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QUALITY PROTEIN MAIZE: A WONDERFUL CEREAL

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Maize (*Zea mays* L.), an American word for corn, literally means "that which sustains life." Maize is emerging as an important cereal crop in the world agricultural economy as food, feed, and industrial raw material after wheat and rice, which is considered as "Queen of cereals," due to the high productiveness, easy to process, low cost than other cereals (Jaliya *et al*., 2008), provides nutrients for humans and animals, serves as basic raw materials for production of starch, oil, alcoholic beverages, and more recently fuel (Punita, 2006). Maize is a valuable source of carbohydrates, fat, protein, some important vitamins and minerals and in spite of several important uses, it has an inbuilt drawback of being deficient in two essential amino acids, *viz*., lysine and tryptophan. This leads to poor protein utilization and low biological value of traditional maize genotypes. The low protein and unbalanced amino acid content in maize cause protein deficiency diseases like kwashiorkor and malnutrition. To overcome this problem and to minimize the prevalence and persistence of malnutrition in developing countries, breeders have modified maize to produce a vitreous endosperm resembling that of conventional maize at Purdue University, USA, in 1963 and named as quality protein maize (QPM) by incorporating opaque-2 gene, which is particularly responsible for enhancing lysine and tryptophan content of endosperm protein. QPM looks and tastes like normal maize with the same or higher yield potential, but it contains nearly twice the quantity of essential amino acids, lysine, and tryptophan which makes it richer in quality proteins. QPM combines the nutritional excellence of opaque-2 maize (whose protein content is twice that of normal maize) with the kernel structure of conventional maize varieties (Vassal *et al*., 1993). Hence, the cultivation of QPM provides an opportunity for the farmers to produce nutritionally superior maize grains, where maize is a staple food and potential source of proteins in many developing countries of Latin America, Africa, and Asia.

History

Genetic variability for most traits in maize is incredibly high and amenable to enhancements. Attempts to improve protein content began towards the latter part of the nineteenth century. Prior to the 1960s, efforts were rather limited to only screening elite maize germplasm and accessions to identify genotypes superior for this trait. Since no specific gene(s) conferring enhanced nutritional value was identified at that time, an improvement strategy involving recurrent selection could not be easily implemented. The lack of a simple genetic system also precluded the use of a straight forward back cross-program. Thus, protein quality remained more of a concern, with no immediate solutions in sight and no action-oriented strategies deployed to resolve the issue. In the early 1960s, scientists manifested a special interest in the search for gene mutants that could provide better quality protein in the maize endosperm. In 1963, researchers at Purdue University, USA, discovered that a mutation, designated opaque-2, made grain proteins in the endosperm nearly twice as nutritious as those found in normal maize (Mertz *et al*., 1964). The opaque-2 mutation was first described by Jones and Singleton in the early 1920s, but the nutritional significance of the mutation was first discovered by Mertz and co-workers (Mertz *et al*., 1964; Nelson *et al*., 1965). This was soon followed by the discovery of another mutation, floury-2 (fl2) that also has the ability to alter endosperm nutritional quality (Bjarnason and Vasal, 1992). These mutations, which derive their names from soft, floury/opaque endosperm, alter the amino acid profile and composition of maize endosperm protein and result in a two-fold increase in the levels of lysine and tryptophan in comparison with the normal genotypes. In addition, other amino acids such as histidine, arginine, aspartic acid, and glycine show an increase, while a decline is observed for some amino acids such as glutamic acid, alanine, and leucine. The decrease in leucine is considered particularly desirable as it makes leucine–isoleucine ratio more balanced, which in turn helps to liberate more tryptophan for niacin biosynthesis, and thus, helps to combat pellagra. The QPM research was started long back during the 1970s, but gained momentum during the 1990s with continuous breeding efforts on the development of high yielding hard endosperm modified Opaque-2 maize germplasm by International center for maize and wheat improvement (CIMMYT). The Directorate of Maize Research (DMR), New Delhi developed the first QPM composite variety Shakti-1 with 0.63 percent tryptophan in the year 1997. The QPM research gained further momentum by the launch of the National Agricultural Technology Project (NATP) on QPM in 1998 by ICAR. Chaudhary Charan Singh Haryana

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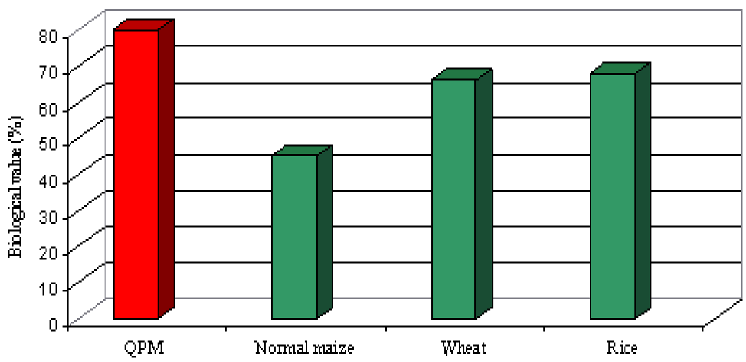
Agricultural University, Karnal released QPM single cross hybrid, HQPM-1 which is the first yellow grain QPM single cross hybrid released for its cultivation across the country.

Nutritional superiority of QPM

The nutritional benefits of QPM for people, who depend on maize for their energy and protein intake, and for other nutrients, are indeed quite significant. Mertz *et al*. in 1964 first reported that the lysine content in QPM was 3.3 to 4.0 g per 100 g of endosperm protein, which was more than twice that of normal maize endosperm (1.3 g lysine per 100 g endosperm protein). The studies indicated that the QPM protein contains, in general, 55% more tryptophan, 30% more lysine, and 38% less leucine than that of normal maize. Besides protein quality, another important factor is 'biological value', which refers to the amount of absorbed nitrogen needed to provide the necessary amino acids for different metabolic functions. The biological value of normal maize protein is 45%, while that of QPM maize is 80%. The other nutritional benefits of QPM include higher niacin availability due to a higher tryptophan and lower leucine content, higher calcium and carbohydrate (Graham *et al*., 1980), and carotene utilization (De Bosque *et al*., 1988). QPM can also be used as an ingredient in the preparation of composite flours to supplement wheat flour for bread and biscuit preparation.

Biological value of different cereals



QPM in livestock feeds

Worldwide, about 70% of the maize produced is utilized in livestock feed. Fifty percent of the commercial poultry feeds consist of maize. In addition synthetic amino acids mainly lysine and methionine which are imported, must be added to poultry feed. Quality protein maize is superior to normal maize in its amino acid balance and nutrient composition and improves the performance of livestock and poultry. It is more economical to use diets incorporating QPM as it can lead to progressive reductions in the use of synthetic feed additives. QPM will reduce the use of fish meal and imported synthetic amino acids. This

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will reduce the cost of the feed, making the feed more profitable. It will also improve the commercial poultry industry which will provide a sustainable market for QPM grain in the region.

Value addition

Value addition is important in increasing the shelf life and usefulness of QPM products, improves taste, increases uniformity, and reduces bulkiness hence easier to transport and store. It also guarantees confidence and satisfaction/visual consumers. Hence, value addition requires creating awareness for the market to accept/demand the product at the value and should be profitable. Processing has the potential for enabling QPM to attain an industrial status that would help to create more employment, improve nutrition and increase incomes for QPM farmers. QPM processing can be achieved through milling, boiling, roasting, deep-frying, baking, cooking, steaming, fermentation, extrusion, and enzymatic processes.

Processing of QPM product values includes milling as straight flour; composite flour/enriched flour; packing and labeling; flour fermentation and manufacture of alcoholic products; starch and glucose manufacture; and manufacture of animal feed.

QPM food processing facilitates eating, easy digestibility, easy absorption and utilization by the body systems. The following QPM products can be produced, marketed and utilized: QPM flour; QPM oil; QPM snacks such as cakes, biscuits, bread, chapatis, cookies, and cornflakes. QPM products like porridge mix flour recommended for feeding children who are malnourished under the age of five. Also, the composite flour is recommended for weaning children and lactating mothers.

QPM single cross hybrids released in India

Single cross hybrid	**Average yield (q/ha)***	**Maturity (days)****	**Protein content (%)**	**Tryptophan content (%)**	**Grain color**	**Area of adaptation**
HQPM-4	67	90	9.0	0.07	Yellow	Across the country
HQPM-7	65	90	9.8	0.07	Yellow	Peninsular India
Vivek QPM-9	45	75	9.2	0.07	Yellow	Himalayan belt
HQPM-5	65	88-90	10.15	0.07	Light- orange	Across the country
HQPM-1	60	88-90	10.09	0.08	Yellow	Across the country
Shaktiman-4	60	95	10.29	0.07	Orange- yellow	Bihar
Shaktiman-3	60	95	8.86	0.06	Orange- yellow	Bihar
Shaktiman-2	60	95	9.27	0.07	White	Bihar

*Yield during *Kharif* season, **During *Kharif* season

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Conclusion

The strategy used by the CIMMYT researchers in developing QPM has proved to be successful. The award of the prestigious 'World Food Prize' in the year 2000 to Surinder K. Vassal and Evangelina Villegas is recognition of an outstanding example of interdisciplinary teamwork of the CIMMYT researchers and signifies the relevance of QPM to millions of people across the world. QPM is now of major interest to breeders, geneticists, seed producers, and the industry, as its large scale production promises to offer significant benefits. Dedicated efforts are required for better public awareness and dissemination of QPM technology, particularly in economically deprived regions where maize is used for food and feed purposes, and complementary sources of proteins are either scarce or unaffordable. With the power of genomic technologies now available, and likely to be further developed, it is possible to effectively complement the breeding efforts, provide greater thrust to the QPM and derive significant nutritional and economic benefits for the society.

References

Bjarnason, M. and Vasal, S. K. (1992). Plant Breed. Rev., 9, 181–216.

De Bosque, C., Castellanos, E. J. and Bressani, R. (1988). In INCAP Reporte Annual, INCAP, Gautemala.

Graham, G. G., Placko, R. P. and Maclean, W. C. (1980). J. Nutr., 110, 1070–1074.

Jaliya, M. M., Falaki, A. M., Mahmud, M., Abubakar, I. U. and Sani, Y. A. (2008). Response of Quality Protein Maize (QPM) (*Zea Mays* L.) to sowing date and NPK fertilizer rate on yield & yield components of Quality Protein Maize. Savannah Journal of Agriculture, (3), pp. 24-35.

Mertz, E. T., Bates, L. S. and Nelson, O. E. (1964). Science, 145, 279–280.

Nelson, O. E., Mertz, E. T. and Bates, L. S. (1965). Science, 150, 1469–1470.

Punita, G. (2006). Physico-chemical properties, Nutritional quality & Value addition to Quality Protein Maize. M.Sc Thesis, University of Agricultural Sciences, Dharwad.

Vassal, S. K., Srinivisan, G., Pandey, S., Gonzalez, F., Crossa, J. and Beck, D. L. (1993). Heterosis and combining ability of CIMMYT's protein maize germplasm. Lowland Trop. Sci., 33, 46-51.