Anti-inflammatory and antioxidant
Kaempferol-7-O-rhamnoside	Roots and leaves	Anti-inflammatory
Kaempferol-7-glucoside-3-rhamnoside	R o o t s	Anti-inflammatory
Kaempferol-3-glucoside-7-rhamnoside	R o o t s	Anti-inflammatory
L u t e o l i n	R o o t s	Anti-tussive, anti-spasmodic, Anti-tumorigenic, and anti-HIV
M y r i c e t i n	R o o t s	A n t i - H I V
P e l a r g o n i d i n	Fruits and Roots	A n t i - o x i d a n t
Q u e r c e t i n	Pods, leaves and Roots	Anti-viral, cytotoxic and anti-tumor
Quercetin-7-O-rhamnoside	R o o t s	Anti-cancer, anti-tumor and anti-viral
R a p h a n u s	R o o t s	Anti-microbial, antioxidant
C y a n i d i n	Leaves and roots	A n t i - u l c e r

**Glucosinolates and Sulphur:** Glucosinolates are the main naturally occurring components of R. sativus, hydrolyzed by the enzyme myrosinase or micro bacteria present in the gut into isothiocyanates as shown in fig: 3.

Figure 3: Hydrolytic reaction of Glucoraphanin and Glucoraphenin<sup>23</sup>.



In 2013 Pocasap et al, separated sulforaphane and sulforaphene, from R. caudatus that exhibited great anticancer activity on HCT-116 cell line<sup>13</sup>. Presence of Sulphur compounds such as brassinin, spirobrassinin and singirin, were also proved in R. sativus<sup>22</sup>. Another study also reported that R. sativus contain glucosinolate compound like sinigrin in a concentration of 120.25 μmol/g<sup>6,24</sup>.

**Alkaloids:** Brassicaare rich insinapine<sup>25</sup>. Saponinsare found abundant in the seeds of radish<sup>26</sup>. In 2015 Kim et al isolated 15 types of alkaloids from R. sativus by Mosher's and spectroscopic methods he also explained their structures. Mosher's method is an effective assay for the determination of the enantiomeric composition of alcohols and amines

**Anthocyanins and Glycosides:** Raphanuside A (Indole glycoside) was isolated from Raphanus<sup>27</sup>. Radish also contains methyl salicylate glycosides [28]. Acylated anthocyanins isolated from Raphanus sprout juice exhibit antioxidant effects<sup>29,30</sup>.

**Lipids:** Raphanus, seeds and pods contain fatty acids which was also reported in Radish seed oil<sup>31,32</sup>. Moreover, Raphanus also contain fatty acids such as palmitic acid, oleic oil, linolenic acid, erucic acid, arachidic acid and stearic acid. Radish and its seed oil have amazing antioxidant effect. In multiple studies, it was reported than linolenic acid help to improve lipid profile<sup>33</sup>. It is supposed that the presence of linolenic acid in R. sativus have an important role in improving cardiovascular disease. Another study also prove the presence of different isomers of fatty acid in radish seed. Erucic acid is isolated in various radish types. Furthermore, palmitic acid and oleic acid were identified too<sup>34</sup>.

**Proteins:** Proteins of different types were isolated from R. sativus possessing antifungal effects<sup>26</sup>.

**Inorganic matters:** Minerals are essential source for the stimulation of enzymes, hormones and organic constituents necessary for various elementary systems of life and growth (Organization, 2004). Raphanus is also important source containing nutritional contents. Raphanus contain several nutrients like iron, copper, lead, chromium and cadmium, potassium, magnesium and sodium<sup>32,35</sup>. Table 3 describes minerals in R. sativus L. pods

Table 3: Minerals in R. sativus L. pods<sup>4</sup>.

M i n e r a l s	A m o u n t i n m g / k g		
I r o n	4		3
Z i n c	3		1
C o p p e r	1		2
C a l c i u m	3	2	2
P h o s p h o r u s	9	3	4
M a n g a n e s e	3		9
M a g n e s i u m	5	6	7

**Vitamins:** Pods of Radish contain folate, vitamin C, vitamin B2, tocopherol, and vitamin B6<sup>13,36</sup>. Table 4 characterizes isomers of tocopherol in R. sativus L. seed.

Table 4: Tocopherol and its Isomers in seeds of R. sativus L<sup>22</sup>.

T o c o p h e r o l i s o m e r s	A m o u n t μ g / g			
α - T o c o p h e r o l	1	2	2	2
β - T o c o p h e r o l	5		2	9
γ - T o c o p h e r o l	2	3	2	6
δ - T o c o p h e r o l	5		2	9

**Oil content in seed:** Types of major constituents present in oil are:

pentyl hexyl, dimethyl disulfide, 4-methyl pentyl isothiocyanate, methyl methanethiolsulfinate, gluconapin, progointrin, and 1-methylthio-3-pentanone<sup>21</sup>. Furthermore, seed oil contains, anthocyanins, sulforaphane, fatty acids, and vitamins (tocopherol)<sup>37</sup>.

**Other chemical Components:** Coumarins, brassinosteroids, and different enzymes are also present in R. sativus<sup>21</sup>.

For development of nutraceuticals Radish can be used in crude, therefore, treating various infectious as well as non-communicable diseases<sup>6</sup>.

**Therapeutic effects:** Whole radish plant is reported for its significant pharmacological activity. Figure 4 illustrates the therapeutic actions and table 5 explains them.

Table 5: Pharmacological Effects of Raphanus sativus L.

Therapeutic Effect	Explanation	Reference
Antimicrobial /anti-fungal effects	Brassicaceae are reported to have antifungal activity. Radish has sound antifungal action; seeds of radish are also reported to have antifungal action with various antifungal components.	[38, 39]
Antiviral effects	Radish root extract indicated antiviral potential against the viral hemorrhagic septemia virus.	
Analgesic effects	Radish indicated analgesic effects. Historically, it was utilized for migraine. Crude leaves extract of R.sativus exhibited effect to ease spasms in a dose-dependent fashion. Raphanus is rich in saturated fatty acids and eicosenoic acids, these components are assumed to have some association with its analgesic and antipyretic activities.	[41, 42, 43, 44]
Antioxidant effects	The antioxidant effects of the aerial parts of Raphanus raphanistrum were reported by flow injection analysis-luminol chemiluminescence, DPPH assay, and thiobarbituric acid assays. Quercetin in the radish showed remarkable ROS scavenging activity.	[45, 46, 47]
Hepato-protective effects	Methanol extract of radish showed significant hepato-protective action against acetaminophen-induced liver damage in the albino rats. Treatment with sulforaphane and sulfur-radish extract resulted in notable amelioration of hepatotoxicity induced by CCl4.	[48, 49]
Immune-protective effects	Tunisian radish indicated immunomodulatory effects in zearalenone-induced ROS.	[50, 51]
Anti-hypertensive / Cardio-protective effects	Different type of extracts and powders of radish showed considerable decrease in blood pressure of spontaneous hypertensive rats. Ethanolic extract of Raphanus seeds resulted in a significant reserve of the ACE enzyme that explains anti-hypertensive possibility. The antihypertensive effects of Raphanus are resulted due to its vasodilator effects. Radish plant is rich in bioactive constituents, because of which it has an outstanding cardio-protective activity. The general anti-hypertensive along with cardio-protective mechanism of Raphanus sativus is illustrated in figure 5.	[52, 53, 46, 54, 55]
Anti-lipase effects	Methanol extracts of Radish exhibited weak inhibitory potential against pancreatic lipase however hydro alcoholic extract of plant leaves showed significant antipancreatic lipase efficacy (IC50 = 10 mg/ml).	[56, 57]
Anti-diabetic effects	Radish plant has notable anti-diabetic and hypoglycemic effects in normal and diabetic rat models. The inhibitory effect of Raphanus on alpha-glucosidase and alpha-amylase enzymes could be correlated to anti-diabetic effects. In a systematic review the role of Raphanus sativus was elaborated in detail in diabetes. The data was combined from June 1987 through May 2017. The possible reasons are mentioned. In another comprehensive review, molecular mechanism of drug targets for diabetes was discussed at length.	[58, 59, 60, 61]
Intestine motility stimulation	Raphanus indicated an increased contractile effect on the duodenum, jejunum, and ileum by activating the muscarinic receptors. Crude extracts of radish showed a spasmogenic effect on guinea pig ileum and colon in dose-dependent manner via the involvement of H1-histaminergic receptors. R. sativus enhances digestion and acts carminative.	[62, 43, 63, 64]
Anti-uroolithiasis effects	Aqueous extract of the plant resulted in slow urolith formation that was in dose-dependent fashion.	[65, 26]
Anti-cancer/ Cytotoxic effects	GC-MS analysis of R. caudatus extract revealed the occurrence of sulforaphane effective against. The possible anti-carcinogenic mechanism of sulforaphane is presented in the figure 6. Variety of extracts of Radish have been reported as potent anticancer against different cancer cell lines like HCT-15, A549, SK-OV-3, SK-MEL-2, HeLa, MCF-7, PC-3, A-549 and HEPG2. Radish also revealed distinct anticancer activity against breast cancer, colon and chronic myeloid leukemia.	[13, 26, 66]
Nephroprotective effects	Radish plant has been traditionally used as nephroprotective. The plant has natural diuretic properties. Radish extract displayed nephroprotective effect against D-galactosamine-induced nephrotoxicity. Sulforaphane present in radish offered extensive usefulness against oxidative tension. Sulforaphane repressed the expiry of dopamine neurons and exposed a shielding outcome against Parkinson's.	[67,68,69,70]

**Toxicity:** In human, any toxicity related to Raphanus have been not reported butvarious procedures like roasting, over-roasting and , drying of seeds can cause toxic effect in mice<sup>71</sup>. Furthermore, erucic acid which is an unsaturated fatty acid is present abundantly in Raphanus seed. Presence of Erucic acid can affect heart and in animals can increase toxicity of doxorubicin as per report.

However, unfavorable effects of erucic acid in Raphanus have not been reported<sup>22</sup>.

Figure 4: Therapeutic effects of Radish (Revised through<sup>21</sup>)

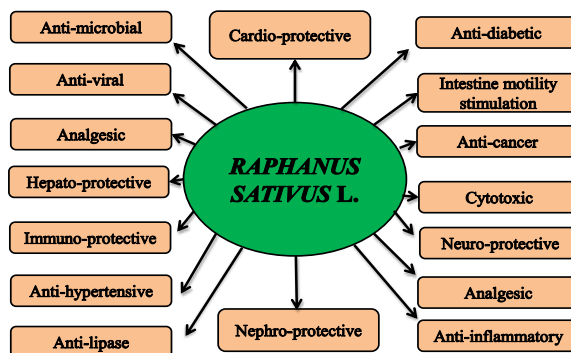


Figure 5: Mechanism of cardio-protection caused by R. caudatus L. (Revised from<sup>22</sup>).

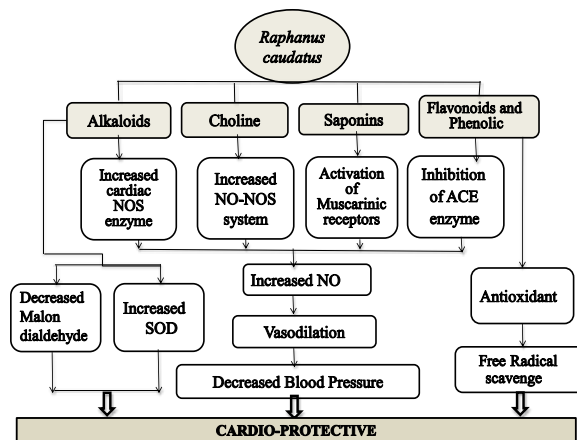
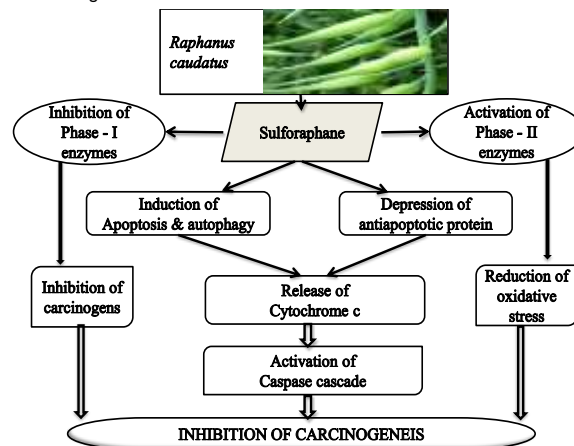


Figure 6: Mechanism of anti-cancer potential caused by R. caudatus L. (Revised through<sup>13</sup>).



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