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# Influence of spraying yeast extract and humic acid on fruit maturity stage and storability of "Canino" apricot fruits

[1]Fatma K. M. Shaaban, [2]Morsey M. M. and [3]Thanaa Sh. M. Mahmoud

[1]Fruit Handling Res. Dept., Hort. Res. Inst. Agric. Res. Cen., Giza, Egypt.
[2]Deciduous Fruit Res. Dept., Hort. Res. Inst. Agric. Res. Cen., Giza, Egypt.
[3]Department of Horticultural Crops Technology, National Research Center, Dokki, Giza, Egypt.

**Abstract:** Fruits of Apricot (*Prunus armeniaca* L.) varity Canino mature trees growing in loamy clay soil at the experimental orchard of the Horticulture Research Station at El Kanater El Khayreia, Kalubia Governorate, Egypt, were sprayed once at full bloom during seasons 2013 & 2014 with yeast extract at 10, 20 and 30 g/L, humic acid as Actosol® (contains 2.9 % humic acid) at 40, 60 and 80 ml/L and yeast extract at 20 g/L + humic acid at 60 ml/L, besides water spray as control. Mature fruits were harvested and stored at 0°C for six weeks. Results indicated that foliar application of 20 g/L yeast extract plus 60 ml/L humic acid/ tree gave the best effect on tree yield and increased vegetative growth parameters, total leaf chlorophyll content and leaf mineral content (N, P, K and Mg). Also, this treatment was effective in improving fruit quality and storability of apricot fruits under cold storage conditions comparing with other treatments.
**Keywords:** Apricot, yeast extract, humic acid, cold storage, fruit quality and storability.

## Introduction

Apricot (*Prunus armeniaca* L.) is a member of the stone fruits of the family Rosaceae, sub family Prunoidea. The fruit is classified as a drupe and distinguished by a double sigmoid curve with rapid growth during cell division, followed by a period of slow or ceased growth during pit hardening, and then a period of rapid cell enlargement.

Apricot fruits are nutritious and demanded by consumers. There has been an expansion in the apricot cultivated area in Egypt. The total production was estimated to be 98772 tons in 2013[1]. In addition to the local cultivars such as El-Ammar, Hamawi and many others strains, there have been an introduction of many new cultivars with low chilling requirements in winter. "Canino" has been considered as one of the most successful new cultivars under Egyptian conditions. This cultivar is characterized by its high yield, high fruit quality, heavy load, large size and round fruits, free stone and soft flesh and the suitability of preserving fruits by freezing or drying. The marketing season of the fruit in Egypt extends from the beginning of June to the middle of July, depending on the area and cultural practices. However, most fruits are harvested during the period from the second half of June to early July. However, apricot fruits are very perishable and it has been a challenge to enhance their storability and shelf life. Among the quality parameters that define the eating quality of apricot; important traits such as texture and flavor that influence final acceptance. Flavor has been defined as a complex attribute of quality in which a mixture of sugars, acids, and volatile compounds play a primary role[2]. Fruit shape, colour intensity, aroma, sweetness, sourness, flesh firmness, and juiciness are all basic sensory descriptors for apricot[3]. Apricots are stone fruits with a limited post-harvest life. They remain fresh for only1–4weeks, depending on cultivar, when stored at –0.5º to 0ºC and 90 ± 5% relative humidity[4].

Yeast extract and humic acid are considered bio-stimulants to enhance the yield and fruit quality of apricot and they become positive factors that minimize utilization of inorganic and chemical fertilizers. They are safe for human and environment [5] and using them was accompanied with reducing the great pollution occurred in our environment as well as for producing organic foods for export. Yeast extract (*Saccharomyces cervisiae, L.*) application activate photosynthesis process through enhancing the release of $CO_2$ as well as its high percentage of protein, large amount of vitamin B and the natural plant growth regulators namely IAA, $GA_3$ and cytokinins. Yeast extract 200 ml/L at full bloom stage and two weeks later increased leaf &fruit N, P and K contents of Amar apricot trees as well as leaf photosynthetic pigments content during the certain three stages of fruit development compared with the control [6]. Spraying Valencia orange trees with active bread yeast either once on March or August or twice at both dates was favorable in improving growth, fruit set, number of fruits and yield as well as fruit weight and volume [7]. Yeast 0.2% at full bloom was very effective in improving nitrogen, potassium and boron contents in Keitte mango leaves, fruit set, fruit retention, yield as number of fruits or weight (kg) / tree and increased fruit length (cm), fruit width (cm), fruit weight (g), pulp/fruit percentage and enhanced total soluble solids. On the other hand, it reduced fruit drop and weight of peel and seed (g) comparing with the control[8].

Humic acid (polymeric polyhydroxy acid) is the most significant component of organic substances in aquatic systems. Humic acid is highly beneficial to both plant and soil; it is important for increasing microbial activity, it is considered as a plant growth bio-stimulate, an effective soil enhancer; it promotes nutrient uptake as chelating agent and improves vegetative characteristics, nutritional status and leaf pigments [9,10].

Humic acid treatments (foliar and soil applications) markedly increased the growth parameters (shoot length, number of leaves / shoot and leaf area), yield and fruit physical and chemical properties (fruit firmness, juice SSC and SSC / acidity ratio) of 'Canino' apricot [11, 12].

Canino apricot leaves contained more N, P and K nutrients as a result of soil application of humic acid which pressed the leaves to gain more chlorophyll and more dry matter, increased retained fruits, fruit yield and enhanced fruit quality [13]. Humic materials significantly increased orange and grapefruit trees growth and fruit production[14], enhanced apple fruit weight; yield and soluble solids content [15] increased yield, fruit quality and grower income of peach and apple[16]. Soil application with yeast +humic acid on Roghiani olives gave better effect on leaf area, fruit yield (kg/tree), increased fruit length, diameter and weight, chlorophyll and leaf content of K,Ca,Mg,Fe,Zn and Mn[17].

The investigation aimed at studying the effect of yeast extract and humic acid (Actosol® (foliar application on vegetative growth, total leaf chlorophyll content, leaf mineral contents, fruit set percentage, yield, fruit maturity stage and storability of Canino apricot trees.

## Materials and Methods

Two field experimental trails were conducted during 2013& 2014 seasons on ten year old "Canino" apricot trees, planted at 5 X 5 m in a loamy clay soil in experimental orchard of the Horticulture Research Station at El Kanater El Khayreia, Kalubia Governorate, Egypt. Eight treatments were designed and treatments were arranged in randomized complete block design with three replicates for each treatment and each replicate was represented by one tree. Trees received the recommended horticulture management of the Horticultural Research Institute (H.R.I.). The following treatments were carried out:

1. Control (Spray with water only).
2. Yeast extract at 10 g/L.
3. Yeast extract at 20 g/L.
4. Yeast extract at 30 g/L.
5. Humic acid at 40 ml/L.
6. Humic acid at 60 ml/L.
7. Humic acid at 80 ml/L.

8. Yeast extract at 20 g/L + Humic acid at 60 ml/L.

The treatments were applied at full bloom as foliar application in 2013 & 2014 seasons.Yeast was brewed for 6 hours to prepare autolysates solution of active dry yeast (*Saccharomyces cerevisiae*), 10 g dry yeast +10 g sugar + 1000 ml water, according to[18]. In the combined treatment humic acid was sprayed after week later to yeast extract. The effect of the previous treatments was studied by evaluating their influence on the following parameters:

**Vegetative growth and total leaf chlorophyll content**:

Tree measurements were determined on five nearly similar two years old branches around each tree in both seasons. Data were recorded on shoot length extension (cm), number of leaves extension / shoot and leaf area ($cm^2$) was measured by using portable leaf area meter [Model: YMJ-A 20110122-1]. Total leaf chlorophyll content was measured by using TYS-A chlorophyll meter portable during mid-June in each season.

**Leaf mineral content:**

Leaves samples were collected from each treatment at the end of each growing season and dried at 70°C till a constant weight for determination of the following nutrient elements (percentage as dry weight) N, P, K and Mg according to [19].

**Fruit set percentage and yield:**

At full bloom, No. of flowers per branch were counted and recorded. Set fruits were counted and recorded 3 weeks after full bloom. At harvest time (May 19th 2013 and May 28th 2014) the number of mature fruits retained till harvest date for each spray treatment were counted and estimated as percentage of total number of fruit setting. Yield per tree in Kg was determined.

**Fruit quality**:

Fruits from each tree were harvested at two different stages of maturity. The first harvest date, chosen for being the conventional stage of maturity for commercial harvest, was determined by external appearance and texture. The second stage of maturity at which fruit was harvested came 5 days after the first harvest. Ten fruits /tree were taken to determine the fruit physical and chemical properties.

**Physical properties were assessed as follow**:

Fruit weight (g), fruit diameter (cm), pulp weight, seed weight (g)**.**

**Fruit color:**

Fruit color was quantified at tri stimulus colormetery data (L, a, b) using Minolta Calorimeter (Minolta Co. Ltd.,Osaka, Japan) on the basis of the CIELAB Color system . Color was represented by L (lightness), a (green - red) and b (blue - yellow) scale[20]. The following equation was used to determine color index.

$$h = 180 - \tan^{-1}(b/a)$$

**Fruit Texture:**

Fruit texture was recorded by l Fra texture analyzer instrument, using a penetrating cylinder of 1 mm of diameter to a constant distance 3 mm inside the pulp and by a constant speed 2 mm /sec and the results were expressed as the resistance force to the penetrating tester in units of pressure ( per gram ).

**Fruit weight loss percentage (FWL %)**:

The boxes of fruits were weighed before cold storage to get the initial weight, and then weighed after each period of cold storage. Fruits weight was recorded and then percentages of weight loss were calculated according to the following equation

$$FWL\% = \frac{W_i - W_s}{W_i} \times 100$$

Where $W_i$ = fruit weight at initial period and Ws = fruit weight at sampling period.

**Chemical properties were assessed as follow:**

**Soluble Solids content (SSC %):**

Abbe refractometer was used to determine the percentage of total soluble solids in fruit juice.

**Titratable Acidity %:**

Titratable acidity % was determined by titrating the juice against 0.1 N sodium hydroxide using phenolphthalein as an indicator. Results were expressed as percentage of malic acid in fresh pulp weight [19]. Therefore the fruits were transferred to the refrigerator to be stored at 0°C and 90-95% relative humidity for forty-two days to study the effect of treatments on fruit quality under cold storage. The fruits were taken periodically each seven days out of refrigerator to determine the fruit quality characteristics under cold storage conditions.

**Statistical analysis:**

The treatments were arranged as a factorial experiment in a randomized complete block design. All data were subjected to statistical analysis according to the procedures reported by [21] and means were compared by Duncan's multiple range tests at the 5 % level of probability in the two seasons of experimentation.

## Results and Discussion

**Effect on vegetative growth and total leaf chlorophyll content:**

Data presented in Table (1) showed the effect of different applied treatments i.e. yeast extract and humic acid as well as combination of the medium concentration of yeast extract and humic acid (20 g/L yeast extract and 60 ml/L humic acid) on shoot length extension, number of leaves extension / shoot, leaf area and total leaf chlorophyll content of "Canino" apricot trees during the two studing seasons.

Results revealed that all treatments increased vegetative growth parameters and total leaf chlorophyll content than the control in both seasons of this study. Foliar application of 20 g/L yeast extract and 60 ml/L humic acid gave higher shoot length extension (51.67 and 51cm) in the first and second seasons consequently, number of leaves extension / shoot (58 and 63) in the first and second seasons consequently, leaf area (39.67and 39.80cm$^2$) in the first and second seasons consequently and total leaf chlorophyll content (85.33and 84.73) in the first and second seasons consequently. Meanwhile, the lowest values of vegetative growth parameters and total leaf chlorophyll content were recorded by the control (shoot length extension was 28.33and 26.33cm in the 1$^{st}$ and 2$^{nd}$ seasons, number of leaves extension / shoot was15 and 10 in both seasons respectively, leaf area was 34 and 35.60cm$^2$ in both seasons respectively and total leaf chlorophyll content was 44.33 and 47.57in both seasons respectively. This is in agreement with [17, 22] which recorded that humic compounds and active dry yeast increased vegetative growth parameters. These results may be attributed to the effect of yeast extract in increasing levels of endogenous hormones, i.e. IAA and GA3 in treated plants which could be interpreted by cell division and cell elongation. In addition, the physiological roles of vitamins and amino acids in the yeast extract which increased the metabolic processes role and its effect in activating photosynthesis process through enhancing the release of $CO_2$ [23, 24].

**Table 1: Effect of spraying yeast extract and humic acid on vegetative growth and total leaf chlorophyll content of Canino apricot fruits during seasons 2013 and 2014.**

| Treatments | Shoot length extension (cm) | | Number of leaves extension / shoot | | Leaf area ($cm^2$) | | Total chlorophyll | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 |
| Control | 28.33F | 26.33G | 15.00F | 10.00G | 34.00F | 35.60E | 44.33G | 47.57E |
| Y( 10 g/L) | 33.00E | 31.67F | 22.00E | 22.00E | 37.67C | 36.27E | 47.333F | 74.53C |
| Y( 20 g/L) | 34.00DE | 37.00E | 25.00D | 24.00E | 38.53BC | 37.97CD | 66.33E | 76.17B |
| Y( 30 g/L) | 38.33C | 39.00D | 26.00D | 24.00E | 39.00AB | 39.50AB | 76.00C | 76.53B |
| H( 40 ml/L) | 34.67D | 40.00CD | 34.00C | 36.00D | 36.43D | 36.70DE | 74.67D | 67.33D |
| H( 60 ml/L) | 40.00B | 41.00C | 35.00C | 37.00C | 35.33E | 38.00CD | 76.67C | 76.23B |
| H(80 ml/L) | 41.00B | 43.00B | 38.00B | 51.00B | 36.33D | 38.40BC | 81.67B | 84.50A |
| Y( 20 g/L) + H( 60 ml/L) | 51.67A | 51.00A | 58.00A | 63.00A | 39.67A | 39.80A | 85.33A | 84.73A |

Means in each column with similar letters are not significantly different.
Y= Yeast extract
H= Humic acid

### Effect on leaf mineral content:

Data in Table (2) clearly indicate that different applied treatments increased N, P, K and Mg levels in the leaves of treated trees during both seasons. Yeast extract at 20 g/L and 60 ml/L humic acid treatment gave the highest values in this respect compared with other treatments. This result may be due to the content of macro and microelements of the yeast extract and humic acid. El-Fouly [25] reported that, foliar application of microelements is highly recommended under Egyptian conditions. In view of the fact the soil pH exceeds 7.5 and sometimes even 8.5 some areas show high $CaCO_3$ contents which among other factors; make soil application of micronutrients more costly and unpractical. Also, the increases in the contents of N, P, K and Mg in the leaves due to the foliar application of yeast extract and humic acid agree with the findings of 13[, 17, 26, 27].

**Table 2: Effect of spraying yeast extract and humic acid on leaf mineral content of "Canino" apricot fruits during seasons 2013 and 2014.**

| Treatments | N% | | P% | | K% | | Mg% | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 |
| Control | 0.87E | 0.82D | 0.18F | 0.13E | 1.16G | 1.05F | 0.27F | 0.26E |
| Y( 10 g/L) | 1.01C | 1.01C | 0.19F | 0.14E | 1.24F | 1.25E | 0.34DE | 0.33D |
| Y( 20 g/L) | 1.01C | 1.01C | 0.25E | 0.18D | 1.32E | 1.33D | 0.24G | 0.27E |
| Y( 30 g/L) | 1.15B | 1.15B | 0.33C | 0.19D | 1.40D | 1.36C | 0.36C | 0.32D |
| H( 40 ml/L) | 0.87E | 1.01C | 0.23E | 0.17D | 1.24F | 1.24E | 0.32E | 0.31D |
| H( 60 ml/L) | 0.94D | 0.96C | 0.27D | 0.21C | 1.38C | 1.36C | 0.35CD | 0.36C |
| H(80 ml/L) | 1.01C | 1.14B | 0.38B | 0.27B | 1.46B | 1.43B | 0.45B | 0.47B |
| Y( 20 g/L) + H( 60 ml/L) | 1.96A | 1.93A | 0.40A | 0.35A | 1.56A | 1.56A | 0.58A | 0.56A |

Means in each column with similar letters are not significantly different.
Y= Yeast extract
H= Humic acid

### Effect on fruit set percentage and yield:

It is obvious from Table (3) that number of flowers per branch, fruit set and percentage of fruit retention/ tree, number of fruit /tree and yield were influenced significantly as a result of foliar applications with yeast extract and humic acid during both seasons of the study. Foliar application of 20 g/L yeast extract and 60 ml/L humic acid gave the highest significant number of flowers/branch (35 and 37) in the first and second seasons consequently, fruit set percentage (43.17and 43.33%) in the first and second seasons consequently, percentage of fruit retention/ tree(28.33 and 28 %) in the first and second seasons consequently, number of fruit /tree (1325 and 1596) during the first and second seasons consequently and yield (53.33 and 56 Kg/tree) in two seasons respectively. Whereas the control gave the lowest number of flowers/ branch (20 and 23) during two seasons respectively, fruit set percentage (25.27 and 20.27%) in the first and second seasons consequently, percentage of fruit retention/ tree (17.67 and 12.67%) in the first and second seasons consequently, number of fruit /tree (747 and 502) in the first and second seasons consequently and yield (17.67 and 17.33Kg/tree) during two seasons, respectively.

These results are in line with [28] reported that spraying Keitte mango trees once at full bloom with yeast was the promising treatment, since it improved fruit set, fruit retention, yield as number of fruit or weight kg/trees. Magda *et al.* [29] reported that application of humic acid on Manfalouty pomegranate increased number of flowers/shoot, fruit set percentage, fruit retention percentage, number of fruits / tree and yield (kg/tree). Fayed [17, 28] recorded that application of yeast + humic acid gave better effect on fruit yield (kg / tree).

**Table 3: Effect of spraying yeast extract and humic acid on fruit set percentage and yield of "Canino" apricot fruits during seasons 2013 and 2014.**

| Treatments | Number of flowers/shoot | | Fruit set (%) | | Fruit retention / tree (%) | | Number of fruits /tree | | Yield (Kg/tree) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 |
| **Control** | 20.00D | 23.00E | 25.27E | 20.27F | 17.67E | 12.67E | 747F | 501H | 17.67H | 17.33G |
| **Y( 10 g/L)** | 32.00B | 24.00E | 24.73E | 23.80E | 2.33C | 22.67C | 874E | 718G | 26.33G | 27.00F |
| **Y( 20 g/L)** | 34.00A | 32.00C | 27.90D | 28.07D | 25.00B | 22.00C | 880E | 840F | 30.33F | 29.33E |
| **Y( 30 g/L)** | 34.00A | 37.00A | 30.53C | 28.33D | 26.00B | 24.33B | 1040D | 1013E | 36.00E | 34.67D |
| **H( 40 ml/L)** | 27.00C | 23.00E | 29.93D | 23.87E | 21.33D | 17.67D | 1153C | 1158D | 40.67D | 42.67C |
| **H( 60 ml/L)** | 27.00C | 26.00D | 31.05C | 31.60C | 23.33C | 18.67D | 1225B | 1205C | 43.67C | 42.67C |
| **H(80 ml/L)** | 33.00B | 34.00B | 39.07B | 38.00B | 33.33C | 21.67C | 1225B | 1435B | 50.00B | 49.00B |
| **Y( 20 g/L) + H(60 ml/L)** | 35.00A | 38.00A | 43.17A | 43.33A | 28.33A | 28.00A | 1325A | 1596A | 53.33A | 56.00A |

Means in each column with similar letters are not significantly different
Y= Yeast extract
H= Humic acid

**Effect on physical characteristics**:

It is obvious from Table (4) that different applied treatments i.e. yeast extract and humic acid as well as combination of the medium concentration of them significantly increased fruit weight, fruit diameter pulp weight and seed weight of "Canino"apricot during two seasons. Foliar application of 20 g/L yeast extract and 60 ml/L humic acid gave the highest fruit weight (43.52 and 42.80g) in the first and second seasons respectively, pulp weight (40.46 and 40.02g) in the first and second seasons consequently, seed weight (3.06 and 2.78g) in the first and second seasons respectively and fruit diameter (4.20 and 4.11cm) in the first and second seasons consequently comparing with other treatments in both seasons. On the contrary, control treatment gave the lowest fruit weight (26.31 and 31.68g) in the first and second seasons consequently, pulp weight (24.37 and 29.42g) in the first and second seasons respectively, seed weight (1.94 and 2.26g) in the first and second seasons consequently and fruit diameter (3.70cm) in the both seasons, respectively.

**Table 4: Effect of spraying yeast extract and humic acid on physical characteristics of Canino apricot fruits during seasons 2013 and 2014.**

| Treatments | Fruit weight (g) | | Fruit diameter (cm) | | Pulp weight (g) | | Seed weight (g) | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2013 | 2014 | 013 | 2014 | 2013 | 2014 |
| **Control** | 26.31G | 31.68H | 3.70E | 3.70E | 24.37F | 29.42H | 1.94E | 2.26D |
| **Y( 10 g/L)** | 32.65F | 33.20G | 3.80D | 3.80D | 30.36E | 30.93G | 2.29D | 2.27D |
| **Y( 20 g/L)** | 32.87E | 34.35F | 4.01C | 3.90C | 30.48E | 31.94F | 2.39C | 2.41C |
| **Y( 30 g/L)** | 34.31D | 35.07E | 4.10B | 4.00B | 31.91D | 32.63E | 2.40C | 2.44C |
| **H( 40 ml/L)** | 35.89C | 35.91D | 4.00C | 3.90C | 33.44C | 33.64D | 2.45C | 2.27D |
| **H( 60 ml/L)** | 36.43B | 38.36C | 4.00C | 3.90C | 33.88B | 35.84C | 2.55B | 2.52B |
| **H(80 ml/L)** | 36.47B | 42.27B | 4.00C | 4.10A | 33.89B | 39.72B | 2.58B | 2.55B |
| **Y( 20 g/L) + H( 60 ml/L)** | 43.52A | 42.80A | 4.20A | 4.11A | 40.46A | 40.02A | 3.06A | 2.78A |

Means in each column with similar letters are not significantly different.
Y= Yeast extract
H= Humic acid

**Fruit color:**

**Lightness (L* value)**:

Data in Table (5) showed that lightness (L*) gradually decrease towards the end of the storage period (6 weeks). At the harvest, fruits treated by 20 g/L yeast extract gave the highest value of L*, while control treatment recorded the lowest value in the two seasons. At the end of storage period humic acid at 80 ml/L treatment gave the higher value of L* in the first season, 20 g/L yeast extract + 60 ml/L humic acid and yeast at 30g/L yeast extract treatments recorded the highest value in the second season without significant differences between them. On the other hand, humic acid at 40 ml/L treatment exhibited the lowest value of L*. Significant differences between all treatments were observed in most cases.

**Table 5: Effect of spraying yeast extract and humic acid on L* value of "Canino" apricot fruits stored at 5 ±1ºC and 90 % RH, during seasons 2013 and 2014.**

| Treatments | Storage period per weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | 0 | 2 | 4 | 6 |
| | 2013 season | | | | 2014 season | | | |
| **Control** | 64.49A-C | 62.75AB | 57.31B | 55.55B | 63.25D | 61.04D | 61.60B | 61.34D |
| **Y( 10 g/L)** | 60.56D | 59.35B | 58.03B | 58.35AB | 67.70A | 64.05B | 63.27B | 65.18AB |
| **Y( 20 g/L)** | 66.92A | 65.31A | 62.50A | 62.98A | 65.08BC | 63.72BC | 62.48B | 62.74CD |
| **Y( 30 g/L)** | 63.22B-D | 62.37AB | 57.54B | 57.90AB | 64.51CD | 64.48B | 66.44A | 63.83BC |
| **H( 40 ml/L)** | 65.05AB | 61.79AB | 57.08B | 55.63B | 64.19CD | 62.61C | 65.53A | 63.44C |
| **H( 60 ml/L)** | 62.06CD | 61.47AB | 60.95A | 57.68AB | 61.57E | 66.03A | 62.42B | 63.79BC |
| **H(80 ml/L)** | 65.50AB | 64.34AB | 59.48AB | 62.36A | 66.27B | 63.40BC | 61.59B | 63.61BC |
| **Y( 20 g/L) + H( 60 ml/L)** | 65.86AB | 64.88A | 62.84A | 58.56AB | 64.83C | 63.93BC | 62.27B | 65.72A |

Means in each column with similar letters are not significantly different.
Y= Yeast extract
H= Humic acid

**Hue angle (hº value)**:

Data in Table (6) showed that hue angle (hº) decreased (increase density of yellow color) with the advance in cold storage periods. At the end of storage period, fruits treated by humic acid at 80 ml/L and yeast extract at 20g/L treatments gave the lowest value of hº (high density of yellow color) in the two seasons, respectively. On the other hand, fruit treated by yeast extract at 30g/L recorded the highest value of hº in the two seasons.

This is in agreement with [30] which recorded that skin color (hº) in "Palsteyn" apricot stored at 0º C and 90% RH was continued to decrease, reaching the lowest values after 42 day.

**Table 6: Effect of spraying yeast extract and humic acid on hue angle (hº value) of "Canino" apricot fruits stored at 5 ±1ºC and 90 % RH, during seasons 2013 and 2014.**

| Treatments | Storage period per weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | 0 | 2 | 4 | 6 |
| | 2013 season | | | | 2014 season | | | |
| **Control** | 81.59C | 83.29A | 80.51A | 79.58B | 87.42DE | 87.03AB | 85.97D | 86.64C |
| **Y( 10 g/L)** | 83.69BC | 80.84A | 82.95A | 74.91C | 89.31BC | 88.12AB | 88.23C | 86.89C |
| **Y( 20 g/L)** | 86.69A-C | 80.65A | 81.13A | 81.41AB | 88.15CD | 85.62B | 89.75BC | 79.68D |
| **Y( 30 g/L)** | 89.26A | 80.70A | 83.55A | 84.10A | 91.30A | 88.21AB | 89.12C | 89.50A |
| **H( 40 ml/L)** | 87.16AB | 80.93A | 82.70A | 78.75B | 86.51E | 87.15AB | 88.08C | 86.62C |
| **H( 60 ml/L)** | 85.36A-C | 80.83A | 84.08A | 79.82B | 89.06BC | 86.36AB | 88.31C | 87.13C |
| **H(80 ml/L)** | 61.76D | 79.42A | 81.14A | 74.39C | 89.86AB | 89.90A | 91.41A | 89.05AB |
| **Y( 20 g/L) + H( 60 ml/L)** | 87.89AB | 70.93B | 82.44A | 79.75B | 90.62AB | 90.05A | 90.90AB | 87.81BC |

Means in each column with similar letters are not significantly different.
Y= Yeast extract
H= Humic acid

**Fruit Texture**:

As shown in Table (7) it is clear that all treatments reduced the rate of texture decline more than the control. However, fruit texture declined towards the end of storage period (6 weeks).The highest texture value was obtained by 20 g/L yeast extract + 60 ml/L humic acid at the harvest for two seasons. At the end of storage period, 20 g/L yeast extract treatment gave the higher values of texture in the first season; 10 g/L yeast extract recorded the highest value in the second season. On the other hand, control fruits exhibited the lowest value of texture (24.00 and 17.33) in both seasons, respectively. Significant differences between all treatments were observed in most cases.

The above findings agreed with those reported by [31, 32, 33] found that application of yeast improving fruit quality in terms of increasing fruit weight and firmness comparing with non-application. Fathy et al. [11, 26, 34] humic acid application as foliar spray is promising treatment for improving fruit quality. Fayed [17, 28] recorded that application of yeast + humic acid gave better effect on fruit quality (fruit length, diameter and weight).

**Table 7: Effect of spraying yeast extract and humic acid on texture at 3mm (g/cm)of "Canino" apricot fruits stored at 5 ±1°C and 90 % RH during seasons 2013 and 2014.**

| | Storage period per weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Treatments** | **0** | **2** | **4** | **6** | **0** | **2** | **4** | **6** |
| | **2013 season** | | | | **2014 season** | | | |
| **Control** | 29.00E | 27.50C | 26.00D | 24.00C | 34.17C | 31.17BC | 26.83B | 17.33AB |
| **Y( 10 g/L)** | 35.33D | 34.33B | 32.83C | 25.17BC | 41.00AB | 38.00A | 27.83B | 22.33A |
| **Y( 20 g/L)** | 37.67D | 33.83B | 33.17BC | 29.67A | 41.67AB | 28.83C | 26.67B | 20.50AB |
| **Y( 30 g/L)** | 44.50BC | 35.93B | 33.33BC | 29.00AB | 41.83AB | 38.00A | 34.33A | 19.00AB |
| **H( 40 ml/L)** | 43.50C | 42.67A | 38.33AB | 24.33C | 35.00C | 34.50A-C | 29.17AB | 18.00AB |
| **H( 60 ml/L)** | 49.33B | 47.00A | 39.83AB | 25.67A-C | 35.33C | 30.83BC | 31.33AB | 21.17AB |
| **H(80 ml/L)** | 55.00A | 43.83A | 33.67BC | 28.00A-C | 36.67BC | 34.83AB | 25.50B | 20.33B |
| **Y( 20 g/L) + H( 60 ml/L)** | 55.17A | 36.50B | 27.67D | 26.67A-C | 45.50A | 39.33A | 27.33B | 20.67AB |

Means in each column with similar letters are not significantly different.
Y= Yeast extract
H= Humic acid

**Weight loss percentage**:

Table (8) cleared that a gradual increase in weight loss was shown towards the end of the storage period (6 weeks). Significant differences between regardless of all treatments. The lowest weight loss percentage was recorded by 30 g/L yeast extract and 60 ml/L humic acid (6.85 and 10.11%) in the first and second seasons, respectively. On the other hand, 20 g/L yeast extract + 60 ml/L humic acid and 20 g/L yeast extract exhibited the highest weight loss value (10.98 and 11.94%) in two seasons, respectively.

In this regard, Abdrabboh and Abdel-Razik[34,35] reported that weight loss percentage significantly increased with the progress of storage periods. These results could be attributed to water loss resulted from transpiration. Additionally respiration, ethylene production and water loss were held to a minimum, ripening and senescence were delayed by low temperatures[36].

**Table 8: Effect of spraying yeast extract and humic acid on weight loss % of "Canino" apricot fruits stored at 5 ±1ºC and 90 % RH, during seasons 2013 and 2014.**

| Storage period per weeks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Treatments | 0 | 2 | 4 | 6 | 0 | 2 | 4 | 6 |
| | 2013 season | | | | 2014 season | | | |
| Control | 0 | 2.94 A | 6.06B | 9.60B | 0 | 2.92A | 6.81C | 10.95B |
| Y( 10 g/L) | 0 | 2.36B | 5.69C | 9.27C | 0 | 2.56AB | 6.36C | 10.31CD |
| Y( 20 g/L) | 0 | 2.48B | 5.73C | 9.27C | 0 | 2.82AB | 8.40A | 11.94A |
| Y( 30 g/L) | 0 | 2.26B | 4.42E | 6.85F | 0 | 2.86AB | 6.71C | 10.16CD |
| H( 40 ml/L) | 0 | 2.80A | 5.21D | 8.05E | 0 | 2.51AB | 6.70C | 10.68BC |
| H( 60 ml/L) | 0 | 2.39B | 5.77C | 9.38C | 0 | 2.68AB | 6.58C | 10.11D |
| H(80 ml/L) | 0 | 2.51B | 5.63C | 8.90D | 0 | 2.72AB | 7.78B | 11.79A |
| Y( 20 g/L) + H( 60 ml/L) | 0 | 2.83A | 6.65A | 10.98A | 0 | 2.40B | 6.81C | 10.56B-D |

Means in each column with similar letters are not significantly different.
Y= Yeast extract
H= Humic acid

**Effect on chemical characteristics**

**Soluble Solids Content (SSC %):**

Data in Table (9) cleared that soluble solid content (SSC %) of fruits gradually increased with the advance in cold storage. The highest percentages of SSC were obtained by yeast extract at 20g/L + humic acid at 60 ml/L and humic acid at 80 ml/L treatments (15%) in the first season, the yeast extract treatment at 10g/L recorded the highest value in the second season .On the other hand, control exhibited the lowest value of SSC % (13.50 and 11.00%). Significant differences between the treatments were obtained during storage periods at the most cases in the two seasons, respectively. This increase in SSC% may be due to water loss during storage period [35, 37] and may possibly be due to hydrolysis of starch into sugars. As the hydrolysis of fruit starch is completed, no further increase in TSS could be detected and subsequently a decline in this parameter predictable since sugars along with other organic acids is primary substrates used for respiration[38]. Moreover, Gouble *et al.* [39] recorded that the increase in SSC during fruit development is normally linked to changes in fruit color and ethylene production.

**Table 9: Effect of spraying yeast extract and humic acid on SSC% of "Canino" apricot fruits stored at 5 ±1ºC and 90 % RH, during seasons 2013 and 2014.**

| Storage period per weeks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Treatments | 0 | 2 | 4 | 6 | 0 | 2 | 4 | 6 |
| | 2013 season | | | | 2014 season | | | |
| Control | 11.83C | 12.23C | 13.17D | 13.50C | 10.00B | 11.00B | 11.00B | 11.00C |
| Y( 10 g/L) | 10.87D | 12.20C | 13.50CD | 14.17C | 10.00B | 11.10B | 11.25B | 11.25C |
| Y( 20 g/L) | 12.46C | 13.40B | 14.00BC | 14.50B | 11.00A | 11.00B | 11.35B | 11.50C |
| Y( 30 g/L) | 11.87C | 12.27C | 14.83A | 14.83B | 10.90A | 11.37B | 11.50B | 11.50C |
| H( 40 ml/L) | 12.23C | 13.47B | 14.57AB | 14.85B | 10.00B | 11.10B | 11.40B | 11.25C |
| H( 60 ml/L) | 12.30C | 12.77BC | 14.47AB | 14.85B | 10.90A | 11.51B | 12.40A | 13.10B |
| H(80 ml/L) | 13.15B | 14.33AB | 15.00A | 15.00A | 10.67A | 11.73B | 12.40A | 12.60B |
| Y( 20 g/L) + H( 60 ml/L) | 14.28A | 14.67A | 14.83A | 15.00A | 12.00A | 12.10A | 12.60A | 14.40A |

Means in each column with similar letters are not significantly different.
Y= Yeast extract
H= Humic acid

**Titratable acidity percentage in juice:**

Data tabulated in Table (10) revealed that titratable acidity % decreased with the progress in storage period up to 6 weeks. After 6 weeks, the highest values (0.94 and 1.05 %) were recorded by control fruits in both seasons, respectively. While the least percentage of acidity were noticed by fruits treated with yeast extract at 20 g/L + humic acid at 60 ml/L (0.58%) in the first season, humic acid at 80 ml/L and yeast extract at 20 g/L + humic acid at 60 ml/L treatment (0. 60%) in the second seasons. The decrease in total acidity during ripening and storage may be attributed to the increase in malic and pyruvate decarboxylation reaction during the climacteric period [40, 41] or may be due to the metabolic changes in fruits or due to the use of organic acids in respiratory process [35 ,42].

The above findings agreed with those reported by [31, 32, 33] found that application of yeast improving fruit quality in terms of increasing total soluble solids and total and reducing sugars and decreasing total acidity % comparing with non-application. Fathy *et al.* [11, 26, 34] humic acid application as foliar spray is promising treatment for improving T.S.S % and decreased acidity %.

**Table 10: Effect of spraying yeast extract and humic acid on titratable acidity % of "Canino" apricot fruits stored at 5 ±1ºC and 90 % RH, during seasons 2013 and 2014.**

| Treatments | Storage period per weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | 0 | 2 | 4 | 6 |
| | 2013 season | | | | 2014 season | | | |
| **Control** | 2.10A | 2.10A | 1.23A | 0.94A | 1.86A | 1.77A | 1. 25A | 1.05A |
| **Y( 10 g/L)** | 1.70D | 1.64CD | 0.98CD | 0.83D | 1.62B | 1.51B | 1.01B | 1.01AB |
| **Y( 20 g/L)** | 1.72D | 1.33E | 0.62F | 0.61F | 1.70B | 1.47BC | 0.92C | 0.92BC |
| **Y( 30 g/L)** | 1.85C | 1.58E | 0.94DE | 0.89B | 1.59B | 1.46BC | 0.85CD | 0.82D |
| **H( 40 ml/L)** | 2.04B | 1.73BC | 1.05BC | 0.67E | 1.57B | 1.44BC | 0.84CD | 0.81D |
| **H( 60 ml/L)** | 2.04B | 1.85B | 1.21A | 0.93A | 1.53B | 1.41BC | 0.78CD | 0.70C |
| **H(80 ml/L)** | 1.67D | 1.64CD | 1.10B | 0.86C | 1.49B | 1.20D | 0.67DE | 0.60E |
| **Y( 20 g/L) + H( 60 ml/L)** | 1.60E | 1.54D | 0.88E | 0.58G | 1.32C | 1.14E | 0.62E | 0.60E |

Means in each column with similar letters are not significantly different.
Y= Yeast extract
H= Humic acid

**Effect on maturity stage characteristics:**

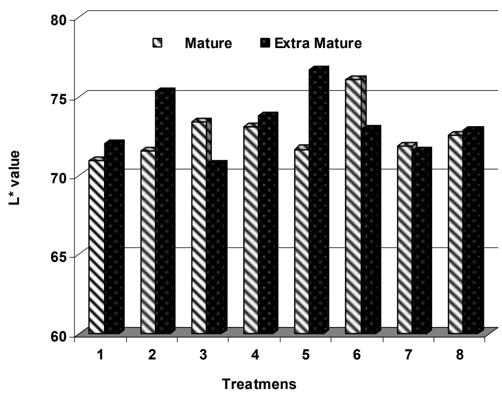
It is obvious from Figure (1) that fruit color (L * and hº values) and texture were influenced as a result of foliar applications with yeast extract and humic acid during both seasons of the study. L * value was increased with advancing of maturity stage, at the extra mature fruit treated by humic acid at 40ml/L exhibited the highest value (76.73 and 76.92) in the two seasons , respectively. On the other hand, fruit treated by yeast at 20g/L and yeast 20g/L + humic 60ml/L gave the least values in the first and second seasons, respectively.

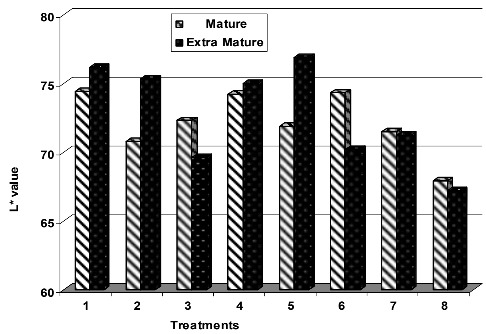
Concerning hº value was continued to decrease in mature fruit, at the extra mature fruit treated by humic acid 40ml/L exhibited the highest value (89.36) in the first season while in the second season humic acid at 60 ml/L recorded the highest value (95.18). Meanwhile the lowest value of hº resulted from yeast 20g/L + humic 60ml/L in the first season and10 g/L yeast extract in the second season. Regarding fruit texture, all treatments decreased it with more advanced stage of maturity. Foliar application of 40 ml/L humic acid gave higher fruit texture at extra mature fruit (49 and 53) in the first and second seasons consequently. However the lowest fruit texture resulted from the control (35) in the first season and humic acid at 60 ml/L (31) in the second season.

Soluble solid content (SSC %) of fruits increased with the advance in mature fruit, yeast 20g/L + humic 60ml/L exhibited the highest value at extra mature fruit (14.28 and 12%) in the first and second seasons, respectively (Fig 2). Acidity % was decreased with advancing of maturity stage; control gave the highest value (2.10 and 1.86%) in the two seasons at the extra mature fruit. Meanwhile the lowest value resulted from application with yeast at 20g/L + humic 60ml/L (1.60 and 1.32%) in the first and second seasons, respectively (Fig 2).

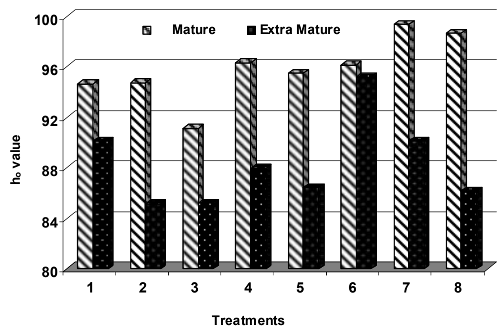
The above findings agreed with those reported by [44] found that during extra maturation of six apricot cvs. there is a greater decrease in firmness of the fruit pulp and organic acids. On the other hand, the levels of soluble solids and sugars (sucrose, fructose and glucose) significantly increased during this stage.

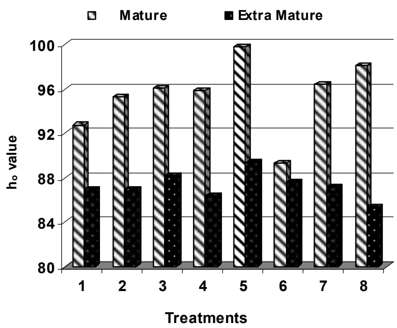
**Season 2013** **Season 2014**



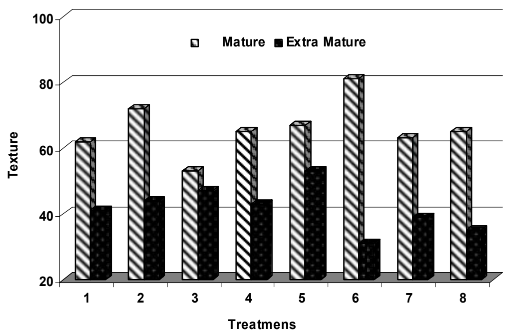



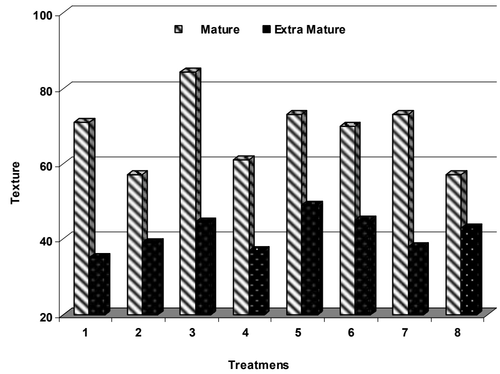

(a) L* value




(b) h∘ value

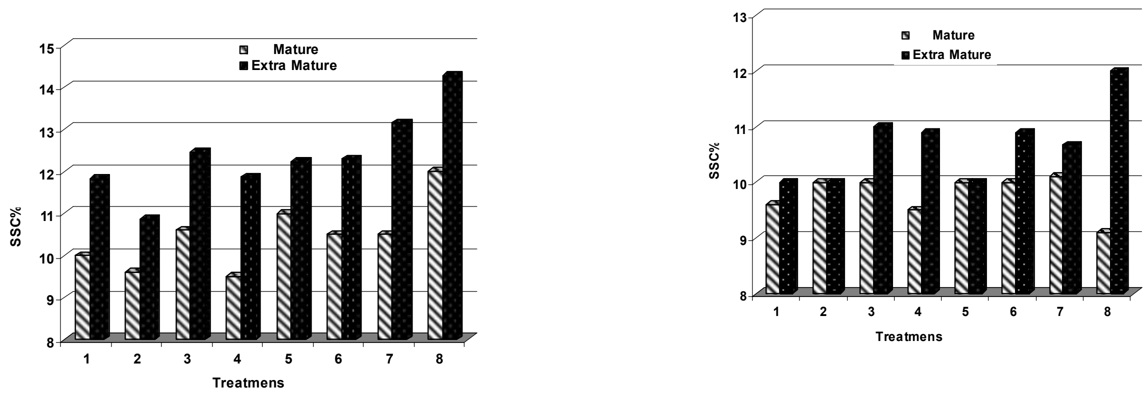


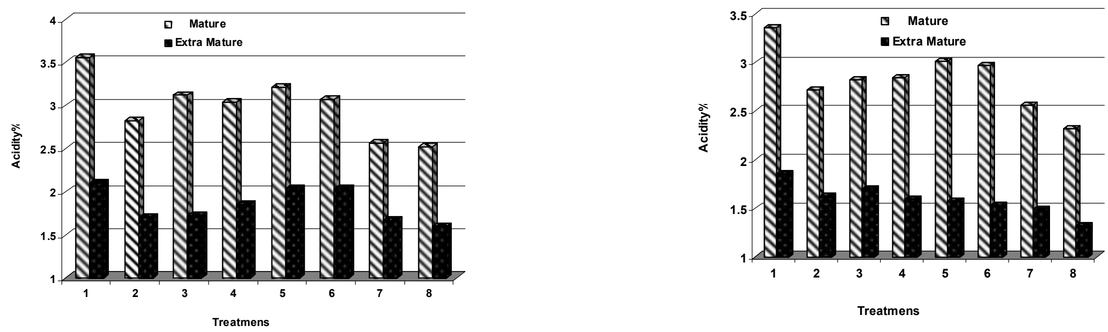

(c) Fruit texture

**Figure 1: Effect of spraying yeast extract and humic acid on L*, h∘ value and fruit texture of "Canino" apricot 1- Control (spray with water only); 2-Yeast extract at 10 g/L; 3- Yeast extract at 20 g/L; 4- Yeast extract at 30 g/L; 5- Humic acid at 40 ml/L; 6- Humic acid at 60 ml/L; 7- Humic acid at 80 ml/L; 8- Yeast extract at 20 g/L + Humic acid at 60 ml/L.**

**Season 2013** **Season 2014**




(a) SSC%




(b) Acidity%

**Figure 2: Effect of spraying yeast extract and humic acid on SSC% and acidity% of "Canino" apricot**
**1- Control (spray with water only); 2-Yeast extract at 10 g/L; 3- Yeast extract at 20 g/L; 4- Yeast extract at 30 g/L; 5- Humic acid at 40 ml/L; 6- Humic acid at 60 ml/L; 7- Humic acid at 80 ml/L; 8- Yeast extract at 20 g/L + Humic acid at 60 ml/L.**

## Conclusion

It could be concluded that using 20 g/L yeast extract plus 60 ml/L humic acid/ tree at full bloom as foliar application for improving nutritional status, yield, fruit quality and storability of "Canino" apricot fruits under cold storage conditions.

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