Asian Journal of Chemistry Vol. 20, No. 2 (2008), 1191-1198

Nitrate and Nitrite Levels of Some Fruit Species Grown in Van, Turkey

ADNAN DOGAN†, AHMET KAZANKAYA*, MEHMET FIKRET BALTA and FERIT ÇELIK†
Department of Horticulture, Faculty of Agriculture
University of Yüzüncü Yil, 65080 Van, Turkey
Tel/Fax: (90)(432)2251331; E-mail: akazankaya@hotmail.com

The levels of nitrates and nitrites were evaluated in some fruits including apple, apricot, peach, nectarine, pear, grape and sour cherry. For investigation, the fruits were collected from July to October based on their harvest seasons and analyzed using cadmium acetate column. The levels of nitrates and nitrites were expressed in mg/kg as wet-basis. Apple, pear, peach and nectarine and grape fruits contained in fresh matter, 3.01-24.36, 0.00-12.09, 0.00-56.39, 0.54-45.02, 0.00-1.92, 0.00-80.90 mg NO_3/kg, respectively. The levels of nitrites were 0.00-0.198, 0.00-0.123, 0.00-0.231, 0.00-0.096, 0.00-0.064, 0.00-0.261 mg NO_2/kg for the fruits of apple, sour cherry, apricot, peach and nectarine and grape, respectively. The levels of nitrates and nitrites of the fruits delivered to street market from the other regions were 24.30-92.80 and 0.284-1.741 mg/kg that were lower than that of the fruits grown in the district of Van. The levels of nitrates and nitrites of all fruits were under the harmful levels to human health.

Key Words: Fruit, Nitrate, Nitrite, Content, Van.

INTRODUCTION

Fruits contain valuable nutrients such as carbohydrates, proteins, oils, especially minerals and vitamins. They increase appetite and improve digestion[1]. Dietary nitrate and nitrite intake should be controlled as they may be considered a health risk factor. Although nitrates are relatively harmless, their conversion to nitrites or other N-nitroso compounds in the body may produce toxic products. Nitrate and nitrite are found in soil and water due to use of fertilizers[2]. Increased fertilizer use in agriculture may have amplified the yield, but also showed deleterious effect in the soils such as increased salinity and alkalinity. Plants use nitrogen in the form of NH_4^+ and NO_3^-. Increased nitrogen intake or hindering of protein

†Department of Horticulture, Professional High School of Ozalp, University of Yuzuncu Yil, Van, Turkey.

formation by certain factors cause the collection of nitrogen in the various parts of the plant[3,4]. Nitrate is found naturally in foods and in high concentrations in certain vegetables. The concentrations in vegetables depend on a number of factors including season, light, temperature, method of growth, fertilizer use and storage[5]. In Europe, the concentrations of nitrate are generally higher in winter owing to the low light intensity and fewer daylight hours[6]. Nitrates and nitrites are undesired chemicals in vegetables because of their unfavourable effects on the human organism[7,8]. Accumulation of these compounds may be higher in the fruits and vegetables in which nitric fertilizers were used at the higher level. Vegetables stores more nitrates than fruits. The nitrate levels of vegetables can vary between 2000 and 10000 mg/kg. The content of the nitrates and nitrites depended on the usable parts of the plant, the year of investigation and the time of harvest, while the method of growing did not affect their amounts. More nitrates and nitrites were found in the stems with leaves than in leaves alone[9]. Therefore, more researches were undertaken to investigate nitrate levels of vegetables. According to the classification, fruits are low nitrate containing foods (< 200 mg/kg)[3,4,10]. Therefore, the studies on the fruits were few.

The ADIs for nitrate and nitrite are 0-3.7 mg/kg bw and 0-0.07 mg/kg bw. The estimated intakes of nitrate and nitrite from vegetables and fruits other than food additives are below their respective ADIs. No deleterious effect of nitrate reported due to fast excretion from the body. However, nitrite takes part in nitrosamine formation that causes chronic toxicities[10,11]. According to Zabunoglu and Karaçal[12], taking of 15-70 mg/kg bw nitrate and 20 mg/kg bw nitrite may be toxic for an adult. Daily intakes of nitrate and nitrite are *ca.* 50-100 mg and 2-5 mg, respectively. 70 % of those come from vegetables, 20 % of from food additives and 10 % of from cereals, dairy products and fruits[8]. In the other study of Egilmez[13] indicated that only 1.4 % of nitrate taken daily comes from fruits. The aim of this work was to determine nitrate and nitrite levels of some fruits grown in the district of Van and to emphasize the importance of the region in terms of organic agriculture potentials.

EXPERIMENTAL

As fruit trees, 18 fruits of apples, pears, sour cherries, 10 fruits of grapes and 5 fruits of peach and nectarines were obtained in the district of Van including counties and villages. From those trees 30 fruit samples each were collected. Apple (*Starking delicious*) samples were picked up in August and September, pears samples in September and October. Hacihamza (Mellahi) pear was mainly grown in the district of Van including county and villages. Flesh fruit of the pear is large having long stalk, soft, watery, sweet flesh, less waxy and thin coating, less gritty flesh and

large seeds[14]. Pear samples obtained from the other region was Akça variety. Sour cheery (*Prunus cerasus*), apricot (*Prunus armeniaca*) of Hacihaliloglu and Sekerpare varieties and peach (*Prunus persica*)-J.H. Hale- were picked up in July and August. Grape fruit (*Vitis vinifera* L.) - Ercis variety- was harvested in September and October. Grapes obtained from the other regions was Sultani seedless variety.

For comparison purposes, the fruits delivered to street market from the other regions were also investigated in terms of nitrate and nitrite contents. Fruits were divided into three groups and 10 fruits in each group. All fruits were washed with tap water, for the last washing step, distilled water was used. All fruit samples were analyzed on the same day. Nitrate and nitrite levels were determined according to the method of ISO 6635 (1984) and reading the absorbance at 530 nm. Nitrates were determined by previous reduction to nitrites using zinc and cadmium acetate column and calculated as given earlier[10,15].

RESULTS AND DISCUSSION

Nitrites and nitrates in analyzed fruit samples, as expected varied among samples. The highest levels of nitrate and nitrite were found in grape samples (32.00- 0.045 mg/kg). The lowest nitrate level was in peach samples (0.87 mg/kg), the lowest nitrite levels were in apricot samples (0.010 mg/kg). The studies on fruit samples obtained from the other regions of country showed that apricot had the highest nitrate level of 92.80 mg/kg and grape had the highest nitrite level of 1.741 mg/kg and pear sample had the lowest nitrite level of 0.284 mg/kg. All fruit samples analyzed contained nitrate level that lower than 300 mg/kg. No problem also exist in terms of nitrite level. In none of the cases was the nitrite content over 5 mg/kg[10,11].

Nitrate levels of apple samples ranged from 3.01-24.36 mg/kg averaging 12.29 mg/kg. The highest level (24.36 mg/kg) was obtained in the sample picked up in Gevas-2 region. The sample of Meslek region had 21.19 mg/kg nitrate. Nitrite levels of apple samples were between 0.00-1.98 mg/kg. Nitrate levels of pear samples grown in the region varied from 0.00-12.09 mg/kg giving average value of 4.27 mg/kg. Edremit-1 had the highest nitrate level (12.09 mg/kg). The sample obtained from Fidanlik-1 had 10.91 mg/kg nitrate. On the other hand nitrite levels were found between 0.0-0.123 mg/kg (Table-1).

Nitrate levels of these samples varied from 41.19-59.47 mg/kg giving average value of 52.34 mg/kg. The sample 1 had the highest nitrate level (59.47 mg/kg). On the other hand nitrite levels were found between 0.365-2.125 mg/kg. The average level was 1.240 mg/kg. Nitrite levels of apple samples were between 0.00-1.98 mg/kg. Apple samples delivered from other region never exceeded the dangereous level of 300 mg/kg. Nitrate

TABLE-1
NITRATE AND NITRITE LEVELS OF APPLES AND PEARS GROWN IN VAN REGION

Apples			Pears		
Region	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})	Region	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})
Edremit-1	6.07	-	Adilcevaz	4.67	-
Elmali-1	5.09	-	Edremit-1	12.09	-
Elmali-2	3.01	-	Edremit-2	10.21	-
Emin Pasa	15.42	-	Elmali-1	4.46	-
Ercis	7.64	-	Elmali-2	5.29	-
Fidanlik-1	19.45	0.043	Emin Pasa	4.23	0.123
Fidanlik-2	11.25	-	Ercis-1	1.96	-
Gevas-1	18.21	0.032	Ercis-2	1.54	0.065
Gevas-2	24.36	0.054	Ercis-3	0.93	-
Gevas-3	13.59	0.013	Fidanlik-1	10.91	0.056
Iskele-1	11.81	0.020	Fidanlik-2	-	-
Iskele-2	5.19	-	Gevas	5.17	-
Meslek-1	21.19	0.198	Iskele-1	-	-
Meslek-2	19.46	0.085	Iskele-2	0.89	-
Selimiye-1	9.32	-	Iskele-3	7.92	0.107
Selimiye-2	6.73	-	Kevenli-2	1.35	0.037
University-1	12.71	-	Kevenli-1	1.37	-
University-2	10.75	-	Serefiye-1	3.85	-
Minimum	3.01	-	Minimum	-	-
Maximum	24.36	0.198	Maximum	12.09	0.123
Average	12.29	0.025	Average	4.27	0.021

TABLE-2
NITRATE AND NITRITE LEVELS OF APPLES AND PEARS DELIVERED FROM THE OTHER REGIONS

Apples			Pears		
Samples	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})	Samples	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})
Starking-1	56.35	1.230	Akça Pear-1	25.13	0.158
Starking-2	41.19	0.365	Akça Pear-2	19.68	0.589
Starking-3	59.47	2.125	Akça Pear-3	28.13	0.104
Minimum	41.19	0.365	Minimum	19.68	0.104
Maximum	59.47	2.125	Maximum	28.13	0.589
Average	52.34	1.240	Average	24.31	0.284

levels of pear samples delivered from the other regions ranged from 19.68-28.13 mg/kg averaging 24.31 mg/kg. Nitrite levels of these samples were between 0.104-0.589 mg/kg averaging 0.284 mg/kg. The highest nitrate

level of pear sample grown in the region was lower than the lowest level of the other pears delivered to the street market. Based on average levels, pears from the other regions had 6 to 10 times higher nitrate and nitrite levels (Table-2).

Nitrate and nitrite contents of sour cherries and apricots grown in Van are presented. In nitrate levels of cherry samples ranged from 0.0-56.39 mg/kg averaging 11.61 mg/kg. The highest nitrate levels of 56.39 and 28.95 mg/kg were found in the samples picked up from Fidanlik-1 and Fidanlik-2 regions, respectively. Nitrite levels of cherries were between 0.0-0.231 mg/kg. The average level was 0.036 mg/kg. On the other hand, nitrate levels of apricots grown in the region varied from 0.54-45.02 mg/kg giving average value of 7.09 mg/kg. Gevas-2 had the highest nitrate level (45.02 mg/kg). The sample obtained from Fidanlik-1 had 10.91 mg/kg nitrate. Nitrite levels were between 0.0-0.96 mg/kg (Table-3).

TABLE-3
NITRATE AND NITRITE LEVELS OF SOUR CHERRIES AND APRICOTS GROWN IN VAN REGION

Sour cherries			Apricots		
Region	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})	Region	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})
Iskele-1	6.98	-	Edremit-1	4.12	-
Iskele-2	2.23	-	Edremit-2	1.17	0.096
Fidanlik-1	56.39	0.065	Edremit-3	0.54	-
Fidanlik-2	28.95	0.112	Gevas-1	21.87	-
Gevas-1	17.26	-	Gevas-2	45.02	0.064
Gevas-2	21.36	0.052	Elmali-1	2.89	-
Gevas-3	2.86	0.023	Elmali-2	1.87	-
Gevas-4	-	-	Adilcevaz-1	7.54	0.013
Edremit-1	25.91	0.043	Adilcevaz-2	1.89	-
Edremit-2	1.23	-	Serefiye-1	0.76	-
Ercis-1	1.52	-	Fidanlik	1.23	-
Ercis-2	9.12	0.096	Üniversite-1	2.01	-
Ercis-3	21.16	0.231	Üniversite-2	7.54	0.012
Merkez-1	0.47	-	Üniversite-3	12.87	-
Merkez-2	0.91	-	Üniversite 4	13.98	-
Merkez-3	1.95	-	Üniversite 5	0.71	-
Serefiye	5.26	0.023	Üniversite 6	0.89	-
Elmali	5.48	-	Merkez	0.76	-
Minimum	-	-	Minimum	0.54	-
Maximum	56.39	0.231	Maximum	45.02	0.096
Average	11.61	0.036	Average	7.09	0.010

Nitrate and nitrite contents of sour cherries and apricots from the other regions are presented in Table-4. Nitrate levels of sour cherries and apricots varied from 16.58-109.18 and 83.95-102.15 mg/kg giving average values of 54.64 and 92.80 mg/kg, respectively. Nitrite levels of sour cherries and apricots were ranged from 0.125-1.256 and 0.236-1.012 mg/kg, respectively.

TABLE-4
NITRATE AND NITRITE LEVELS OF SOUR CHERRIES AND APRICOTS DELIVERED FROM THE OTHER REGIONS

Sour cherries			Apricots		
Samples	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})	Samples	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})
Kütahya-1	109.18	1.256	Sekerpare	83.95	0.653
Kütahya-2	38.16	0.125	Hacihaliloglu-1	102.32	1.012
Kütahya-3	16.58	0.954	Hacihliloglu-2	92.15	0.236
Minimum	16.58	0.125	Minimum	83.95	0.236
Maximum	109.18	1.256	Maximum	102.15	1.012
Average	54.64	0.778	Average	92.80	0.630

Nitrate and nitrite contents of peach, nectarine and grape fruits grown in Van are given in Table-5. Nitrate levels of peach and nectarine samples varied from 0.0-1.91 mg/kg giving average value of 0.87 mg/kg. The fruit picked up in University-3 had the highest nitrate level (1.91 mg/kg). On

TABLE-5
NITRATE AND NITRITE LEVELS OF PEACH, NECTARINE AND GRAPE FRUITS GROWN IN VAN REGION

Peach-Nectarine			Grape		
Region	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})	Region	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})
University-1(Peach)	0.65	-	Ercis-1	76.50	-
University-2(Peach)	0.91	-	Ercis-2	80.90	0.133
University-3(Peach)	1.91	0.064	Ercis-3	25.16	-
University-4(Peach)	1.34	-	Ercis-4	30.58	-
University-5(Peach)	0.93	-	Ercis-5	60.25	-
University-1(Nectarine)	0.74	-	Ercis-6	-	-
University-2(Nectarine)	-	-	Ercis-7	9.65	0.058
University-3(Nectarine)	-	-	Ercis-8	20.17	-
University-4(Nectarine)	0.97	-	Ercis-9	2.65	-
University-5(Nectarine)	1.23	0.051	Ercis-10	14.12	0.261
Minimum	-	-	Minimum	-	-
Maximum	1.91	0.064	Maximum	80.90	0.261
Average	0.87	0.012	Average	32.00	0.045

the other hand nitrite levels were between 0.0-0.064 mg/kg. Average nitrite level was 0.012 mg/kg. Grape contained 0.00-80.90 mg/kg nitrate and 0.00-0.261 mg/kg nitrite. Average nitrate and nitrite levels were 32.00 and 0.045 mg/kg, respectively.

Nitrate levels of peach, nectarine and grape fruits delivered from the other regions ranged from 42.15-74.12 mg/kg averaging 55.44 mg/kg. Nitrite levels of these fruits were between 0.387-0.581 mg/kg averaging 0.486 mg/kg (Table-6). As shown in Table-6, Sultani seedless grape delivered from the other region contained 25.39-94.87 mg/kg nitrate and 0.00-0.261 nitrite.

TABLE-6
NITRATE AND NITRITE LEVELS OF PEACH, NECTARINE AND GRAPE FRUITS DELIVERED FROM THE OTHER REGION

Peach-Nectarine			Grape		
Samples	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})	Samples	Nitrate (mg kg^{-1})	Nitrite (mg kg^{-1})
Peach	42.15	0.489	Sultani seedless	65.34	1.265
Peach	74.12	0.387	Sultani seedless	94.87	1.587
Nectarine	47.06	0.581	Sultani seedless	25.39	2.370
Minimum	42.15	0.387	Minimum	25.39	1.265
Maximum	74.12	0.581	Maximum	94.87	2.370
Average	55.44	0.486	Average	55.20	1.741

In terms of nitrate level, locally grown grape in Ercis has similarity Sultani grape from the other regions and also had higher nitrate level comparing the other investigated fruits. Wenter[16] reported that nitrate level in fresh grape varied between 3-62 mg/kg. However, Zengin and Gülderen[10] reported more nitrates and nitrites levels of 10.67-294.30 mg/kg nitrate and 0.00-280 mg/kg nitrite. Considering these findings the investigated grapes fruits had nitrate at lower level than the reported levels.

As a result, apple, pear, sour cherry, apricot, peach, nectarine and grape fruits grown in the region and delivered from other region to the market never exceeded the dangereous level of 300 mg/kg nitrate and 5 mg/kg nitrite level. We are confident that no health risk exist of consuming these nutritious fruits. Nitrate level in fruits is less than certain vegetables. Environmental concern has increased recently due to use of heavy use of fertilizer, pesticide, herbicide that cause soil pollutions. Fertilizers cause deleterious effect in the soils and increased collection of nitrogen in the plants. As indicated earlier the concentrations of nitrate are generally higher in winter owing to the low light intensity and fewer daylight hours in Europe[6]. In addition, nitrate and nitrite levels of locally grown fruits has 1-63 times lower nitrate and 13-63 times lower nitrite levels than that of delivered to market from the other regions.

REFERENCES

1. S. Özbek, Fruit Growing, Ankara Univ. Agi. Fac. Publ. No. 111, p. 386 (1977) (In Turkish).
2. WHO, Guidelines for Drinking-water Quality, edn. 2, Addendum to Volume 2. Health Criteria and Other Supporting Information, Geneva (1998a).
3. R. Yamankaradeniz, *Ataturk Univ. J. Agric. Sci.*, **12**, 183 (1981) (In Turkish).
4. E.E. Kara, *J. Ecol.*, **7**, 10 (1993) (In Turkish).
5. J. Dich, R. Järvinen, P. Knekt and P.L. Penttilä, *Food Add. Contamin.*, **13**, 541 (1996).
6. European Community, Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, Official Journal of the European Communities,L330. 32 ± 54 (1998).
7. N.M. Crawford and A.D.M. Glass, *Turk. Plant Sci.*, **3**, 389 (1998).
8. M. Eichholzer and F. Gutzwiller, *Nutr. Rev.*, **56**, 95 (1998).
9. G. Jaworska, *Food Chem.*, **89**, 235 (2005).
10. MM. Zengin and M.S. Gülderen, *Tr. J. Agric. Forest*, 21, 463-468 (1997).
11. S. Özçelik, *Food*, **4**, 183 (1982) (In Turkish).
12. S. Zabunoglu and I. Karaçal, The Effect on Nitrate and Nitrite Accumulation of Fertilizing in Lettuce and Spinach, Tubitak Sci. Congress, Adana (1982) (In Turkish).
13. I. Egilmez, Levels of Nitrate, Nitrite and Nitrosamine in Well Waters from Konya District, Master Thesis, Seluck Univ. health Sci. Inst., Konya (1990) (In Turkish).
14. S. Özbek, Special Fruit Growing, Cuk. Univ. Agic. Fac. Publ. No. 128, p. 485 (1978) (In Turkish).
15. International Standard. ISO 6635-1984 (E). Fruits. Vegetables an Derived Products-Determination of Nitrite and Nitrate Content Molecular Absorption Spectrometric Method.
16. F.V. Wenter, *Landwirtsch. Forsch.*, **37**, 277, 287 (1984).

(*Received*: 6 February 2007; *Accepted*: 1 October 2007) AJC-5956