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Exploring Biotechnological Advances in Nutritional Enrichment of Solanaceous Crops

Avirup Mukherjee[1] and Dr. Vaishno Dutt[2]
[1]Research Scholar, Department of Economics
[2]Research Guide, Department of Economics
NIILM University, Kaithal, Haryana, India

Abstract: *Solanaceous vegetables include vitamins C, A, E, thiamine, niacin, pyridoxine, folacin, minerals, and fiber, making them important for human nutrition. Besides providing nutrition, veggies provide diversity and make meals appealing with their color, texture, and taste. Rich in minerals, vitamins, and phytonutrients, they are called protective foods. Traditionally, crop development programs have prioritized yield and disease resistance above nutrition. Major antioxidants from solanaceous plants like rely on consumer approval. Plant breeding relies on nutritional qualities to assess plant product appropriateness for diverse purposes and economic output. Total soluble solids, acidity, ascorbic acid, carotenoids, lycopene, vitamin C, reducing sugar, and dry matter hereditary non-additive and overdominance in tomatoes Kalloo Tomatoes, brinjal, chilli, sweet pepper, and potatoes are perennial favorites. Solanaceous vegetables include vitamins, minerals, phytonutrients, antioxidants, flavanoids, carbohydrates, proteins, and lipids. Tomatoes and chillies should be bred for ascorbic acid and other nutrients. AC-588-1 has the greatest antioxidant content among chilli cultivars, followed by BCC-62 and AC 465. These cultivars may be employed in future breeding programmes. As both additive and non-additive genetic components inherited anthocyanin in brinjal, reciprocal recurrent selection may increase this trait.*

Keywords*:* Solanaceous vegetables, Nutritional enhancement, Biofortification

I. INTRODUCTION

With a total cultivated area of 9.20 mha and a production of 162.18 mt, India is the world's largest producer of vegetables, ranking second only to China (NHB, 2013). However, the country's growing population and the mounting pressure on land from urbanization and industrialization have left us with no choice but to boost productivity. Nutrition is the process of obtaining the right quantity of energy and nutrients from food or from ingesting food. Assess the produce's nutritional worth for humans and animals, taking into account its protein and oil contents, vitamin and mineral contents, and the existence of any antinutritional elements. Although farmers and consumers may find them difficult to grasp, they are crucial in determining the health of both humans and animals.

Since tomatoes are a rich source of minerals, vitamins, and organic acids, they are often regarded as "Protective Foods." They may be eaten raw in salads, sandwiches, and other dishes, or processed into paste and puree. The most vital vegetable in the human diet is the chilli, which also provides vitamin A, ascorbic acid, and dietary fiber. Iron (0.24 mg/100 g) and carbs (4.0 g/100 g) are abundant in brinjal. Because they contain more carbohydrates in the form of starch, tuber crops like potatoes provide more calories than green leafy vegetables. Although they are low in protein, calcium, iron, and B vitamins, tuber crops are a somewhat excellent source of vitamin C.

II. NUTRITIONAL STATUS

Malnourished and underweight children make up 53% of the world's kid population, with 40% of them residing in India. South and Southeast Asia is home to 70% of the world's malnourished population. Almost 1.3 billion people live on less than $1 USD every day, and approximately 800 million people still go hungry. Every day, malnutrition-related illnesses claim the lives of over 19,000 out of 40,000 babies. 3.2 billion people suffer from iron and vitamin "A" deficiencies, which cause 125 million schoolchildren to become permanently blind. Table 1 lists diseases and disorders in humans that are brought on by dietary deficiencies.

III. NUTRITIONAL ATTRIBUTES

- **Vitamins:** These are organic substances that an organism needs in trace quantities as essential nutrients. A vitamin is an organic chemical molecule that must be received from food since the body is unable to produce it in adequate amounts.
- **Minerals:** Apart from the four elements found in typical biological molecules carbon, hydrogen, nitrogen, and oxygen minerals are the chemical elements needed by living things. The seven main minerals in the human body are calcium, phosphorus, potassium, sulfur, sodium, chlorine, and magnesium, in order of abundance. Mammalian survival depends on important "trace" or small minerals such iron, cobalt, copper, zinc, molybdenum, iodine, and selenium.
- **Phyto-nutrients:** Plants naturally contain chemical compounds called phytochemicals, which give them color and organoleptic qualities like the rich purple of blueberries and the smell of garlic. Chemicals that may have biological importance but are not recognized as necessary nutrients are often referred to by this name.
- **Antioxidants:** A chemical that prevents fat molecules from oxidizing is called an antioxidant. A chemical process known as oxidation occurs when a material gives up electrons or hydrogen to an oxidizing agent. Free radicals may result from oxidation processes. These radicals may then initiate a chain reaction. A cell may suffer damage or perhaps die as a result of the chain reaction. By eliminating free radical intermediates, antioxidants stop these chain reactions and prevent further oxidation processes. Vitamin C, β-carotene, lycopene, terpenoids, anthocynin, and phenolic compounds are essential sources of antioxidants found in solanaceous plants.
- **Flavanoids:** Flavonoids, sometimes called bioflavonoids, are a type of secondary metabolites found in plants. The name flavonoids comes from the Latin flavus, which means yellow, and refers to their natural color.
- **Dry matter:** Carbohydrates, fats, proteins, vitamins, minerals, and antioxidants would all be considered dry stuff. Ninety percent of a diet's dry weight is made up of the proteins, fats, and carbohydrates that provide food its energy.
- **Carbohydrates:** a dietary ingredient that gives the body energy. Carbohydrates fall into three main categories: sugars, starches, and fiber. Compared to the other macronutrients, carbohydrates raise blood glucose levels more quickly and more than fiber and resistant starch.
- **Proteins:** Large biological molecules called proteins are made up of one or more chains of amino acids. In living things, proteins carry out a wide range of tasks, including as transferring molecules from one place to another, reacting to stimuli, copying DNA, and activating metabolic activities. Monoglycerides, diglycerides, triglycerides, phospholipids, fats, waxes, sterols, and fat-soluble vitamins are all examples of the large class of naturally occurring compounds known as lipids.

IV. DONORS FOR NUTRITIONAL ATTRIBUTES

Wild and weedy relatives of cultivated Species: A crop's ancestral forms, related weedy species, and other species in the same genus that are not being grown are all considered wild relatives. These might be possible sources of genes to enhance the farmed forms' nutritional value. Solanaceous vegetable wild species might be employed as crop enhancement donors.

Breeding approaches for nutritional improvement in Solanaceous Vegetables Evaluation of germplasm: It involves checking for nutritional qualities and favorable agronomic characteristics of germplasm, including cultivars. Forty-two tomato genotypes were assessed at two distinct sites. For TSS% over a broad range of atmospheres, Pantbahar, CLN-31-0-4-2, CLN2123A, CLN2123E, CLN2143B, CLN1621L, AC1017, AC1037, and AC897 showed promise (Joshi and Kohli, 2003).

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Hybridization: Crossing two genotypes with different genetic makeups is known as hybridization. In some situations (polygenic nutritional characteristics), hybridization may potentially be followed by selection using the pedigree breeding approach. The reverse cross technique of breeding may be used to introduce monogenic nutritional traits into cultivated kinds. In order to disrupt unfavorable links and boost desirable gene frequencies, recurrent selection is used. RS and RRS to raise tomato's TSS content.

Interspecific hybridization: These crosses often produce high-quality lines that are used as parents in hybridization programs. High beta carotene is found in tomatoes produced by Lycopersicon esculentum x Lycopersicon hirsutum and Lycopersicon esculentum x Lycopersicon hirsutum f glabratum (Kalloo, 1988).

Table 1: Disease/disorder caused by nutritional deficiency in human

Constituents	Diseases/disorder caused
Protein	Kwashiorkor and Marasmus
carbohydrates	Kwashiorkor and Marasmus
Vitamins	
A	Night blindness
B1	Kwashiorkor and Marasmus
B2	Ckacking of skin
B12	Anaemia
C	Scurvy
D	Rickets
K	Hemorrhage
E	Sterility

Table 2: Wild Species

Wild species	Trait	Crops
Lycopersicon p impinellifolium, L. peruvianum	Ascorbic Acid	Tomato
L.chmielewskii	Total Soluble Solids	-do-
Solanum. khasianum and S. aviculare	solasodine	Brinjal
Capsicum. annuum var aviculare	Capsaicin	Chilli
Solanum microdontum	Calcium	Potato
S.vernei	Starch	-do-
S.phureja spp. phureja	Carotene	-do-

Table 3: Cultivated variety source of nutritional

Varieties	Attribute	Crop
Pusa Red Plum (33mg/100g) Double Rich, Redrock and Hisar Arun	Vitamin C	Tomato
Red Cherry, Novelty, Angurlata, Pusa Ruby	TSS	Tomato
Caro Red, High Pigment	Lycopene and β-carotene	Tomato
NIC 19953	Colour extraction	chilli
CH-3	Vitamin C	Chilli
Kufri Dewa and Kufri Red	Dry matter	Potato
Kufri Chandramukhi and Kufri Sindhuri	Protein and Vitamin C	Potato
Kufri Chipsona 1, 2, 3, & 4	Starch	Potato

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Table 4: Inheritance Pattern of nutritional attributes in solanaceous vegetable crops

Attributes	Gene action	Crops
TSS	Non additive	Tomato
Acidity	Non additive	Tomato
ascorbic acid	Non additive	Tomato
Dry matter content	Over dominance	Tomato
carotenoids and lycopene	Over dominance	Tomato
Reducing sugar	Non additive	Tomato
capsaicin content	Monogenic Additive gene	chilli
Vitamin A	Additive gene	chilli
Vitamin C	Additive and dominance gene	chilli
Anthocynin	Dominant complementary	Brinjal

Table 5: Hybrids have high nutritive value

Hybrids	Attributes	Crops
Arka Vikas x Sel 12, KS10 x Pant T 3 & EC 818703×EC 13042	Ascorbic acid	Tomato
PT 10 x Pant Bahar & Pant Bahar X Pusa Ruby	TSS and Ascorbic acid	Tomato
G-2 x HS 110	Carotenoid and Lycopene	Tomato
L. esculentum cv Rutgers x L. hirsutum	Carotene	Tomato
Punjab Gucchaidar X LLS	Capsaicin	Chilli
PKM-1 x Arka Lohit	Oleoresin	Chilli
CH-3	High vitamin C	Chilli

V. RECENT ADVANCES IN BREEDING OF SOLANACEOUS VEGETABLES FOR NUTRITIONAL IMPROVEMENT

Somaclonal variations: Somaclonal variants are the significant variation that is produced during tissue culture and is heritable (Rai and Rai, 2006). The tomato cultivar "DNAP-9" has 20% more soluble solids thanks to genetic diversity found in plants grown in tissue culture. Transgenic and Nutritional Improvement: A transgenic plant is one in which a foreign gene has been introduced by genetic engineering; the gene is known as a transgene (Singh, 2001).

Transgenic Tomato with Enhanced Antioxidants: According to Roemer et al. (2000), we have created transgenic lines with a bacterial carotenoid gene (crtI) expressing the enzyme phytoene desaturase, which transforms phytoene into lycopene, in order to increase the carotenoid content and profile of tomato fruit. Total carotenoid levels in transgenic tomatoes were not increased by this gene's expression. Nonetheless, the amount of beta-carotene rose about twofold,

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reaching 45% of the total carotenoid content. With the exception of phytoene synthase, which was suppressed, endogenous carotenoid genes were simultaneously increased.

Growth and development were unaffected by these plants' altered carotenoid concentration. The transformants' levels of noncarotenoid isoprenoids remained constant. It has been determined that the phenotypic is repeatable and persistent for a minimum of four generations. Transgenes for low-sugar potatoes: One of the main issues facing potatoes today is the conversion of starch to sugar when they are stored at low temperatures (0°–4°C). To get around this issue, create varieties using transgenes. ADP-GPPase and starch synthatase are the two genes that cause the starch content of potato tubers to rise by 20–40%. These genes come from bacteria (E. coli). The tobacco plant has a gene called an invertase inhibitor, which prevents starch from being converted to sugar while it is being stored. The food sector needs potato types with a high starch content. High-sugar potato cultivars cause the sugar to burn while chips are being made.

Creating a vitamin-rich tomato with a carrot gene: The methods below may be used to generate a tomato that is high in vitamins using the carrot gene:

Copy a carrot gene which converts a pigment beta carotene

Insertion the carrot gene into plasmid

Reintroduction of plasmid into the Agrobacterium

The Agrobacterium transfers the carrot gene to the cells of tomato leaves in petridish

The tomato cells grow and divide in a culture with hormones that encourage the cells to become new shoots and roots

As the tiny new plant grows, the carrot gene converts the tomato's pigment into beta-carotene, creating an enhanced tomato.

VI. CONCLUSION

As has been done in tomato, hp, and ogc, which alter vitamin A concentration, germplasm should be carefully screened to identify key genes for nutritional purposes. The identification of marker traits linked to quality in crops is important as there is no general criteria for accurately and effectively evaluating variable germplasm and separating generations for quality attributes. All veggies' wild cousins should have their qualitative qualities assessed. For instance, it has been discovered that Lycopersicon Chmielewski has a very high soluble solids content.

Modern technologies, such as transgenics, which only introduce one desired gene into the DNA of the new plant, prevent excessive or undesired gene transfer, are also crucial for quality enhancement. bolstering the collecting of germplasm. creation of induced mutants, varieties, and F1 hybrids with improved nutritional properties. using cellular genetics and molecular biology to create transgenics with very nutritious features. The goals that a breeder is supposed to accomplish while breeding for nutritional enhancement must be specified by human nutritionists. For yield, nutritional features should be included into standard breeding practices. Breeding for nutritional quality will advance more quickly if nutritionists and breeders work closely together.

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