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Mini Review

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Antioxidant and anticancer activities of *Brassica rapa*: a review

Abstract

Brassica rapa is one of the key *Brassica* species and used against different types of cancer. The different sub-species of *B. rapa* including Pak choi, Chinese cabbage, Sylvestris, Rapa and other vegetable types have both anticancer and antioxidant properties. Its various plant parts like root, leaves, fruit and seeds are full of some important anticancer and anitoxidant compounds including glucosinolates, carotenoids, flavonoids, ketones, aldehydes, vitamin C, selenium, etc. are used against numerous types of cancer cell lines. However, the antioxidant and anticancer activity of *B. rapa* vary with type of genotype, changing dose concentration and associated time interval, type of solvent used for extraction, method of extraction, part of the plant used, type of cancer and cell line, gene expression of different transcription factors involved and other biotic or abiotic factors. The present review focuses on the antioxidant and anticancer activities of different *Brassica* genotypes. In addition the anti-mutagenic potentials of different *B. rapa* genotypes against various types of cancer cell lines have been discussed. However, further research is needed to identify and characterize useful bioactive compounds from diverse *B. rapa* sub-species or ecotypes against other lethal cancer types.

Keywords: anticancer, antioxidant, *brassica rapa*, cancer cell line, vegetable

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Introduction

About 30-40% of cancer diseases are linked to imbalanced diet and other correlated factors.[1] Epidemiological reports give a direct relation between the intake of vegetables and fruits and lower mortality rate from cancer, heart and other degenerative diseases.[2–5] Many vegetables of Cruciferous family are consumed in large quantities in all over the world.[6] The important vegetable types of *Brassica oleracea* are kale, cabbage, broccoli, Brussels sprouts, cauliflower and *Brassica rapa* vegetable types are the turnip, Chinese cabbage and Pak choi.[7] The *Brassica* vegetables i.e. broccoli, cabbage, kale, turnip, Brussels sprouts and cauliflower possess maximum antioxidant potentials.[8] These vegetable species are full of many important secondary metabolites like glucosinolates, folic acid, vitamin C, selenium, carotenoids, and phenolics.[9–13] and efficiently work against many types of cancer causing agents. These compounds work strongly against broad ranges of cancer types like ovary, colon, bladder, lung and breast.[14–17] The anticancer activities of *B. rapa* against different types of cancer is given in Figure 1.

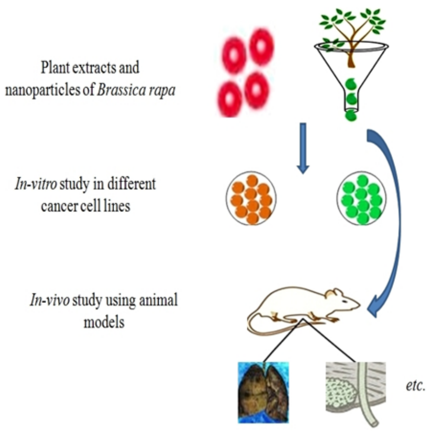

Figure 1 *In-vitro* and *in-vivo* anticancer activities of *B. rapa* against different types of cancer.

Important secondary metabolites of different B. rapa genotypes

Medicinal plants are used all over the world for control and treatment of many lethal diseases.[18–23] The mustard leaves possess many secondary metabolites having potent antioxidant activities.[24] The leaves of *B. campestris*/*B. rapa* show the protective activities against the chromosomal damage and oxidative stress.[25] Brassinosteroids are highly distributed in both pollen and seed of *B. campestris* and *B. napus* and its concentration varies with plant tissues used.[26] Brassinosteroids play vital role in controlling both prostate and breast cancers at micro molar concentration.[27–29]

The other sulphur and nitrogen based compounds like ketones, aldehyde, esters and norisoprenoids are also present.[30] Almost all parts (roots, both young and old leaves, flowers and stem) of *Brassica rapa* sub-species *pekinensis* contain carotenoids. However the higher concentrations of lutein and β-carotene are predominantly present in the flower and leaves.[31] Chung et al.[32] recorded high levels of glucosinolates, phenolic compounds and gene expression from the hairy root culture of *Brassica rapa* ssp. *rapa*. Aires and Carvalho[33] identified three important indole glucosinolates compounds (glucobrassicin, 4-methoxyglucobrassicin, and 1-methoxyglucobrassicin) from the hairy roots culture of *Brassica rapa* subsp. Pekinensis by HPLC-DAD-UV/Vis method. Several other important antioxidant phenolic compounds were studied and identified from Chinese cabbage leaves[34–38] Seo et al.[39] envisaged Glucosinolates (GSLs) amount and its expression analysis in 38 diverse *B. rapa* accessions from eight different sub-species. Twelve new GSLs were identified and were grouped into three different groups on the basis of GSL amount and its expression levels. However, they recorded varying GSLs amount and its BRMYB transcription factors (TFs) in all tested genotypes. The three BRMYB TFs (*BrMYB28.3, MYBB51.1* and *BrMYB122.*2) positively regulated the GSLs content in almost all genotypes. In addition high levels of gene expression of *BrMYB28*s and *BrMYB34* was observed in both biotic and abiotic stresses.

The antioxidant and anticancer activities of different *B. rapa* genotypes

The crude extract and different fractions of the fruit part of *B. rapa* shows strong antioxidant activity on glutathione peroxidase (GPx), superoxide dismutase (SOD) enzymes and total antioxidant status (TAS) in blood sample at concentration dependent manner.[40] The anticancer potential of vegetable *Brassica* species is directly linked to the presence of these bioactive substances. It enhances detoxification enzymes, minimizes the oxidative stress, evokes immune response, lower cancer risk and malignancy, inhibits the mutation and also lowers cancer cells proliferation. The presence of glucosinolates undergoes break down to other important bioactive compounds i.e. indoles and isothiocyanates with the help of important plant tissue enzyme called myrosynase. The resultant biologically active substances with the help of two phase enzymes (Phase I and II) of xenobiotic metabolism may lead the elimination of cancer causing factors; inhibit DNA methylation and cancer growth.[41]

The strongest antioxidant activities of the aqueous extract of both aerial parts and roots of *B. rapa* are also recorded by Beltagy.[42] However more antioxidant activities were reported from root extract than turnip greens. The ethyl acetate fraction of *B. rapa* roots give maximum free radical scavenging, lipid peroxidation inhibition and reducing power activities due presence of highest amount of total phenolic compounds.[43] The antioxidant potential and phenolic content is higher in white cabbage (*B. oleracea*) than Chinese cabbage (*B. rapa*). But the antioxidant amount in cabbage was much higher in the first 8-12 weeks.[44] The choy sum genotype of *B. rapa* have higher antioxidant activity than three genotypes of *B. oleracea* genotypes (broccoli, cabbage and cauliflower). Among *B. oleracea* genotypes the broccoli shows maximum antioxidant activities followed by cabbage and cauliflower.[45] The antioxidant activities among different *Brassica* species vary with steaming, boiling and microwave processes. The antioxidant activity is higher in steamed followed by boiled and microwave respectively. In Chinese cabbage slight boiling leads to unchanged or minor decrease the antioxidant activity.[45] The nutrient rich soil increases the antioxidant capacity of green cabbage.[46] The sulphur availability leads to increased of antioxidant activity in two *B. rapa* sub-species sylvestris.[47]

B. rapa has strong anticancer and moderate antioxidant activity against human lung cancer A-549 cell line (ATCC#CCL-185).[48,49] The crude extract of *B. rapa* contain glucosonalates and it work as mutagenic agent in human lymphocytes.[50] The *in-vitro* cytotoxic activity of *B. rapa* roots was also recorded in three different types of cancer cell line including Hela, Hep-2 and AMN-3. However, the cytotoxic potential of crude root extracts varies with type of dose concentrations and its timing and with type of cells. The maximum growth inhibition of 42 and 63% were recorded at 1250μg/ml concentration against Hep-2 and ANM-3 cell lines respectively. While, the optimum growth inhibition (64%) against Hela cell was recorded at 10,000μg/ml concentration after exposure for 24hours exposure.[51] The other important bioactive compounds of *B. rapa* i.e. brassica phenanthrene A, diarylheptanoid, 6-paradol and trans-6-shogaol, possessed high level of inhibitory activity against three human cancer cell lines i.e. HeLa, HCT-116 and MCF-7.[52] The transgenic hairy roots of *Brassica rapa* ssp. *rapa* have more antioxidant potential than non-transgenic roots. Also the anticancer activities against MCF-7 and HT-29 cell lines were higher in hairy root culture than non-transformed roots.[32] The juice of *Brassica* species provides protection to human hepatome cells against the genotoxic effect of the carcinogens.[53] Mayilsamy and Krishnaswamy[54] studied the anti-tumor effect of methanolic extract and nanoparticles of *Brassica rapa* Chinensis at two different doses (800 mg/kg b.wt and 1mg/kg b.wt). They recorded strong antitumor effect against Dalton ascites lymphoma cells (DLA) in mice model experiment. They also reported that DLA tumor induced mice might survive long due to the presence of some important anti-tumor secondary metabolites.

Conclusion

Brassica rapa has rich diversity in the world including different sub-species. Its different plant parts show strong anticancer and antioxidant activities. In recent studies, its metabolites showed strong anti-cancerous potential against ovary, colon, bladder, lung, prostate, breast and many other types of cancer. The root and leaf parts of different vegetables sub-species are predominantly used against different types of cancer cell lines and showed strong inhibitory activities against cancer. But further studies are needed to identify other unknown secondary metabolites in other important *B. rapa* sub-species against broad ranges of cancer disease, as it is not possible to suggest one cultivar/variety as being the best in terms of antioxidant or anticancer properties. More nanotechnology and *Agrobacterium rhizogenes* hairy root culture techniques should be used to identify and characterize other important bioactive compounds of *B. rapa* against different types of cancer.

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Conflict of interest

Author declare there is no conflict of interties.

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