

## EXTENDING THE SHELF-LIFE OF SWEET CORN BY SHRINK-WRAPPING AND REFRIGERATION

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### Abstract

Sweet corn is one of the most perishable vegetables, as it has a very high respiration rate, thus, minimum safe low temperature (0°C) and high relative humidity control are essential to maximum shelf-life and to minimize quality loss. In addition, film wraps can be beneficial in maintaining high relative humidity and extending the storage life.

The present investigation is undertaken to study the effect of shrink-wrapping and refrigeration (0°C and 90± 5%RH) on quality changes of sweet corn ears during storage. Quality changes of sweet corn were monitored during storage at 0°C, unwrapped or wrapped in shrink Film. Film wrapping maintained freshness, reduced weight loss and decay better than lack of unwrapping. Wrapping in shrink film resulted in lower O<sub>2</sub> and higher CO<sub>2</sub> concentrations within packages. Wrapping in shrink film maintained total soluble solids and total sugars than unwrapping.

### INTRODUCTION

The recommended storage and transit temperature for fresh sweet corn is 0°C at 95% relative humidity, its respiration rate is one of the highest of all fresh fruit and vegetables (Hardenburg *et al.*, 1986). Storage for more than a few days results in serious deterioration and loss of tenderness and sweetness. Weight loss of sweet corn ears with no trimming was rapid and averaged nearly 22% after 6 days from storage. Ears with removed shanks and flags lost about one-half as much weight as ears with no trimming (Hardenburg, 1971). Denting is an indication of loss of quality. A loss of 2% moisture from sweet corn may result objectionable kernel denting (Sims *et al.*, 1971).

Unwrapped dehusked white sweet corn lost its moisture at a much more rapid rate when stored at 20°C compared to storage at 10°C. Unwrapped yellow corn (not dehusked) lost moisture at a much slower rate. There was up to 15% increase in moisture content in internals of shrink-wrapped corn e.g. corn wrapped in cryovac E bags and stored at 10°C for 29 days (Deak *et al.*, 1987). Trimming shanks and flag leaves from sweet corn at harvest had a very marked effect on kernel denting and husk appearance. Trimming shanks, shanks + flags and complete husking + packaging were effective in preventing any significant amount of kernel denting. Removal of flag leaves retarded denting slightly in comparison with no trimming, but

denting of deflagged ears become severe after 25 days when both flags were trimmed. The absence of wilting flags slightly improved ear appearance. The inner husks remained fresh and green on the ears with trimmed shanks. Unwrapped dehusked white corn held at 20°C dried within 3-4 days and was unpalatable, unwrapped yellow corn with husks intact stored at the same temperature dried within 2 weeks but showed little spoilage. Yellow ears with husks showed deterioration within 10 days at 20°C. Kernels became discolored, slimy and moldy in appearance. Husks of yellow corn turned brown and mold colonies developed. Shrink-wrapped unhusked yellow corn stored at 10°C remained in good condition for 4 weeks. By the end of this period some husks showed browning, but no observable flavor or odor changes were noted (Deak *et al.*, 1987). In general, super sweet corn wrapped, in stretch or shrink film, appeared fresher, less dried and had less denting than unwrapped corn. Corn stored at 1°C was in better condition than corn stored at 4 or 10°C (Risse and McDonald, 1990).

The concentrations of total soluble solids decreased with time in shrink-wrapped corn stored at 10°C and 20°C. In unwrapped sweet corn, particularly when husks were removed and corn was stored at 20°C, TSS contents were increased due to dehydration (Deak *et al.*, 1987). After most storage times, corn that was stretch-wrapped did not have higher TSS content than unwrapped corn (Risse and McDonald, 1990).

The sugar content (which largely determines quality) has decreased relatively slowly at approximately 0°C, being about one-fourth as rapid at 0°C as at 10°C. Evensen and Boyer (1986) and Olsen *et al.* (1990) stated that total sugars concentration in sweet corn was significantly affected by cultivars, time in storage and storage temperature. Sugars were generally lower when the corn was stored at 10°C than at 0°C. Modified – Atmosphere storage, i.e., adjusting gas composition and relative humidity in addition to refrigeration, is more advantageous than cooling alone (Kader, 1986), but it is costly. A less – costly method of modified atmosphere storage is the use of plastic film to wrap produce (Ben-Yehoshua, 1985). Deak *et al.* (1987) reported that shrink – wrapping of sweet corn in bags and storing it at 10° or 20°C and 65 % and 55 % RH, respectively, reduced the changes associated with post harvest deterioration relative to unwrapped samples. The amount of CO<sub>2</sub> increased rapidly from 0 at time of packing to 2% to 8% after 2 days, depending on storage temperature, then stabilized. There was a positive relation between storage temperature and CO<sub>2</sub> concentration. The atmosphere within the shrink-wrap contained almost twice as much CO<sub>2</sub> as that within the perforated stretch wrap at all storage temperature. However, temperature had a major effect on atmospheric composition within the package. Film – wrapping maintained freshness of sweet corn

by maintaining a high relative humidity within the package, but also accelerated microbial growth in the presence of damaged husks or kernels of corn. The objective of the present study was to identify the proper method to prolong storage period of sweet corn.

## MATERIALS AND METHODS

The experiments were conducted at Dokki Experimental Site, Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center. Seeds of two sweet corn F1 hybrids (Sucro and Merit) were sown on 15th and 25th of September of 2002 and 2003 seasons, respectively under plastic house condition. The dimension of the plastic house was 9 m width, 60 m length and 3.25 m height. Each plastic house was divided into five raised beds of 1 m width, 0.6 m space in between. Each bed was planted with double rows along the bed with 30 cm between rows and 25 cm between plants within each row. Normal practices were followed whenever needed. At milky stage (horticultural maturity), ears were harvested and kept overnight at 0°C with 90-95 % relative humidity. The following morning marketable and uniform ears were randomly distributed into husked and unhusked ears. The leaves were completely removed in case of unhusked ears but in husked ears, the outer leaves were partially dehusked and maintaining leaves which were attached to ear and pulling a window of 2.5 to 4 cm wide of husks from the ears as practiced commercially. All shanks were cut to at least 1 cm from the ear and silk ends were cut to the end of ear. Husked ears were divided into wrapped, using shrink film of 11 mm thickness and unwrapped treatment. Each four ears were placed on a tray. Wrapped or unwrapped ears were weighted, labeled and placed in a carton box. Fruit samples were used for evaluation at the beginning of storage then stored at 0°C and 90± 5% relative humidity. Samples were taken at 5, 10, 15, 20 and 25 days from storage and then were transferred for an additional five shelf-life days at 20°C (simulation of market) to study physical and chemical characteristics, as follows:

### Physical changes:

- Weight loss was expressed as the percentage of loss from the initial weight.
- Visual appearance was evaluated separately for the flag leaves, cut ends kernels, once mycelia appeared on each of them, and was expressed as a percentage of the total amount of cobs that were rated decayed
- General appearance was graded on a scale of 1 - 5, with 1=poor quality (dry and brown flag leaves associated with fungal growth) and 5=excellent quality. A cob which was rated higher than 2.5 was considered marketable.

### Chemical changes:

- Total soluble solids were measured with refractometer.

- Total sugars were measured as mg /100 f.w. according to Southgate (1969).
- The atmosphere within the packages was sampled by syringe through a septum in package. Oxygen and carbon dioxide were analyzed by as chromatography. The concentration of CO<sub>2</sub> and O<sub>2</sub> according to Cross (1966) as follows:

Concentration of CO<sub>2</sub> or O<sub>2</sub> for sample =

$$\frac{\text{Peak height for sample}}{\text{Peak height for standard gas}} \times \text{Concentration of standard gas \%}$$

### **Experimental design:**

Complete randomized factorial experiment with three factors design with three replications was performed with two cultivars as main factor and husking and unhusking as second factor and the third factor was the wrapping and unwrapping treatments.

### **STATISTICAL ANALYSIS:**

Data were analyzed for statistical significant differences using LSD test at 0.05 level according to Snedecor and Cochran (1989).

## **RESULTS**

### **Physical characters:**

#### **1 – Loss in weight:**

Weight loss in ears, generally, increased with time during storage (Table 1). Ears of Merit hybrid showed higher weight loss during storage compared to those of Sucro. As for wrapping, the weight loss was increased significantly in unwrapped ears compared to wrapped ones. Concerning husking, data presented in (Table 1) indicated that husked ears increased the weight loss as compared to unhusked ones.

The interaction between cultivars and husking treatment was not significant in both tested seasons, (Table 2). The interaction between cultivars and wrapping treatment was generally significant all over the storage period (Table 3). Sucro wrapped ears showed the lowest weight loss compared to cultivar of Merit.

Respecting the interaction between husking and wrapping treatments, results presented in Table (4) indicated that no significant difference in weight loss was observed.

Regarding the interaction among cultivars, husking and wrapping treatments, results in Table (5) indicated that there was no significant influence.

#### **2- Visual appearance:**

Data shown in Table (6) indicated the visual appearance of ears was reduced with time during storage. Regardless of cultivars, the ears of Sucro hybrids showed higher visual appearance compared to those of Merit. As for husking, data shown in

Table (6) indicated that there was no significant differences between husked and unhusked ears in visual appearance.

Concerning wrapping, results shows that wrapping significantly maintain the good visual quality. This was true in both tested seasons.

Regarding the interaction between cultivars and husking, the obtained data in Table (7) showed that there was no significant effected due to the tow tested factors. The results held true in the two growing seasons. The interaction between cultivars and wrapping treatments Table (7) showed that wrapping had good effect in maintaining visual appearance of sweet corn ears in the two hybrids compared to the unwrapped treatments. As regarding to the interaction between husking and wrapping, data in Table (8) shows that there was no significant difference between treatments until 15 days from storage in the two seasons. Concerning the influence of the interaction among cultivars, husking and wrapping, the obtained data showed that thoes factors did not significantly affect the visual appearance, in both tested seasons (Table10)

Data shows that wrapping had a good effect in maintaining visual appearance of sweet corn ears in the two hybrids compared to the unwrapped treatment because wrapping reduced weight loss and denting. The wrapped and unwrapped corn were rated acceptable after 15 days, but the wrapped corn stored for 25 days was fresher, greener, and showed less drying than nunwrapped corn stored for 15 days. During simulated retail display (S R D), the appearance of the corn deteriorated rapidly. The husks on the nunwrapped corn dried out and turned brown after 15 days during storage. In general, wrapped corn appeared fresher, less dried and had less denting than unwrapped corn.

#### **Chemical characters:**

##### **1 – Total soluble solids:**

Data shown in Table (11) indicate that ears of Sucro hybrid had higher T.S.S. percent than those of Merit through the same storage period. The difference between the two hybrids was significant, in both seasons. Regarding husking, the obtained results (Table 11) indicated that the percentage of T.S.S. in sweet corn ears was not statistically influenced by this treatment during storage.

As for the effect of wrapping, it was noticed that wrapping tend to increase T.S.S. compared to unwrapping.

The combination between each two factors (Table 12,13,14) or among the three tested factors (Table 15) had insignificant impact on T.S.S percent during storage. In other words the studied factors had independent influences on the percentage of total soluble solids during storage.

**2- Total sugars:**

Data shown in Table (16) indicate that total sugars percent in ears of Sucro hybrid were higher than those in ears of Merit at the beginning of storage period. While, thereafter, they showed lower values compared to those of Sucro with prolonging the storage period. On the contrary, total sugars of Sucro ears, generally, increased during storage.. Loss in total sugars with Merit hybrid may be due to respiration. However the increase in total sugars in Sucro hybrid might be due to starch hydrolysis (Olsen et al 1990). Concerning the effect of husking and wrapping (Table 16) data show, in general, that there were no significant effects due to the two factors on total sugars during storage. Combination effect of each of the two factors from the three studied factors (Table 17, 18, 19) and the combination among them (Table 20) were not, in general, statistically significant. However Wrapping together with Husking was statistically the best treatment for increasing total sugars in ears of Sucro hybrid.

**3- Carbon dioxide and oxygen:**

The amount of CO<sub>2</sub> and O<sub>2</sub> represented in Fig. (1 and 2) show the effect of wrapping in shrink film on the levels of both gases inside the bags during storage in 2003 season. It is clear as a general trend that the levels of oxygen decreased while those of carbon dioxide increased in bags of both cultivars during the whole storage periods. The amount of CO<sub>2</sub> increased rapidly from 0% at time of packing to 3 and 2% after 5 days for Merit hybrid and sucro hybrid respectively. However, the resulted values showed clearly that CO<sub>2</sub> increased rapidly up to the end of storage. It is clear that amount of O<sub>2</sub> in shrink film wrapped exhibited a gradual decrease trend with the advance of storage periods up to 20 days followed by a rapid decrease till the end of storage period .

**DISCUSSION**

Various fruits and vegetables could benefit from the Modified Atmosphere(MA) produced within suitable sealed polymeric film by delaying both their physiological and pathological deterioration during storage, transit and marketing (Ben-yehoshua,1985,Barkai-Golan,1990). Wrapping sweet corn with shrink film maintained the keeping quality of the ears, especially during storage and marketing simulation. The significant differences in the quality of the sweet corn wrapped with shrink film are due to the less permeability to gases and water vapour. The lower decay incidence found in the shrink-wrapped corn probably due to the high level of CO<sub>2</sub> and low level of O<sub>2</sub> within the packages mainly during marketing simulation. This is due to the high respiration rate of sweet corn (kader, 1987) (Forney et al., 1989). Carbon dioxide levels, above 10% were found to inhibit spore germination and mycelia growth of many decay-causing fungi (Barkai-Golan, 1990).

Risse and Mc Donald (1990) reported that the overall quality of cobs wrapped in shrink film (cryovac) was better than those wrapped in PVC stretch film or left unwrapped.

## CONCLUSION

The interaction between husking and wrapping under 95% RH. grown at 0 °C gave the best result regarding weight loss and decay of sweet corn. On the other hand the same treatment lead to increase T.S.S. and total sugars content.

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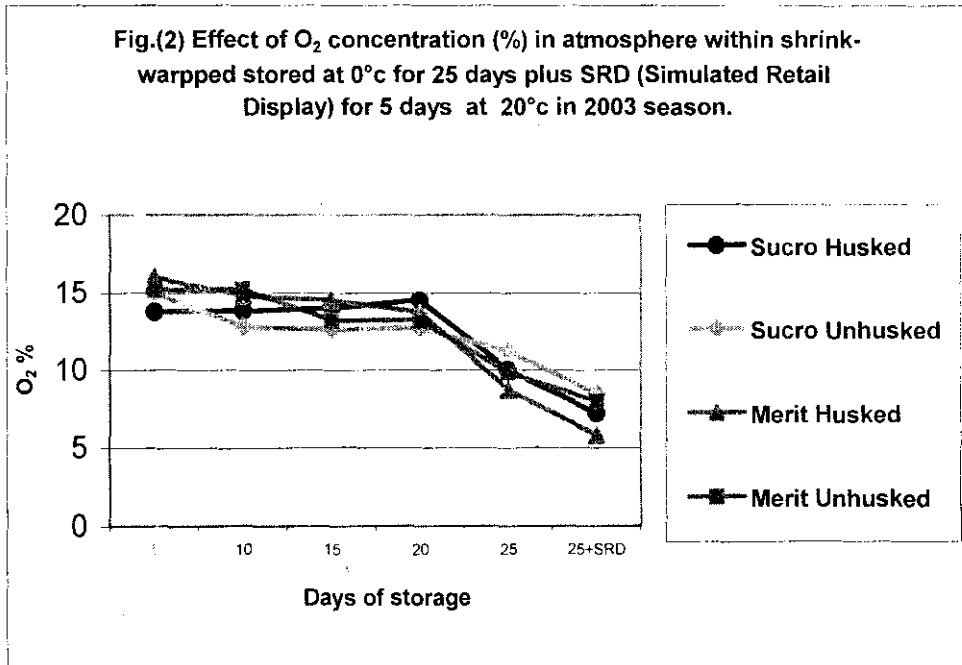
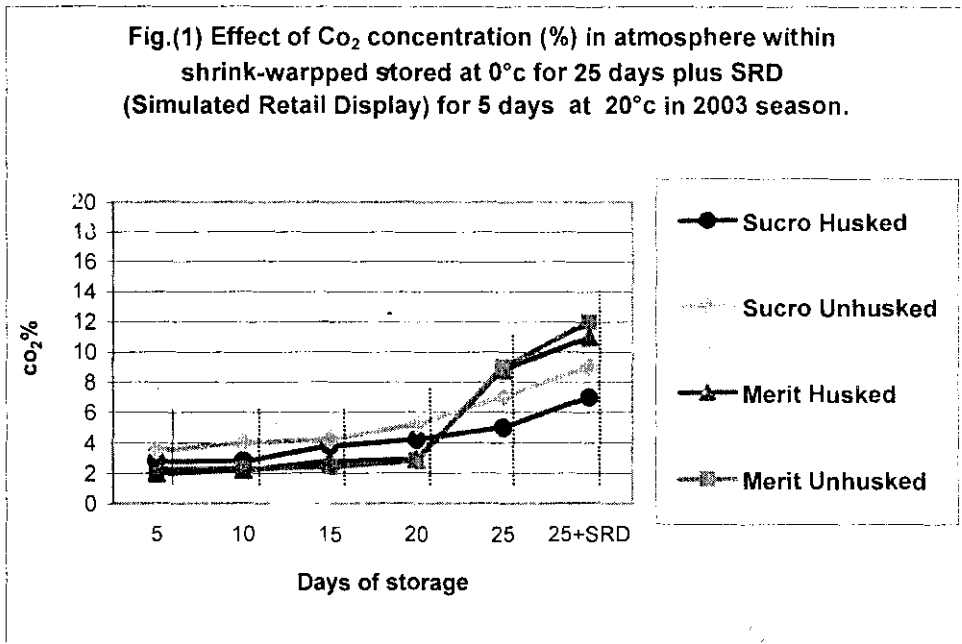




Table 1. Effect of cultivars, husking and wrapping on weight loss% of sweet corn ears during storage at 0°C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20°C.

| Treatments  | 2002 season         |      |      |       |       |        | 2003 season |      |       |       |       |        |
|-------------|---------------------|------|------|-------|-------|--------|-------------|------|-------|-------|-------|--------|
|             | Storage time (days) |      |      |       |       |        |             |      |       |       |       |        |
|             | 5                   | 10   | 15   | 20    | 25    | 25+SRD | 5           | 10   | 15    | 20    | 25    | 25+SRD |
|             | Cultivars           |      |      |       |       |        |             |      |       |       |       |        |
| Sucro       | 4.05                | 6.05 | 8.16 | 10.70 | 12.95 | 16.12  | 4.45        | 6.35 | 8.57  | 10.95 | 13.20 | 16.40  |
| Merit       | 4.40                | 7.15 | 9.85 | 11.15 | 13.35 | 17.20  | 4.85        | 6.66 | 9.07  | 11.85 | 13.72 | 17.20  |
| L.S.D at 5% | N.S                 | N.S  | N.S  | N.S   | N.S   | N.S    | N.S         | N.S  | N.S   | N.S   | N.S   | N.S    |
| Husking     |                     |      |      |       |       |        |             |      |       |       |       |        |
| Husked      | 5.70                | 6.85 | 8.70 | 9.85  | 11.50 | 15.17  | 5.90        | 6.95 | 8.90  | 10.10 | 11.60 | 15.40  |
| Unhusked    | 9.6                 | 5.98 | 7.95 | 8.90  | 10.40 | 14.60  | 5.15        | 6.40 | 8.30  | 9.20  | 10.70 | 14.95  |
| L.S.D at 5% | N.S                 | N.S  | N.S  | N.S   | N.S   | N.S    | N.S         | N.S  | N.S   | N.S   | N.S   | N.S    |
| Wrapping    |                     |      |      |       |       |        |             |      |       |       |       |        |
| Wrapped     | 0.00                | 0.06 | 0.56 | 0.80  | 1.12  | 3.90   | 0.00        | 0.71 | 1.19  | 1.55  | 1.78  | 4.55   |
| Unwrapped   | 5.12                | 7.15 | 9.65 | 10.92 | 13.11 | 16.60  | 7.15        | 8.65 | 10.10 | 11.20 | 14.60 | 17.40  |
| L.S.D at 5% | .98                 | 1.75 | 0.85 | 1.15  | 0.75  | 0.92   | 1.25        | 1.33 | 0.98  | 1.27  | 0.89  | 1.20   |

Table 2. Effect of interaction between cultivars and husking on weight loss% of sweet corn ears during storage at 0°C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20°C.

| Cultivars   | Husking  | 2002 season         |      |      |      |      |        | 2003 season |      |      |      |      |        |
|-------------|----------|---------------------|------|------|------|------|--------|-------------|------|------|------|------|--------|
|             |          | Storage time (days) |      |      |      |      |        |             |      |      |      |      |        |
|             |          | 5                   | 10   | 15   | 20   | 25   | 25+SRD | 5           | 10   | 15   | 20   | 25   | 25+SRD |
| Sucro       | Hushed   | 4.51                | 5.37 | 6.04 | 7.19 | 9.20 | 14.25  | 4.78        | 5.60 | 6.75 | 7.85 | 9.25 | 14.65  |
|             | Unhusked | 4.20                | 5.10 | 5.90 | 7.05 | 9.00 | 14.10  | 4.50        | 5.30 | 6.20 | 7.15 | 8.80 | 14.10  |
| Merit       | Hushed   | 4.90                | 5.85 | 6.75 | 7.70 | 9.90 | 15.20  | 4.20        | 5.90 | 7.05 | 8.10 | 9.90 | 15.30  |
|             | Unhusked | 4.65                | 5.70 | 6.20 | 7.10 | 9.25 | 15.05  | 4.40        | 5.70 | 6.90 | 8.20 | 9.30 | 15.05  |
| L.S.D at 5% |          | N.S                 | N.S  | N.S  | N.S  | N.S  | N.S    | N.S         | N.S  | N.S  | N.S  | N.S  | N.S    |

Table 3. Effect of interaction between cultivars and wrapping on weight loss% of sweet corn ears during storage at 0°C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20°C.

| Cultivars   | Wrapping  | 2002 season         |      |       |       |       |        | 2003 season |      |       |       |       |        |
|-------------|-----------|---------------------|------|-------|-------|-------|--------|-------------|------|-------|-------|-------|--------|
|             |           | Storage time (days) |      |       |       |       |        |             |      |       |       |       |        |
|             |           | 5                   | 10   | 15    | 20    | 25    | 25+SRD | 5           | 10   | 15    | 20    | 25    | 25+SRD |
| Sucro       | Wrapped   | 0.00                | 0.05 | 0.52  | 0.75  | 1.20  | 3.80   | 0.0         | 0.06 | 0.54  | 0.89  | 1.29  | 4.05   |
|             | Unwrapped | 5.35                | 7.25 | 9.85  | 11.34 | 13.80 | 16.95  | 5.52        | 7.54 | 9.95  | 11.46 | 14.05 | 17.10  |
| Merit       | Wrapped   | 0.00                | 0.06 | 0.55  | 0.80  | 1.35  | 3.95   | 0.00        | 0.07 | 0.59  | 0.92  | 1.36  | 4.17   |
|             | Unwrapped | 6.25                | 7.56 | 10.15 | 12.10 | 14.20 | 17.35  | 5.92        | 7.90 | 10.05 | 11.65 | 14.70 | 17.90  |
| L.S.D at 5% |           | 0.81                | 0.96 | 0.78  | 0.92  | 0.67  | 1.05   | 0.48        | 0.85 | 0.62  | 0.45  | 0.77  | 1.42   |

Table 4. Effect of interaction between husking and wrapping on weight loss% of sweet corn ears during storage at 0°C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20° C.

| Husking     | Wrapping  | 2002 season         |      |      |       |       |        | 2003 season |      |      |       |       |        |
|-------------|-----------|---------------------|------|------|-------|-------|--------|-------------|------|------|-------|-------|--------|
|             |           | Storage time (days) |      |      |       |       |        |             |      |      |       |       |        |
|             |           | 5                   | 10   | 15   | 20    | 25    | 25+SRD | 5           | 10   | 15   | 20    | 25    | 25+SRD |
| Husked      | Wrapped   | 0.00                | 0.05 | 0.54 | 0.78  | 1.05  | 3.95   | 0.00        | 0.06 | 0.58 | 0.80  | 1.10  | 4.05   |
|             | Unwrapped | 5.33                | 7.25 | 5.95 | 10.45 | 13.20 | 16.72  | 5.50        | 7.32 | 9.12 | 10.62 | 13.36 | 16.97  |
| Unhusked    | Wrapped   | 0.00                | 0.04 | 0.50 | 0.75  | 1.02  | 3.76   | 0.00        | 0.05 | 0.54 | 0.76  | 1.05  | 3.85   |
|             | Unwrapped | 4.86                | 6.82 | 8.72 | 10.05 | 13.00 | 16.52  | 4.95        | 6.97 | 8.90 | 10.20 | 13.20 | 16.65  |
| L.S.D at 5% |           | N.S                 | N.S  | N.S  | N.S   | N.S   | N.S    | N.S         | N.S  | N.S  | N.S   | N.S   | N.S    |

Table 5. Effect of interaction between cultivars, husking and wrapping on weight loss% of sweet corn ears during storage at 0°C and 90% ± 5 % RH plus simulated retail display (SRD) for 5 days at 20c.

| Cultivars   | Husking  | Wrapping  | 2002 season         |      |      |       |       |        | 2003 season |      |       |       |       |        |
|-------------|----------|-----------|---------------------|------|------|-------|-------|--------|-------------|------|-------|-------|-------|--------|
|             |          |           | Storage time (days) |      |      |       |       |        |             |      |       |       |       |        |
|             |          |           | 5                   | 10   | 15   | 20    | 25    | 25+SRD | 5           | 10   | 15    | 20    | 25    | 25+SRD |
| Sucro       | Husked   | Wrapped   | 0.00                | 0.06 | 0.56 | 0.80  | 1.12  | 3.90   | 0.00        | 0.71 | 1.19  | 1.55  | 1.78  | 4.55   |
|             |          | Unwrapped | 6.12                | 8.15 | 9.65 | 10.92 | 13.11 | 16.60  | 7.15        | 8.65 | 10.10 | 11.20 | 14.60 | 17.40  |
|             | Unhusked | Wrapped   | 0.00                | 0.06 | 0.50 | 0.74  | 1.09  | 3.85   | 0.00        | 0.75 | 0.74  | 0.87  | 1.20  | 3.97   |
|             |          | Unwrapped | 6.05                | 7.05 | 9.16 | 10.70 | 12.95 | 16.12  | 6.04        | 7.35 | 9.57  | 10.95 | 13.20 | 16.40  |
| Merit       | Husked   | Wrapped   | 0.00                | 0.14 | 0.67 | 0.96  | 1.36  | 4.25   | 0.00        | 0.21 | 0.76  | 1.15  | 1.75  | 4.82   |
|             |          | Unwrapped | 6.65                | 9.23 | 9.97 | 11.34 | 13.86 | 17.42  | 6.92        | 9.82 | 10.45 | 11.84 | 14.05 | 17.95  |
|             | Unhusked | Wrapped   | 0.00                | 0.10 | 0.56 | 0.85  | 1.18  | 4.12   | 0.00        | 0.19 | 0.67  | 0.92  | 1.32  | 4.67   |
|             |          | unwrapped | 6.40                | 9.15 | 9.85 | 11.15 | 13.35 | 17.20  | 6.85        | 9.66 | 10.07 | 11.35 | 13.72 | 17.70  |
| L.S.D at 5% |          |           | N.S                 | N.S  | N.S  | N.S   | N.S   | N.S    | N.S         | N.S  | N.S   | N.S   | N.S   |        |



Table 8. Effect of interaction between cultivars and wrapping on visual appearance of sweet corn ears during storage at 0°C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20°C.

| Cultivars   | Wrapping  | 2002 season         |      |      |      |      |      |        | 2003 season |      |      |      |      |      |        |
|-------------|-----------|---------------------|------|------|------|------|------|--------|-------------|------|------|------|------|------|--------|
|             |           | Storage time (days) |      |      |      |      |      |        |             |      |      |      |      |      |        |
|             |           | 0                   | 5    | 10   | 15   | 20   | 25   | 25+SRD | 0           | 5    | 10   | 15   | 20   | 25   | 25+SRD |
| Sucro       | Wrapped   | 5.00                | 5.00 | 5.00 | 5.00 | 4.75 | 4.25 | 2.75   | 5.00        | 5.00 | 5.00 | 5.00 | 4.70 | 4.25 | 2.50   |
|             | Unwrapped | 5.00                | 4.00 | 3.00 | 2.50 | 1.75 | 1.00 | 1.00   | 5.00        | 4.00 | 3.00 | 2.50 | 1.50 | 1.00 | 1.00   |
| Merit       | Wrapped   | 5.00                | 5.00 | 5.00 | 5.00 | 4.50 | 4.25 | 2.50   | 5.00        | 5.00 | 5.00 | 5.00 | 4.75 | 4.00 | 2.25   |
|             | Unwrapped | 5.00                | 4.00 | 3.30 | 2.50 | 1.70 | 1.00 | 1.00   | 5.00        | 4.00 | 3.00 | 2.50 | 1.75 | 1.00 | 1.00   |
| L.S.D at 5% |           | N.S                 | N.S  | N.S  | N.S  | N.S  | N.S  | N.S    | N.S         | N.S  | N.S  | N.S  | 0.92 | 0.86 | 0.56   |

Table 9. Effect of interaction between husking and wrapping on visual appearance of sweet corn ears during storage at 0°C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20°C.

| Husking     | Wrapping  | 2002 season         |      |      |      |      |      |        | 2003 season |      |      |      |      |      |        |
|-------------|-----------|---------------------|------|------|------|------|------|--------|-------------|------|------|------|------|------|--------|
|             |           | Storage time (days) |      |      |      |      |      |        |             |      |      |      |      |      |        |
|             |           | 0                   | 5    | 10   | 15   | 20   | 25   | 25+SRD | 0           | 5    | 10   | 15   | 20   | 25   | 25+SRD |
| Husked      | Wrapped   | 5.00                | 5.00 | 5.00 | 5.00 | 4.75 | 4.50 | 2.75   | 5.00        | 5.00 | 5.00 | 5.00 | 4.70 | 4.25 | 2.50   |
|             | Unwrapped | 5.00                | 4.00 | 3.50 | 2.50 | 1.75 | 1.00 | 1.00   | 5.00        | 4.00 | 3.25 | 2.50 | 1.50 | 1.00 | 1.00   |
| Unhusked    | Wrapped   | 5.00                | 5.00 | 5.00 | 5.00 | 4.50 | 4.25 | 2.50   | 5.00        | 5.00 | 5.00 | 5.00 | 4.25 | 4.00 | 2.25   |
|             | Unwrapped | 5.00                | 4.00 | 3.00 | 2.25 | 1.50 | 1.00 | 1.00   | 5.00        | 4.00 | 3.00 | 2.00 | 1.25 | 1.00 | 1.00   |
| L.S.D at 5% |           | N.S                 | N.S  | N.S  | N.S  | N.S  | N.S  | N.S    | N.S         | N.S  | N.S  | N.S  | N.S  | N.S  | N.S    |



Table 11. Effect of cultivars, husking and wrapping on total soluble solids (%) of sweet corn ears during storage at 0°C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20°C.

|             | 2002 season         |       |       |       |       |       |        | 2003 season |       |       |       |       |       |        |
|-------------|---------------------|-------|-------|-------|-------|-------|--------|-------------|-------|-------|-------|-------|-------|--------|
|             | Storage time (days) |       |       |       |       |       |        |             |       |       |       |       |       |        |
|             | 0                   | 5     | 10    | 15    | 20    | 25    | 25+SRD | 0           | 5     | 10    | 15    | 20    | 25    | 25+SRD |
|             | Cultivars           |       |       |       |       |       |        |             |       |       |       |       |       |        |
| Sucro       | 14.20               | 13.90 | 14.40 | 12.00 | 14.10 | 13.60 | 16.50  | 13.70       | 13.00 | 11.50 | 11.90 | 12.10 | 12.00 | 13.10  |
| Merit       | 11.60               | 11.80 | 11.30 | 10.60 | 10.00 | 10.40 | 11.10  | 11.20       | 10.50 | 10.60 | 10.20 | 10.00 | 10.80 | 18.60  |
| L.S.D at 5% | N.S                 | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    | N.S         | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    |
|             | Husking             |       |       |       |       |       |        |             |       |       |       |       |       |        |
| Husked      |                     | 13.80 | 13.53 | 12.60 | 12.50 | 12.30 | 13.20  |             | 13.60 | 12.90 | 13.20 | 12.50 | 13.00 | 14.320 |
| Unhusked    |                     | 13.60 | 13.80 | 13.90 | 12.70 | 12.40 | 13.60  |             | 13.20 | 13.00 | 13.10 | 13.30 | 13.00 | 14.00  |
| L.S.D at 5% |                     | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    |             | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    |
|             | Wrapping            |       |       |       |       |       |        |             |       |       |       |       |       |        |
| Wrapped     |                     | 15.50 | 15.00 | 15.80 | 16.00 | 15.80 | 16.00  |             | 14.60 | 14.00 | 14.70 | 15.00 | 15.20 | 15.10  |
| Unwrapped   |                     | 14.40 | 14.90 | 14.50 | 15.00 | 15.20 | 15.40  |             | 13.20 | 13.00 | 13.40 | 13.90 | 14.00 | 14.00  |
| L.S.D at 5% |                     | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    |             | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    |

Table 12. Effect of interaction between cultivars and husking on T.S.S % of sweet corn ears during storage at 0° C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20° C.

| Cultivars   | Husking  | 2002 season         |       |       |       |       |        | 2003 season |       |       |       |       |        |
|-------------|----------|---------------------|-------|-------|-------|-------|--------|-------------|-------|-------|-------|-------|--------|
|             |          | Storage time (days) |       |       |       |       |        |             |       |       |       |       |        |
|             |          | 5                   | 10    | 15    | 20    | 25    | 25+SRD | 5           | 10    | 15    | 20    | 25    | 25+SRD |
| Sucro       | Husked   | 14.00               | 14.20 | 14.60 | 13.90 | 15.00 | 15.60  | 13.80       | 13.60 | 14.00 | 12.80 | 13.90 | 14.80  |
|             | Unhusked | 13.90               | 14.00 | 14.40 | 13.50 | 14.00 | 15.20  | 13.50       | 13.20 | 13.70 | 13.00 | 13.50 | 14.50  |
| Merit       | Husked   | 11.20               | 11.00 | 11.80 | 12.00 | 12.40 | 13.60  | 11.00       | 11.20 | 11.60 | 12.10 | 12.30 | 14.00  |
|             | Unhusked | 11.00               | 11.00 | 11.20 | 11.40 | 11.60 | 12.90  | 11.20       | 11.00 | 11.40 | 12.00 | 12.40 | 13.90  |
| L.S.D at 5% |          | N.S                 | N.S   | N.S   | N.S   | N.S   | N.S    | N.S         | N.S   | N.S   | N.S   | N.S   |        |





Table 15. Effect of interaction between cultivars, husking and wrapping on T.S.S % of sweet corn ears during storage at 0° C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20c.

| Cultivars   | Husking  | Wrapping  | 2002 season         |       |       |       |       |        | 2003 season |       |       |       |       |        |
|-------------|----------|-----------|---------------------|-------|-------|-------|-------|--------|-------------|-------|-------|-------|-------|--------|
|             |          |           | Storage time (days) |       |       |       |       |        |             |       |       |       |       |        |
|             |          |           | 5                   | 10    | 15    | 20    | 25    | 25+SRD | 5           | 10    | 15    | 20    | 25    | 25+SRD |
| Sucro       | Husked   | Wrapped   | 11.60               | 14.90 | 14.30 | 14.60 | 14.20 | 16.60  | 12.9        | 13.60 | 13.90 | 13.60 | 14.90 | 15.00  |
|             |          | Unwrapped | 14.00               | 14.50 | 11.80 | 14.10 | 13.60 | 16.40  | 11.30       | 11.90 | 11.10 | 11.80 | 12.00 | 13.20  |
|             | Unhusked | Wrapped   | 14.00               | 14.90 | 13.90 | 14.50 | 14.80 | 16.20  | 14.80       | 14.20 | 13.70 | 14.50 | 14.80 | 15.90  |
|             |          | Unwrapped | 13.20               | 14.00 | 13.00 | 14.10 | 14.00 | 15.90  | 11.10       | 11.20 | 11.00 | 11.70 | 12.20 | 13.00  |
| Merit       | Husked   | Wrapped   | 11.90               | 12.00 | 11.90 | 11.50 | 11.80 | 12.80  | 11.90       | 11.50 | 11.80 | 12.30 | 12.00 | 12.90  |
|             |          | Unwrapped | 11.80               | 11.20 | 10.50 | 10.00 | 10.30 | 11.00  | 10.50       | 10.70 | 10.00 | 10.10 | 10.70 | 12.30  |
|             | Unhusked | Wrapped   | 10.90               | 11.70 | 11.40 | 12.00 | 11.90 | 13.00  | 11.90       | 12.10 | 11.80 | 11.90 | 12.00 | 13.80  |
|             |          | unwrapped | 15.20               | 10.90 | 10.20 | 11.70 | 11.30 | 12.80  | 10.40       | 10.50 | 10.00 | 10.00 | 10.70 | 18.60  |
| L.S.D at 5% |          |           | N.S                 | N.S   | N.S   | N.S   | N.S   | N.S    | N.S         | N.S   | N.S   | N.S   | N.S   |        |

Table 16. Effect of cultivars, husking and Wrapping on total sugar (mg/100g f.w) of sweet corn ears during storage at 0oC and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20° C.

| Treatment   | 2002 season         |       |       |       |       |       |        | 2003 season |       |       |       |       |       |        |
|-------------|---------------------|-------|-------|-------|-------|-------|--------|-------------|-------|-------|-------|-------|-------|--------|
|             | Storage time (days) |       |       |       |       |       |        |             |       |       |       |       |       |        |
|             | 0                   | 5     | 10    | 15    | 20    | 25    | 25+SRD | 0           | 5     | 10    | 15    | 20    | 25    | 25+SRD |
| Cultivars   |                     |       |       |       |       |       |        |             |       |       |       |       |       |        |
| Sucro       | 12.54               | 12.40 | 12.95 | 10.16 | 13.70 | 14.20 | 14.60  | 12.30       | 12.50 | 13.00 | 10.90 | 13.60 | 14.40 | 15.00  |
| Merit       | 7.60                | 7.50  | 7.10  | 6.50  | 6.85  | 5.30  | 5.000  | 7.90        | 7.40  | 7.00  | 6.25  | 5.90  | 5.20  | 4.95   |
| L.S.D at 5% | 0.98                | 0.69  | 0.86  | 0.46  | 1.45  | 1.49  | 1.56   | 0.88        | 0.72  | 0.56  | 0.64  | 1.23  | 1.42  | 1.49   |
| Husking     |                     |       |       |       |       |       |        |             |       |       |       |       |       |        |
| Husked      |                     | 13.10 | 12.95 | 10.45 | 12.50 | 12.30 | 12.00  |             | 12.60 | 12.10 | 10.10 | 11.40 | 11.20 | 11.00  |
| Unhusked    |                     | 12.45 | 12.96 | 10.32 | 10.65 | 12.50 | 12.20  |             | 11.23 | 11.46 | 10.05 | 13.50 | 11.30 | 11.20  |
| L.S.D at 5% |                     | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    |             | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    |
| Wrapping    |                     |       |       |       |       |       |        |             |       |       |       |       |       |        |
| Wrapped     |                     | 13.70 | 13.20 | 11.12 | 13.00 | 12.80 | 12.50  |             | 13.50 | 13.00 | 11.10 | 12.90 | 12.60 | 12.20  |
| Unwrapped   |                     |       |       |       |       |       |        |             | 11.45 | 12.20 | 10.30 | 10.60 | 10.95 | 11.00  |
| L.S.D at 5% |                     | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    |             | N.S   | N.S   | N.S   | N.S   | N.S   | N.S    |

Table 17. Effect of interaction between cultivars and husking on total sugar (mg/100g f.w) of sweet corn ears during storage at 0° C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20c.

| Cultivars   | Husking  | 2002 season         |       |       |       |       |        | 2003 season |       |       |       |       |        |
|-------------|----------|---------------------|-------|-------|-------|-------|--------|-------------|-------|-------|-------|-------|--------|
|             |          | Storage time (days) |       |       |       |       |        |             |       |       |       |       |        |
|             |          | 5                   | 10    | 15    | 20    | 25    | 25+SRD | 5           | 10    | 15    | 20    | 25    | 25+SRD |
| Sucro       | Hushed   | 13.60               | 14.00 | 10.75 | 14.70 | 14.60 | 14.20  | 13.20       | 13.80 | 11.00 | 13.40 | 13.70 | 13.50  |
|             | Unhusked | 13.20               | 13.80 | 10.20 | 14.50 | 14.70 | 14.50  | 12.95       | 13.50 | 11.10 | 13.30 | 13.80 | 13.40  |
| Merit       | Hushed   | 8.20                | 10.15 | 8.00  | 7.50  | 7.00  | 6.40   | 8.00        | 9.80  | 7.80  | 7.40  | 7.00  | 6.20   |
|             | Unhusked | 8.40                | 10.00 | 8.10  | 7.60  | 7.20  | 6.30   | 8.10        | 9.70  | 7.90  | 7.30  | 6.90  | 6.40   |
| L.S.D at 5% |          | N.S                 | N.S   | N.S   | N.S   | N.S   | N.S    | N.S         | N.S   | N.S   | N.S   | N.S   | N.S    |

Table 18. Effect of interaction between cultivars and wrapping on total sugar (mg/100g f.w) of sweet corn ears during storage at 0°C and 90% ± 5% RH plus simulated retail display (SRD) for 5 days at 20°C.

| Cultivars   | Wrapping  | 2002 season         |       |       |       |       |        | 2003 season |       |       |       |       |        |
|-------------|-----------|---------------------|-------|-------|-------|-------|--------|-------------|-------|-------|-------|-------|--------|
|             |           | Storage time (days) |       |       |       |       |        |             |       |       |       |       |        |
|             |           | 5                   | 10    | 15    | 20    | 25    | 25+SRD | 5           | 10    | 15    | 20    | 25    | 25+SRD |
| Sucro       | Wrapped   | 14.20               | 14.50 | 11.90 | 14.80 | 15.00 | 14.90  | 13.85       | 14.15 | 11.80 | 14.60 | 14.90 | 14.60  |
|             | Unwrapped | 11.60               | 11.80 | 10.70 | 12.00 | 13.30 | 13.20  | 11.30       | 11.50 | 10.40 | 13.10 | 13.20 | 13.00  |
| Merit       | Wrapped   | 9.60                | 10.40 | 9.00  | 8.50  | 8.00  | 7.90   | 9.25        | 10.15 | 8.85  | 8.10  | 7.70  | 7.20   |
|             | Unwrapped | 8.75                | 8.60  | 8.00  | 7.60  | 7.20  | 7.10   | 8.15        | 8.20  | 7.75  | 7.40  | 7.00  | 6.9    |
| L.S.D at 5% |           | N.S                 | N.S   | N.S   | N.S   | N.S   | N.S    | N.S         | N.S   | N.S   | N.S   | N.S   | N.S    |



## إطالة الفترة التخزينية للذرة السكرية باستخدام التغليف والتبريد

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يعتبر محصول الذرة السكرية من محاصيل الخضر السريعة التلف بعد قطفها ، لذا اجرى هذا البحث بموقع الدقى - الجيزة - مصر خلال موسمي ٢٠٠٢-٢٠٠٣ بهدف محاولة إطالة الفترة التخزينية لكيزان الذرة السكرية من خلال تغليف الكيزان بالرقائق المغلفة الانكماشية وتخزينها على درجة الصفر المئوي ورطوبة نسبية ٩٠% ± ٥% ومعرفة تأثير هذه المعاملات على التغيرات التي تحدث لمواصفات الجودة طوال فترة التخزين . وقد لوحظ أن تغليف الكيزان بالرقائق المغلفة الانكماشية أدى إلى احتفاظها بطراحتها كما قلت نسبة الفقد فى الوزن وأيضاً نسبة التلف فيها بمقارنتها بالمعاملات التي لم تغلف ، كما أن تغليف الكيزان أدى إلى زيادة نسبة المواد الصلبة الكلية والسكريات الكلية بها بمقارنتها بتلك التي لم تغلف . كما أن نسبة ثاني أكسيد الكربون زادت داخل العبوات وأن نسبة الأوكسجين قد قلت خلال الفترة التخزينية ، ونتيجة لكل العوامل السابقة فإن عملية تغليف الكيزان بالرقائق المغلفة الانكماشية والتخزين على درجة الصفر المئوي والرطوبة النسبية ٩٠% ± ٥% أدى إلى زيادة الفترة التخزينية إلى ٢٥ يوماً وهى بحالة جيدة.