



Determination of Nitrate and Nitrite Contents in Tomato and Processed Tomato Products in Syrian Market

Mohammad Amer Zamrik*

Department of Pharmacology and Toxicology, Faculty of pharmacy, Damascus University, Damascus, Syria.

*Corresponding author's E-mail: zamrik-a@hotmail.com

Accepted on: 03-01-2013; Finalized on: 28-02-2013.

ABSTRACT

In this study, quantification of both nitrate and nitrite in 121 sample included 72 of tomato samples collected randomly from the wholesale market for fruits and vegetables in addition to the 49 samples of processed tomato products included tomato juice, tomato paste, pizza sauce and ketchup. Nitrate and nitrite were estimated spectrophotometrically, nitrate was determined after reduction to nitrite with cadmium column. Results showed that the average amount of nitrate in tomato was 10.89 mg/kg, while it was 5.00 mg/kg in the tomato juice. As for the amount of nitrates in tomato paste was 20.43 mg/kg. The study also showed that the content of nitrate in pizza sauce and ketchup, in which the tomato represent the essential ingredient were 30.39 and 53.97 respectively. The nitrite levels in tomato and derived products are very low, under 1mg/kg excluding two results for tomato. This study showed that the amount of nitrates and nitrites in the tomatoes were within internationally accepted limits, and this will be reflected on their presence in the tomato processed products.

Keywords: Nitrate, Nitrite, Tomato, Processed tomato products, Cadmium reduction column.

INTRODUCTION

In the last few years, calling for many researchers in the fields of public health attention to assess the content of nitrate and nitrite in food products, in addition to providing possible solutions to minimize the presence (accumulation) of these compounds in food products. The nitrate ion itself considered relatively nontoxic to human, and the toxicity attributed mainly to its reduction to nitrite in saliva and digestive system.^{1, 2} Nitrite which is known to cause adverse effects on human health, by the possibility of reacting with secondary and tertiary amines and amides in the stomach forming N-nitroso compounds which have a carcinogenic potentiality.¹⁻⁴ Furthermore, excessive intake of nitrate and nitrite in the diet may cause toxic effects associated with the formation of methaemoglobinaemia (Blue Baby Syndrome) which produced by oxidation of haemoglobin by nitrite. Infants are more susceptible to this syndrome.^{1, 2, 5}

Despite the fact that presence of nitrate and nitrite in tomato vegetable fruit the edible part of tomato – also called tomato (*Lycopersicon esculentum* L, family: *Solanaceae*) are in low concentration (<200 mg kg⁻¹ FW),³ the tomato has an increasing consumption in recent years as an important part of the low-energy foods. The Global tomato production (fresh and processing) has increased 291 percent since 1961, reaching 108 million metric tons in 2002.⁶

Tomato since the old earned a special place, the French call it as pommes d'amour or love apple, also there is a tomato festival in Spain called la tomatina, and even so, the tomato seedlings have even been grown in Space.⁷

Back to Syria, according to the data comes from the U.N. Food and Agriculture Organization and the Syrian group of agricultural statistics (2010), Syria ranks the eighteen in the world with production quantities of 11563300 tonnes.^{8, 9}

It is well known that the accumulation of nitrate in tomato will varies according to the harvesting period, the temperature that it is grown at, the sunlight exposure, and the level of natural nitrogen in the soil. Also, whatever the verity of tomatoes the main role in the nitrate accumulation is the high application of nitrogen fertilizers, from the farmer point of view reducing nitrogen applications is likely to obtain lower yields. In addition to the problem of irrigation with water contaminated with domestic effluent containing high nitrate concentration.¹⁰⁻¹²

Respecting to chronic effect of nitrate and nitrite, the international agency for research on cancer (IARC), stated that, the JECFA (FAO/WHO expert committee on food additives) and SCF (The European Commission's, Scientific Committee on Food) set an ADI (Acceptable Daily Intake) for nitrate ion as 0 - 3.7 mg/kg body weight per day (equivalent to 219 mg/day for a 60 kg person), and the ADI for nitrite as 0 - 0.06 mg/kg of body weight per day (equivalent to 3.6 mg/day for a 60 kg person).¹³

The national academy of sciences (NAS) stated that the vegetables provide 87% of nitrate in a normal diet while the other products including fresh and cured meat, and dairy, provide the remainder.¹⁴

The goal of this study is to determine the nitrate and nitrite contents in tomato fruit as a raw and its processed products in the Syrian market, including tomato paste,

tomato juice, ketchup and pizza sauce, as tomato represent the key ingredient in these products.

MATERIALS AND METHODS

Samples Collection

Raw material

A total of seventy two tomato samples were collected from wholesalers of fruit and vegetable markets in Damascus - Syria covering the period from July to the end of October, 2012. After purchase, samples were transported to the laboratory in cool box. Prior to analyses the tomato samples were washed with distilled water for air pollutants removal and placed on absorbent paper towel (nitrite –nitrate free).

Processed products

All samples were obtained randomly from Damascus local and open markets in Syria, with fifteen samples of tomato paste, nine samples of tomato juice, sixteen sample of ketchup and nine samples of pizza sauce. All samples were kept at +4°C before starting the analysis.

Method of Analysis

Determining of the dry matter

Dry matter contents of all samples were determined by oven-drying at 105°C until a constant weight was obtained.¹⁵

Determining of nitrate and nitrite

All reagents were of analytical grade quality. The extraction and determination procedures were based on

ISO 6635.¹⁶ Initial preparation of the sample passes through six stages beginning from cutting, blending, weighing, dissolution in warm water, precipitation of the fat and proteins, ending with filtration.

The nitrate in a portion of filtrate was reduced to nitrite by means of metallic cadmium in glass column. For the determination of nitrate in the reducing form (nitrite) and nitrite, sulphanilamide and N-1-naphtyl-ethylenediamide were used as colouring developing reagents. Measurement of the colour intensity was made by Spectronic Genesys 2 spectrophotometer at a wavelength of 538 nm, and compared with standard nitrite solutions. The method was continuously tested by standard addition of nitrate and nitrite. Recoveries have been found to be between the 98 and 102%. The limit of detection was 0.34 ppm for nitrate and 0.05 ppm for nitrite. Analyses were run in duplicate.

RESULTS AND DISCUSSION

In this study, dry matter, nitrate and nitrite were determined in all samples with a total of hundred twenty one samples of tomato fruit and its processed products available in Syrian market, including tomato paste, tomato juice, ketchup and pizza sauce as tomato represent the key ingredient in these products.

The dry matter content

In order to conduct a comparison between the content of nitrate and nitrite in the samples studied, dry matter content was determined according to the association of office analytical chemists (AOAC, 2000).¹⁵ Results for dry matter content % are presented in table 1.

Table 1: Dry matter content % in 121 samples of tomato and Processed tomato products

Samples	Number of samples	Dry matter content %			
		Minimum	Maximum	Mean	Standard Deviation
Tomato fruit	72	4.28	7.38	5.37	0.69
Tomato paste	15	17.84	36.24	24.24	5.62
Tomato juice	9	2.84	5.71	4.64	1.01
Pizza sauce	9	14.75	21.38	17.21	1.98
Ketchup	16	29.16	33.86	30.97	1.38

Regarding to the table 1, the ascending orders of content of solid material were as follows: Tomato juice (4.64 %) < Tomato fruit (5.37 %) < Pizza sauce (17.21 %) < Tomato paste (24.24 %) < ketchup (30.97 %).

For Tomato paste, values were more dispersed ranging between 17.84 % and 36.24 % with a standard deviation of 5.62; this noticeable dispersion is due to the fact that nine samples of the fifteen samples studied have been obtained from the open market and they are manufactured in unauthorized small-scale processing facilities, without being subject to the Syrian specifications related with tomato paste.

The Nitrate and Nitrite content

The Nitrate content

The results concerning nitrate contents in tomato and processed derived products are represented in table 2 and table 3 respectively.

Regarding to the fresh weight basis, the nitrate concentration (mg/kg) in analyzed tomato ranges between 0.71 - 61.17 mg/kg with an average of 10.89 mg/kg.

Table 2: Nitrate content (NO₃ mg/kg FW) in 121 samples of tomato and Processed tomato products according to fresh weight (FW).

Samples	Number of samples	Nitrate mg/kg FW			
		Minimum	Maximum	Mean	Standard Deviation
Tomato fruit	72	0.71	61.17	10.89	13.96
Tomato paste	15	2.34	87.95	20.43	22.35
Tomato juice	9	1.95	11.52	5.00	2.78
Pizza sauce	9	8.16	78.60	30.39	25.24
Ketchup	16	12.83	141.69	53.97	45.87

Table 3: Nitrate content (NO₃ mg/kg DW) in 121 samples of tomato and Processed tomato products according to dry matter weight (DW).

Samples	Number of samples	Nitrate mg/kg DW			
		Minimum	Maximum	Mean	Standard Deviation
Tomato fruit	72	11.55	1078.91	205.43	258.12
Tomato paste	15	10.00	428.61	85.10	104.08
Tomato juice	9	37.72	211.27	112.40	61.51
Pizza sauce	9	38.17	451.72	182.02	153.39
Ketchup	16	42.72	459.44	174.30	149.63

Table 4: Nitrite content (NO₂ mg/kg FW) in 121 samples of tomato and Processed tomato products according to fresh weight (FW).

Samples	Number of samples	Nitrite mg/kg FW			
		Minimum	Maximum	Mean	Standard Deviation
Tomato fruit	72	ND	1.27	0.18	0.30
Tomato paste	15	ND	0.54	0.13	0.18
Tomato juice	9	0.09	0.32	0.13	0.07
Pizza sauce	9	ND	0.70	0.23	0.22
Ketchup	16	ND	0.33	0.11	0.11

ND: Not Detected.

Table 5: Nitrite content (NO₂ mg/kg DW) in 121 samples of tomato and Processed tomato products according to dry matter weight (DW).

Samples	Number of samples	Nitrite mg/kg DW			
		Minimum	Maximum	Mean	Standard Deviation
Tomato fruit	72	ND	27.16	3.31	5.64
Tomato paste	15	ND	2.72	0.60	0.88
Tomato juice	9	1.56	6.15	2.97	1.56
Pizza sauce	9	ND	4.39	1.36	1.41
Ketchup	16	ND	1.00	0.36	0.33

ND: Not Detected.

By comparing our results for the concentration of tomato nitrate (NO₃ mg/kg fresh weight basis) with international data regarding different country, we find that the existing amounts of nitrate were within satisfactory limits and even lower than those recorded in numbers of international studies. For instance, in China, which has the first rank in the world production quantities of

tomato in the year 2010,⁸ the study of the centre for food safety in Hong Kong (2012), shows average concentration of 57 mg/kg in Hong Kong, while the study of Feng et al., (2006), shows average concentration of 35 mg/kg in Beijing,¹⁷ in addition to the previous studies, the study of Zhong et al., (2002), mentioned average nitrate concentration of 78 mg/kg.¹⁸ In European Countries the

average of nitrate was 43 mg/kg.¹ In Iran, Ardabil Province, the concentration of nitrate ranges between ND – 2.67 mg/kg.¹⁰ In Romania, the study of Simion et al., (2008), (field and greenhouse without nitrogen fertilizer) represent nitrate concentration ranges between 82.24 – 116.75 mg/kg.¹² In United Kingdom the study of Meah et al., (1994), shows average concentration of 1.3 mg/kg, and in the same country the study of Ysart et al., 1999, shows average concentration of 17 mg/kg.¹⁸ In New Zealand the study of Pickston et al., (1980) mentioned average concentration of 19 mg/kg.¹⁸ Finally in Turkey, there was a study of the Ayaz et al., 2007, with nitrate average concentration of 11.06 mg/kg.¹⁹

For the processed tomato products, by arranging the results for average nitrate content mg/kg on the basis of fresh weight in the ascending order, the results show the following: ketchup < pizza sauce < tomato paste < tomato fruit < tomato juice.

Returning to table 3, which demonstrates the results of nitrate mg/kg according to dry matter weight, and by manipulating the results statistically (PASW Statistics 18 – one way ANOVA – Tukey HSD), it can be noticed that, the differences between the values were statistically insignificant at p=0.05, and this may return to the use of the raw material (tomato fruits) as the collection of samples in the period between July and the end of October, consistent with low economic price for tomato in Syria, this low economic price encourages making the different derivatives of tomato - and on the assumption that, the additives for this tomato derivatives do not play an important role in changing the statistical manipulating for the results.

The Nitrite content

Results for nitrite content are represented in table 5 and table 6 respectively.

Regarding the fresh weight basis, the nitrite levels in tomato and processed derived products are very low, under 1mg/kg except two results for tomato fruit, and there were undetected nitrite in forty nine percent of studied samples. While the nitrite content in tomato paste was undetected in forty seven percent of studied samples. For pizza sauce and ketchup the undetected nitrite were twenty two and thirty one percent of studied samples respectively.

The nitrite contents of tomato have been investigated in several countries. For instance, in China, the study of the centre for food safety in Hong Kong (2012), shows average concentration of 0.5 mg/kg in Hong Kong.¹⁷ In Iran, Ardabil Province, the concentration ranges between ND – 0.76 mg/kg.¹⁰ In Romania, the study of Simion et al., (2008) shows nitrite concentration less than 1 mg/kg.¹² In Turkey, nitrite average concentration was 0.36 mg/kg.¹⁹

By comparing the results obtained for nitrite in tomato in this study with the previous mentioned studies (NO₂

mg/kg fresh weight basis), we find that the existing amounts of nitrite were in consistence with this studies.

Returning back to table 5, which represents the results of nitrite mg/kg according to dry matter weight, and by manipulating the results statistically (PASW Statistics 18 – one way ANOVA – Tukey HSD), it can be said that, the differences between the values were statistically insignificant at p=0.05. Finally, whatever the nitrite content in tomato and its derivatives, the differences of nitrite content may be due to the unstable nature of nitrite in addition to the fact that normally small amounts of nitrite are present in tomato, and the possibility of forming nitrite by the reduction of nitrate if the tomatoes are stored incorrectly.

CONCLUSION

In conclusion, the nitrate and nitrite are considered as chemical compounds present normally in vegetables including tomato and have adverse impact on human health; this requires strict and continuous control for the levels of these anionic compounds in food products by interested in the environmental and food safety. Accordingly, this study was conducted on one of the popular consumption vegetables (tomato) and its processed products. This study showed that the amounts of nitrate and nitrites in tomato were within internationally accepted limits, where they were close but are less in some of its data from those in a number of international studies, this will be applied to the other tomato processed products.

REFERENCES

1. European Food Safety Authority (EFSA), Nitrate in vegetables scientific opinion of the panel on contaminant in the food chain, The EFSA Journal 69, 2008, 1-79.
2. Shao-ting D, Yong-song Z, Xian-yong L, Accumulation of nitrate in vegetables and its possible implications to human, Agricultural Sciences in China, 6 (10), 2007, 1246-1255.
3. Santamaria P, Review – Nitrate in vegetables: toxicity content, intake and EC regulation, J. Sci. Food Agric. 86, 2006, 10-17.
4. Speijers GJA, Van den Brandt PA, Nitrite and potential endogenous formation of N-nitroso compounds. In: WHO Food Additives Series 50, World Health Organization, Geneva, 2003.
5. Toxicity and Exposure Assessment for Children's Health (TEACH chemical summary), Nitrates and nitrites. U.S. EPA, 2007.
6. Foreign Agricultural Service-United States Department of Agriculture (FAS/USDA), Processed tomato products outlook and situation selected countries, 2003. Available at: <http://www.fas.usda.gov>.
7. The British Tomato Growers' Association. Available at: <http://www.britishtomatoes.co.uk>.
8. U.N. Food and Agriculture Organization (FAO/FAOSTAT), Tomatoes, by Production, 2010. Available at: <http://www.faostat.fao.org>.



9. Syrian group of agricultural statistics (2010), Ministry of agriculture and agrarian reform, 2010. [Document in Arabic]
10. Ebadi A, Davari M, Razmjoo J, Nitrate and nitrite accumulation in tomato and potato in Ardabil province, International meeting on soil fertility land management and agroclimatology, Turkey, 2008, 389-392.
11. Zamrik M.A., A study about the anionic compounds in drinking water in kalamoon, Arab journal of pharmaceutical sciences, Journal of the association of Arab universities 3 (5), 2007, 97-108. [Document in Arabic]
12. Simion V, Campeanu GH, Vasile G, Artimon M, Catana L, Negoita M, Nitrate and nitrite accumulation in tomatoes and derived products, Romanian Biotechnological Letters 13 (4), 2008, 3785-3790.
13. International Agency for Research on Cancer (IARC), Monographs on the evaluation of Carcinogenic risks to humans - Ingested Nitrate and Nitrite and Cyanobacterial Peptide Toxins, WHO, 94, 2010.
14. Kyriakidis NB, Tarantili Georgiou K, Tsani- Batzaka E, Nitrate and nitrite content of Greek cheeses, J. Food Comp. Analysis, 10 (4), 1997, 343-349.
15. Association of Analytical Communities (AOAC), Official methods of analysis, Washington DC, USA, 2000.
16. ISO- 6635, Fruits - vegetables and derived products – Determination of nitrite and nitrate content - Molecular absorption spectrometric method, International Organization for Standardization, 1984.
17. Hong Kong - Centre for Food Safety (CFS), Nitrate and nitrite in vegetables available in Hong Kong, food and environmental hygiene department, the government of the Hong Kong special administrative region, 2012.
18. Thomson B, Nitrates and nitrites dietary exposure and risk assessment, the Institute of Environmental Science and Research Limited for the benefit of the New Zealand Food Safety Authority ("NZFSA"), New Zealand, 2004.
19. Ayaz A, Topcu A, Yurttagul M, Survey of nitrate and nitrite levels of fresh vegetables in Turkey, Journal of Food Technology, 5 (2), 2007, 177-179.

Source of Support: Nil, **Conflict of Interest:** None.

