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Induced Mutation for Improvement in Nutritional Quality of Pulse Crops

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ABSTRACT

Pulses have an important role in daily diet and about 60 grams of pulsesare necessary for good heath of human being (WFP).They are great source of protein, high insoluble and non-soluble fiber content, vitamins and minerals - iron, potassium, magnesium, zinc etc. As per WHO, pulses particularly helps to fight against some non-communicable diseases by improving the immune capacity.
As per IAEA, 3290- mutant varieties were developed through induced mutagenesis. Out of which, in pulse crop- 460 mutant varieties were developed throughout the world while India contributed 57mutant varieties. The improved characters were early maturity, high yield, high protein content, disease resistant, resistant to biotic and abiotic stresses etc. Likewise, 1161 and 1,026 mutant varieties were developed for improvement in quality and nutritional traits as well as for high yield respectively. (IAEA https://mvd.iaea.org).
Improving nutritional quality by lowering anti-nutritional factors through induced mutagenesis beneficial to increase consumption and to fulfill nutritional demand of increasing population, helps to reduce malnutrition among the poor's especially in women and also beneficial to ensure additional income to the farmers.

Keywords: Pulse Crop, Nutritional quality, induced mutations

I. INTRODUCTION

In the world, India is the largest producer of pulses. Pulses are valuable economically important group of plants as they are source of foreign currency for the country. Pulses have high nutritional value. Pulses are main source of protein in the daily diet and rich in carbohydrate, fats, dietary fibers and calories required for good health of human being. Pulses are multifunction crops that fix atmospheric nitrogen and increase soil fertility and boost the growth and development of the next crop in crop rotation. Pulses can grow in all type of soil including marginal soil and thus helpful to poor farmers by reducing the cultivation cost. Majority pulses are short duration crops thus cultivation of another crop on the same farm is also possible to farmer. Pulses provide raw material to various food related industries like papad, dal and roasted grain industries.Along with three major cereals viz. wheat, maize and rice, pulse crops are also important valuable source of protein which meets the demand of increasing population of the world.
Mainly Chickpea (*Cicer arietinum* L.), Pigeon pea (*Cajanuscajan* L.), Mungbean (*Vigna radiata* L. Wilczek), Urdbean (*Vigna mungo* L. Hepper), Lentil (*Lens culinaris* L.), Fieldpea (*Pisum sativum* L.) etc. are the popular

pulse crop. As per the data reported by Chauhan and Gupta (2016), In India, pulses contribute 25.7% to the world production proves that India is the largest producer of pulses.The states - Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka, Andhra Pradesh, Gujarat, Tamil NaduBihar are known for highest pulse crop production

Pulses are not only good source of protein and fiber, it is also rich source of vitamins and minerals, such as iron, zinc, folate, and magnesium. It has great medicinal properties due to the various phytochemicalsfound in pulses possess antioxidant and anti-carcinogenic effects, indicating that pulses may have significant anti-cancer effects. It also effective positively to lowers blood pressure. High content of fibre thus have a low glycemic index which helps to maintain blood glucose and insulin levels.

II. MUTAGENESIS

Hugo de Vries (1901) identified that the heritable change in character was due to mutation which is differ from segregation or recombination. After that H. J. Muller (1927)in fruit fly, Drosophila melanogaster and by L. J. Stadler (1928) in maize and barley through X-rays proved that mutations may be induced artificially. Later on in 1934, Tollenaar isolate a light green "Chlorina" mutant of Tobacco and released for commercial cultivation in Indonesia (Kharkwal, 2012). After that use of physical mutagen X-rays, gamma rays, alpha and beta particles, neutrons, protons, ultra-violet (UV) radiation and chemicals like ethyl methanesulphonate (EMS), ethylineimine (EI), N-nitroso-N-methyl urea (NMU), sodium azide (SA) etc., were found to be more efficient and effective to induce mutation to create variability and were useful to release new varieties with improved characteristics.Now a days mutation breeding has contributed significantly to the global biodiversity, agriculture and human welfare by producing 3290 mutant varieties with enhanced production and productivity in a large number of crop species. Out of 3290, India (341) secure 3rd position afterChina (810) and Japan (479). (IAEA https://mvd.iaea.org).

III. MUTAGENESIS IN PULSE CROP

In pulse crop, trough out the world,461 mutant varieties were developed. Highest number of mutant varieties i.e.170 was reported in soybean followed by ground nut (72), French bean (59), Mung bean (36), Pea (32) etc. India contributed 57 mutant varieties- Mungbean (15), blackgram (9), chickpea (8), cowpea (10), mothbean (5), pea (1), pigeonpea (5), frenchbean (1) and lentil (3).The improved characters were early maturity, high yield, high protein content, improved nutritional quality, disease resistant, resistant to biotic and abiotic stresses etc.

Mutagenesis for enhanced nutritional quality in pulse crop:

Out of total 3290 mutant varieties, 1161 mutant varieties of different crops were developed for improved quality and nutritional traits. (IAEA https://mvd.iaea.org).Mutant varieties of Cowpea (*Vigna unguiculata*Walp.) - CBC5 and Lukusuzi were developed from Zimbabwe and Zambia in 2017 and 2018 respectively. The mutant variety of Lentil (*Lenseculinaris*Medik.) - Binamasur-8 and Soybean (*Glycine max* L.) - DT2012 were released for cultivation from Bangladesh and Viet Nam in 2014 and 2017 respectively. (https://mvd.iaea.org/)

Concerning about the anti-nutritional factor, phytic acid content, induced mutations were proved to be beneficial tool for reduction of phytic acid content. Wilcox et al. (2000) reported that, phytic acid content was decreased 2-3 fold (about 50-70%) in mutant lines - M156 and M766 of soybean. Raboy (2002) also reported that seed phytic acid is reduced by 50–95% in soybean (*Glycine max*) through induced mutations. Low phytic acid mutants have been isolated by several researchers. Campion et al. (2009) in common beanby using chemical mutagenesis andYuan et al. (2007) in soybean byusing chemical and physical mutagenesis reported their results. The data of some improved nutritional quality mutant varieties of pulses were recorded in Table No.1

The successful attempts were made by Nuclear Agriculture and Biotechnology Department (NABTD) of Bhabha Atomic Research Centre, Trombay, Mumbai (Maharashtra) in Development of mutant varieties. They have been developed valuable 42 different crop varieties for commercial cultivation in different climatic zones of country (http://www.barc.gov.in).

The mutant variety - TAMS 98-21 of Soybean (*Glycine max* L.) released for cultivation in 2007. The improved characters were multiple disease and pest resistance, (2243kg/ha) produced 21% higher yield over best check variety JS-335 (1853kg/ha) in Maharashtra State multi-location trials. The mutant variety-TC-901 of Cowpea (*Vigna unguiculata*Walp.) has yield superiority of 15% over the national check variety RC-101 and was released for commercial cultivation in 2018. It is semi-determinate mutant, High yielded, increased seed size, pod size and number, resistance to cowpea mosaic and root-rot diseases.

Nutritional quality of food grains is achieved by improving biomolecule availability by lowering phytic acid content. It was confirmed by many researchers that induced mutations were effective tool for reduction of phytic acid content of food grains.Sweta Kumari et al (2014) reported that phytic acid and phytic acid phosphorus (PA-P) contents significantly reduced in five mutant lines, IR-JS-101-4, IR-V-101-3, IR-DS-118-2, IR-DS-119-4 and IR-DS-122-2 of plants of M10 generation as compared to their parent lines of soybean by using EMS and γ-radiations.

IV. CONCLUSION

Mutation breeding plays an important role indevelop new varieties with desirable traits. But now the research work should be focused on the nutritional quality of the pulse crop by lowering the anti-nutritional factors like phytic acid, tannins, polyphenols etc. This research work will be beneficial to increase consumption and thereby farmers may attract for cultivation. Thus, it leads to fulfill nutritional demand of increasing population, helps to reduce malnutrition among the poor's especially in women and also beneficial to ensure additional income to the farmers.

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Table No. 1 Some Released Mutant Varieties for nutritional quality (https://mvd.iaea.org/)

Pulse crop	Variety	Country	Year of release	Mutagen	Character
Glycine max L.	Bisser	Bulgaria	1984	100Gy gamma rays and 0.1%EMS.	higher protein content and yield
	DT90	Viet Nam	1993	gamma rays (180 Gy)	higher protein content and yield
	DT96	Viet Nam	2004	gamma rays (180 Gy).	high protein content (43 – 45%)
	Yume-minori	Japan	2004	Gamma rays	Low allergen and high globulin content
	Tamaurara	Japan	1999	Hybridization with mutant line	protein content of "Tamaurara" is 2-3%
	TAEK C10	Turkey	1994	gamma rays (200 Gy)	High yield, higher seed protein and pod position
	TAEK A3	Turkey	1994	gamma rays (100 Gy)	Higher oil content, early maturity and higher yield
	Sui Nong 12	China	1996	gamma rays (120 Gy)	High yield, high protein content (40-54%) and high oil content (21%)

	Ryokusui	Japan	1990	gamma rays (200 Gy).	Good eating quality
	Ore-richi 50	Japan	2008	x-rays (200 Gy)	High oleic acid content
	Kefeng 14	China	2003	EMS	high protein content and high-yield.
	Kexin 3	China	1995	EMS	Nutritional quality . specialty and anti-nutrients
	Kaidou 4	China	2005	gamma rays	Nutritional quality . specialty and anti-nutrients
	Heihe 48	China	2006	Crossing with two mutants	Industrial and marketing quality
	Ludou 9	China	1993	Irradiation of seeds from F1 generation with gamma rays (180 Gy).	protein content (38%), fat content (21%),
	Heihe 48	China	2006	(Crossing with two mutants)	Industrial and marketing quality
	Heinong 31	China	1987	thN	fat (23.14%), protein (41.4%),
	Heinong 32	China	1987	thN, 5x10e11	good adaptability, 22.8% fat and 40.7% protein
	Heinong 34	China	1988	Croosing with mutant gamma rays (100 Gy)	High yield and high protein content
	Heinong 35	China	1990	Crossing with mutant gamma rays (100 Gy)	High yield and high protein content
	Heinong 37	China	1992	thermal neutrons (1x 10e11)	Culinary (eating and cooking) quality
	Heinong 38	China	1992	thermal neutrons (1x 10e11)	Nutritional quality . specialty and anti-nutrients
	Heinong 41	China	1997	Hybridization of two mutant (thN induced mutant)	Nutritional quality . specialty and anti-nutrients High protein content (45,29%),
	Heihe 47	China	2004	Crossing with one mutant	Nutritional quality . specialty and anti-nutrients
	Heihe 12	China	2000	neutrons	High yield and good quality

				(5x10e11)	
	Kinu-sayaka	Japan	2008	Hybridization with mutant obtained by irradiation with gamma rays.	All-lipoxygenase free
Arachis hypogaea L.	Colorado Irradiado	Argentina	1972	X-rays (200 Gy).	higher oil content.
	TG 39	India	2008	Gamma rays, 200-350Gy	Seed contains 50% oil, 26.5% protein, 12.6% carbohydrate and 4.5% sucrose. Its oil contains 59% oleic acid and 23% linoleic acid.
	TDG 39	India	2009	Hybridization with mutant	Large seeds, 120 days maturity and high content of oleic acid
	Huayu 16	China	1999	gamma rays (250 Gy)	High yield, high protein content and good adaptability
	Huayu 22	China	2003	Co 7-rays	High yield, good quality
	Luhua 15	China	1997	Hybridization with mutant Irradiated Runner obtained by irradiation with gamma rays (250 Gy)	Main improved attributes of mutant variety are oil ratio, early maturity and high yield.
Vigna radiata (L.) Wil.	Chai Nut 84-1	Thailand	2012	Gamma rays, 500Gy	Starch content
*Lens culinaris*Medik.	Verzuie	Moldova, Republic of	2004	Gamma rays (250 Gy).	proteins – 26,7%, oils 1,5%, fructose – 0,17%, glucose – 0,08%, saharose -1,23%, starch - 45,30%, cellulose – 7,16%
Viciafaba L.	Severino-vskie 1	Russian Federation	1992	0.01% NMU	High yield and high protein content
	Babylon	Iraq	1994	gamma rays (30 Gy)	Resistence to diseases, high yield and high protein content
	Geca 5	Moldova, Republic of	2008	gamma rays (250 Gy)	Quality and nutrition traits: dry substance -90,68%, proteins – 30,2%, oils 1,2%, fructose – 0,17%, glucose – 0,08%,

					saharose -1,23%, starch - 45,30%, cellulose – 7,16%.
Pisum sativum L.	Moskovsky 73	Russian Federa-tion	1974	0.03% dES	Larger grain size and higher protein content