A Potential Scope of Sweet Corn for Peri-Urban Farmers in India

M. C. Dagla1*, R. N. Gadag2, Narendra Kumar3, B. C. Ajay4 and Chet Ram3

1Scientists, Directorate of Groundnut Research, Junagadh – 362 001
2Principal Scientist, Division of Genetics, IARI, New Delhi-110012
3Scientist, Division of Genomic Resources, NBPGR, New Delhi-10012

*Email of corresponding author: manu9322gen@gmail.com

Among the specialty corns, sweet corn has gaining its importance in urban areas due to its taste and other uses for human consumption. But, non-availability of high yielding sweet corn varieties, the green ears of flint-grained local varieties which are relatively sweeter and taste better are also consumed as roasted ears. Thus, enhancement of kernel sugar content, in addition to higher productivity will be a desirable attribute in facilitating diversified utilization through human consumption of fresh kernel as well as processed food.

Introduction

Maize (Zea mays L.; 2n=20), considered as queen of cereals, is the world's third most important crop after wheat and rice. It occupies an important place in world agriculture, being cultivated in more than 150 countries, including USA, China, Brazil, Mexico, France and India. In India, maize is mainly grown for grain purpose and is consumed either as food or as feed. It is the staple food in hilly and sub-mountain tracts of northern India, although consumed all over country. It is extensively grown in Karnataka, Andhra Pradesh, Maharashtra, Bihar, Rajasthan and Madhya Pradesh. Over 85% of maize produced in the country is consumed as human food. Several food dishes including Rotis are prepared out of maize flour and grains. Green cobs are roasted and eaten by people with great interest. It is also a good feed for poultry, piggery and other animals. Maize grain contains about 70% carbohydrates, 10.4% albuminoides, 10% protein, 4% oil, 2.4% crude fiber and 1.4% ash. Although, there is no official record available regarding total area, production and productivity in India, the major sweet corn growing states are Andhra Pradesh, Karnataka and Maharashtra. In India, the most widely cultivated type of maize belongs to flint or semi-flint type and considering the high productivity and untapped potentiality of maize crop, the need for diversification of its utility is felt.

Of the different forms of human consumption, use of maize ears at immature stage following roasting or boiling is a popular practice.

Diverse Uses of Corns

Exploitation of maize for particular purpose is rare. Main reasons behind this are unavailability of high yielding varieties, lesser attention to applicable production technologies and lack of awareness among the growers, traders and consumers. Among the various specialty corns, sweet corn has a very
huge market potential especially if the processing and packing needs from large scale production are taken care of. This has potentiality not only in national market but in global market as well. Sweet corn is the type of corn with a thin pericarp layer, translucent, horny appearance of kernels when matures and wrinkled when it dries, and consumed at immature grain stages of endosperm at twenty days after fertilization. Total sugar content in sweet corn at milky stage ranges from 25 to 30% as compared to 2 to 5% of normal corn. Fresh and raw sweet corn ears are consumed after cooking as well as in roasted form. Fresh sweet corn is increasingly in high demand in the hotels for the preparations of delicious sweet corn soup. Sweet corns are eaten green as highly valued fresh products like baby corn; immature kernels are parboiled and/or dried to produce candy. Mature kernels are crushed to produce the confection pinnole as a fermentable source for the production of an alcoholic beverage, chichi. It also serves as a raw material for deriving large number of industrial products such as starch syrup, dextrose and dextrin etc. Thus sweet corn with varied uses has a great potential in export as well as domestic market. Sweet corn matures early and green ears can be harvested in 75-80 days after planting. The left over stalk can serve as useful fodder for the livestock. Thus it can fit easily in multiple or intercropping systems.

There is an emphasis on the diversification of cultivated crops and finding of alternative crops as a suitable strategy for the problem faced by Indian farmers. In view of this, maize represents a good opportunity as well as unparalleled prospects, compared to other important cereals, considering its suitability for diverse uses, as elaborated earlier. As maize consumption at green ear stage is a prevalent and popular practice, immediate importance and prospects of sweet corn for this purpose is apparent. This can give much needed impetus and better option for the maize growers in general and for those in peri-urban regions in particular. With the progressive increase in the demand for and consequent cultivation of sweet corn, the necessary requirements for processing and packaging need to be addressed for transporting to distant markets as well as longer storage. Such scenario would be triggering a chain reaction of demand, investment and higher utility for the maize at green ear stage and maize products.

In sweet corn, there is a high incidence of disease and pest attack and with shrunken endosperm field emergence is low. So the emphasis should also be given to ensure better field emergence, vigour, resistance to biotic stresses in addition to enhanced productivity and sugar content. Furthermore, as most of the sweet corns are of temperate origin, systematic efforts are needed to develop sweet corn cultivars better adapted to tropical and sub-tropical conditions. Adaptability in terms of early vigour and field emergence was studied by Malver et al. (1997) and importance of suitable field corn was emphasized to improve sweet corn.

**Genetic Origin of Sweet Corn**
Sweet corn (*Zea mays var. saccharata*) is differentiated from other maize types by the presence of gene(s) which alters endosperm starch synthesis and results in the plants to be used as vegetable. Sweet corn flavour is determined largely by sweetness, which in turn is affected by the amount of
sugar and starch in the endosperm (Tracy, 1994). There are many different endosperm mutations in maize that influence kernel carbohydrate metabolism (Coe and Polacco, 1994). Most of the mutants of interest in sweet corn improvement increase sugar content and decrease starch content (Hannah et al., 1993). Starch synthesis in corn endosperm has been studied covering starch biosynthesis and genetic modification of endosperm carbohydrate (Boyer and Shannon, 1983). Of the many mutants of corn known to affect endosperm development, 14 have been used or studied for used in sweet corn and eight have been used commercially. For this, some identified genes are sugary (su), sugary enhancer (se) and super sweet (sh2). Therefore, the inheritance pattern of such traits enhancing sweetness along with high yield attributing characters should be analysed.

Almost all commercial sweet corn is based on one or more homozygous recessive alleles that alter the kernel carbohydrate content. Several mutants such as sugary (su), sugary2 (su2), brittle1 (bt), brittle2 (br2), shrunken1 (sh), shrunken2 (sh2), shrunken4 (sh4), sugary enhancer (se), amylase extender (ae), dull (du), and waxy (wx) have been identified which confer higher sugar content in the endosperm of immature kernel. Traditional sweet corn variety is homozygous for sugary mutation. Compared to field corn, sugary endosperms accumulate more sugar and a highly branched, water soluble forms of starch known as phytoglycogen which gives creamy texture to kernels at harvest. Several inbreds, hybrids and composites of sweet corn have been released in USA and Hawaii by incorporating these endosperm mutants in the genetic background of elite genotypes. A better understanding of the relationship between kernel characteristics associated with eating quality and stand establishment could be helpful in selection of superior genotypes (Azanza et al., 1996). The potential of enhanced and diversified use of corn for specialty purpose based on existing uses and new products to meet the needs of future generations provides the maize breeders with unique challenges.

**Development of Sweet Corn Varieties**

In India, improvement of sweet corn genotypes has received little attention and till now only few varieties developed and released (Table-1). Some varieties of sweet corn are also in public domain developed from private sector. Green ears of starchy field corns are also consumed in various forms while sweet corns are more suited for such usage. Single cross maize hybrids with enhanced sugar content are the few under public domain. But, some varieties/hybrids have been developed by private sector also. These hybrids are expected to be better, fulfilling the requirements of uniformity and quality, in addition to exhibiting yield superiority over the composites. There is enough genetic variability present in inbred lines for sugar content, with high heritability. Studies also showed the advantage of lines and crosses on the basis of combining ability and heterosis. Hence, there is a scope and need for developing sweet corn cultivars that can meet the diverse requirements of direct consumption, processing and even potential utility for extraction of products such as ethanol. In addition to this sweet corn has poor germination due to its seed characteristics, hence the genes responsible for sugar content may be transferred in the background of dent or flint corns. The
improved sweet corn varieties ensure income security to farmers in changing climate which has adverse effect on yield, due to various options related to harvest time and various economical products.

**Table 1: Released sweet corn varieties and their features**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Variety</th>
<th>Area of adoption and other features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Madhuri</td>
<td>For Andhra Pradesh, early maturing variety.</td>
</tr>
<tr>
<td>2</td>
<td>Priya</td>
<td>For Andhra Pradesh, Tamil Nadu, Maharashtra, and Karnataka, grain yield is 25q ha(^{-1}), tolerance of turicum leaf blight, CR, late wilt and other stalk rots.</td>
</tr>
<tr>
<td>3</td>
<td>Win Orange</td>
<td>Recommended for Jammu &amp; Kashmir, Uttarakhand, North Eastern region, and Himachal Pradesh, grain yield is 65q ha(^{-1}), medium maturity, seed is shriveled and sugary dent, tolerance of maydis leaf blight, turicum leaf blight, and ESR.</td>
</tr>
<tr>
<td>4</td>
<td>HSC-1</td>
<td>Recommended for Himachal Pradesh, and Uttarakhand, average green ear yield is 120q ha(^{-1}).</td>
</tr>
<tr>
<td>5</td>
<td>Punjab Sweet Corn 1</td>
<td>For peri-urban regions in Punjab, grean ear yield 125q ha(^{-1}), tolerant to maydis leaf blight, leaf spot, and resistant to stalk rot.</td>
</tr>
</tbody>
</table>

**Conclusion**

Sweet corn is becoming increasingly popular in India and other Asian countries. Increasing demand, premium price and global spread of sweet corn make them attractive options for the farmers. Its cultivation has increased in areas surrounding big towns and cities of different states of India. Developing suitable sweet corn cultivars/hybrids especially adaptable to Indian conditions might be one of the approaches, especially for fulfilling short and/or medium term goals.

**Future Perspectives**

Emphasis needs to be given for early maturity varieties, considering the fact that many crops can be taken under the Indian conditions due to reasonably favourable weather across the year in most of the states. Thus, *kharif*, *rabi* and spring crop can be taken even for the normal field corn and this can certainly be extended/enlarged for sweet corn. Early maturity is also important trait to fit sweet corn in to specific cropping sequence as well as inter-cropping. Further, the prospects and feasibilities of finding acceptable sequence for sweet corn even with different vegetables can also be looked into.

Single cross hybrids are in common, found to exhibit heterosis for early flowering and maturity and this can be taken benefit. Selection among the potential parental lines for early maturity may also be fruitful to some extent. Field corns can also be used for the improvement of many important traits.
like productivity and early maturity. This is especially attractive, due to the availability of a huge number of maize inbred lines, thanks to the higher focus towards the development of single cross hybrid in India, since last two decades. Some of the elite maize inbred lines can be crossed with the standard sweet corn lines and subsequently handled in specific ways, depending on the interests and objectives to be fulfilled. These include enhancement of productivity per unit area, inputs as well as per unit time through incorporating earliness in the sweet corn genotypes or/and enhancing the kernel sugar content in the field corn lines. Including of these, some candidate genes involving in sugar biosynthesis such as *sucrose synthase* can also be cloned and over-expressed into desired background to increase sugar content into the kernels.

**References**


