

## **Effect of Packaging Methods on the Quality Characteristics of Tomato Fruits Produced in Hydroponics**

**Mustafa A. Al-Mughrabi**

*Plant Production Department, College of Agriculture,  
King Saud University, Riyadh, Saudi Arabia*

**Abstract.** Fruits of two tomato (*Lycopersicon esculentum* Mill) cultivars, "Dombito" and "Dombo", were produced in hydroponic culture and harvested at mature-green stage. They were tested for three methods of packaging; bagging, individual wrapping and control at two storage temperatures (13°C and 24°C) for a period of 50 days after harvest. Several physico-chemical quality attributes i.e. weight loss, decay percentage, coloration of fruits, total soluble solids (TSS), titratable acidity (TA), and vitamin C (Vit. C) content of the fruits were evaluated and compared.

Bagging of fruits was efficient in reducing weight loss, but detrimental in increasing decay and secondary infection. Individual wrapping was practically preferred, it reduced the percentage of decay and increased vitamin C content of fruits. Storage at 13°C was more favorable for prolonged shelf life and increasing vitamin C content, but storage at 24°C was the best for rapid ripening and good red color of fruits.

### **Introduction**

Packaging can markedly extend the shelf-life of many fresh fruits and vegetables [1, 2] through the inhibition of physiological deterioration and reducing weight loss [3]. Packing can create modified gas atmospheres around the product which inhibit respiration. Sealing of tomatoes in polyethylene film packages extended the length of time until ripening [4]. Weight loss in wrapped tomatoe was significantly less and fruits were more firm than non-wrapped tomatoes [3]. It had been found that the best storage temperature for delaying ripening of tomatoes fruits is 12.7°C (55°F) [5, 6]. Previous work by the present investigator [7] proved that storage at 25°C was preferable for good red color of fruits.

The objective of the study was to compare different methods of packaging, storage periods and storage temperatures as to their effects on the quality characteristics of two cultivars of tomato fruits.

### Materials and Methods

Tomato seedlings of two cultivars, "Dombito" and "Dombo", were transplanted to hydroponic culture inside a greenhouse at Dirab Experimental Research Station, College of Agriculture, King Saud University, Riyadh. The tomato fruits were harvested at the mature-green stage from the fifth cluster of the plants in March, 1990. Fruits were brought to the laboratory and divided into three equal packagings. Each packing received one of the following treatments:

1. Bagging: Ten fruits were tightly tied in plastic bag.
2. Wrapping: Each fruit was individually wrapped in a double layer of polyethylene.
3. Control: unbagged, non-wrapped tomatoes.

Two storage temperatures were used with each treatment; 13°C and room temperature (24°C). The relative humidity was maintained at about  $75 \pm 5\%$ . Weight loss, decay and coloration of the tomatoes were determined visually and presented as percentages. Chemical analyses including total soluble solids (TSS), vitamin C and titratable acidity (TA) were determined according to the Association of Official Agricultural Chemists [8]. TSS was determined using Abb refractometer. Vitamin C and TA were measured by titration as ascorbic and citric acids respectively.

Measurements were accomplished four times; 0, 10, 30 and 50 days after storage. Data were statistically analyzed in  $2 \times 2 \times 3$  factorial design [9]. The least significant difference was used to compare the means according to Steel and Torrie [9] and SAS program [10].

### Results and Discussion

The analysis of variance and mean values for different factors are summarized in Tables 1 and 2 and Figs. 1 and 2. Quality assessment involved analysis of both physical and biochemical characteristics. Physical attributes included weight loss, percent decay, and degree of coloration while biochemical attributes included total soluble solids (TSS), titratable acidity, vitamin C (Vit. C) and the ratio of TSS to TA.

#### *Physical attributes*

Weight loss of tomato fruits during storage was largely due to the loss of moisture via evapotranspiration. Weight loss was the most important factor affected by packaging method. Bagging or placing the fruits in polyethylene bags was the most efficient way to reduce weight loss (Fig. 1). Reduced weight loss was primarily due to the elevated relative humidity within the bag which minimized evaporation and

**Table 1. The effect of cultivars and storage period on tomato quality characteristics**

Quality characteristics	Cultivars		Storage period (days)		
	Dombito	Dombo	10	30	50
Weight loss (%)	3.32 b	3.83 a	2.30 c	7.44 b	12.03 a
Coloration (%)	70.6 a	71.6 a	56.89 c	85.28 b	100.00 a
Decay (%)	1.69 a	1.27 a	0.71 c	2.02 b	8.46 a
TSS (%)	6.76 a	7.04 a	6.75 a	5.96 b	– (z)
TA (%)	0.47 a	0.47 a	0.49 a	0.47 a	–
Vit. "C" (mg/100 ml.)	2.20 a	1.49 a	2.50 b	4.35 a	–
TSS/TA	14.67 a	15.32 a	14.18 a	12.9 a	–

(z) After 50 days of storage, the biochemical characters were lost. Means followed by the same letter are not significantly different at the 0.05 level.

**Table 2. The effect of storage temperature and packaging methods on physico-chemical characteristics of tomatoes**

	TA %	TSS/TA	Coloration %	TSS %
Packing				
Bagging	0.45 a	15.49 a	70.83 a	– (z)
Wrapping	0.46 a	15.03 a	65.92 a	–
Control	0.50 a	14.47 a	76.50 a	–
Storage Temp				
13°C	0.48 a	14.39 a	– (z)	6.75 a
Room Temp.	0.46 a	15.6 a	–	7.06 a

(z) Illustrated graphically (Figs. 1 and 2). Means followed by the same letter are not significantly different at the 0.05 level according to L.S.D.

transpiration from the fruits. Individual wrapping the fruits was less efficient than polyethylene bags in minimizing loss, but was superior to control fruits (Fig. 2). Weight loss of the control fruits was substantially higher than the other methods tested (Fig. 1).

The coloration of tomato fruits was not affected by the method of packaging (Tables 1 and 3). Fruits of the control had much better coloration than of other packaging methods. Both bagging and wrapping delay the ripening of many fruits [1, 2, 3]. A high percentage of damaged fruits was associated with bagging (Fig. 2). This may probably be due to the high moisture content of the bag atmosphere which favors growth of pathogens. It may also be related to what is called secondary infection. In

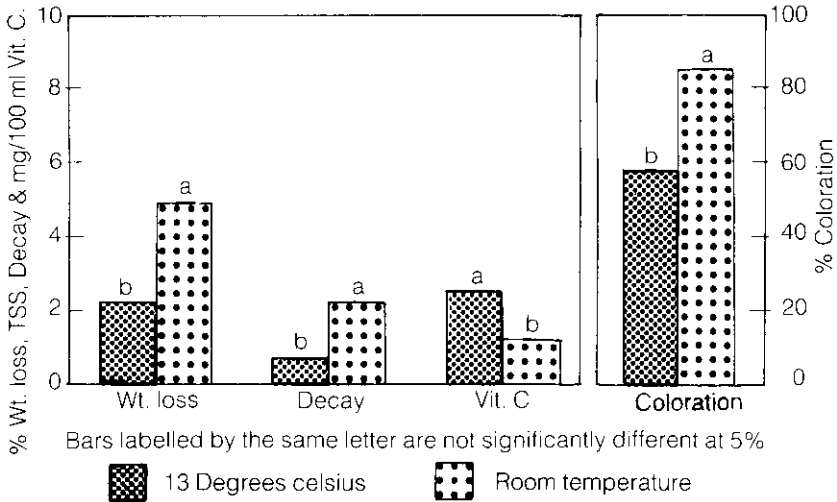


Fig. 1. Effect of storage temp. on weight loss, percent decay, vit. C content and percent coloration of tomato fruits.

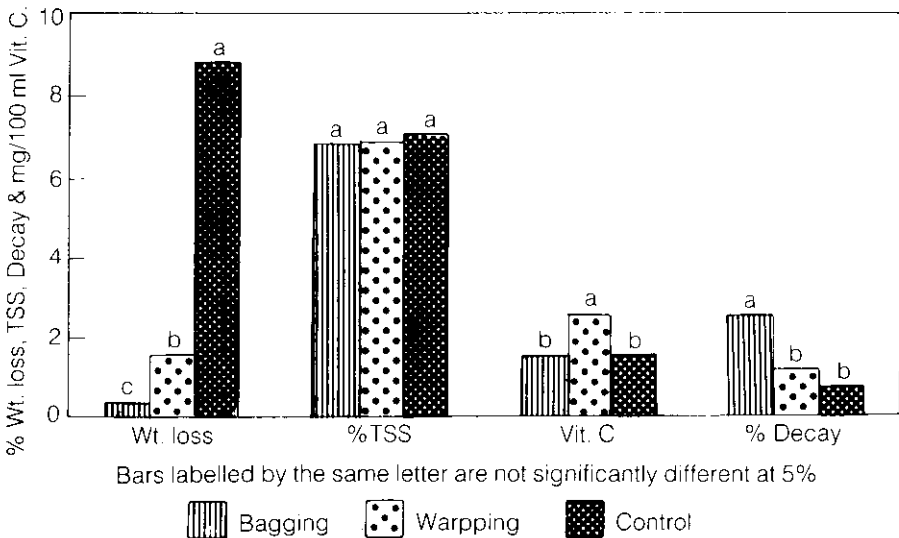


Fig. 2. Effect of packaging methods on weight loss, total soluble solids, vit. C content and decay percent of tomatoes.

this case, one rotten fruit may infect the entire fruits of the container [2]. Such case can be eliminated in individual wrapping method.

Although bagging reduced the weight loss of fruits, it increased percent decay and secondary infectoin. Individual wrapping may, therefore, be practically preferred [2]. The weight loss from tomato cultivar, "Dombo" was significantly higher than

**Table 3. Significance levels (ANOVA) of cultivars, storage temperature, packaging method and storage duration of tomatoes.**

Sources of variance	Weight loss	Color	Decay	TSS	TA	Vit. C	TSS/TA
Cultivars	*	NS	NS	NS	NS	NS	NS
Packing	**	NS	*	NS	NS	*	NS
Period	**	**	**	**	NS	**	*
Temperature	**	**	**	NS	NS	**	NS

\* = significant at 0.05

\*\* = significant at 0.01

NS = not significant

Weight loss = as %

TSS = total soluble solids

TA = titratable acidity as %

Vit. C = vitamin C as mg/100 ml

that of "Dombito" (Table 1). This could be attributed to cultivar differences. No significant differences occurred between coloration and decay percentages of cultivars. Storage at 13°C was preferable for prolonged tomato shelf life [5, 6]. But storage at 24°C was the best for rapid ripening and good coloration [7].

Tomato fruits stored for 50 days at 13°C showed a gradual increase in the weight loss, coloration and decay percentage from the beginning to the end of the storage period (Table 1).

### ***Biochemical attributes***

The data presented in Tables 1 and 3 show no significant differences in the chemical characteristics of fruits between the two tested tomato cultivars.

Vitamin "C" content was affected by packing, storage period and storage temperature (Table 1 and Figs. 1 and 2). Individually wrapped fruits had a slightly higher percent of vitamin than bagged fruits (Fig. 2). An obvious increase in vitamin C content was observed in fruits, 30 days after storage (Table 1). This also occurred when storage was done at 13°C (Fig. 1 and Table 3).

TSS and the ratio TSS/TA were also affected by storage period, the difference being highly significant in the former case and significant at 5% level only in the latter (Table 3).

All factors tested had no apparent effect on TA. Packing and, storage temperature proved to have no effect on TSS or the ratio TSS/TA (Table 3).

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## تأثير طرق التعبئة على خواص الجودة للطماطم المنتجة في الزراعة المائية

مصطفى عبداللطيف المغربي

قسم الإنتاج النباتي، كلية الزراعة، جامعة الملك سعود

الرياض، المملكة العربية السعودية

ملخص البحث. أنتجت ثمار الطماطم للصنفين «دميتو» و «دمبو» في الزراعة المائية، وحصدت عند اكتمال النمو/ الخضراء. تم دراسة أثر طرق التعبئة وطول مدة التخزين ودرجة حرارته على بعض الصفات الطبيعية والكيميائية للثمار مثل الفقد في الوزن، الإصابة بالأمراض، تلوين الثمار، المواد الصلبة الذائبة الكلية، الحموضة، نسبة المواد الصلبة الذائبة الكلية إلى الحموضة ومحتوى الثمار من فيتامين ج.

اتضح أن تكييس الثمار كان فعالاً في خفض الفقد في الوزن، ولكنه أدى إلى زيادة الإصابة بالأمراض وخاصة الإصابة الثانوية. وكان تغليف ثمار الطماطم أفضل من التكييس، كما كانت درجات الحرارة المفضلة هي ١٣ م لاطالة حياة الثمرة في الخزن و ٢٤ م لتلوين وسرعة نضج الثمار.

