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A study on shelf-life extension of freshly harvested sweet corn cobs (*Zea mays* var. Rugosa)

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SUMMARY :

The sweet corn cobs were packed in 6 different packages and stored in the modified atmosphere environment (glass jars) with silicone membrane and diffusion channel using six treatments (LDPE film with and without ventillation, vacuum packaging and shrink wrapping and stored at 0^0C) to extend the shelf-life of sweet corn. The biochemical properties like total sugar, reducing sugar, non-reducing sugar and starch were evaluated before and after storage. The shelf-life of corn cobs was 3 days in ambient condition compared to 16 days at 0^oC temperature in the modified atmosphere packaging (shirk wrapping).

KEY **W**ORDS : Shelf-life, Extension, Sweet corn, Corn cobs

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The corn ranks among the most essential crops in the world agricultural economy. It is recognized as the most efficient converter of the sun's energy into food. The United States is the largest corn-producing country, followed by China, Brazil, Russia, Mexico and India (Food Encyclopedia, 1996). The sweet corn is distinguished from other corns by its high sugar content during the milky and early dough stages and kernels are wrinkled and translucent when dry. The sweet corn is also called Indian corn, sweet corn, sugar corn, pole corn or simply corn and is a variety of maize with a high sugar content. It is the result of a naturally occurring recessive mutation in the genes which control conversion of sugar into starch inside the endosperm of the corn kernel. Unlike field corn varieties, which are harvested when the kernels are dry and fully mature, the sweet corn is picked when immature and eaten as a vegetable instead as a grain. Since the process of maturation involves converting sugar into starch, sweet corn stores poorly and must be eaten, canned, or frozen before the kernels become tough and starchy.

The sweet corn is not able to be stored for short-term even. However, it can be stored at 0^0C and 90-98 per cent relative humidity for a week or more, if precooled immedieietely after harvesting. Ryall and Lipton (1972) also stated that to maintain the best qualities, sweet corn must be cooled to as near 0^0C as soon as possible after harvest. Time is critical importance because sucrose rapidly changes to starch after harvesting. Sweet corn must also be kept as close to 0^0C as feasible at wholesale and retail market. The storage life of sweet corn is very limited because sweetness and tenderness are lost rapidly. Corn will have satisfactory culinary quality for a maximum of 6-8 days at 0^0C, 3-4 days at 5^0C and 2 days at 10^0C. Now-a-days there is increased acceptance and demand for fresh-cut fruits and vegetables (sometimes called minimally processed or ready-to-eat produce) for many reasons such as their

convenience, perceived high nutritional values, and freshness. The flourishing of the fresh-cut industry in the last decade encourages the development of new fresh-cut products and there is now greater feasibility of sweet corn kernels being developed as a fresh-cut product, but work is needed to determine the limiting factors in storing and handling such a value-added product. Keeping this point in view present study was conducted to find out the storage studies of sweet corn.

EXPERIMENTAL METHODS

Fresh, well developed, mature and uniform sized sweet corn cobs were procured from a farmer's field near Hoskote, Bangalore Rural district. The experiment was laid out in a Completely Randomized Design (CRD) with three replications. The storage study was conducted to find the good packaging system for fresh sweet corn cobs with husk (sheath) intact. The modified atmosphere packaging systems, namely, pearlpet jars with silicone membrane and diffusion channel, LDPE film with and without ventillation, vacuum packaging and shrink wrapping were studied to enhance its shelf-life. The sweet corn cobs were stored at 0^0C with the following 6 treatments:

T_1 -Storage in LDPE (200 G) pouch with 0.2 per cent ventilation.

T_2 - Storage in LDPE (200 G) pouch with no ventilation.

T_3 - MAP storage using diffusion channel of 250 mm length × Φ 5 mm.

T_4 - MAP storage with silicone membrane 10 mm × 10 mm in glass jars.

T_5 - Vacuum packaging in polypropylene film (200 G) @ 60 per cent vacuum.

T_6 - Shrink wrapping with LLDPE film.

EXPERIMENTAL FINDINGS AND ANALYSIS

The biochemical parameters of sweet corn cobs were estimated before and after storage. The influence of different packages on quality parameters of stored sweet corn cobs are presented in Tables 1 to 4.

Table 1 : Total sugar content of sweet corn stored in different packages at 0^0C

Treatments	Total sugar content (%) Storage duration								
	Initial	2nd	4th	6th	8th	10th	12th	14th	16th
T_1	37.50	27.50	20.00	12.50	–	–	–	–	–
T_2	37.50	32.50	27.50	25.00	20.00	12.50	10.00	–	–
T_3	37.50	22.50	7.50	5.00	–	–	–	–	–
T_4	37.50	27.50	20.00	10.00	–	–	–	–	–
T_5	37.50	27.50	22.50	20.00	15.00	12.50	7.50	–	–
T_6	37.50	32.50	25.00	22.5	15.00	12.50	10.00	7.50	5.00
Mean	37.50	28.33	20.41	15.8	8.33	6.25	4.58	1.25	0.83
F test	*	*	*	*	–	–	–	–	–
S.E. ±	0.057	0.057	0.338	0.488	0.43	0.22	0.3	0.021	0.21
C.D. (P=0.05)	0.17	0.175	1.022	1.48	1.32	0.67	0.93	0.066	0.066

Table 2 : Reducing sugar content of sweet corn stored in different packages at 0^0C

Treatments	Reducing sugar content (%) Storage duration								
	Initial	2nd	4th	6th	8th	10th	12th	14th	16th
T_1	2.80	2.00	1.20	0.40	–	–	–	–	–
T_2	2.80	2.40	2.00	1.60	1.20	0.80	0.40	–	–
T_3	2.80	2.40	1.60	0.40	–	–	–	–	–
T_4	2.80	1.60	0.80	0.40	–	–	–	–	–
T_5	2.80	2.40	2.00	1.60	1.20	0.80	0.40	–	–
T_6	2.80	2.60	2.40	2.00	1.92	1.60	1.20	0.80	0.40
Mean	2.80	2.23	1.66	1.06	0.72	0.53	0.33	0.13	0.06
F test	NS	*	*	*	–	–	–	–	–
S.E. ±	0.057	0.057	0.057	0.577	0.037	0.043	0.037	0.021	0.021
C.D. (P=0.05)	–	0.175	0.175	0.175	0.114	0.132	0.114	0.066	0.066

NS=Non-significant

Total sugar :

Total sugar content of sweet corn cobs in treatments T_1, T_2, T_3, T_4, T_5 and T_6 decreased from 37.5 to 12.5 per cent, 25, 10, 5, 20 and 22.5 per cent, respectively, on the 6th day of storage at 0^0C (Table 1). This might be due to very rapid conversion of sugars into starch (Brecht and Sargent, 1988; Evensen and Boyer, 1986; Wann *et al*., 1971). Appleman and Arthur (1919) showed that sugar loss was about four times rapid at 10^0C as also at 0^0C. At 30^0C storage temperature, about 60 per cent of the sugars in sweet corn might have be converted to starch in a single day compared to only 6 per cent at 0°C (Brecht, 2002). The sugar content, which largely determines the quality of sweet corn, declines rapidly at room temperature and decreases less rapidly when stored at 0°C.

It is a well documented fact that the fast pre-cooling and storing at a low temperatures (0-1^{0}C) and high relative humidity (>90%) are the key factors to ensure postharvest quality in sweet corn (Boyer and Evensen, 1986; Brecht and Sargent, 1988; Brecht, 2002). This is due to the reduction in metabolic rates at lower temperatures causing reduction in the respiration rate and consequently the sugar conversion (high sugar content is the main quality factor in sweet corn). Moreover, the low metabolic rate reduces the conversion of sugars into starch thus helping to retain high sugar content. Also, low temperatures reduce water loss and subsequently reducing denting and husk drying of cobs. On the other hand, the low temperatures also prevent microbial growth and hence safe preservation of sweet corn.

Reducing sugar :

During storage of sweet corn cobs at 0^0C in different packages, the reducing sugar content of sweet corn kernel was found to decrease with increased storage duration (Table 2). On the 6th day of storage, the reducing sugar content (initially 2.8%) was just 0.4 per cent in treatments T_1, T_3 and T_4, whereas in treatment T_6, it was found to be 2.0 per cent. The reduction rate in reducing sugar content was relatively slow in shrink wrapped sweet corn (T_6). This reduction of sugars might be due to conversion of sugars into starch irrespective of the thickness of polyethylene bag (Naik *et al.*, 1993). Rumph *et al.*

Table 3 : Non-reducing sugar content of sweet corn stored in different packages at 0^0C

Treatments	Non–reducing sugar content (%) Storage duration								
	Initial	2nd	4th	6th	8th	10th	12th	14th	16th
T_1	34.70	25.50	18.80	12.10	–	–	–	–	–
T_2	34.70	30.10	25.50	23.40	18.80	11.70	9.60	–	–
T_3	34.70	25.10	18.40	9.60	–	–	–	–	–
T_4	34.70	20.90	6.70	4.60	–	–	–	–	–
T_5	34.70	25.10	20.10	18.40	13.80	11.70	7.10	–	–
T_6	34.70	29.90	22.60	20.50	13.08	10.90	8.80	6.70	4.60
Mean	34.70	26.10	18.68	14.76	7.61	5.71	4.25	1.11	0.76
F test	NS	*	*	*	–	–	–	–	–
S.E. ±	0.057	0.057	0.057	0.057	0.037	0.043	0.037	0.021	0.021
C.D. (P=0.05)	–	0.175	0.175	0.175	0.114	0.132	0.114	0.066	0.066

NS=Non-significant

Table 4 : Starch content of sweet corn cobs stored in different packages at 0^0C

Treatments	Starch content (%) Storage duration								
	Initial	2nd	4th	6th	8th	10th	12th	14th	16th
T_1	14.62	22.5	28.12	33.75	–	–	–	–	–
T_2	14.62	19.12	22.50	29.25	39.30	41.60	–	–	–
T_3	14.62	29.25	43.80	45.00	–	–	–	–	–
T_4	14.62	24.75	30.37	41.60	–	–	–	–	–
T_5	14.62	19.12	24.75	28.10	30.30	34.20	39.30	–	–
T_6	14.62	19.12	23.62	27.00	30.30	33.70	36.00	38.20	39.30
Mean	14.62	22.31	28.86	34.1	16.65	18.25	14.33	6.36	7.86
F test	*	*	*	*	–	–	–	–	–
S.E. ±	0.057	0.031	0.031	0.309	0.004	0.022	0.21	0.002	0.001
C.D. (P=0.05)	0.017	0.094	0.094	0.938	0.012	0.067	0.66	0.007	0.004

(1972) had reported that the reducing sugars decreased as the maturity of sweet corn proceeded. Also, in the present study, the sweet corn cobs were found to be active in the maturation process during storage.

Non-reducing sugar :

The non-reducing sugar content of sweet corn (initially 34.7%) was found to decrease with increased storage duration in all the packages tested (Table 3). On the 6th day of storage, the non-reducing sugar content was maximum in T_2 followed by T_6 (20.5%) and T_5 (18.4%). The sugar content was found to be very low in the remaining treatments, namely, T_1, T_3 and T_4. Nearly 2/3 of the non-reducing sugar was lost on 10th day of storage. This might be due to some enzymes activity which converted the non-reducing sugars and also inversion of non-reducing sugar into reducing sugar (Tripathi *et al.*, 1996).

Starch :

It could be seen from Table 4 that the starch content of sweet corn cobs increased from the initial value of 14.62 to 46 per cent when stored in different packages (Table 4). This might be due to the conversion of sugar into starch (Creech, 1968; Laughnan, 1953; Wann *et al.*, 1971). This conversion rate is high after harvesting and storage resulting in rapid quality loss (Doehlert *et al.*, 1993). About 6 per cent of sugars in the cobs were converted into starch in a single day (Brecht, 2002) at 0^0C. A similar trends were reported by Simonne *et al.* (1999), Suk and Sang (1999) and Liu-Peng *et al.* (2003).

Shelf-life extension of sweet corn :

Among the packages studied, the maximum shelf-life of sweet corn cobs was found to be up to 16 days in shrink wrapping. However, the sweetness of the corn kernels did not last that long and was poor beyond 6th day of its storage during which period the total sugar content was about 22.5 per cent. The next best was found to be with vacuum packaging and LDPE package without ventilation (both 12 days). The packaging systems namely, MAP using silicone membrane and diffusion channel concept and LDPE with 2 per cent ventilation was found to be inadequate for storage of sweet corn cobs with husk biomass intact. Based on the physiological loss of weight, biochemical quality, sensory scores and microbial infestation, the treatment T_6 *i.e.*, the shrink wrapping proved to be the best packaging treatment for storage of sweet corn cobs with husk intact.

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