Effect of Two types of Packages on Quality and Shelf-life of Banana (Musa sp.) and muskmelon (Cucumis melo L.) fruits

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Abstract: A comparative study of banana fruits grown in Al-Damazine area and muskmelon fruits grown in Arabic Company Farms in Omdoum area, stored in two types of packaging materials for 15 days at 18 ± 1 °C and 85-90% relative humidity was carried out. The first type is the approved packages of Sudanese Standards and Meteorological Organization (SSMO), and the other is the commercially available packages. The physicochemical changes (respiration rate, weight loss, peel color, fruit flesh firmness, TSS, titratable acidity, ascorbic acid content and reducing sugars) of the fruits were studied during storage. Results indicated that the banana fruits reached the maximum respiration rate in the commercial packages in the eighth day (17.467 mg CO₂/kg-hr), while in muskmelon in the seventh day) 58.333 mg CO₂/kg-hr). In the SSMO approved packages the rate continued until the eleventh day for the bananas (19.033 mg CO₂/kg-hr), and ninth day for muskmelon (58.367 mg CO₂/kg-hr). Results also indicated that there were significant differences (P ≤ 0.05) in weight loss, peel colour, fruit flesh firmness, T.S.S, titratable acidity and reducing sugar of banana packed in SSMO packages compared to fruits packed in traditional packages, but there was no significant difference in ascorbic acid content. For muskmelon results showed that there were significant differences in weight loss, fruit flesh firmness and reducing sugar of fruits packaged in SSMO packages compared to those packed in traditional packages. While there was no significant difference in peel colour, T.S.S, titerable acidity, ascorbic acid content and reducing sugar. It was observed that the total soluble solids, reducing sugars and weight loss had increased as fruits ripened. At the same time firmness, Ascorbic acid (vitamin C) and acidity maintaining good quality decreased. This study showed that the SSMO packages have the privilege of decreasing the respiration rate, decreased weight loss and hence prolonged the shelf life of fruits, compared to conventional packages.

Keywords: SSMO packages, traditional, Sudanese Standards

Introduction

The importance of fruits and vegetable cannot be overemphasized. The vitamin content in fruits and vegetable is known to be nutritionally superior when compared to many cereal and leguminous crops (FAO, 1992). They are highly perishable due to high water content and thereby susceptible to rapid deterioration soon after harvest. Therefore they have to be properly packaged and stored if not consumed immediately. Traditionally, storage materials such as calabash, earthen pots, and baskets have been used for the purposes of
extending shelf life few days after harvest (Kordylas, 1991).

Banana (*Musa sp.*) is one of the most important fruit crops in the world trade (FAO, 2007). In Sudan, banana is the most popular fruit for its nutritive value, low price and availability all year round. It is grown in almost every state, with annual production of 540 thousand metric tons (AOAD, 2008).

Banana is a typical climacteric fruit that exhibits characteristic rise in ethylene production and respiration rate during ripening (Kader, 2002). The high rate of respiration and ethylene production, which is usually associated with short shelf-life, soft texture and high moisture content makes banana a very perishable fruit that requires absolute care during handling and transportation (Wills *et al*., 1998).

Muskmelons (*Cucumis melo L.*) are among the major vegetables that are grown worldwide. The demand for fresh muskmelons is increasing for their excellent flavor, attractive fragrance, beautiful color, delicious taste and health giving properties (Salunkhe and Desai, 1984). In Sudan, the production of muskmelons, particularly hybrid Galia F1, has become a well established business. There is a considerable interest in recent years, by governmental and private sectors, in production of melons mainly for export. The main markets for muskmelons are European countries and the Gulf States. Muskmelons rank first in exported vegetables and second to mango in Sudanese total horticultural exports (Abbas, 2004). Although Sudan has great potentiality to produce and export high quality muskmelons, the harvesting and post-harvest handling practices are still not taken care of by both producers and distributors. These practices need a lot of improvement for the development of a sound muskmelon industry, for both local and export markets. During the last few years, farmers failed to harvest and to keep their production in the right way to comply with export requirements. Records from Wafra company and Arab Company for Production and Agricultural Industry (ACPAI) showed that a significant portion (25-30%) of the packed melons was discarded before shipment (SHEC, 1999). This was attributed to water loss, shriveling and physiological and pathological disorder. Importers feedback also indicated that a considerable part of production was discarded at destination for poor quality due to improper harvesting stage, fruit softening and shriveling (MACK, 1999).

The objectives of this study were:
1. To evaluate the effect of packages type on quality and shelf life of muskmelon and banana fruits.
2. To investigate some of the compositional changes during banana and muskmelon fruits packaging for export.

**Materials and Methods**

Banana (*Musa spp.*) variety giant was Cavendish fruits were obtained from a private orchard in Eldamzein area 700 km South of Khartoum. Fruits were harvested at the “full three quarters” mature-green stage in winter season. One of the important export ‘Galia F1 - Ghaleb’ muskmelon (*Cucumis melo L.*) cultivars, namely ‘Galia F1 - Ghaleb’ fruits, were obtained from a private farm at Al-mutamyza company for fruits and vegetables production (Arabic company farms), Um Doum, 25 km east of Khartoum. Fruits were harvested at the green stage in winter season. The banana and muskmelon fruits were selected for uniformity of size, color and freedom from blemishes and defects. Then washed with tap water to remove latex and dust and air-dried. These fruits were distributed between the two treatments (50 fruits each) in a completely randomized design with three replications. The fruits were packed in carton boxes, two types of boxes, the first type was in compliance with the parameters set by SSMO, i.e. fruit volume, ventilation points, good cartoon quality, perforated polyethylene bed. The second type were usual market boxes. The
fruits stored at 18 °C ± 1 and 85%-90% RH for two weeks.

Respiration Rate was determined for each replicate separately from the sample, using the total absorption method of Charlimers (1956). Weight loss of fruits was determined every day, by weighting each replicates separately. Every replicate contained 12 fruits of banana and 4 fruits of muskmelon, and weight loss percentage was calculated. Peel color determined according to Chiquita Brand Inc.(1975) in banana and sensory evaluation for muskmelon, total soluble solids (TSS) was measured directly according to (A.O.A.C, 1990). Flesh Firmness was measured by the Magnets and Taylor Firmness Tester, (D. Ballanf Meg. Co), equipped with an 8 mm diameter plunger tip. Reducing Sugar was determined according to Nelson (1944), as modified by Somogyi (1952). Ascorbic Acid is determined by the 2, 6 dichlorophenol-Indophenol Titration method (Ruck, 1963) and the titratable acidity was determined according to the method described by Person (1973).

Results and Discussion

Respiration rate

The respiration curves of banana and muskmelon in both types of packages exhibited a typical climacteric pattern. Banana fruits reached a climacteric peak of 17.5 mg CO$_2$/kg-hr after 8 days in the usual market packages and a peak of 19.0 mg CO$_2$/kg-hr after 11 days in SSMO packages (figure 1). Muskmelon reached a climacteric peak of 58.9 after 7 days and 58.4 after 9 days in the usual market and SSMO packages, respectively (figure 2). This increase and delay in the climacteric peak of respiration was most probably due to the difference of the material and the design of the packaging boxes. Biale et al, (1954) found that the stage of ripeness corresponded closely with the climacteric peak in fruits such as banana, tomato and mango. Unripe banana fruit produces ethylene at constant but low rates. Then ethylene production rises dramatically and respiration increases.

![Figure 1: Respiration rate of banana packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity](image-url)
Figure 2: Respiration rate of muskmelon packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity

Weight loss
The fruits of both types of packages showed gradual increase in weight loss during ripening period. Similar finding was reported in mango by Rathore et al., (2007). Fruits stored in traditional market packages exhibited the higher weight loss compared with those stored in SSMO packages. This might be a result of the difference in the quality and specifications of the packages (Figures 3, and 4).

Peel Colour
There was a significant difference noticed in peel color of both banana and muskmelon packed in SSMO packages fruits and the traditional market packages. Peel color score progressively increased during storage of banana fruits. Fruits stored in the traditional market packages reached the full yellow stage (colour score 6.8667) after 12 days. At that time, the colour score was just (5.0333) in the fruits stored in SSMO packages. These results are in full agreement with Palmer, (1971). Rind colour of muskmelon fruits gradually increased during storage in the two types of packages. Rind colour between muskmelon fruits changed from dark-green to grayish-green and then to yellowish-green as the melon fruits approaches maturity (Salunkhe and Desai, 1984). Both of fruits stored in the traditional market packages and SSMO packages reached the yellow stage (colour score 5) after 13 days (Table 1).
Figure 3: Weight loss of banana packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity

Figure 4: Weight loss of muskmelon packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity
Table 1: Peel colour of banana and muskmelon packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity

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(S1) = (SSMO), packages (S2) = traditional market packages
Any two mean values having different superscript letter(s) in each column differ significantly (P≤ 0.05).
Fruit flesh firmness
Table (2) shows that there was a significant difference in fruit flesh firmness during storage of banana SSMO packages fruits and usual market ones after 7 days (0.507, 0.438) respectively. For muskmelon SSMO packages fruits and usual market ones there was a significant difference in flesh firmness after 9 days (0.5441, 0.4701). Similar drop in fresh firmness was reported in melon and banana by Chisari et al., 2008 and Abu-Goukh et al., 1995 respectively.

Total soluble solids
Total soluble solids (TSS) increased in both types of the banana and muskmelon fruits with decrease flesh firmness. Biale et al. (1954) attributed the increase in TSS and total sugars during fruit ripening to hydrolysis of starch to sugars (figure 5,6).
Table 2: Flesh firmness change of banana and muskmelon packaged in SSMO and traditional market package stored at 18±1 °C and 85-90% relative humidity

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<td>S1</td>
<td></td>
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<td>0.59&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.5894&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.579&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>0.255&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.245&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>0.235&lt;sup&gt;a&lt;/sup&gt;</td>
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<td></td>
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<td>0.59&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.5889&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>0.335&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>0.4701&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>0.220&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.17&lt;sup&gt;a&lt;/sup&gt;</td>
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</table>

(S<sub>1</sub>)= (SSMO), packages (S<sub>2</sub>)= traditional market packages
Any two mean values having different superscript letter(s) in each column differ significantly (P≤ 0.05).
6. Reducing sugar
Reducing sugar content increased rapidly during storage period in both banana and muskmelon SSMO packages fruits and usual market packages fruits. Similar finding in guava was reported by, Elbashir (2003) (figure 7,8).

7. Ascorbic acid content
Table (3) shows that there was no significant difference in ascorbic acid (%) during storage of banana and muskmelon SSMO packages fruits and traditional market packages fruits. Ascorbic acid decreased steadily during storage of banana and muskmelon between (SSMO) packages fruits and traditional market packages fruits, but no significant difference. Similar reduction was reported in guava (Elbashir, 2003). Ascorbic acid content depended on the physiological properties of the cultivar and on the condition of plant growth (Rubinskiene et al., 2006).

8. Titratable acidity
Titratable acidity decreased steadily in both fruits of the two types of packages, but no significant difference was observed between them. Similar reduction in acidity was reported in mango (Rathore et al., 2007). The reduction in acidity during storage might be due to the degradation of citric acid or due to their conversion into sugars and their further utilization in metabolic process (Rathore et al., 2007)(figure 9,10).

![Graph showing TSS change of banana packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity](image-url)
Figure 6: TSS change of muskmelon packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity

Figure 7: Reducing sugar change of banana packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity
Figure 8: Reducing sugar change of muskmelon packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity
Table 3: Ascorbic acid content change of banana and muskmelon packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity

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<tr>
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<td>S1</td>
<td>8.0&lt;sup&gt; a &lt;/sup&gt;</td>
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<tr>
<td>S2</td>
<td>8.0&lt;sup&gt; a &lt;/sup&gt;</td>
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<td><strong>Muskmelon</strong></td>
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<td>S1</td>
<td>11&lt;sup&gt; b &lt;/sup&gt;</td>
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<td>S2</td>
<td>11&lt;sup&gt; b &lt;/sup&gt;</td>
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(S<sub>1</sub>) = (SSMO), packages (S<sub>2</sub>) = traditional market packages
Any two mean values having different superscript letter(s) in each column differ significantly (P ≤ 0.05)
Figure 9: Acidity change of banana packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity.

Figure 10: Acidity change of muskmelon packaged in SSMO and traditional market package stored at 18 ± 1 °C and 85-90% relative humidity.
Conclusion:
- It was found that banana and muskmelon have long shelf life when they were stored in (SSMO) package compared to the traditional market packages.
- The type of fruits packaging material is important in keeping quality.
- It is recommend that to use the packages which are in compliance with the specifications set by SSMO, i.e. fruit volume, ventilation points, good carton quality, perforated polyethylene bed, etc.
- Additional studies to ensure safety, stability, optimum storage conditions, and suitable packaging requirements, are needed.

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Wills, R.; B. McGlasson; D. Graham and D.Joyce. (1998). Postharvest: An Introduction to the physiology and Handling of fruit, Vegetables and Orna-
لتثبت دراسة تأثير نوعين من العوامل على تخزين تمر الموز الزراعي في منطقة الدائرة وثمار الشمام،

الموز المزرع في مزارع الشكير العربية في منطقة أم دوم في مرحلة ما قبل النضوج لمدة أسبوعين في درجة حرارة °C

و18 ± 1 ورطوبة نسبة 90-95% النوع الأول هي العوامل المضافة بها من قبل الهيئة السودانية للمواصفات والمقياسين والثاني عوامل عادية من الأسواق المحلية من حيث التغييرات الفيزيوكيميائية (تنضج نمازم). فقد الوزن، لون الفصة، تماسك لب الموز، المواد الصلبة الذاتية الكمية، الحموضة المعايرة، حمض الأسكوربيك والميكروبات المختلطة التي تطرأ على الشمام أثناء فترة التخزين. أظهرت النتائج أن الشام بلغت قمة التنفس في تمر الموز المخزنة في العوامل العادية في يوم الثامن (17.671) وفي شعير الشمام في اليوم السابع (58.333). بينما استمرت في شعير الموز المخزنة في العوامل المضافة بها من الهيئة السودانية للمواصفات والمقياسين حتى اليوم الحادي عشر (19.353). واستمرت حتى اليوم التاسع في شعير الشمام (58.367). لاحظ أن كمية المواد الصلبة الذاتية والسركاريتات المختلطة والفقد في وزن الفصيرة قد ارتفعت كلما تقدمت الشام في النضج بينما تناقصت درجة الصلابة ومحتوى الفصيرة من حمض الأسكوربيك وحمض الدهون. أشارت النتائج أيضاً إلى وجود اختلافات معينة إحصائياً (P ≤ 0.05) فيما يخص باقین الوزن لون الفصيرة، تماسك لب الموز، المواد الصلبة الذاتية الكمية، الحموضة المعايرة، الوكرانتات المختلطة للوزن في العوامل المضافة بها من الهيئة السودانية للمواصفات والمقياسين مقابل ذلك المعيار في العوامل العادية. في حين لم توجد أي اختلافات معنية في محتوى الفصيرة وحمض الأسكوربيك بالنسبة للشام، ظهرت النتائج أيضاً أن وجود اختلافات معينة فيما يخص باقین الوزن، تماسك لب الموز، والميكروبات المختلطة للوزن في العوامل المضافة بها من الهيئة السودانية للمواصفات والمقياسين مع ذلك المعيار في العوامل العادية. في حين لم توجد أي اختلافات معينة في محتوى الفصيرة، المواد الصلبة الذاتية الكمية، الحموضة المعايرة، حمض الأسكوربيك والميكروبات المختلطة. أثبتت نتائج الدراسة أن العوامل المضافة بها من الهيئة السودانية للمواصفات والمقياسين قد تميزت على العوامل التقليدية في الحفاظ على جودة الشام وإبطاء معدل التنفس، الأمر الذي أدى إلى تقليل فقد الوزن وبالتالي إطالة فترة تخزينها.