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EFFECT OF SPRAYING THE AQUEOUS EXTRACT OF LICORICE ROOTS ON FRUIT CRACKING IN *Ziziphus*spp. (Mill.)CULTIVARS PLANTED IN BASRA PROVINCE-IRAQ

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ABSTRACT

This study was conducted during the growing season (Sept., 20th, 2013-April, 20th, 2014) at private orchard at Abu Al Khaseeb area, Basra, Iraq, to study the effect of spraying the aqueous extract of Licorice Roots on the phenomenon called fruit cracking in some *Ziziphus*spp. (Mill.) cultivars, as follow: Bathri, Toffahi, Mallasi, Laimoni, Baidh Al Asfoor and Hindi. The results showed a significant superiority of Toffahi in the percentage of cracking, Cracks number in fruits and length and wide of crack, which was significantly not different from the Hindi cultivar, which belongs to the same species *Ziziphusmauritiana* comparing with other studied cultivars. While the cultivars Bathri, Mallasi and Laimoni, which belong to the species *Ziziphusspina- christi*were superiorin the percentage of calcium Pectate in fruits, also Bathri was superior in the percentage of T.S.S.

Keywords: *Ziziphus*, fruit cracking, licorice extract, toffahi cultivar, Basra.

INTRODUCTION

The *Ziziphus*spp. plant is one of the evergreen fruitful trees grown in tropical, subtropical and warm moderated zones (Williams, 2006). This plant was of a global interest because of being one of the unused fruitful trees that has a big future and for being a multipurpose tree (Pareek, 2001). The plant fruits distinguished by a high nutritive value due to their content of high rate of Vit. C, carbohydrates, Proteins, amino and Organic acids, fats, vitamin and mineral salts, in addition to their medical advantages of fruits, leaves and tree bark (Nasri and Nabil, 2006). Nowadays, an increasing interest in this plant took place globally for being optimal plant to be cultivated in arid and semi-arid zones (Arndt, 2000).

The physiological damages in the pre - picked fruits are considered to be one of the most important reasons of their spoil and decreasing in quality, and perhaps the fruit cracking is one of the important and serious damages which is globally dispersed, and occurs in many fruits whether were fruits or vegetable fruits (Arndt, 2000). Mostly, the cracking happens at the stage of physiological maturing of fruits, then its intensity increases by the processing of maturing, this will lead to destroy the fruits; and exposing them to many fungal or insect infections, reflecting in a huge economic losses (Dawood, 1986). Also, Young (1957) has pointed that the occurrence of cracking in some cultivars of one species more than another species may be due to several factors such as: genetic differences, fruit size enlargement, weakness in the flexibility of fruit skin, thickness of pericarp, fruit shape, concentration of elements in the fruit sap, physiological age of fruit, fruit not covered by leaves, in addition to environmental and agricultural factors, which affect the cracking. The studies indicated to the presence of some plant extracts, that have a good effect to encourage the vegetative and flowering growth of many horticultural plants, this might be resulted from the plant content of many naturally chemical compounds, which quantitatively and qualitatively different depending on species, plant part, plant growth stages and environmental conditions that plants live in (Mann, 1986). For the negative collateral damages of artificial chemicals on the human, environment and living beings live in, as well as the environmental pollution caused by these chemicals; the studies have begun towards natural compounds as alternatives (Grimstad, 1995), then the use of extracts started to be applied on plants, for their contents of nutrients or secondary products, the initiators of many compounds, like plant hormones or antibiotics. So many plant extracts have been using, such as Licorice root extract (Hussein, 2001). Also, some studies have shown that the use of some plant extracts, for example licorice root powder extract had growth regulator - like effect on the improvement of vegetative and flowering features for different plants (Al Sahhafand Al Marsoomi, 2001; Al Rubaee, 2003). As well as, this Licorice extract is one of the used materials in spraying the plants, for its importance to increase both vegetative and flowering growth, due to its content of big group of elements and nutrients and its mechanism is Gibberellin - like (Mosa*et al*., 2002). Besides, the extracts are usually somewhat cheap and naturally available.

Because of the diversion of cracking damage in fruits of most *Ziziphus*spp. cultivated in Basra Province, and due to the rarity of studies about the effect of plant extracts, including Licorice roots, on this phenomenon (cracking), this study has been conducted.

MATERIALS AND METHODS

This study was conducted in a private orchard at Abu Al Khaseeb area in Basra Province during the growing season 2013 - 2014 on (20/9/2013 - 20/4/2014), where 36 trees of *Ziziphus*spp. were collected, 2 trees for each studied cultivar, the cultivars were selected to be

similar in size and age as possible, their age was ranged between (7 - 10) years, the cultivars were grafted on trees of seed origin, using the bud grafting method.

Preparation of Licoriceroots aqueous extract

Licorice*Glycyrihizaglabra*(L.) roots were brought from native market, washed several times with tap - water, boiled in distilled water one time, then left to be cold for (12) hrs, thereafter, the extract was centrifuged at 3000 rpm for half an hour, later the extract was filtered through whatmann No.1 filter paper, in a funnel and kept under -18 ºC as a crude extract to next preparation of the wanted concentrations, as mentioned by Al Marsoomi (1990).

Concentrations of Licoriceroot extract

a) 0 g. L^{-1} Conc. (Control Group) distilled water only.
b) 5 g. L^{-1} Conc.
c) 10 g. L^{-1} Conc.

The extract concentrations were applied to the *Ziziphus*spp. trees by the foliar spraying method.

Spraying dates

a. First spray was on 20/10/2013.
b. Second spray was on 20/11/2013.
c. Third spray was on 20/12/2013.

Date of collecting the samples from the field

Samples were collected from the field in order to study some characteristics of fruit cracking for the studied cultivars, samples were collected starting from the physiological maturity stage until the final maturity that means from the week 18-20 after fruit setting on 25/2/2014 concerning the early ripening cultivars (Toffahi, Baidh Al Asfoor, Laimoni), and from the week 20 after fruit setting on 10/3/2014 concerning late ripening cultivars (Bathri, Mallasi, Hindi).

Studied characteristics

A. Percentage of fruit cracking (%)

Calculated by picking random samples of fruits from each tree, then the cracked fruits were accounted in the sample, the total number of fruits also accounted, then the cracking percentage were calculated as follow:

$$\text{Cracking Percentage (\%)} = \frac{\text{No. of Cracked Fruits}}{\text{Total No. of Fruits}} \times 100$$

B. Length of crack (cm)

Measured by taking a random sample of cracked fruits (50 fruits) from each replicate, then the vernier was used to measure the length of each crack, later the average of crack length was calculated by dividing the total No. of cracked fruits (the total No. of lengths of cracks for each fruit for all cracked fruits of each replicate) to the number of cracked fruits.

C. Width of crack (mm)

The same samples in (B) above were measured concerning their widths of crack, by vernier, too. Where the average of width of the crack calculated by dividing the total No. of cracked fruits (the total width of cracks for each fruit for all cracked fruits of each replicate) to the number of cracked fruits.

D. Number of cracks (crack. $fruits^{-1}$)

The average number of cracks were calculated in (50) fruits by dividing the total numbers of cracks for each cracked fruit (in the 50 fruits) for each replicate to the number of cracked fruits.

E. Calcium pectate (%)

Were estimated according to the method of Rouhani and Bassiri (1976).

F. Total Soluble Solids T.S.S.(%)

The hand refractometer were used to estimate the T.S.S. (%) of fruits, the readings were revised into 20 ºC by using special tables according to Howrtiz (1975).

Designation and analysis of the experiment

Data were analyzed according to Randomized Completely Block Design (.R.C.B.D.) as a factorial experiment of two factors (i.e., 2 × 6 × 3) resulted in 36 factorial treatments. Where the first factor was the concentration of Licorice roots extracts (0, 5 and 10 g. L^{-1}) and the second factor was the cultivar (6 cultivars), each experimental unit was of 2 replicates. The results were analyzed by using the SPSS statistical program, then the means were compared by using the R.L.S.D. (Revised Least Significant Difference) at probability level of (0.05) according to Al-Rawi and Khalaf Allah (2000).

Table-1. Weekly averages of temperatures (high and low) and relative humidity during the period of study (ripening stage of fruits)*.

Month	Week	Average of High temperature (ºC)	Average of low temperature (ºC)	Average of relative humidity (%)
February	1	19.55	9.86	56.54
	2	23.73	11.21	63.43
	3	21.92	12.17	56.37
	4	21.61	10.57	61.22
	Average	21.703	10.953	59.390
March	1	22.36	15.72	52.06
	2	35.07	15.03	50.33
	3	23.57	14.69	46.67
	4	24.71	15.96	43.67
	Average	26.427	15.350	48.183
April	1	35.57	17.41	61.47
	2	36.53	19.77	45.65
	3	37.59	18.86	46.33
	4	36.89	20.37	48.52
	Average	36.645	19.103	50.493

*Direct recording of the field readings.

RESULTS AND DISCUSSIONS

a) Percentage of fruit cracking (%)

Data in Table-2 shows significant differences among the studied cultivars concerning this characteristic. Where the statistical analysis of results showed that the highest percentage of cracking occurred in Toffahi cultivar, which belongs to the species *Z. mauritiana* (L.) of 13.47 % that significantly differ from that of Hindi cultivar (12.60 %) which belongs to the same species above comparing with other cultivars, this difference in the cracking percentage among the cultivars may be resulted from the increasing in the average of temperature (as seen in Table-1), during the period of fruit ripening of the cultivars, where the average of high and low temperature during the ripening of Toffahi and Hindi cultivars were 26.42 and 15.35 ºC during the period (1/3 - 1/4/2013), in the other hand, for the cultivars during the same period, the temperature averages were 36.65 and 19.10 ºC for the high and low temperatures respectively. Also the high temperature may cause an increment in the averages of water absorbance which cause swelling of cells inside the fruits and then rupturing of fruits into longitudinal cracks or cracks in cuticle (Young, 1957; Jansen *et al*., 1960), or the increasing of fruit temperature may increase the pressure of core towards the epidermis (skin) causing the crack origins which later they develop into large cracks along with ripening of fruit progression (Peet, 1992). Or the differences among the cultivars due to their difference in elasticity and plasticity of their walls, as there was a negative relation between the wall thickness of cultivar fruits and their wall resistance to the cracking (Jansen *et al*., 1960). This result is in accordance with Dawood (1986) who confirmed that the occurrence of cracking in a cultivar more than other cultivars may be, mainly due to genetic factors, these results gained by Young (1957) who explained them as genetic difference, too. Also Johnson and Knavel (1990) referred to the reason behind the increment of cracking in a cultivar more than others to many factors such as: Big volume of fruits, weakness of the skin to expand, thickness of pericarp, fruit shape, concentration of elements inside the fruit, physiological age of fruit, fruits are not covered by leaves, besides to the environmental and agricultural factors.

For the singular effect of licorice root extract concentration, the data in Table-2 too, refer to a significant difference among the applied concentrations of extract. Where the (10 g. L^{-1}) was significantly superior comparing with other treatments, by causing thelest average of percentage of fruit cracking (8.54 %). This decreasing of this percentage with increasing concentration may be resulted from the role of extract been containing semi-growth regulators which have basic role in the increasing of activity of treated plants, and also to the role of the active substances of extract which take part in these positive effects on growth indicators and later on the yield indicators of the plants. This result is in accordance with other researchers, who mentioned that the using of some plant extracts like licorice root powder, have growth regulators-like effects on the improving of the vegetative and flowering indicators for different cultivated plants (Al Sahhafand Al Marsoomi and, 2001; Al Rubaee, 2003).

Besides to the explanation that referred to by Mosa*et al*. (2002), who mentioned that the licorice root extract contains a big group of the elements and nutrients and the extract works like gibberellin.

For the interaction treatments, the data in the table-2, confirmed that the treatment (10 g. L^{-1} extract + Bathri Cultivar) gave the least percentage of cracking (4.92%) which was significantly not different from the (0 and 5 g. L^{-1} extract + Bathri cultivar) of (6.02 and 5.08 %) respectively and from the (0, 5 and 10 g.L^{-1} extract + Laimoni cultivar) of (7.05 , 6.72 and 6.33%) respectively, and also from the (0, 5 and 10 g. L^{-1} extract + Baidh Al Asfoor cultivar) of (7.72, 7.44 and 7.40%) respectively.

Table-2. Effect of licorice root extract concentration, the cultivar and their interaction on the percentage of cracking (%).

Cultivar and species	**Licorice extract concentrations** (g. L^{-1})			**Average of cultivar**
	0	5	10	
Bathri*Z. spina-christi*	6.02	5.08	4.92	5.34
Mallasi *Z. spina-christi*	10.68	9.57	8.43	9.56
Laimoni *Z. spina-christi*	7.05	6.72	6.33	6.70
Toffahi*Z. maurintiana*	14.36	13.41	12.57	13.47
Baidh Al Asfoor *Z. maurintiana*	7.72	7.44	7.40	7.52
Hindi *Z. maurintiana*	13.55	12.69	11.57	12.60
Average of extract Concentration	9.90	9.15	8.54	
R.L.S.D.(0.05) for the cultivar: 2.04 R.L.S.D. (0.05) for the extract : 0.63 R.L.S.D. (0.05) for the interaction: 3.13				

b) Number of cracks (cm)

Results in Table-3 give rise to significant difference among *Ziziphus*cultivars concerning this characteristic per each fruit. Where the Bathri cultivar was significantly superior with the least number of cracks per fruit (2.16 crack. $fruit^{-1}$) comparing with other cultivars. From this result it was shown that the cracking in *Ziziphus*spp. fruits increased in the cultivars belong to the species *Ziziphusmaurintiana* (L.) Wild. The reason behind the increment of cracking in a cultivar more than other, may be mainly due to genetic factors (Young, 1957), or because of many other factors such as the bigness of fruit volume and shape (Johnson and Knavel, 1990), where this was happened in this current study for the Toffahi and Hindi cultivars, which they distinguished by big volume fruits comparing with other cultivars.

Concerning the singular effect of licorice root extract concentration, data in Table-3 referred to significant differences among the used concentrations, where the extract treatment (10 g. L^{-1}) gave less average of crack number (3.37 crack. $fruit^{-1}$), that significantly wasn't differ from (5 g. L^{-1}) treatment of (3.79 crack. $fruit^{-1}$). While the control fruits had the highest number of cracks (4.16 crack. $fruit^{-1}$). This decrease in the number of cracks, which resulted from spraying the extract of licorice roots, probably due to the role of this extract and what it contains of growth regulators–like substances, which has a basic role in increasing the activity of treated plants, also due to the active substances in this extract which are the cause behind the incidence of these positive effects in the yield parameters of plants. This result is in accordance with those of other researchers who confirmed that the use of licorice root powder had growth regulators-like effects in improving the vegetative and flowering features of different plants (Al Sahhafand Al Marsoomi, 2001; Al Rubaee, 2003).

For the interaction effect, there was superiority of the interaction treatment (10 g. L^{-1} extract + Bathri cultivar) of least number of cracks in fruits (2.02 crack.$fruit^{-1}$), which significantly was different from the treatment (0 and 5 g. L^{-1} extract + Bathri cultivar) of (2.29 and 2.17 crack.$fruit^{-1}$) and from the treatments (0, 5 and 10 g. L^{-1} extract + Laimoni cultivar) of (3.39, 3.36 and 3.36 crack. $fruit^{-1}$) respectively, and from (10 g. L^{-1} extract + Baidh Al Asfoor cultivar) of (3.12 crack. $fruit^{-1}$).

Table-3. Effect of Licorice root extract concentration, the cultivar and their interaction on the average of cracks number (crack. fruit^{-1}).

Cultivar and species	Licorice extract concentrations (g. L^{-1})			Average of cultivar
	0	5	10	
Bathri*Z. spina-christi*	2.29	2.17	2.02	2.16
Mallasi *Z. spina-christi*	5.16	4.53	3.69	4.46
Laimoni *Z. spina-christi*	3.39	3.36	3.36	3.37
Toffahi*Z. maurintiana*	5.38	4.66	3.97	4.67
Baidh Al Asfoor *Z. maurintiana*	3.66	3.41	3.12	3.40
Hindi *Z. maurintiana*	5.07	4.61	4.36	4.68
Average of extract Concentration	4.16	3.79	3.37	
R.L.S.D. (0.05) for the cultivar: 1.04 R.L.S.D. (0.05) for the extract: 0.36 R.L.S.D. (0.05) for the interaction : 1.55				

c) Length and width of crack (cm and mm)

Data in Tables(4 and 5) show significant differences among the studied *Ziziphus*cultivars concerning the length and width of cracks in fruits, where the Bathri cultivar fruits were significantly of the least averages in length and width of crack (1.47 cm and 1.44 mm) respectively comparing with other cultivars, while the high averages of the length and wide of cracks were found in Toffahi cultivar fruits of (3.37 cm and 2.41 mm), this result was in accordance with that of Young (1957), who attributed the reason behind the differences in the length and width of cracks in some cultivars more than others to the genetic differences. This result, too, is resembled to that of Dawood (1986) andAl-Mayahi (2004), who assigned the relation between the average of length and width of crack in fruit with the nature of cultivar, but not with the stage of fruit ripening. The temperature of the environment has an effect on the length and width of cracks in fruits, where the cracking of fruits (length and width of cracks) increased with increasing temperature, as that, the differences among the night and day temperatures, enhanced the cracking, because the cracking increased with increasing the period that the evaporation was reduced during the night hours comparing with high evaporation during the day hours (Lang and During, 1990), as that the high temperature may cause an increment in water absorbance, which leads to cell swelling in fruits, and then fruits were ruptured into longitudinal cracks or cracks in cuticle (Ackley and Krueger, 1980).

For the singular effect of extract concerning these two diameters (length and width of cracks), the data of Tables (4 and 5) indicated to significant differences among treatments, where the extract Concentration treatment (10 g. L^{-1}) was superior of the least length of crack 2.21 cm) which significantly didn't differ from the concentration (5 g. L^{-1}) of (2.35 cm), while the high length caused by the control treatment of (2.51 cm). Also for the width of crack the superiority was for the extract treatment (10 g. L^{-1}) that caused the least width (1.67 mm), which significantly didn't differ from (5 g.L^{-1}) of (1.74 mm), but the widest crack caused by the control treatment (1.83 mm), this decrease in the length and width of cracks of fruits, may be due to the role of licorice root extract which contains growth regulator–like substances, these substances increase the activity of treated plants, and due to other active components of the extract which cause these positive effects in the cracking phenomenon in fruits, these results are in accordance with those of (Al-Rubaee, 2003) who referred to the licorice extract as growth regulator–like substance in improving the vegetative indicators of different plants, besides to its role in increasing the vegetative growth of plants due to its content of huge group of nutrients and elements (Mosa*et al*., 2002).

The interaction effect as seen in tables (4 and 5), show superiority of the interaction treatment (10, 5 and 0 g. L^{-1} extract + Bathri cultivar) of (1.13, 1.51 and 1.77 cm) respectively concerning the length of crack, while the highest length caused by the treatment (10, 5 and 0 g. L^{-1} extract + Toffahi cultivar) of (3.37, 3.36 and 3.37 cm) respectively, and the treatment (10, 5 and 0 g. L^{-1} extract + Laimoni and Baidh Al-Asfoor cultivars) of (2.03, 2.38 and 2.67 cm) and (2.36, 2.37 and 2.37 cm) for both cultivars respectively. But for the width of crack, no statistically significant differences were found concerning the interaction treatments.

Table-4. Effect of licorice root extract concentration, the cultivar and their interaction on the average of crack length of fruits (cm).

Cultivar and species	Licorice extract concentration (g. L^{-1})			Average ofcultivar
	0	5	10	
Bathri*Z. spina-christi*	1.77	1.51	1.13	1.47
Mallasi *Z. spina-christi*	2.33	2.15	2.11	2.20
Laimoni *Z. spina-christi*	2.67	2.38	2.03	2.36
Toffahi*Z. maurintiana*	3.37	3.36	3.37	3.37
Baidh Al Asfoor *Z. maurintiana*	3.37	3.37	3.36	3.37
Hindi *Z. maurintiana*	2.56	2.30	2.31	2.39
Average of extract Concentration	2.51	2.35	2.21	
R.L.S.D. (0.05) for the cultivar: 0.71 R.L.S.D. (0.05) for the extract: 0.15 R.L.S.D. (0.05) for the interaction : 1.66				

Table-5. Effect of licorice root extract concentration, the cultivar and their interaction on the average of crack width of fruits (mm).

Cultivar and species	Licorice extract concentration (g. L^{-1})			Average of cultivar
	0	5	10	
Bathri*Z. spina-christi*	1.56	1.56	1.21	1.44
Mallasi *Z. spina-christi*	1.72	1.51	1.56	1.60
Laimoni *Z. spina-christi*	1.32	1.22	1.26	1.27
Toffahi*Z. maurintiana*	2.45	2.45	2.35	2.41
Baidh Al Asfoor *Z. maurintiana*	1.77	1.51	1.51	1.60
Hindi *Z. maurintiana*	2.16	2.18	2.10	2.15
Average of extract Concentration	1.83	1.74	1.67	
R.L.S.D. (0.05) for the cultivar: 0.14 R.L.S.D. (0.05) for the extract: 0.08 R.L.S.D. (0.05) for the interaction : N.S				

d) Percentage of Total Soluble Solids (T.S.S.) (%)

From Table-6 there was a significant increment in T.S.S. (%) in the fruits of cultivars belong to the species *Z. mauritiana*(Toffahi, Baidh Al Asfoor and Hindi cultivars) of (15.82, 14.85 and 14.97 %) respectively, while there was a significant decrease in T.S.S. (%) in the fruits of cultivars belong to the species *Z. spina-christi* (Bathri, Mallasi and Laimoni cultivars) of (10.40, 11.31 and 1.00 %) respectively. From this study it was shown that the cultivars with high average of cracking, distinguished by high percentage of T.S.S. as seen in Toffahi, Baidh Al-Asfoor and Hindi cultivars comparing with those of *Z. spina- christi* species which distinguished by a decrease in cracking percentage, length and width of cracks (present study), and in general the least percentage of T.S.S. was found in Bathri fruits (10.40 %) which didn't differ from Laimoni (11.00 %) of the same species (*Z. spina-christi*). This result showed an increment in T.S.S. in fruits that led to the cracking of fruits. This was in accordance with Lidster (1978) and Singh and young (1971), who confirmed that the high percentage of T.S.S. in fruits decreases their tolerance against the damage of cracking. Also, the reason behind the difference among cultivars concerning this indicator (T.S.S. %) may be due to the genetic nature of the cultivars and their variant responses towards the environmental factors like temperature during the ripening stage [see Table-1], this was in accordance with Lang and During (1990), who referred to an increment in T.S.S. percentage (along with longer day-time and high temperature, especially during ripening stage), as a result to the increasing of carbohydrate content produced by photosynthesis, this increment considered to be a major factor in the increment of T.S.S. content in fruits.

For the singular effect of licorice root extract, the data of Table-6 showed a significant difference among the treatments, where the concentration (10 g. L^{-1}) of the extract was superior over other concentrations with highest T.S.S (%) value (13.86 %), while the control plants had the least percentage of T.S.S. in their fruits (12.08 %). This increment in T.S.S. which resulted from spraying the

extract, may be due to the extract role because of its content of growth regulator–like substances, which have a basic role in increasing of the activity of treated plants, besides to the role of extract content of big group of minerals and nutrients (likel: N, P, K, Ca, Fe, Zn, Mg, and Si), which are the reason behind the positive effects on quality of yield features including T.S.S. (Grieve, 1995 and Mosa*et al*., 2002).

Finally, no significant differences found concerning the effect of the interaction among the extract concentrations and cultivars on T.S.S. % in fruits.

Table-6. Effect of licorice root extract concentration, the cultivar and their interaction on the percentage of T.S.S. in fruits (%).

Cultivar and species	**Licorice extract concentration** (g. L^{-1})			**Average of cultivar**
	0	**5**	**10**	
Bathri*Z. spina-christi*	10.48	9.94	10.79	10.40
Mallasi *Z. spina-christi*	11.17	11.09	11.68	11.31
Laimoni *Z. spina-christi*	10.72	10.76	11.51	11.00
Toffahi*Z. maurintiana*	15.99	14.34	17.13	15.82
Baidh Al Asfoor *Z. maurintiana*	13.43	14.52	16.61	14.85
Hindi *Z. maurintiana*	15.01	14.44	15.46	14.97
Average of extract Concentration	12.08	12.52	13.86	
R.L.S.D. (0.05) for the cultivar: 1.21 R.L.S.D. (0.05) for the extract: 1.03 R.L.S.D. (0.05) for the interaction : N.S				

e) Percentage of calcium pectate (%)

It was shown in the Table-7 that there were significant differences among the studied cultivars of *Ziziphus*concerning the percentage of calcium Pectate in fruits. Where the significant highest value of calcium Pectate (%) was found in the fruits of cultivars belong to the species *Z. spina-christi* (Bathri, Mallasi and Laimoni cultivars) of (6.63, 4.75 and 4.35 %) respectively, whilst the lowest values found in the fruits of cultivars belong to the species *Z. mauritiana* (Toffahi, Baidh Al-Asfoor and Hindi cultivars) of (4.05, 3.54 and 3.54 %) respectively. That means the cultivars of high percentage of cracking were distinguished by low percentage of calcium Pectate as in the (Toffahi, Baidh Al-Asfoor and Hindi cultivars) belong to the species *Z. mauritiana*, comparing with those cultivars belong to the species *Z. spina-christi* who were distinguished by a low percentage of Calcium Pectate, where the least value was found in Hindi fruits (3.54 %), which significantly wasn't differ from Baidh Al-Asfoor value (3.54 %) (Both cultivars belong to the species *Z. mauritiana*). From this result it was shown that higher Calcium Pectate (%) in fruits led to lower damage of cracking in fruits, this was in accordance with (Singh and Young, 1971 and Lidster *et al*., 1978), who confirmed that the higher percentage of Calcium Pectate in fruits enhanced their tolerance against the damage of cracking. That means the lower percentage of Calcium Pectate in fruits had a direct relation in the occurrence of cracking. This result also agree with what had found by Milad and Shachel (1992) who mentioned that the cracking-durable fruits, must contain high content of soluble and non-soluble pectin. Also many other factors cause the cracking in a cultivar more than other, those factors such as fruit volume, fruit shape, lacking of flexibility of skin to extend, thickness of pericarp, content of nutrients in fruit, physiological age of fruit, or the covering of fruits by leaves, besides to other environmental and agricultural factors that may cause the cracking in fruits (Johnson and Knavel, 1990).

For the singular effect of the extracts, data in Table-7 show significant differences among the treatments, where the (10 g. L^{-1}) extract treatment caused the highest percentage of calcium Pectate (4.55 %), which didn't differ from (5 g. $L.^{-1}$) of (4.52 %), while the least value was due to control treatment (4.36 %). The increment in the percentage of Calcium Pectate after spraying the extract may be due to the role of licorice roots content of growth regulator–like substances, besides to what had mentioned by Mosa*et al*., (2002), that the licorice root extract contains a big group of minerals and nutrients (Al-Rubaee, 2003).

While concerning the interaction between extract and the cultivar, the same table (7) referred to that the interaction treatments (0, 5 and 10 g. L^{-1} extract + Bathri cultivar) gave the highest percentage (6.60, 6.63 and 6.66 %) respectively, while the least value resulted from the interaction treatments (0 g. L^{-1} extract+ Hindi cultivar) of (3.30 %) and (0 and 5 g. L^{-1} extract + Baidh Al-Asfoor cultivar) of (3.40 and 3,54 %) respectively.

Table-7. Effect of licorice root extract concentration, the cultivar and their interaction on the percentage of Calcium Pectate in fruits (%).

Cultivar and species	Licorice extract concentration (g. L^{-1})			Average of cultivar
	0	5	10	
Bathri*Z. spina-christi*	6.60	6.63	6.66	6.63
*Mallasi**Z. spina-christi*	4.72	4.74	4.80	4.75
Laimoni*Z. spina-christi*	4.21	4.33	4.51	4.35
Toffahi*Z. maurintiana*	3.92	4.23	4.01	4.05
Baidh Al Asfoor *Z. maurintiana*	3.40	3.54	3.67	3.54
Hindi*Z. maurintiana*	3.30	3.66	3.66	3.54
Average of extract Concentration	4.36	4.52	4.55	
R.L.S.D. (0.05) for the cultivar: 0.67 R.L.S.D. (0.05) for the extract: 0.13 R.L.S.D. (0.05) for the interaction : 1.03				

CONCLUSIONS AND RECOMMENDATIONS

From this study it's concluded that there was a big difference among the *Ziziphus*spp. cultivars under study concerning the cracking phenomenon which occurs in fruits during their ripening stage. The study confirmed that the cultivars belong to the species *Z. mauritiana* were more sensitive against cracking than those cultivars belong to the species *Z. spina-christi*,and that the spraying of licorice roots extract (especially its concentration 10 g. L^{-1}) was highly participated in decreasing the effect of cracking in the fruits of *Ziziphus*spp.

According to the results of this study the researchers recommend to use the licorice root extract (of 10 g. L^{-1} concentration) with the *Ziziphus*spp. trees grown under environmental conditions of Basra Province. And also, recommend to use another plant extracts for the purpose of removing the damages caused by cracking in fruits such as: Using the Calcium Chloride to limit the occurrence of cracking, in addition to improving the agricultural procedures, where most orchards of *Ziziphus*spp. suffer from highly bad agricultural procedures nowadays.

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