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ORIGINAL PAPER

Breeding for processing qualities in traditional vegetables conventional and molecular approaches

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Quality is a multi-faceted and subjective concept. The International Organization for Standardization (ISO) defines quality as "**the totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs**" (ISO No 8402; 1986, 3.1). The most important quality characteristics depend on user perspectives, needs and priorities, which vary across groups of users. For this reason the major challenge is to achieve a compromise among the needs of the various possible users (current and potential) in order to produce and disseminate statistical outputs that satisfy the most important needs given constraints concerning available resources. The complexity of quality as a breeding target is its likely cause for neglect. Sometimes, what may be good quality to some is not adequate to others. The multiplicity of breeding objectives other than quality is already a tremendous burden to the plant breeder that very often consideration of quality comes as an afterthought. Among the diverse attributes contributing to quality, the most commonly used, though not necessarily the most important, are yield, size, colour, texture, flavour and absence of defects. Quality characteristics were grouped into three classes Quantitative (which includes yield and net weight); hidden (including nutritive value and toxic substances) and sensory (subdivided into appearance, e.g. colour, size, flavour including smell and texture. Another important aspect determining the quality parameters is the pre-harvest and post-harvest factors affecting the quality of the vegetables. Processing qualities of vegetable crops are basic requirements which all breeders have to consider and the breeders along with processors will determine the qualities of future cultivars and the products derived them. Both breeders and processors are being influenced by the consumers. Consumers are becoming more selective and more demanding for vegetables with specific characteristics.

The improvements that they require of vegetables and vegetable products are a higher vitamin content, a higher sugar to acid ratio and a better natural colour and flavour with little or no need for colour additives.

The quality traits may be governed by

(1) Oligo genic Inheritance

(2) Polygenic Inheritance

(3) Maternal Effects

(1) Oligo genic inheritance:

Inheritance is governed by one or few major genes, each gene has large and easily detectable effect on the expression of nutritional quality character. In tomato, high beta carotene content is conditioned by two major genes plus modifiers.

(2) Polygenic inheritance:

Inheritance is governed by several genes each with small additive effect. In such inheritance, the variation for a character is continuous from one extreme to another. Characters which are governed by polygenes are sensitive to environmental changes and generally have low heritability. In carrot, high carotenoid content exhibits complex inheritance pattern.

(3) Maternal Effects:

Usually, such traits are concerned with grain characteristics, eg, seed size (quite common), protein content *etc*. For ex. reported for protein content in cowpea.

OKRA

Improvement of various quality and processing attributes of okra has been never been attempted though direct breeding. The improvement, if any, in these traits has been through breeding for other economic characters. The important characteristics that determine the quality and processing ability are Yield, fruit number, length, weight, color, pod pubescence Spines, Fiber ,Content of vitamin C Protein, Total sugar content , Resistance or tolerance to pest and diseases.

For Dehydration: less fiber, less mucilaginous substances, high protein, high dry matter and minerals are important attributes.

For canning and Freezing: high chlorophyll, less crude fiber and mucilage substance, low dry matter and high protein, vitamin and minerals are required.

Small tender pods should be taken for canning. (G. KALLOO, 1986)

CUCUMBER

To breed a variety for processing cucumber (uniform, concentrated fruit set having more number of lateral branches (Multiple lateral branching) and desirables fruit size,

shape and colour.The pickling type of cucumber have smaller length / diameter ratio than the slicing cucumber types and have more pronounced warts (tubercles) at the immature stage. In pickling cucumber, placental hollowness and carpel sepration are the problems.

BITTER GOURD

Bitter gourd (*Momordica charantia* L. also known as karela in hindi or balsam pear or bitter melon is the most widely cultivated species of *Momordica*. It is grown in India, Srilanka, Philippines, Thailand, Malaysia, China, Japan, Australia, tropical Africa, South America and the Caribbean. Bitter gourd is consumed regularly as part of several Asian cuisines and has been used for centuries in ancient traditional Indian, Chinese, and African medicine. It is a common cucurbit in the wild flora of Africa, occurring almost throughout tropical Africa and occasionally collected from the wild as a vegetable or medicinal plant. Other species, apart from their importance as wild relatives of bitter gourd, have direct utility as nutritious vegetables and multipurpose medicinal plants. Bitter gourd fruits are good source of carbohydrates, proteins, vitamins, and minerals and have the highest nutritive value among cucurbits (Behera *et al*., 2007). Considerable variation in nutrients, including protein, carbohydrates, iron, zinc, calcium, magnesium, phosphorous, and ascorbic acid, has been observed in bitter gourd.

Bitter gourd extracts possess antioxidant, antimicrobial, antiviral, antihepatotoxic and antiulcerogenic properties while also having the ability to lower blood sugar. These medicinal activities are attributed to an array of biologically active plant chemicals, including triterpenes, pisteins and steroids (Grover and Yadav, 2004). Ethno-medical reports of *M. charantia* indicated that it is used in traditional treatment of various ulcers, diabetes, and infections (Beloin *et al*., 2005). While the root decoctions have abortifacient properties, leaf and stem decoctions are used in treatment of dysentery, rheumatism, and gout (Subratty *et al*., 2005). In addition, juice of *M. charantia* drawn directly from fruit traditionally has been used for medicinal purposes world- wide. Likewise, the extracted juice from leaf, fruit and even whole plant are routinely used for treatment of wounds, infections, parasites (e.g., worms), measles, hepatitis, and fevers (Behera *et al*, 2010).

Plant extracts of bitter gourd have been used traditionally, in the treatment of diabetes (e.g., India, China, and Central America. The beneficial attributes of hypoglycaemic compounds anti-carcinogenic and hypercholesterolemic properties in bitter gourd fruit mesocarp, seed and vegetative plant parts have been widely documented. It has been determined-that bitter gourd contains the health-promoting substances charantin, momorcharin (inactivating ribosome; Leung *et a*l., 1997), MAP30 (a *Momordica*-HIV protein that suppresses HIV activity; vicine (hypoglycaemic, and momordicoside A and B. The antimicrobial antifertility, antiviral, and antiulcer genic activities characterized in bitter gourd have been attributed to a broad array of biologically active phytochemicals, including triterpenes, and steroids.

The antioxidant properties of carotenoids which protect plant photosynthetic processes may also protect humans from carcinogens and heart disease (Simon, 1997). Natural antioxidants in bitter gourd are primarily plant phenolics and polyphenolic compounds derived from fruits and seeds, and thus are alternatives to replace synthetic antioxidants to enhance food quality. Bitter gourd fruit contains as many as 14 carotenoids (five at the immature stage, and six and 14 in the mature-green and ripe stages, respectively) and crypto-xanthin which is the principal chloroplast- and chromoplast-based pigment in ripe fruit.

Additional carotenoids such as β-carotene, zeaxanthin and lycopene (primarily at ripe stage), and lutein and ά-carotene (primarily at immature fruit) are also prevalent in the fruits, and thus bitter gourd could serve as an instructive model for studying carotenogenesis during ripening Tran and Roymundo, 1999). The total carotenoid dry weight concentration of the seeds of bitter gourd at the immature (~2.8 µg/ g^{-1}) stage is relatively low compared to the ripe (~271 ug/g^{-1}') stage. Carotene in the ripe seed coat is exclusively lycopene (~261 µg/g-1) which accounts for 96% of the total carotenoids found in ripe seeds. Bitter gourd fruits are also a rich source of the phenolic compounds like gallic acid, gentisic acid, catechin, chlorogenic acid, and epicatechin that vary from 80 to over 800 mg/kg-1, each on dry weight basis among cultivars and tissues. These natural plant phenolics are an excellent source of antioxidants for reducing blood pressure, cancer, and cardiovascular diseases.

WAX GOURD

The immature fruit is consumed as a vegetable. The mature fruit are used as raw, or cooked and for preparing candies / Petha. The young leaves, flowers and immature and mature seeds are also eaten.It is also used in ayurvedic medicines. It lowers the blood sugar.

DRUMSTICK

Drumstick leaves (*Moringa oleifera*) is one of the most useful tropical trees. Presently, one of the most important trends in food and pharmaceutical industries is the growing demand for valuable natural sources of nutritional compounds. Green leafy vegetables are good sources of vitamins and minerals. The leaves are also free of anti-nutritive factors such as phenols, tannins and saponins . Fellows reported that blanching which is an important preprocessing heat treatment of vegetable destined for freezing, canning or dehydration inevitably causes separation and loss of water soluble nutrients such as minerals, water soluble vitamins. Leafy vegetables occupy an important position in the Indian diet. India produce about 12% of the total world's production of vegetables but it is not enough to meet this country's requirements. Beside post-harvest loss reduction, improved processing and storage of processed products can play a significant role in availability of these products. Reduction in processing and storage costs can further increase their availability. Drying is the most commonly used method for enhancing shelf life of leafy vegetables. The utilization of dried Coriander leaves powder since a

decade during unavailability or offseason. The dried green leafy vegetables were mostly used in powder form, which reduced the volume required for storage and easy to handle. During the drying process there is lot of losses takes place like nutritional, physical and chemical composition of leaves. When fenugreek leaves were dried by using solar, infra-red and tray drier there was a loss of color pigments. Fenugreek leaves pretreated with 0.1% Sodium bicarbonate gave better results in chlorophyll-a, chlorophyll-b and carotene retention. So, to minimize drying losses various pretreatments are used. India is one of largest producer of fruits and vegetables in world. It is estimated that India processes less than 1% of production and about 30-35% production cannot be utilized due to lack of adequate technology for processing, handling, storage and processing infrastructure. To avoid the extensive losses drying is required. The leaves are highly nutritious, being a significant source of beta-carotene, proteins. (Satwase *et al.,* 2013)

AMARANTHUS

Leaf amaranths are used as vegetable but the young plants with tender stems and leaves of grain amaranths are also eaten as leafy vegetables. The amaranths are rich source of protein, minerals and vitamin A and C. The ant nutrient factors like oxalates and nitrates cause kidney stone and methaehaemoglobinin the blood. (Gupta *et al*., 1989)

LUFFA SPECIES

Luffangulin, a novel ribosome inactivating peptide from ridge gourd (Wang *et al*., 2003) .Both LUCY and LUAC leaves extracts may be a potential source of natural antioxidants, antimicrobial compounds and anticancer agents to be used in the treatment of various oxidative disorders, infectious diseases caused by resistant microorganisms and cancer respectively. (Bulbul *et al*., 2014)Snake-bite is an important and serious medicolegal problem in many parts of the world, especially in South Asian countries. Almost 80% of people in developing countries depend on traditional medicines for primary health care most of which are derived from the plants. The village folk, especially the sugali tribal people are still using the natural resources available in their surroundings. Ethnobotany, the interaction between plants and people involves traditional use of medicinal plants by indigenous communities and management of plant diversity by the aboriginals. Traditional herbal medicine is readily available in rural areas for the treatment of snakebite. Application of the plant or its sap onto the bite area, chewing leaves and bark or drinking plant extracts or decoctions are some procedures used to counteract snake venom activity. Plants are used either single or in combination, as antidotes for snake envenomation by rural populations in India and in many parts of the world (Bello *et al*., 2013).

CONVENTIONAL AND NON CONVENTIONAL BREEDING METHODS

If trait is control by additive gene action selection breeding (mass selection, pedigree selection, bulk selection) is done and if by non-additive gene action hybridization methods are followed like heterosis breeding, back cross method, polyploidy breeding,

mutation breeding and distant hybridization. **Non-conventional methods like molecular** breeding (MAS), tissue culture, somatic hybridization and transgenic are used.

Haploid breeding: most rapid route to the achievement of homozygosity and production of pure lines. There are several ways in which haploid can be achieved. Spontaneous occurrence in plant populations where they are recognized by small narrow leaves, male sterility and abnormal physical features. Such haploids occur at very low frequency and may be of maternal or paternal origin. Anther and microspore culture where the male gamete develops into embryo by a process called androgenesis. The culture of unfertilized ovules and ovaries leading to embryo development from one or more of the haploid cells within the unfertilized embryo sac. This process is called gynogenesis.

Double haploid breeding: Conventional plant breeding methods require 11-13 years for releasing a cultivar whereas double haploid (DH) production helps in getting complete homozygous individuals in a single generation Mainly DH in crucifer breeding applied for construction of linkage maps, genetic analysis of quantitative traits and capturing genetic variation.

Quantitative trait loci (QTL) analysis : Quantitative traits are defined as traits that have a continuous phenotypic distribution. Variances of these traits are often controlled by the segregation of many loci, called quantitative trait loci (QTL). Also known as polygenic traits. Environmental variants can play a large role in determining the phenotypic variance. The polygenic nature and the ability of being modified by the environment make the study of genetic basis for quantitative traits more difficult than that for monogenic traits. The advent of molecular maps and the derived quantitative trait locus (QTL) mapping technology has provided strong evidence that despite the inferior phenotype, exotic germplasm is likely to contain QTLs that can increase the quality of elite breeding lines. These results have motivated the development of a new molecular breeding strategy, referred to as advanced backcross (AB) QTL method which integrates QTL analysis with variety development, by simultaneously identifying and transferring favourable QTL alleles from unadapted to cultivated germplasm.

FUTURE THRUST

There is need to design vegetable varieties suitable for various processing traits. Identification of stable sources of processing traits and molecular markers associated with qualities traits. Identification of transgressive segregants (conventional breeding). Embryo rescue technique to avoid post fertilization barriers. Popularization of transgenic crops among consumers and molecular characterization of crops to know the variability present within the germplasm.

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