Organoleptic Evaluation of Shrink-wrapped Muskmelon

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Additional index words. *Cucumis melo*, postharvest, flavor, quality, packaging film, disorders, mold

Abstract. Organoleptic evaluations of shrink film-wrapped and nonwrapped muskmelon (*Cucumis melo* L. var. *reticulatus* cv. TAM Uvalde) fruit were conducted to determine changes in flavor and taste during refrigerated storage. Ripe green and yellow 'TAM Uvalde' muskmelons, shrink film-wrapped in 12.7- μ m high-density polyethylene film, were compared to nonwrapped melons during 21 days of storage at 4C and 90% to 95% RH. After 21 days of storage, both yellow and green shrink-wrapped melons had better appearance, less surface mold, and less vein tract browning than nonwrapped melons. However, the flavor and taste of shrink-wrapped fruit were significantly inferior to those of nonwrapped melons. Green-wrapped melons were rated poorer in taste and flavor than yellow-wrapped and nonwrapped melons after 14 days of storage. These results indicate that shrink-wrapping may enhance undesirable flavor changes in muskmelon during storage.

Good quality muskmelon fruit have a potential shelf life of $\approx$ 15 days at 2 to 5C when harvested at the green hard ripe stage (Hardenburg et al., 1986). Considerable work has been done to increase the shelf life of produce by preventing moisture loss and providing a modified atmosphere through film wrapping or surface waxing (Smith et al., 1987). Lester and Bruton (1986) reported that shrink-wrapping muskmelon fruit in Clysar EHC-50 high-density polyethylene (HDPE) film increased the shelf life to 40 days. The prolonged shelf life was assumed to be the result of a decreased transpiration rate and the creation of a water-saturated microatmosphere under the shrink-wrap. Ben-Yehoshua (1978) used a 10- μ m HDPE to shrink-wrap citrus and reported a doubling of storage life. Hughes et al. (1981) reported that shelf life was longer for shrink-wrapped bell peppers than for nonwrapped peppers. Bhomik and Sebris (1988) found that shrink-wrapping peaches in 15- μ m HDPE film extended storage life from 3 to 6 weeks at 1 and 10C.

A good shrink-wrap for fresh produce should be durable, flexible, allow adequate gas exchange, and maintain the fresh appearance of the produce (Ben-Yehoshua, 1985). Although Lester and Bruton (1986) reported that the appearance of shrink-wrapped muskmelons was superior to non-

wrapped melons, organoleptic properties of the muskmelons were not evaluated after storage. Off-flavors with shrink-wrapped produce have been reported. Golomb et al. (1984) noted that shrink-wrapped grapefruit developed off-flavors after extended storage. Shrink-wrapped mangos were also found to have off-flavors following storage (Miller et al., 1986). The objective of this study was to evaluate changes in organoleptic properties of muskmelon in response to shrink-wrapping.

One hundred and fifty full-slip hard yellow and full-slip green 'TAM Uvalde' muskmelon fruit were obtained from Three Rivers Produce, Atoka, Okla. All fruit were obtained from the same harvest, were similar in appearance, size, weight, and quality and had a soluble solids content $> 12\%$. Fruit were dipped in a 10% sodium hypochlorite solution at 38C for 1 min and air-dried. Half of the yellow and green melons were individually shrink-wrapped in 12.7- μ m HDPE Clysar 50 EHC-F film (E.I. Dupont de Nemours and Co., Wilmington, Del.) and passed through a shrink-wrap tunnel (Allied Automation, Inc., Dallas, Texas). Shrink-wrapped and nonwrapped melons were packed into waxed ventilated melon boxes and stored at 4 ± 2 C at $90\% \pm 5\%$ RH. Eighty fruit were used for organoleptic and laboratory evaluations. The remaining fruit were evaluated weekly for 21 days for stem-scar mold, surface mold, vein tract browning, and general appearance. Each criterion was rated subjectively on a scale where 1 = highly acceptable, 3 = marginally acceptable, 5 = unacceptable.

A random sample of five melons was taken from each treatment. The melons were weighed and cut in half longitudinally through

the ground spot. One-half of the melon was used for organoleptic tests and the remaining half was used for other quality evaluation tests.

Organoleptic tests were conducted on mesocarp tissue (2.5×2.5 -cm cubes) taken at random and placed on three-digit numbered plates. A trained panel and a consumer panel evaluated the muskmelons for organoleptic properties at 0, 7, 14, and 21 days postharvest. Muskmelon samples were presented to taste panelists at room temperature. The study was a completely randomized design over time. Data were subjected to analysis of variance and means were separated by least significant difference ($P \leq 0.05$).

Organoleptic evaluation:

Trained taste panel evaluation. The trained taste panel consisted of eight members from the Wes Watkins Agricultural Research and Extension Center, Lane, Okla., who were trained and screened for taste sensitivity with solutions of sugars (sweetness), citric acid (sourness) (Larmond, 1977), and melons of varying degrees of ripeness and intensities of off-flavors. A multiple comparison test was conducted; melon samples from each treatment were compared to a reference melon sample. The reference sample consisted of a freshly harvested yellow table ripe 'TAM Uvalde' melon. The panelists rated the treatments more acceptable, equal, or less acceptable for flavor than the reference melon and whether the degree of difference was none, slight, moderate, fairly extreme, or extreme.

The trained panelists also completed a descriptive analysis test. Samples from the treatments and the references were evaluated on a line scale from 0 (acceptable) to 10 (unacceptable) (Larmond, 1977). The characteristics evaluated were flavor (no off-flavor to extreme off-flavor), texture (firm to mushy), odor (no off-odor to extreme off-odor), sweetness (just right to not sweet enough), and overall acceptability (acceptable to not acceptable).

Consumer evaluation. Consumer taste panel evaluations were performed inside a local shopping center. Samples were taken from halves of five randomly selected muskmelons from each of the four treatments at each storage date and prepared as previously

Table 1. Main effects of wrapping on appearance and disease of 'TAM Uvalde' muskmelon after 21 days of storage.^a

Criterion	Wrapped melon rating	Nonwrapped melon rating
Stem-scar appearance	1.7 a	3.3 b
Surface mold	1.5 a	2.1 b
Vein tract browning	1.7 a	2.3 b
Appearance	2.2 a	3.1 b

^aMeans with different letters are significantly different within rows at the $P \leq 0.05$ level using LSD.

Received for publication 13 Nov. 1989. Cooperative Agreement no. 58-7MN1-7-113, USDA, ARS, SCARL, Lane, OK 74555. Oklahoma State Univ. Journal Series no. J5767. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.

Fig. 1. Descriptive analysis rating by a trained taste panel of reference (REF), green nonwrapped (GRE), yellow nonwrapped (YEL), yellow shrink-wrapped (SWY), and green shrink-wrapped (SWG) melons. Fruit were rated for flavor (A) and overall acceptability (B) using a scale of 10 (acceptable) to 0 (not acceptable). Vertical bars represent LSD.

described. At least fifty consumers evaluated the treatments individually, using a hedonic scale from 1 to 9, to rate how much they liked or disliked the melons. Consumers also rated the melons for texture (hard to mushy), flavor (extremely good to extremely bad), and indicated whether or not they would purchase the melons representing the different treatments.

Laboratory assays

Halves of remaining melons from sensory tests were used for laboratory assays. Juice was extracted from 2.5-cm mesocarp wedges and soluble solids content was measured with a hand-held refractometer. Firmness was measured using a McCormick fruit penetrometer (McCormick Fruit Tech., Yakima, Wash.) with a 1.2-cm diameter tip. Three penetrometer readings were taken on the middle mesocarp of each melon. Four cylindrical plugs (0.9 cm diam. $\times$ 1 cm thick) were removed from the tissue directly below the rind for electrolyte leakage determinations. Plugs were divided into two replicates of $\approx$ 1.9 g each and electrolyte leakage was measured according to the methods of Lester and Bruton (1986), using a YSI Model conductivity meter and a YSI 3417 cell (Yellow Springs Instrument, Yellow Springs, Ohio).

Organoleptic tests

Trained taste panel evaluation. The results from the multiple comparison test indicated that all treatments were equal to the reference melon on day 0 (data not shown). On day 7, the green melons were rated significantly higher for flavor than the yellow melons, regardless of the wrap condition. There were no significant differences among treatments for this test for days 14 and 21 (data not shown).

For the descriptive analysis test, there were no significant differences in flavor or overall acceptability ratings among treatments at day 0 (Fig. 1A, B). By day 7, nonwrapped green melons were rated higher in flavor and overall acceptability than the yellow and shrink-wrapped yellow melons (Fig. 1A, B). On day 14, nonwrapped green and reference samples were rated higher than wrapped green samples for flavor. There was no significant difference in ratings for overall acceptability. On day 21, green nonwrapped melons were rated significantly higher in flavor than shrink-wrapped green and yellow melons. Green nonwrapped melons were rated significantly higher than green wrapped melons for overall acceptability (Fig. 1A, B). There were no differences among the other treatments.

Consumer evaluation. Consumers were unable to identify differences in taste and flavor and did not have a buying preference between melon treatments until day 14 (Fig. 2A-C). On day 14, nonwrapped green melons were rated the highest while shrink-wrapped green melons and yellow nonwrapped melons were consistently rated lowest in taste, flavor, and consumer acceptability. By day 21, nonwrapped green melons were rated significantly higher than all other treatments for taste, and nonwrapped melons were rated significantly higher than wrapped melons for flavor (Fig. 2A, B). Consumers indicated a significant preference for nonwrapped green melons compared to melons from other treatments. Eighty percent responded that they would purchase the nonwrapped green melons while only 45% would purchase the wrapped green melons (Fig. 2C).

The absence of perfect ratings (10) is not uncommon in consumer taste evaluations (McGill, 1979). Throughout the present study, consumer ratings were never higher than 8. Ratings of <8 on a similar scale were reported in a taste test evaluation with muskmelon cultivars (Zanoni, 1989).

Results from both trained taste panelists and consumers indicated that nonwrapped full-slip green melons had better flavor than nonwrapped yellow melons after 7 days in storage. These results correspond to those of Evensen (1983), where 10 taste panelists consistently rated green full-slip melons higher in flavor than yellow full-slip melons after 7 days of storage. Kemp et al. (1973) reported that fruit volatiles were relatively unaffected in nonwrapped muskmelons stored for 2 weeks. However, Miyazaki and Ookubo (1989) noted changes in some flesh volatiles of polyethylene seal-packaged muskmelons during storage. These volatile changes may be related to off-flavor development. Our data suggest that shrink-film wrapping enhances the development of off-flavors in 'TAM Uvalde' muskmelons by 14 days of storage. Researchers have reported off-flavor development with seal-packaged grapefruit (Golomb et al., 1984) and mangos (Miller et al., 1986). Conversely, Ben-Yehosua (1985), Bhomik and Sebris (1988), and Elkashif et al. (1983) reported no development of off-flavors during storage of shrink-wrapped citrus, peaches, and broccoli.

There are indications that off-flavors in film-wrapped produce may be related to excessive levels of CO_2 and/or reduced levels of O_2 . Miller et al. (1986) reported that mangos shrink-wrapped in 12.7- μ m HDPE at the soft-ripe stage had off-flavors and elevated CO_2 levels after 9 days of storage. Because of off-flavor and decay problems, they found no benefit in shrink-wrapping mangos. Green bell peppers stored at 25C developed off-flavors when wrapped in 12- to 35- μ m polyvinyl chloride and HDPE films (Bussel and Kenigsberger, 1975). In addition, the CO_2 concentration below the film increased from 1.5% to 8%, while O_2 decreased from 16% to 9.5%. In a preliminary study, we moni-

Fig. 2. Taste test by 50 consumers of green nonwrapped (GRE), yellow nonwrapped (YEL), yellow shrink-wrapped (SWY), and green shrink-wrapped (SWG) melons. Fruit were rated for taste (A), flavor (B), and consumer purchasing (C) using a scale of 10 (acceptable) to 0 (not acceptable). Vertical bars represent LSD.

tored CO₂ levels below the wrap for 21 days in shrink-wrapped 'TAM Uvalde' muskmelons. Carbon dioxide concentrations were 0.75% for wrapped melons compared to 0.07% for nonwrapped melons (data not shown).

Laboratory assays

Although the organoleptic ratings were lower for stored shrink-wrapped melons compared to nonwrapped melons; appearance ratings were higher (Table 1). Our results were similar to those reported by Lester and Bruton (1986). By the end of the study,

nonwrapped melons were rated significantly worse for stem-scar mold, surface mold, vein-tract browning, and appearance compared to wrapped melons (Table 1). Green melons were rated higher (1.4) than yellow melons (2.2) for surface mold only. Although nonwrapped melons had higher disease ratings than the wrapped melons, the ratings were still in the marginally marketable range.

Nonwrapped melons lost 7% fresh weight after 21 days of storage compared to 5% weight loss from wrapped melons regardless of degree of ripeness. This weight loss was higher than that reported in other studies for shrink-wrapped produce. However, all other

quality indices were highly acceptable and correspond to other research, indicating high initial quality. There were no significant differences in firmness, electrolyte leakage, or SSC between treatments at any sampling date (data not shown).

In conclusion, although fruit appearance was maintained, shrink-wrapping adversely affected the taste and flavor of 'TAM Uvalde' muskmelon during extended storage. Further studies are needed to elucidate the factors involved in off-flavor development with shrink-wrapped muskmelon, including interactions with CO₂/O₂ concentrations and natural flavor components.

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