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Review Article

SWEET CORN: NEW AGE HEALTH FOOD

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ABSTRACT

Sweet corn, a member of the *Gramineae* family is available in wide varieties globally but variety preference is different for each region. Standard yellow sweet corn is the most commonly known variety Sweet corn has been reported to contain 75.7 percent moisture, 6.8mg/100g vitamin C, 2.0mg/100g calcium, 37mg/100g magnesium, 15.2mg/100g sodium on fresh matter basis. Unlike field corn varieties, which are harvested at full maturity, sweet corn is picked when immature, it is a costly and perishable vegetable with short shelf life due to higher respiration rate efforts are needed to promote processing of sweet corn so as to enhance its shelf life and prevent post harvest losses. In the present article, production, nutritional composition and processing of sweet corn to increase shelf life, have been discussed.

INTRODUCTION

Sweet corn is the new age super diet for health conscious people. The nutritive value of sweet corn is comparable to several high priced vegetable like cauliflower, cabbage, french beans, fibre content and low in cholesterol (Yodpetch, 1979). It is one of the most popular vegetable in the western and advanced countries of the world (ICAR, 2006). Sweet corn is rich in carbohydrates and Sugars and contains useful amounts of vitamins A, B_3 (which supports metabolism, the nervous and digestive systems) and C. It also contains Folic Acid, Fibre, minerals and Protein (Gebhardt and Mattews, 1981). The total sugars in sweet corn ranges from 25-30 percent (Ramachandrappa and Nanjjappa, 2006). Perhaps the most surprising is that it offers even greater health benefits when cooked. The Sweet corn's antioxidant activity is significantly increased when cooked, helping to battle cancer, heart disease and protect against cataracts (http://www.mdidea.com). There is notion that processed fruits and vegetables have a lower nutritional value than fresh produce. Those original notions seem to be false, as cooked sweet corn retains its antioxidant activity, despite the loss of vitamin C. It has been reported that thermal processing at 115^0C for 25 minutes significantly elevated the total antioxidant activity of sweet corn by 44 per cent and 54 per cent, although 25 per cent vitamin C loss was observed (Dewanto *et al.*, 2002).

Sweet corn is a member of the *Gramineae* (grass family) along with barley, wheat, and rice. This mutated grass is native to the tropical environments of the America. Sweet corn is used as human food at the milk stage of the endosperm development when the kernel is soft, succulent and sweet (Pajic *et al.*, 2004). Unlike field corn varieties, which are harvested when the kernels are dry and fully mature (dent stage), sweet corn is picked when immature (milk stage) and can be harvested in 75-80 days after planting and eaten as a vegetable, rather than grain (Schultheis, 1994). There are many varieties of sweet corn available, but variety preference is different for each region. Standard yellow sweet corn is the most commonly known variety.

Sweet corn varies from normal corn essentially for gene(s) that affect starch synthesis in the seed endosperm where in the recessive sugary (su) allele elevates the level of water soluble polysaccharides (sugars) and decreases starch. Thus the kernels of sweet corn taste sweet especially at 18 to 21 days after pollination. Super sweet or extra sweets have a shrunken (sh) gene, a name that describes the light-weight, wrinkled seed of this group. This gene raises original levels of complex sugars even further, again extending their flavour by slowing conversion to simple sugars and finely to starch. Moisture also is retained in this type, and shelf life is remarkably long. There usually will be more seed per lb. in the super sweet (sh) types due to low seed density (Duffy and Calvert, 2010). New "high sugar or sweeter" varieties with longer shelf life are being adopted for consumption (Lertat and Pulam, 2007). The kernels are boiled or steamed, and usually served with butter and salt. In Europe, China, Korea and Japan, they are often used in pizza, or in salads.

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Production of Sweet corn

According to the Food and Agriculture Organization of the United Nation statistics data, in 2005 the world' s sweet corn production for the fresh, frozen and canned food industries by harvest area is about 1.06 million ha. In 2004, the world's top four leading producers were the USA (4.12 million metric tons), Mexico (0.63 million metric tons), Nigeria (0.58 million metric tons) and France (0.50 million metric tons) (Henard 2003).

Shnitzler (1994) reported that export competition varies by region. In Asia, the USA must compete against Canadian and Australian products as well as local production in Japan, Korea, Thailand, Taiwan, China and Malaysia. In Europe, the USA competes with France in the EU as well as Hungary and Israel. and McNeil *et al* (1997) reveled that US exports of canned sweet corn in 1997 are forecast at 210 000 tons, up 18% from 1996 based on strong shipments to date. US canned sweet corn exports from January-August, 1997 were 22% ahead of the previous year's volume during the same time period. Japan continues to be the top US market for canned sweet corn. Other major US canned sweet corn markets include Taiwan, Hong Kong and the Korea Republic. US exports of frozen sweet corn in 1997 are forecast at 65 000 tons, up 13% from 1996, also based on strong exports to date. The world's top four leading exporters of canned sweet corn are the US (0.14 million metric tons), Hungary (0.13 million metric tons), France (0.10 million metric tons) and Thailand (0.10 million metric tons). And the world's top four leading exporters of canned sweet corn are the US (0.07 million metric tons), Hungary (0.04 million metric tons), New Zealand (0.03 million metric tons) and Belgium (0.04 million metric tons). (Henard 2003)

Global import of canned sweet corn is valued over $468million in 2004. The top five importing countries are the Russian Federation, Germany, the UK, Japan and the Republic of Korea. Global import of frozen sweet corn is valued over $218 million. And the top five importing countries for frozen sweet corn are the UK, Japan, Belgium, the U.S. and China. In terms per capita consumption of sweet corn, the US currently consumes 2.5 kg per year higher than the EU (1.5 kg per year). And French per capita consumption is one of highest in Europe (Henard 2003)

Nutritional composition of sweet corn

Brewbaker *et al.* (1975) reported a range of 46% total sugars, 18% starch, 14.5% protein and 17% oil in sweet corn. Biochemical characteristics of super-sugar corn and the possibility of its utilization studied by Shmaraev *et al.* (1976) revealed that Grain of super-sugar corn harvested at technical maturity contained 24-30% Dry Matter 36.8% total sugar, no or very little dextrin and 21.9% starch compared with 16.7% sugar, 24.2% dextrin and 30.1% starch. The high sugar content made it possible to harvest the ears during a longer period than that acceptable for sweet corn and to store the harvested ears for a few days without losses of sugar. Grain of super-sugar corn contained more lysine than that of sweet corn. The absence of dextrin was, however, regarded as a negative feature. Oliveira *et al.* (1991) studied nutritional attributes of a sweet corn fibrous residue. A sweet corn fibrous byproduct with 72.7% neutral detergent fiber (NDF) was chemically and nutritionally characterized. The fiber components were hemicellulose, 67.9%; cellulose 31.4%; and lignin, 0.7%. Goldman *et al.* (1994) observed kernel protein concentration in sugary-1 and shrunken-2 sweet corn. Changes in endosperm type used for commercial sweet corn production may affect protein levels. The two most widely used endosperm types are sugary-1 (su1) and shrunken-2 (sh2). To determine the effects of endosperm type on protein concentration, kernel N concentrations of dry mature kernels of seven inbreds near-isogenic for sugary-1 and shrunken-2 and of four samples of commercially canned sugary-1 and shrunken-2 sweet corn were calculated. Nitrogen values were converted to protein values using a standard conversion factor for maize. For the dry kernels and the canned samples, significant differences were detected between endosperm types for kernel protein concentration when measured on a weight basis. Averaged over all inbreeds, the shrunken-2 dry kernels had 30% more protein than sugary-1 kernels. On a weight basis, the shrunken-2 canned samples averaged 22% more protein than the sugary-1 samples. When compared on a kernel basis, protein concentration of the two endosperm types did not differ. Thus, shrunken-2 sweet corn may be identified as a higher protein product when the serving size is based on weight or calories. Makhlouf *et al.* (1995) studied some nutritional characteristics of sweet corn, Sweet corn was reported to contain 75.7 percent moisture, 6.8mg/100g vitamin C, 2.0mg/100g calcium, 37mg/100g magnesium, 15.2mg/100g sodium on fresh matter basis.

Dewanto *et al.* (2002) reported that processed sweet corn has higher antioxidant activity despite the loss of vitamin C. Processed sweet corn has increased antioxidant activity equivalent to 210 mg of vitamin C/100g of corn compared to the remaining 3.2 mg of vitamin C in the sample that contributed only 1.5 per cent of its total antioxidant activity. Yue *et al.* (2003) studied the change of carbohydrate and taste quality in the kernels of super sweet corn in the milky maturity stage. Results showed that the soluble sugar and sucrose contents peaked at 16-18 days after pollination, while moisture and reducing sugar decreased. Kernel taste was significantly correlated with sweetness sucrose and moisture. The correlation coefficient between sucrose and taste or between crude fibre and taste were also significant. Coskun *et al.* (2006) reported the physical properties of sweet corn. The average length, width and thickness were 10.56 mm, 7.91 mm and 3.45 mm, at a moisture content of 11.54 per cent dry basis, respectively. The bulk density decreased from 482.1 to 474.3 kg m (-3) with an increase in the moisture content range of 11.54–19.74 per cent dry basis.

Processing of sweet corn

Although sweetness is the most important quality characteristic in sweet corn, the importance of other flavor components in consumer acceptance is also well documented (Evensen and Boyer, 1986). For sweet corn, the consensus recommendation is to keep it as close to 0°C as possible during transportation and storage and this may be of even more importance for fresh-cut sweet corn. On the other hand, controlled atmosphere (CA) storage benefits with regard to extension of fruit and vegetable shelf life are well documented (Nakhasi *et al.*, 1991) including sweet corn (Aharoni *et al.*, 1996).

Collins *et al.* (1996) observed that the flavour qualities of frozen sweet corn are affected by genotype and blanching. Research showed that total peroxidase activity did not parallel flavour changes in frozen unblanched super sweet (sh2) or sugary enhanced (Su1/Se) sweet corn genotypes. Although changes in total peroxidase activity may not predict flavour changes in all genotypes, the presence or absence of certain per oxidase isozymes may be useful in predicting off flavour development in (Su 1) frozen corn. Riad *et al*. (2003) reported that controlled atmosphere (CA) storage is beneficial in maintaining the visual quality of fresh-cut sweet corn kernels, sugar and flavor losses was reduced during 10 days storage at 5 °C compared with storage in air. The main benefit of this controlled atmosphere (CA) was to prevent after cooking browning. Preliminary results indicate that after cooking browning is not associated with a Maillard reaction since 5-hydroxymethylfurfural (HMF), the characteristic intermediate compound produced during the Maillard reaction, is not present in cooked sweet corn kernels exhibiting browning. There were no significant changes in the total soluble phenolics content during storage in air or CA, but the soluble phenolic levels decreased with cooking, which suggests that the after cooking brown color may be due to as yet unidentified insoluble phenolic-protein complexes in the cooked sweet corn tissue The total aerobic microbe count increased with storage and the increase was significantly greater in air. This suggests that the browning could be a response of the sweet corn tissue to the microorganisms, or it may be associated with some product of microbial enzyme activity. Because Sweet corn is very costly and perishable vegetable, it has a short shelf life due to higher respiration rate efforts are needed to promote processing of sweet corn so as to enhance its shelf life and prevent post harvest losses.

CONCLUSION

Sweet corn shelf life is one of the shortest among fruits and vegetables. This is due to its high metabolic and respiration rates, which lead to severe sugar loss (the most important quality characteristics of sweet corn) and rapid quality deterioration. The preproduction of sweet corn is on a strong rise all around the World, but due to its limited shelf life, efforts are needed towards processing of sweet corn so as to minimize the post harvest losses and better utilization of this sweet gift of nature to mankind.

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