Biofortified maize for improved productivity and quality

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Maize, also known as queen of cereals, has been a staple food for centuries, providing sustenance to millions of people around the world. Together, the three main global staple grains - wheat, rice, maize - make up an important part of the human diet. Compared to wheat and rice, maize is a more versatile multi-purpose crop. It is a major food crop that is cultivated on a large scale for commercial purposes as well as for sustenance by numerous farmers who have little resources. It is not only food, feed and fodder crop but maize finds application in the production of biofuels, pharmaceuticals, and industrial materials also. It serves as a dietary staple in many regions, providing a rich source of carbohydrates, fibre, and essential nutrients. Since there are many types of maize like normal maize, baby corn, sweet corn and popcorn it can be used in different ways. Maize is not only consumed directly but is also a vital ingredient in numerous food products, including flatbread, baked bread, tortillas, cereals, and animal feed. Its production and consumption have significant economic and social implications for farmers and their communities. Earlier there was a gap for upliftment of maize because of the nutritional quality of maize. This nutrition gap was pronounced mainly for two essential amino acids- lysine and tryptophan. Normal maize has low content of essential amino acids and vitamins that is why the food or feed made from it is nutritionally poor and result in poor growth in animals and human being when it is consumed in the form of feed and food respectively. It also results in low milk productivity in cattles and meat productivity in poultry and swines.

With the development of biofortification in maize, a speciality maize known as Quality protein maize, has been developed that provides a new opportunity to use maize for food revolution. The quality protein maize (QPM) is a specialized maize which is similar to normal maize in appearance, grain yield, resistance to different biotic and abiotic stresses but it has double the content of lysine and tryptophan than the normal maize and has double biological value than the normal maize. Here are some noteworthy developments from Chaudhary Charan Singh Haryana Agricultural University with their average yields: HQPM 1 (*Kharif*- 57-62 q/ha, *Rabi*- 65-70 q/ha), HQPM 4 (*Kharif*-55-60 q/ha), HQPM 5 (*Kharif*- 60 - 65 q/ha, *Rabi* -67.5 - 72.5 q/ha) across the country and HQPM 7 with average yield 63 q/ha in Peninsular Zone of India. These hybrids possess high protein content (9.0 - 10.8 %) along with high tryptophan content 0.85-0.94 %) and lysine content (>2.5%). Efforts were also successful for the development of biofortified maize enriched in Provitamin A also by CCSHAU in collaboration with ICAR- Indian Agricultural Research Institute and named as interinstitutional hybrids.

Provitamin-A is the precursor of Vitamin A and the maize rich in Pro vitamin A has four times provitamin-A (4 ppm) as compared to normal maize (approximately 1ppm) after four months of storage of maize. The QPM hybrids which has additional trait of pro vitamin A may be helpful not only eradication of malnutrition problem in the country but helpful in earning foreign currency by exporting it directly as grain or by developing value added products. Some of the biofortified maize hybrids enriched with Provitamin A are: Pusa HQPM 1 Improved (Posseses high provitamin-A (7.02 ppm) high lysine (4.59%) and tryptophan (0.85%)), Pusa HQPM 5 Improved (Possesses high provitamin-A (6.77 ppm), high lysine (4.25%) and tryptophan (0.94%) and Pusa HQPM 7 Improved (Possesses high provitamin-A (7.10 ppm), high lysine (4.19%) and tryptophan (0.93%)).

Thus, with the embrace of these advancement in normal maize, it is not considered as an ordinary cereal, rather it is a nutria-cereal, a cereal grain being rich in nutrients and have numerous health benefits. It results in better growth in animals and human being when consumed in the form of feed and food respectively. More importantly, it is also rich in important vitamins and minerals such as vitamin C, vitamin B6, magnesium, folate and potassium like normal maize. A balanced life can be achieved if

quality protein maize is included in our daily consumption and required to meet quality protein needs and raise the human nutritional status. Like all other foods, it should be consumed in proper amounts as a balanced diet as it provides antioxidants, fiber, proteins and more importantly it is gluten free. It is the boon for patients suffering from celiac disease- a disease in which patient is suffering from wheat allergy.

In addition to being a nutrient-dense food, maize is also versatile and can be used in a variety of dishes. It can be ground into flour for bread or tortillas, popped for a snack, or boiled and mixed with other ingredients for a savory dish. As this maize is not only nutritional and versatile crop but a sustainable too. Since groundwater of India is declining and, in the rice, growing areas dependent on groundwater, it is the perfect crop to be grown because of its low requirement of water as compared to rice. In terms of production and productivity it also surpasses other major crops. For these reasons, promoting the consumption of quality protein maize or biofortified maize, can have a positive impact on both the environment and society. Furthermore, incorporating quality protein maize into our diets and in the midday meal of children's can provide us with essential nutrients and improve our overall health.

Furthermore, maize is apparent to have a number of advantages by smallholder farmers also. By supporting local farmers who grow maize, we can contribute to the development of rural communities by the setup of small-scale industries of QPM products. A large number of value-added products of quality protein maize can be developed viz., QPM dalia, ladoo, sev, halwa, flour etc. It can be used in all the ways like normal maize could be and can help farmers improve their productivity and income. In conclusion, we have explored the various aspects of maize as a nutricereal. Considering all these points, it is clear that quality protein maize has the potential to be considered as a nutricereal. Its nutritional value, versatility, and sustainability make it a valuable addition to any diet. By promoting its consumption, we can not only improve our own health but also contribute to a more sustainable future.

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