Indian Journal of Agricultural Sciences **81** (8): 723–8, August 2011

Study on changes in mineral content of plum (*Prunus domestica*) and strawberry (*Fragaria×ananassa*) during canning

CAHIDE YAGMUR[1] and MELIKE TASKIN[2]

Çukurova University, Faculty of Agriculture, Food Engineering Department, Adana

Received: 8 March 2010; Revised accepted: 21 April 2011

ABSTRACT

Plums and strawberries treated for canning were examined for changes in Fe, Cu, Zn and Mn content. Samples were taken from the production line of a commercial firm established in Turkey during 2006. The mineral content was determined for raw material, fruit after the washing treatment and the end product after heat treatment (canned fruit and syrup). The Fe, Cu, Zn and Mn concentrations of the unprocessed plum were found to be, on an average, 5.8389, 0.4510, 0.8630 and 0.5374 ppm, respectively. After washing, these values changed to 4.7032, 0.4080, 0.8119 and 0.4593 ppm, respectively. The values for the canned plum (*Prunus domestica* L.) were found to be 2.6112, 0.3076, 0.6780 and 0.4033 ppm. The Fe, Cu, Zn and Mn concentrations of the unprocessed strawberry were found to be, on average, 5.0798, 0.4918, 0.894 and 2.5083 ppm, respectively. After washing, these values changed to 2.7062, 0.4083, 0.8389 and 2.344 ppm, respectively. The values for the canned strawberry were found to be 4.6001, 0.3620, 0.7236 and 2.1073 ppm. The trace mineral values of plums and strawberries (*Fragaria×ananassa* Duch) decreased during the canning process (unprocessed fruit-fruit after the washing treatment- canned fruit). However, It was observed that there was no significant difference between the mineral content of the fruit after the washing treatment and the total combined mineral values of the fruit and syrup after canning. During the canning of fruit there is mineral transfer into the syrup, so consuming the fruit and syrup together results in a greater intake of minerals.

Key words: Canned food, Plum, Strawberry, Trace mineral

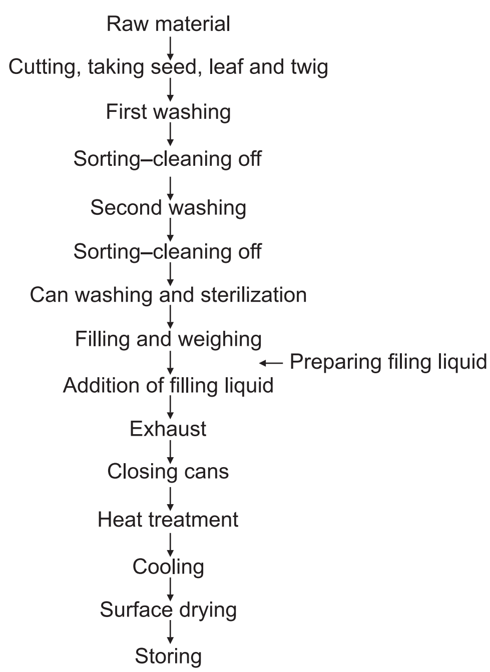
Commercial food processing preserves food quality and extends shelf-life by destruction of food-spoilage micro-organisms and certain endogenous enzymes, which could otherwise promote spoilage and/or reduce nutritive value. Some losses of certain nutrients during food processing are inevitable. Retension studies of nutrients to assess the effects of food processing on the nutritive value of foods are great impotance to food technologists and consumers (George 2006).The trace minerals of the fruits decrease during the canning process. During the washing treatment some of mineral content of the fruit is transferred to the water (Saldamli 2007). Cemeroğlu (2009) states that since most of the minerals of fruits and vegetables are water-soluble, the loss of these minerals will be highest during boiling. It was reported that the soluble nutrients in water pass from the tissue to water during the process requiring water contact, the ratio of nutrient passage depends on the level of physical damage of the tissues (decomposition, strip, saw) or increases with thermal process in the water, the factors such as *p*H level, temperature, water-nutrient ratio, area of the passage surface etc. affect the losses. (Clydesdale *et al.* 1991; Saldamlý 2007). The loss of nutrient ingredients in vegetable foods during canning process were reported by several researchers (Lopez *et al.* 1999; Coskuner and Özdemir 1997). But there were no findings with the changes in the amounts of trace minerals in the fruit during the canning process in the literature. This research aims to determine the changes in the amounts of iron, copper, zinc and manganese in two different fruits at different phases of the canning process, from staple material to end product.

[1]Professor (email: cyagmur@cu.edu.tr); 2mtasking80 @hotmail.com)

MATERIALS AND METHODS

The samples used in the experiment were obtained from the production line of a commercial company located in Osmaniye, south eastern region of Turkey. For present investigation strawberry (*Fragaria × ananassa* Duch) and plum (*Prunus domestica* L.) samples were taken in June and September, respectively. Sample size was determined to represent at least 25% of a single batch. 72 samples containing 36 each of strawberry and plum were picked out to be used in the analysis of the raw material, washed fruit and canned fruit phases. Samples were chosen randomly during the previously stated stages.

For washing and syrup preparation treated water from company well was used. For preparation of syrup and canning commercial sugar and citric acid were used for stawberry fruits. Additive material was not used in the filling syrup for canned plums.The mineral content was determined for the raw fruit at the beginning, after washing, during canning, and for the end product of the fruit and syrup together.The samples taken at the defined stages were homogenized with a hand blender. The canned fruit samples taken from the last step were strained for 2 min. using a plastic drainer to separate the syrup and the fruit completely. The homogenized samples were stored at –18°C in polyethylene bags. Each analysis was repeated twice in parallel. The samples were prepared by dry burning to allow for mineral content determination (Tolay 2000). The mineral content determination was performed by using an Atomic Absorption Spectrophotometer (Varian Spectra A.A.220) (Anonymous 1990). Statistical analysis: variance analysis were performed with a statistical package programme (SPSS ver.13.0). The differences between the mean values were evaluated at $P<0.01$ level using Duncan's multiple comparison test (Sümbüloğlu *et al.* 1993).The fruit canning process steps are shown as below.



RESULTS AND DISCUSSION

The mineral content (iron, copper, zinc and manganese) of the plums and strawberries during the canning process are shown in Tables 1, 2.

The Fe, Cu, Zn and Mn concentrations of the unprocessed plums were found to be, on average, 5.8389, 0.4510, 0.8630 and 0.5374 ppm, respectively. After washing, these values changed to 4.7032, 0.4080, 0.8119 and 0.4593 ppm, respectively. The values for the canned plums were found to be 2.6112, 0.3076, 0.6780 and 0.4033 ppm; and for the syrup 2.1710, 0.0960, 0.1343 and 0.0959 ppm, respectively. The average Fe, Cu, Zn and Mn contents of the syrup (before being added to the fruit) were determined as 0.006, 0.005, 0.0489 and 0.0010 ppm, respectively.

The Fe, Cu, Zn, Mn concentrations of canned plum fruits according to untreated fruit were determined lesser on average 55.28%, 31.80%, 21.40%, 24.95%, respectively.The Fe, Cu, Zn, Mn concentrations of washed plum fruits according to untreated fruits were determined lesser on average 19.45%, 9.53%, 5.92%, 14.53%, respectively. The Fe, Cu, Zn, Mn concentrations of canned plum fruits according to washed fruits were determined lesser on average 44.48%, 24.61%, 16.49%, 12.19%, respectively. The Fe, Cu, Zn and Mn concentrations of the unprocessed strawberries were found to be, on average, 5.0798, 0.4918, 0.8940 and 2.5083 ppm respectively. After washing, these values changed to 4.7179, 0.4083, 0.8389 and 2.3440 ppm, respectively. The values for the canned strawberries were found to be 4.6001, 0.3620, 0.7236 and 2.1073 ppm; and for the syrup 2.8133, 0.0492, 0.1020 and 0.1455 ppm, respectively. The average Fe, Cu, Zn and Mn contents of the sugar used in syrup preparation were determined as 0.2830, 0.0090, 0.0519 and 0.0130 ppm, respectively. The Fe, Cu, Zn, Mn concentrations of canned strawberry fruits according to untreated fruit were determined lesser on average 9.44%, 26.39%, 19.06%, 15.99%, respectively.The Fe, Cu, Zn, Mn concentrations of washed strawberry fruits according to untreated fruits were determined lesser on average 7.12%, 16.98%, 6.16%, 6.55%, respectively. The Fe, Cu, Zn, Mn concentrations of canned strawberry fruits according to washed fruits were determined lesser on average 2.50%, 11.34%, 13.74%, 10.10%, respectively. The findings of this research have shown that the trace mineral values of plums and strawberries decreased during the canning process (unprocessed fruits-fruits after washing treatment- canned fruits). After the washing of both fruits, Fe, Cu, Zn and Mn contents decreased signficantly. This situation has been related to the solubility of minerals in water; it was thought that during the washing treatment some of the mineral content of the fruit was transferred to the water (Clydesdale *et al.* 1991; Saldamli 2007). Before washing procedure, the plum fruits were divided into two pieces; their seeds were removed and then washed in 15 m depth pool. The damage on fruit tissue after cutting procedure is thought to have effect on losses. Strawberry fruits were also washed out in the same pool. During the washing procedure of strawberry fruits, the water in the pool turned to red. Since strawberry is a soft tissue fruit, the color change of water support the idea that strawberry fruit leave some of its water to the washing water.

It was observed that amounts of Fe, Cu, Zn and Mn also decreased during the period between washing and finally

Table 1 Amounts of Fe, Cu, Zn, Mn at different stages during canning process of plums (ppm)

Sample no.	Mineral	Raw material	After washing	Canned fruit	Syrup	Canned product (fruit + syrup)
1	Fe	5.9153	4.6252	2.4986	2.1075	4.6061
	Cu	0.4519	0.4258	0.3092	0.0955	0.4047
	Zn	1.0259	0.8773	0.6760	0.1528	0.8288
	Mn	0.5402	0.4447	0.4011	0.0936	0.4947
2	Fe	5.8780	4.6373	2.7548	2.0601	4.8149
	Cu	0.4985	0.4334	0.3165	0.1007	0.4172
	Zn	0.9144	0.8078	0.6898	0.1233	0.8131
	Mn	0.5477	0.4674	0.3991	0.1085	0.5076
3	Fe	5.7838	4.9722	2.5563	2.1398	4.6961
	Cu	0.4591	0.4261	0.2961	0.0932	0.3893
	Zn	0.7914	0.8420	0.6713	0.1153	0.7866
	Mn	0.5282	0.4577	0.4086	0.0912	0.4998
4	Fe	5.9673	4.7227	2.5625	2.0567	4.6192
	Cu	0.4506	0.4075	0.3034	0.0918	0.3952
	Zn	0.8707	0.7852	0.6687	0.1526	0.8213
	Mn	0.5430	0.4555	0.4071	0.0933	0.5004
5	Fe	5.8549	4.5565	2.4101	2.0018	4.4119
	Cu	0.4778	0.4386	0.3301	0.0906	0.4207
	Zn	0.9309	0.8249	0.6756	0.1358	0.8114
	Mn	0.5396	0.4596	0.4092	0.1019	0.5111
6	Fe	5.8637	4.5715	2.7863	2.1006	4.8869
	Cu	0.4064	0.4122	0.3152	0.0911	0.4063
	Zn	0.8756	0.7813	0.6614	0.1310	0.7924
	Mn	0.5284	0.4571	0.3961	0.0983	0.4944
7	Fe	5.7353	4.7191	2.7173	2.1724	4.8897
	Cu	0.4520	0.4046	0.2980	0.0943	0.3923
	Zn	0.7457	0.8224	0.6732	0.1261	0.7993
	Mn	0.5276	0.4570	0.3941	0.0935	0.4876
8	Fe	5.9694	4.6119	2.8217	2.3062	5.1279
	Cu	0.4796	0.3961	0.3276	0.0928	0.4204
	Zn	0.8103	0.8167	0.6836	0.1622	0.8458
	Mn	0.5411	0.4629	0.4171	0.0942	0.5113
9	Fe	5.8196	4.5338	2.6472	2.2771	4.9243
	Cu	0.4581	0.3886	0.2904	0.1019	0.3923
	Zn	0.9031	0.8253	0.6790	0.1265	0.8055
	Mn	0.5351	0.4586	0.4024	0.0953	0.4977
10	Fe	5.6582	4.9124	2.5125	2.2676	4.7801
	Cu	0.4541	0.3855	0.2953	0.0934	0.3887
	Zn	0.8297	0.8241	0.6640	0.1426	0.8066
	Mn	0.5345	0.4449	0.3951	0.0928	0.4879
11	Fe	5.8763	4.6863	2.6170	2.3347	4.9517
	Cu	0.4484	0.3795	0.3960	0.1013	0.4109
	Zn	0.8330	0.7914	0.7129	0.0945	0.8074
	Mn	0.5402	0.4884	0.4085	0.0945	0.5030
12	Fe	5.7448	4.8896	2.4497	2.2271	4.6768
	Cu	0.4011	0.3982	0.3001	0.1057	0.4058
	Zn	0.8250	0.8141	0.6806	0.1243	0.8049
	Mn	0.5433	0.4578	0.4017	0.0939	0.4956
Avr	Fe	a 5,8389±0,0947	b 4,7032±0,1471	c 2,6112±0,1356	2,1710±0,1098	4,7821±0,1919
	Cu	a 0,4510±0,0286	b 0,4080±0,0195	c 0,3076±0,0127	0,0960±0,0050	0,4037±0,0119
	Zn	a 0,8630±0,0743	b 0,8119±0,0182	c 0,6780±0,0136	0,1343±0,0150	0,8123±0,0171
	Mn	a 0,5374±0,0061	b 0,4593±0,0111	c 0,4033±0,0063	0,0959±0,0048	0,4993±0,0079

Table 2 Amounts of Fe, Cu, Zn, Mn at different stages during canning process of strawberries (ppm)

Sample no.	Mineral	Raw material	After washing	Canned fruit	Syrup	Canned product (fruit + syrup)
1	Fe	4.6745	4.6512	4.6974	2.8762	7.5736
	Cu	0.4938	0.4163	0.3672	0.0438	0.4110
	Zn	0.9044	0.8733	0.7431	0.1038	0.8469
	Mn	2.4876	2.3966	2.2373	0.1455	2.3828
2	Fe	5.0920	4.7233	4.0155	2.8316	6.8471
	Cu	0.4755	0.4175	0.3671	0.0395	0.4066
	Zn	0.8525	0.8473	0.7034	0.1019	0.8053
	Mn	2.4749	2.3474	2.0727	0.1436	2.2163
3	Fe	5.4393	4.6927	4.9215	2.7707	7.6922
	Cu	0.5407	0.4224	0.3442	0.0447	0.3889
	Zn	0.9206	0.8107	0.7015	0.0994	0.8090
	Mn	2.6888	2.2093	2.0569	0.1285	2.1854
4	Fe	5.3258	4.6892	4.8488	3.0820	2.9308
	Cu	0.5158	0.3851	0.3636	0.0457	0.4093
	Zn	0.9259	0.7854	0.7554	0.1034	0.8588
	Mn	2.6091	2.2403	2.1085	0.1523	2.2608
5	Fe	4.9021	4.8009	4.6773	3.1418	7.8191
	Cu	0.4846	0.3943	0.3486	0.0501	0.3987
	Zn	0.8779	0.8268	0.6517	0.0986	0.7503
	Mn	2.4909	2.2659	2.0055	0.1423	2.1478
6	Fe	5.3695	4.7452	4.7495	2.4869	7.2364
	Cu	0.4604	0.4361	0.3678	0.0516	0.4194
	Zn	0.8572	0.8984	0.7556	0.1021	0.8577
	Mn	2.4016	2.4257	2.1707	0.1421	2.3128
7	Fe	5.0110	4.7728	4.2374	2.6072	6.8446
	Cu	0.5025	0.4298	0.3731	0.0527	0.4258
	Zn	0.9555	0.8538	0.7303	0.1046	0.8349
	Mn	2.4952	2.4724	2.0351	0.1388	2.1739
8	Fe	4.7947	4.8206	4.9564	3.0431	7.9995
	Cu	0.4568	0.4046	0.3441	0.0570	0.4015
	Zn	0.8476	0.8359	0.7154	0.1056	0.8210
	Mn	2.4033	2.3441	2.0708	0.1518	2.2226
9	Fe	4.9885	4.6951	4.2019	2.4626	6.6645
	Cu	0.4959	0.3623	0.3756	0.0544	0.4300
	Zn	0.9006	0.7946	0.7332	0.1081	0.8413
	Mn	2.5253	2.2047	2.1594	0.1403	2.2997
10	Fe	5.2126	4.6472	4.5630	2.8853	7.4483
	Cu	0.5419	0.3987	0.3630	0.0430	0.4060
	Zn	0.9376	0.8497	0.6955	0.1014	0.7969
	Mn	2.5926	2.4608	2.0970	0.1637	2.2607
11	Fe	5.0331	4.6649	4.8710	2.6953	7.5663
	Cu	0.4777	0.4261	0.3526	0.0552	0.4078
	Zn	0.8791	0.8607	0.7462	0.1037	0.8499
	Mn	2.4925	2.4415	2.1564	0.1586	2.3150
12	Fe	5.1141	4.7113	4.4618	2.8766	7.3384
	Cu	0.4554	0.4058	0.3769	0.0524	0.4293
	Zn	0.8687	0.8303	0.7516	0.0908	0.8424
	Mn	2.4381	2.3189	2.1177	0.1387	2.2564
Avr	Fe	a 5,0798±0,2306	b 4,7179±0,0510	b 4,6001±0,3097	2,8133±0,2203	7,4134±0,4416
	Cu	a 0,4918±0,0296	b 0,4083±0,0210	c 0,3620±0,0117	0,0492±0,0056	0,4111±0,0127
	Zn	a 0,8940±0,0460	b 0,8389±0,0395	c 0,7236±0,0312	0,1020±0,0043	0,8255±0,0320
	Mn	a 2,5083±0,0851	b 2,3440±0,0972	c 2,1073±0,0653	0,1455±0,0096	2,2529±0,0679

being canned. This situation has also been suggested to be related with the fact that minerals dissolve in water and thus that the trace mineral values of the fruit have been transferred into the syrup during the process of heat treatment. Cemeroğlu (2009) states that since the most of the minerals of fruits and vegetables are water-soluble, the loss of these minerals will be highest during boiling. It was reported that the soluble nutrients in water pass from the tissue to water during the process requiring water contact, the ratio of nutrient passage depends on the level of physical damage of the tissues (decomposition, strip, saw) or increases with thermal process in the water, the factors such as *p*H level, temperature, water-nutrient ratio, area of the passage surface etc affect the losses (Clydesdale *et al.* 1991, Saldamli 2007). The loss of nutrient ingredients in vegetable foods during canning process were reported by several researchers (Lopez *et al.* 1999, Coskuner and Özdemir 1997, Akpapunam 1985). Lopez and Williams (1988) found that the canned beans had less Fe, Mg, Mn, K and Zn values compared to haricot beans,and explained this loss via the passage of minerals to the washing, boiling and/or filling water. Çoskuner and Özdemir (1997), found less Fe, Cu, Zn and Mn values in canned mushrooms with respect to fresh mushrooms. They reported losses during boiling was 35.3%, 3.9%, 23.5% and 45% respectively and explained these losses as the passage of minerals to water during thermal process. Lopez *et al.* (1986), based on their research on fresh and canned peas, stated that the mineral levels changed during the canning procedure. Canned peas had less Fe, Cu, Zn and Mn levels than fresh peas.

In fact, it was observed that there was no significant difference between the mineral content of the fruit after the washing treatment and the total combined mineral values of the fruit and syrup after canning. This has led to the conclusion that the decrease in the mineral content of the fruit is due to the transfer of minerals into the syrup. However, when the total Fe values of strawberry and filling liquid in the canned products were analyzed, it was found to be higher than the Fe value of fruit after washing. It has been proposed that the reason for iron content increase of strawberry is the iron transfer from the equipments for straining that strawberries are kept on while being washed. After the first washing process of fruits and before transferring to the second pool, they are transported over a wire band to be picked out for 10 min. After the washing process was finished in the second pool, they were again picked out over a wire band for 10 min. Then they were filled into the cans. It was thought that during these processes Fe can be attached to the fruits from the iron equipments. The Fe content of filling liquid in strawberry cans was found as 0.283 ppm. It can be thought that some of the Fe content of the final canned food can come from the filling liduid; rest of the Fe content can come from the passage from the fruit to the water and/or via attaching from the equipments.

As a result of variance analysis applied after the transforming of values into% changes at each of the three stages, it was found that the differences between changes in mineral content of both fruits were significant ($P<0.01$). Moreover, the differences between the per cent changes in content of each individual mineral for plums and strawberries were also found to be significant ($P<0.01$). It can be thought that the differences in texture of plums and strawberries lead this result, due to plums has harder texture. And also during processing plums seed is removed by cutting into two pieces; therefore it is thought that cutting damage on fruits affect trace mineral content loss. The filling syrup for two fruit are different as described in method. Mineral concentrations loss percentage of canned strawberry fruit according to washed fruits were lower than plum fruits, due to citric acid and sugar addition to strawberry filling syrup. For plum fruit filling syrup was heated to 82–85°C and 1600 g of syrup added; the temperature and addition amount of strawberry filling syrup was 80–82°C and 685 g. (total filling weight for plum and strawberry fruit was 2900 g, and 1000 g respectively). The heat treating temperature and period during canning was 94–96°C and 25–30 min. for plum fruit; 92–96°C de 25–30 min. for strawberry fruit. The heat treating processes are similar for each fruit. But also, the extent of the water-soluble nutrient losses depends on the time/temperature conditions and the rate of heat transfer into the product during canning (George 2006). In this study, it was determined that trace mineral loss rate in strawberry fruit during canning process according to untreated fruits was lower than plum fruits.

It is concluded that during the canning, washing and heat treating stages of canned fruit production, precautions should be taken to minimize the loss of minerals and, due to the fact that during the canning of fruit there is mineral transfer into the syrup, consuming the fruit and syrup together results in a greater intake of minerals. The quality should be optimized via detecting critical control points during processes. The minimization of preparation processes harming the fruit tissue, their being done after the processes requiring water contact will have positive effects over nutrient content that are water soluble. Although the application of thermal process during canning improves the foodstuff quality in many cases, it reduces the nutritive values of some components. Therefore, the temperatures applied in commercial practice should be aimed to achive maximum microbial destruction commensurate with acceptable organoleptic and nutritional value. After thermal process, the cooling process should be done quickly to prevent the tissue integrity. So, the passage of ingredient to the liquid water will be minimized. Because the losses during canning process is mostly observed via the passage of ingredients to the liquid water. The canned fruits should be served via their filling liquid and consumed via the filling liquid to increase the nutrient level. As a result, although it is impossible to prevent all the nutrient values of foods during canning process, the appropriate carriage, storage, processing, storage of processed food and service can minimize the nutrient loss.

REFERENCES

Akpapunam M A. 1985. Effects of blanching , soaking and cooking on the HCN yields nitrogen, ash and minerals of Lima beans. *Journal of Food Science* **50**.

Association Official Analytical Chemists. 1990. *Official Methods of Analysis*. AOAC. Vol (1).

Cemaeroğlu B. 2009. Fruit and vegetable processing technology. *Food Technology Association Journal* No. 38, Third Press, Ankara.

Clydesdale F M, H o L T, Lee C Y, Mondy N I and Shewfwlt R L. 1991. The Effects of Postharvest Treatment and Chemical Interactions on the Bioavailibility of Ascorbic Acid, Thiamin, Vitamin A, Carotenoids and Minerals, *Crit. Rev. Food Sci. Nutr.,* **30** (6): 599–638.

Coskuner Y, Özdemir Y. 1997. Effects of Canning Processes on The Elements Content of Cultivated Mushrooms (Agaricus bisporus). *Food Chemistry* **60** (4) : 559–62.

George F M B. 2006. *Vitamins in Foods* (*Analysis, Bioavailability and Stability*), CRC Press, United States.

Lopez A. 1986. Essential Elements and Cadmium and Lead in Fresh and Canned Peas. *Journal of Food Science* **51** (3) : 604–7.

Lopez A and Williams H L. 1988. Essential Elements In Dry and Canned Kidney Beans. *Journal of Food Protection* **51** (1): 39–42.

Lopez M A A, Rojas R M, Cosano G Z and Segarra P J S. 1999. Nutritional changes In the essential trace elements content of *Asparagus* during industrial processing. *Food Research Internatýonal* **32**: 479–86.

Saldamli I. 2007. *Food Chemistry*. Hacettepe University Publishers, Ankara.

Sümbüloğlu K and Sümbüloğlu V. 1993. *Biostatistics*. Özdemir Publishing. Ankara.

Tolay I. 2000. ‘Screening of different wild and modern wheat’s for zinc efficiency and evaluation of plant traits. Affecting tolerance to zinc defficiency.’ PhD thesis, The Universty of Cukurova Institute of Natural and Applied Sciences Department of Soil Science, Adana.