



Brassicaceous Vegetable Crops: A Significance

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ABSTRACT :

Brassica is a genus of plants in the cabbage and mustard family (Brassicaceae). The members of the genus are informally known as cruciferous vegetables, cabbages, mustard plants, or simply brassicas. Crops from this genus are sometimes called cole crops—derived from the Latin *caulis*, denoting the stem or stalk of a plant.

KEYWORDS:-Seed, Flavor, Agriculture, Vitamins, Value

INTRODUCTION:

The cruciferous vegetable yielding crops viz. Cabbage (*Brassica oleracea* var. *capitata*, L.), Cauliflower (*Brassica oleracea* var. *botrytis*, L.), Knol-knol (*B. oleracea* var. *gongyloides*), Brussel's sprout (*B. oleracea* var. *gemmifera*), kadambsag (*B. oleracea* var. *acephala*), Mustard (*B. campestris* var. *sarson*, L.), Radish (*Raphanus sativus*, L.), Sengri (*B. sativus* var. *caudatus*) and Turnip (*B. rapa*, L.) etc. provide essential ingredients necessary for human diet and for improvement of the large proportion of Indian population health particularly the vegetarians and save the cereals and grains by maintaining the price index of food stuffs. The term "vegetable" is applied to edible herbaceous plants parts there of which are commonly used for culinary purposes and form most nutritive menu of human beings and tone up their energy and vigour. Vegetable growing is one of the most important branch of agriculture. They were appreciated even by ancient people for their tempting succulence, pleasing flavors, high nutritive value and regulatory effects. Vegetable yielding crops contain about 2.0 per cent to 3.0 per cent more protein; four times riboflavin and ten times thiamine than of cereals. They are also rich in minerals and vitamins, which are wanting in other food materials. Previous epidemiological studies have consistently shown that consumption of fruits and vegetables has been associated with reduced risk of chronic diseases, such as cardiovascular diseases and cancers (Gerber et al., 2002, Kris-Etherton et al., 2002 and Serafini et al., 2002) and neurodegenerative diseases, including Parkinson's and Alzheimer's diseases (Di Matteo and Esposito, 2003) as well as inflammation and problems caused by cell and cutaneous aging (Ames et al. 1993). Consuming a diet rich in plant foods will provide a milieu of phytochemicals, nonnutritive substances in plants that possess health-protective benefits. Vegetables contain an abundance of phenolic compounds, terpenoids, pigments, and other natural antioxidants that have been associated with protection from and/or treatment of chronic diseases viz. heart, cancer, diabetes, and hypertension as well as other medical conditions (Craig, 1997). The protective action of Brassicaceous vegetables has been attributed due to the presence of antioxidant phytochemicals, especially antioxidant vitamins including ascorbic acid, α -tocopherol and β -carotene (Prior and Guohua, 2000). As antioxidants, the carotenes, tocopherols and ascorbate have the potential to prevent and treat malignant diseases

Current Status of vegetable cultivation in India:

The production of vegetable crops is insufficient to meet out the present day requirements. Along with progress in development, the proportion of the population who do not receive adequate food is also decreasing. However, levels of household food inadequacy are highest among agricultural workers, and in the states of West Bengal (10.6%) followed by Orissa (4.8%), with shortages highest from December to March. (Johnson et al., 2008) According to world health organization the minimum requirement of pulses and vegetables is 80.0 gms per individual and we are able to get only 40.0 gms (Sidhu and Sidhu, 1991). Vegetables constitute hardly 8.0-10.0 percent of total food intake, which is distressingly low as compared to 45.0 percent in Japan. Of the total land (Fig 1), an operational area of 166 million ha (107 million farms) are available for agriculture (1991 = latest available data) (INDIASTAT, 2007) with 4% used for vegetables (Johnson et al., 2008). The area and production growth trend for vegetable crops has been rising each year (Fig 2) however the production has to be boosted from 12.0 million tonnes to 23.80 million tonnes by the end of 20th century to meet the boosting need of growing population (Lal, 1986), which can be achieved by minimizing the incidence of losses held during threshing, transportation, processing and storage. India is the second largest producer of vegetables in the world next only to China with an estimated production of about 50.09 million tonnes from an area of 4.5 million hectares at an average yield of 11.3 tonnes per hectare. Varied agro-climatic conditions in India make it possible to grow a wide variety of vegetable crops all the year round in one part of the country or another. (Sidhu, 1998).

Brassicaceous vegetable crops and their nutritional value:

Out of these vegetables Cabbage (*B. oleracea* var. *capitata*, L.), Cauliflower (*B. oleracea* var. *botrytis*, L.), Radish (*Raphanus sativus*, L.), Turnip (*B. rapa*, L.), Sarson (*B. campestris*, L.), have a prominent place in our diet being rich in source of antioxidants viz. vitamins A and C, calcium, iron, folate, solvent fibres, lignans, carbohydrates, fats, proteins and minerals essential for a balanced diet and maintenance of good health (Heimler et al., 2006). These vegetable crops because of high nutritional value are regarded as 'functional food'. But the seeds of these vegetable crops harbour fungal spores during storage and cause damages either directly to the crops or which are raised from contaminated stocks. Government of India is fully cautious of this problem and has been trying level best to accelerate the production of these crops so far. Family Brassicaceae also known as the Cruciferae, (the Mustard or Cabbage family) is of flowering plants (Angiospermae). It contains over 338 genera and about 3,700 species. These are of high economic importance. Brassicaceous vegetables are consumed all over the year as the ingredients of different salads or after cooking of raw and frozen vegetables. As regards to the nutritional profile, the Brassicaceae have a low caloric value (24–34 kcal/100 g.) depending on the low contents of protein (1.44– 2.82/100 g.) and fat (0.12–0.37/100 g.) and an average content of fibre of 2.5/100 g. On the contrary, the contents of minerals, vitamins and others phytochemicals such as polyphenols, glucosinolates and sulphur containing compounds are notable. The contribution of Brassicaceous vegetables to health improvement can be related to their antioxidant capacity. Phenolic compounds with vitamin C are the major antioxidants of Brassica vegetables. Lipid-soluble antioxidants (carotenoids and vitamin E) were responsible for up to 20% of the total antioxidant activity of Brassica vegetables (Podsędek, 2007). In addition to antioxidant vitamins, carotenoids, and polyphenols, Brassica vegetables provide a large group of glucosinolates, which according to (Plumb et al., 1996) possess rather low antioxidant activity, but the products of their hydrolysis can protect against cancer (Keum et al. 2004; Paolini, 1998). Glucosinolates are substrates of myrosinases, which convert the glucosinolates to the corresponding isothiocyanates when plant tissues are mechanically disrupted. Glucoraphasatin and glucoraphenin-derived isothiocyanates induced apoptosis in cancer cells (Papi et al., 2008). Seeds of Brassicas contain 35.0-50.0 per cent fatty oil and 2.0 per cent protein matter. The essential oil content is very low containing small amount of glucosides, which on hydrolysis yield volatile Mustard oil. The fatty oil obtained from different varieties resemble one another and are characterized by a higher proportion of erucic acid (C₁₂H₄O₂), oleic acid 20.0-30.0 per cent and linoleic acid 15.0- 25.0 per cent. The saturated acids, 'palmetic', 'stearic' and 'lignoceric', are present in very small proportions. The glycerides consist of 45.0 per cent of dioleorucins and oladodierucins (Hilditch, 1943). The Mustard oil pressed from Mustard seeds, *B. nigra* and *B. alba* is called Mustard oil. In India edible Mustard oil derived from Brassicas (Hindi: sarson ka tel, kadva tel) is called Mustard oil. It is extracted from the seeds of yellow and black sarson, toria and rai. *B. juncea* var. *cunefolia* in north Bengal and Assam is chiefly grown as vegetable crops. Brassica *campestris*, commonly known as Sarson is widely cultivated as vegetable and oilseed. It has broad-based stem and clasping leaves, which are somewhat hairy and glaucous. In India it is represented by the two varieties viz. *B. campestris* var. *dichotoma* (watt and toria) and *B. campestris* var. *toria* (duthie and fuller) known in Hindi as toria. *B. campestris* var. *dichotoma* is grown all over Punjab and other provinces of India. It is grown as mixed crop. *B. campestris* var. *sarson* is commonly called as yellow sarson in Hindi and in Bengali-sarisa. Petals are narrow. Pods are plumpy with a slightly flattened beak with 1-2 seeds. Seeds are yellow with smooth seed coat and nonmucilaginous epidermis. Plant is a self sterile and also matures later than toria. Plants are easily distinguished by stem, clasping leaves and rigid compact and tall in habit, commonly grown in Bengal, Bihar and Uttar Pradesh having its origin in North Eastern India and China. The seed contains about 40% semi-drying oil. The oil is used as salad and cooking oil or in the manufacture of margarine. Radish (*Raphanus sativus*) is an edible root vegetable of the Brassicaceae family. Radish is grown and consumed throughout the world, Far East Asian countries, such as Japan, Korea, and China, is the major consuming regions. Radishes are rich in ascorbic acid, folic acid, and potassium. They are a good source of vitamin B6, riboflavin, magnesium, copper, and calcium. Radishes are suggested as an alternative treatment for a variety of ailments including whooping cough, cancer, coughs, gastric discomfort, liver problems, constipation, dyspepsia, gallbladder problems, arthritis, gallstones, kidney stones and intestinal parasites. Radish taproots are eaten raw, pickled, and boiled. Recently, researchers have become interested in the Radish because extracts and compounds made from Radishes have shown many health benefits. Glucoraphasatin, a major glucosinolate in the Radish, quenches hydrogen peroxide and can be efficiently oxidised to glucoraphenin, which is a minor glucosinolate in the Radish (Barillari et al., 2005). Recent studies on the health-promoting properties of the Radish have highlighted the functions of glucosinolates and isothiocyanates, because these compounds show antioxidative and anticarcinogenic activities (Barillari et al., 2005, Hanlon et al., 2007, Papi et al., 2008). Glucosinolate (GS) is thought to be the key determinants to Radish's characteristic taste and aftertaste attributes often regarded as pungent and burning sensation (Levine et al., 1998). Turnip or White Turnip (*Brassica rapa* var. *rapa*) is a root vegetable commonly grown in temperate climates worldwide for its white, bulbous taproot. Small, tender varieties are grown for human consumption, while larger varieties are grown as feed for livestock. Its fleshy roots are edible. It is grown as a cold season crop in the plains of Punjab, U.P and sometimes on hills. The seeds from varieties like Turnip red and Turnip are sown during July and August. It can grow on all kinds of soils. It thrives best in deep rich loam and requires limited manuring. Seeds are sown in broadcast and seedlings are thinned. It requires frequent irrigation and harvested in 45-70 days. The Turnip's root is high only in Vitamin C. The green leaves of the Turnip top ("Turnip greens") are a good source of Vitamin A, C and K, folate, as well as calcium. Turnip greens are high in lutein. Cabbage is a popular cultivar of the species *Brassica oleracea* var. *capitata*, L. of the Family Brassicaceae (Cruciferae), used as a leafy green vegetable. It is a herbaceous, biennial, dicotyledonous flowering plant distinguished by a short stem upon which is crowded a mass of leaves, usually green but in some varieties red or purplish, which while immature form a characteristic compact, globular cluster (Cabbage head). The sharp or bitter taste sometimes present in Cabbage is due to glucosinolates. Cabbages are also a good source of riboflavin. The only part of the plant that is normally eaten is the leafy head; more precisely, the spherical cluster of immature leaves, excluding the partially unfolded outer leaves. The so-called 'Cabbage head' is widely consumed raw, cooked, or preserved in a great variety of dishes. Cabbage is also used in many popular dishes in India. Cabbage is an excellent source of Vitamin C. It also contains significant amounts of glutamine, an amino acid which has anti-inflammatory properties. It is a source of indole-3-carbinol, or I3C, a compound used as an adjuvant therapy for recurrent respiratory papillomatosis, a disease of the head and neck caused by human papillomavirus (usually types 6 and 11) that causes growths in the airway that can lead to death. *Brassica oleracea* var. *botrytis*, L. In India it is known as phool ghobi. The edible portion of Cauliflower is the white curd like mass of aggregation of abortive flowers. It is cultivated throughout India, known as 'Patna', 'Snowball' and 'Forerunner'. The crop requires cool and moist climate. The plants thrive best on a

rich loamy soil. The plants produce head prematurely if not sufficiently moist. The seeds are sown between April to September in the plains and from February to June on the hills. Cauliflower is low in fat, high in dietary fiber, folate, water and vitamin C, possessing a very high nutritional density. As a member of the Brassica family, Cauliflower shares with Broccoli and Cabbage several phytochemicals which are beneficial to human health, including sulforaphane, an anti-cancer compound released when Cauliflower is chopped or chewed. In addition, the compound indole-3-carbinol, which appears to work as an anti-estrogen, appears to slow or prevent the growth of tumors of the breast and prostate. Cauliflower also contains other glucosinolates besides sulfuraphane, which improve the liver's ability to detoxify carcinogenic substances. A high intake of Cauliflower has been found to reduce the risk of aggressive prostate cancer.

Brassicaceous crops and diseases:

Despite of their economic importance and high yield varieties and new agroclimatic practices, per hectare production of Brassicaceous vegetable crops is low in Uttar Pradesh and other states of the country. Amongst the various factors for such a poor yield and deterioration of the proteinaceous content in the seeds, the cultivation of Brassicaceous vegetable crops is highly handicapped due to incidence of destructive diseases in most of the vegetable growing areas in the world causing substantial loss in yield. Every year the crops suffer from the diseases caused by fungi, bacteria, viruses, nematodes and mycoplasma like organism. This awakening has led to the intensification of research embracing various disciplines and role of seed health as a new strategy, is now increasingly realized. Despite the role of seed borne organism in causing diseases of economic importance which have been known in India and abroad for a long period, this field has altogether neglected. Introduction Chapter 1 8 Seed carry within themselves several organisms such as fungi, bacteria, viruses and actinomycetes from one locality to another locality externally or internally which deteriorate market value of seeds causing considerable damages and reduction in seed contents. The incidence and spread of seed borne diseases have increased in recent years due to introduction of new varieties into territories where they are not indigenous and also by growing the same crop over wide areas to facilitate its handling and harvesting to get maximum yield per hectare by intensive cropping. Brassica crops are heavily challenged by various fungal pathogens and insects, whereas bacterial and viral diseases have little effect on yield. *Fusarium oxysporum* is the plant pathogen that infects Brassica crops causing the wilt disease leading to great loss in quantity and quality of oilseed Brassica. *Aspergillus niger* causes black mold on certain fruits and vegetables and is a common contaminant of food. *Leptosphaeria maculans* causing blackleg or stem cankers are the most devastating fungal diseases for oilseed Brassica, particularly canola (*Brassica napus* and *Brassica rapa*). The devastating effect of *L. maculans* can lead to severe yield loss in many regions in the world. For example the oilseed rape industry of Australia was completely wiped out due to *L. maculans* in 1970s. The annual costs of blackleg (*L. maculans*) are estimated to range between 11.3 and 30.1 million € in Australia, 36.8 and 147 million € in France, and 14 and 56 million € in the U.K. The vegetable crops under study viz. *Brassica campestris* var. *sarson*, *Brassica oleracea* var. *capitata*, *B. oleracea* var. *botrytis*, *B. rapa* and *Raphanus sativus* are subjected to large number of diseases as reported from India and abroad. Damping-off normally caused by soil fungi such as *Pythium* and *Rhizoctonia*, Black-leg, caused by *Phoma lingam* (*Leptosphaeria maculans*), Club-root, caused by *Plasmodiophora brassicae*, *Fusarium* yellows or wilt, a soil-borne fungus, caused by *Fusarium oxysporum*.sp. *conglutinans*, white mold or white rot, caused by the fungus *Scierotinia sclerotiorum* Downy mildew, caused by *Peronospora parasitica*, *Alternaria* leaf spots, caused by *Alternaria brassicae* are the common seedborne disease occurring in the Brassicaceous crops. Besides these pathogenic diseases the seeds of Brassicaceous crops under study are subjected to large number of microorganisms which may be present outside or inside the seed samples which during storage are responsible for reduction of seedling vigour and deterioration in quality. They are also known to cause heating of Introduction Chapter 1 9 seeds, mustiness and sick and germ damage seeds in storage. Microorganisms associated with seeds cause seed rot, seedling mortality, leaf spot, blight, stem or petiole blight, rot, pre and post emergence and damping of seedling or disease of adult plant in the field. Post harvest spoilage of stored grains due to seed borne fungi also caused biochemical changes in seed contents making them unfit for consumption and sowing purposes. Premature harvesting and its unscientific harvesting promotes the aggressiveness of the mycoflora causing seed rot, seedling mortality, changes in seed contents, discolouration of seeds, malformation, spot on leaves and pods and other visible symptoms on plants. Hyper parasitism is well known in phytopathological studies especially with parasitic forms. There are numerous examples as detailed in review of literature, where single organism produced greater pathogenic effects, when attack alone or in association with others. Apart from the disease causing organisms a large number of saprophytic microorganisms associated with different kinds of Brassicaceous seeds are the species of *Alternaria*, *Aspergillus*, *Mucor* and *Rhizopus* etc. Some fungi viz. *Mucor* and *Rhizopus* overgrow germination beds covering the germinated seeds with mycelia mat and hamper the rate of germination. The different species of *Aspergillus* and *Penicillium* are the major cause of post harvest deterioration and spoilage of stored seeds unfit for use producing various toxins containing health hazard for human being. During storage period of seeds in different containers, seeds are often affected by different abiotic and biotic factors. The former include the nature of container, seed moisture content, temperature, relative humidity, initial viability, stage of maturity at harvest, storage gas and the initial moisture content of seed entering into storage (Harrington, 1972), whereas latter include the attack of different insects, pests, fungi, nematodes and other microorganisms. Seeds cannot retain their viability indefinitely and after a period of time, the seeds deteriorate (Pascual et al., 2006). Proper and safe storage conditions are defined as those that maintain seed quality without loss of vigour for three years (Joao Abba and Lovato, 1999). The parameters of temperature and relative humidity during storage are decisive in the process of loss of seed viability and alterations in the grain colour and composition (Whigham and Minor, 1978; Liu, 1997; Lacerda et al., 2003). Introduction Chapter 1 10 Moisture is one of the major factors contributing to the deterioration during storage of durable agricultural products in the tropics and subtropics. All crops contain moisture at harvest. The seeds being a viable organ respire to produce heat and moisture. This moisture if allowed to retain produces conditions suitable for the growth of microorganism. The condition may also encourage the germination of stored seeds which may lead to its complete economic loss to the farmer. It is concluded that ultra-dry seed storage is beneficial for maintaining seed vigour and that starchy mobilization proceeds regularly during germination (Wang et al., 2005). Seed vigour is defined by the International Seed Testing Association (ISTA) as “the sum total of those properties of the seed that determine the level of activity and performance of the seed during germination and seedling emergence” (ISTA, 2006). Temperature is another important factor which affects the seed quality during storage. High temperature conditions are required for most of the fungal growth. As the temperature is reduced the metabolic rate of the microorganism is decreased which reduces its growth and prevalence in seeds. Thus for the maintenance of seed vigour and viability an average

temperature and moisture conditions are required. Fluctuations in temperature, humidity and prolonged storage result in considerable nutrient losses (Shah et al., 2002). As reported by Bhale et al. (2001), seed health testing is important because: (i) seed may harbour a virulent strain of the disease pathogen, (ii) the presence of the pathogen in the seed implies the earliest possible establishment of the infection in seedlings, (iii) pathogen-free soil may be infected as a result of planting infected seeds there by increasing the soil-borne inoculum which may eventually affect subsequent crops raised from healthy seed, (iv) new physiological races/strains may be introduced with the seed so that varieties resistant to endemic races of the organism become affected, and (v) it is important to know the health status of seed lots and to keep their quality under storage and consequently their planting value. Infection of seed-borne pathogens results in seed rots, seedling decay, pre and post emergence mortality and abnormalities (Icishahayo et al. 2009).

Objectives :

1. Collection of seed samples of Cabbage, Cauliflower, Mustard, Radish and Turnip.
2. To detect out the seed borne fungi associated with the seeds by isolating them in pure culture from the seed samples collected from different localities.
3. Identification of fungi isolated on the basis of morphological and cultural characters.
4. Study the effect of different lengths of storage, temperature and relative humidity during the storage on the type and prevalence of mycoflora on the seed borne fungi of seeds.
5. Study the effect of isolated fungi on the germination of seeds and seedlings under laboratory conditions.
6. Study the effect of isolated fungi on the commercial quality of the seeds under different storage conditions.
7. Study the effect of isolated fungi on the constituents of seeds.
8. Study the effect of associative antagonism between the seedborne fungal species of mycoflora isolated.
9. Study and suggest control measures against the mycolora, which affect the quality of seeds and their germination.
10. Study the effect of fungicidal seed treatment on seed germination, plant stand and yield.

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