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Review

Nitrogenous Contamination in Iranian Vegetables: a Review

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Abstract

Vegetables are the main source of nitrate food contamination. More than 80% of nitrates are consumed by humans through vegetables. The present study was conducted to investigate the contamination of nitrite and nitrate vegetables in Iran. In this systematic overview we reviewed all internal and external databases for relevant articles. According to different studies, contamination was detected in different types of vegetables in different regions of Iran. Articles that examined nitrite values above the standard limit were not reported. Due to nitrate contamination in vegetables in some cities of Iran and the effects of this nitrogen combination on human health, it is necessary to find a solution in this regard.

Keywords: nitrite, nitrate, vegetables, Iran

Introduction

With increasing population growth in Iran, demand for food is increasing. For this reason**,** the use of organic and chemical fertilizers is very common in terms of production per unit area [1]. Nitrogen is the most consumed element of the plant that is used in agriculture in large quantities. By increasing nitrogen concentrations in soil and water, nitrogen content in plant tissues increases and nitrate levels are usually associated with the concentration of nitrogen in the plant [2]**.** The accumulation of nitrate in plants is a natural phenomenon and occurs when accumulation of nitrate in the plant is more than its reduction due to absorption [3]. Vegetables are the main source of food contamination with nitrate, so that they make 300 to 940 mg/g of daily intake [4]. More than 80% of human nitrate is fed through vegetables [5]. Nitrate accumulated in vegetables is converted to nitrite and nitros acids and if they are combined with the first- and second-type amines, nitrosamines are produced and their health risks have been proven [6]. Nitrite and nitrate are stored in different vegetables organs**.** The amount of nitrate accumulation in plants depends on factors such as cultivation, plant variety, age of the plant, climatic conditions, type and amount of fertilization cropping, harvesting time, and how to store the crop after harvest [7]. At high temperatures the ratio of nitrate reduction in

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the root also increases. High levels of nitrate are found in contaminated food or in fragile tissues of vegetables stored for a few days at room temperature [4]. Inappropriate, unbalanced, and excessive use of nitrogen fertilizers in Iran has increased the concentration of nitrate in soil, water, and plants. Also**,** the application of nitrogen fertilizers is very high due to the effect of nitrogen on plant growth [8]. In humans**,** nitrate is rapidly absorbed from the stomach and the intestine and at least 25% is transmitted to the saliva. The concentration in saliva is 10 times that of plasma. In young people, 5-7% total nitrogen converts to nitrite. In kids and those with stomach ailments because of lower gastric pH, the conversion rate to nitrite is higher [9]**.** The presence of nitrate and nitrite in food is associated with an increased risk of gastrointestinal cancers in adults and methemoglobinemia in babies. The amount of methemoglobin in the body is usually 1-3%, but more than 10 percent is clinically significant [10]. The lethal dose of nitrate produced by food is 330 mg/kg body weight and nitrite is 10 times more toxic than nitrate [11]. The United States Environmental Protection Agency (EPA) reported a reference nitrate value of 1.6 mg nitrogen per kg body weight per day (equivalent to 7 mg nitrate per kg body weight per day) [4]. In the Joint Expert Committee of the Food and Agriculture (JECFA) and the European Commission's Scientific Committee on Food (SCF), the amount of ADI for nitrate is 0-3.7 for each kilogram of body weight [12]. The consumption of only 100 grams of raw vegetables with a concentration of 2,500 mg/kg of nitrate leads to the absorption of 250 mg of nitrate. the consumption of this amount of vegetable alone for a person of 60 kg makes the amount of nitrate absorbed 13% more than ADI. By calculating the conversion of 5% of this nitrate to nitrite content after each use, the SCF and ADI levels for nitrite (0.6 mg /kg body weight) increased by more than 247% [4].

The review study of Croitoru et al. (2015) showed that vegetables with the lowest nitrate concentration included lettuce, parsley root, radish, and licorice root, and no correlation was found between nitrite and nitrate levels [13]. Suh et al. in South Korea (2013) found that nitrite and nitrate concentrations in 25 types of vegetable were 0.6-719 mg/kg and 0.1-635 mg/kg, so that there was no risk to consumers [14]. Considering the different studies in the field of contamination of vegetables with nitrate and nitrite, a critical review of these articles seems necessary in order to obtain a general view of contamination of vegetables used in this dangerous substance in Iran. This study tries to present a comprehensive overview of vegetable contamination by presenting the results of research carried out in this field and suggests ways to reduce nitrate contamination.

Materials and Methods

Iran's 1,648,195 km^2 make it the 18^{th} largest country by area in the world, and based on the census of 2016 has 79,926,270 people [15]. Iran is semi-arid and dry in terms of precipitation. In agriculture and horticulture Iran has high rankings for some products. According to 2007 statistics, the country is 2nd in world for cucumber production, and 4th and 5th for melon and watermelon, respectively [16]. In this study, nitrite and nitrate contamination in vegetables were surveyed in different cities of Iran.

Result and Discussion

The results of the study on nitrite and nitrate of vegetables are presented in Tables 1-3. In some areas based on the culture and habits of people in the cities and the fertile nature of some areas due to the geographical location, cultivating a variety of vegetables takes place. The results of the study indicate that nitrogen (nitrite and nitrate) compounds are present in all of the studied products in Iranian cities. Therefore, in order to clarify the control of nitrate and nitrite in vegetables grown in Iran's cities it is necessary to pay enough attention from the authorities and farmers on the proper fertilization and irrigation of vegetables in order to develop optimum products with low nitrate content. First of all, it is necessary to explain that the standard nitrate in mg/kg in cabbage, lettuce, spinach, radish, carrots, tomato, potato, celery, onions, and eggplants is respectively 5,000, 3,000, 3,500, 1,500, 1,400, 300, 150, 60, 5,000, 1,000, and 2,000. In the study of the effect of traditional and mechanized crops on the level of contamination of tomato and potato in Khorasan Razavi [30], we determined that the culture did not have a significant effect on potato contamination and in both types of culture, and the amount of nitrate was less than standard. But the amount of tomato contamination in mechanized crops (18.3 times the standard limit) was higher than traditional culture (3.41 times the standard limit), and this difference was statistically significant ($P<0.05$). In a study conducted in Isfahan, the effect of irrigation water on nitrate and nitrate accumulation in vegetables was studied [38]. In this study, nitrate levels in tomato, cucumber, onion, lettuce, and spinach in both irrigation methods were found to be lower than the standard limit. However, nitrate content in irrigated potatoes with Zayandeh Rood water (1.07 times the limit) was lower than that observed in well water wells (1.94) in irrigated potatoes, and this relationship was significant ($P<0.05$). According to various reports from different cities of Iran, the nitrate content in carrots in Isfahan and Shiraz was exceeded and permitted in Ahvaz [30-31, 35].

In the Nuezde Gonzlez et al. (2015) study on nitrate and nitrate in raw vegetables in the United States, 124 fresh vegetable types such as cabbage, lettuce, and spinach were examined as organic and conventional cultures from 5 cities located in different geographic regions. There was no difference in the average concentration of these 2 cultivars. But the amount of nitrate was significant. The concentration of nitrate in organic cultures was lower [43]. The study of Iammarino et al. (2014) on

Table 1. Nitrite and nitrate (mg/kg) in different types of vegetables supplied in west, east, north, and south of Iran.

West of Iran					
Reference	City	Type of vegetable	Nitrate, mg/kg	Nitrite, mg/kg	Others note
Pirsaheb et al. (2010) [15]	Kemanshah	Radish leaves	0.4	-	Mean concentration of nitrate in potato was higher than standard level. Nitrat content depend on use of nitrate fertilizer, season, type of product is different.
		Radish	4.3	-	
		Cabbage	0.9	-	
		Lettuce	0.4	-	
		Celery	1.2	-	
		Potato	0.69	-	
		Tomato	3	-	
		Melon	0.6	-	
		Watermelon	0.58	-	
Pirsaheb et al. (2011) [16]	Dorood faraman	Mint	284.09	0.28	Unlike nitrate, mean different of nitrite content in all samples was significant ($p<0.05$). Maximum and minimum of nitrite obtained in leek and cucumber, respectively.
		Melon	91.1	0.1	
		Watermelon	31.65	0.356	
		Cucumber	-	0.17	
		Tomato	-	0.17	
	Mahidasht	Mint	-	0.59	
		Spinach	-	1.58	
		Radish	-	6.05	
		Radish leave	-	0.63	
		Leeks	-	1.78	
		Onion	-	0.36	
		Melon	-	0.13	
		Watermelon	-	0.1	
		Cucumber	-	0.1	
Shahabzadegan et al. (2010) [17]	Ardebil	Onion leaves	1555.8	-	Nitrate concentrations in leafy vegetables and root tuber is more than vegetables. Fruits than vegetables nitrate levels are low. The highest nitrate concentrations at spring onion, purple, cabbage, spinach leaves and red apples and yellow were the lowest level.
		Purple cabbage	1394.8	-	
		Spinach	1021	-	
		Tomato	-	0.12	
Nouwrouz et al. (2012) [18]	Tabriz	Cabbage	161	-	Nitrate concentrations were below of others reported at different countries. The mean concentration of nitrate at all vegetables in autumn was higher than in spring significantly.
		Lettuce	781	-	
		Spinach	83	-	
		Parsley	707	-	
		Coriander	441	-	
		Dill	501	-	
		Leeks	1702	-	
		Fenugreek	684	-	
		Tarragon	805	-	
		Fumitory	772	-	
		Mint	191	-	

Table 1. Continued.

West of Iran					
Reference	City	Type of vegetable	Nitrate, mg/kg	Nitrite, mg/kg	Others note
Sadeghi et al. (2013) [19]	Kermanshah	Coriander	128.17	115.32	The concentrations of nitrate and nitrite were significantly different ($p<0.5$) in terms of vegetable type. vegetables. It is crucial to monitor and control the quality of this product and studying other food processing because of the daily intake of vegetables and potential risks of nitrate and nitrite accumulation and itsassociation with some illnessesand gastrointestinal tract cancers.
Rostamzade at al. (2013) [20]	Tabriz	Cucumber	1800-1900	-	Use of nitrogen fertilizer in cucumber was high.
		Parsley	214.33	123.33	
		Torre	235	371.7	
		Spinach	103.33	99.17	
		Scallion	49.17	42.5	
Rezaeei et al. (2014) [21]	Arak	Cucumber	42.7	9.03	Mean of nitrate concentration was lower than WHO standard. Nitrite concentration in some samples was higher than standard.
		Tomato	7.82	1.81	
		Watermelon	26.61	5.5	
		Cantaloupe	58.98	28.36	
		Melon	33.64	7.65	
Pirsaheb et al. (2014) [22]	Kermanshah	Tomato	0.65	10.56	Different of nitrate concentration in south of Mian Darband region was higher than others.
Eftekhari et al. (2014) [23]	Tabriz	Spinach	5151	112.1	
	Oromie		5692.5	104.2	
	Zanjan		6775.5	132.7	
	Khoramabad		5889.8	93.95	
	Hamedan		5692.5	187.8	
Lahiji et al. [24]	Hamedan	Potato	1058	-	Nitrate residual was higher than Iran standard level.
			1000	-	
Shariati-Rad et al. (2016) [25]	Kermanshah	Lettuce	-	0.294	
		Cabbage	-	0.051	
		Cucumber	-	ND	
Fazlzadeh et al. (2016) [26]	Ardabil	Potato (chemical fertilizer)	122.6	-	using organic fertilizer in agriculture industries can be considered in long-term programs of fisheries organizations to reduce adverse effects.
		Potato (organic fertilizer)	85.5	-	
Mousavi Moayeid et al. (2016) [27]	Hamadan	White Onion	60.65 (April) 194.85 (February)	-	The concentration of nitrate in red onions of collected in April and white onions collected in February are more than WHO standard. the reason of high nitrate is probably use of unsuitable, unbalanced and high amount of nitrate manures.
		Red onion	275.97 (April) 244.67 (February)	-	

Table 1. Continued.

East of Iran					
Jalini et al. (2011)[28]	Khorasane razavi In Traditional farms	Potato	61.7	-	Use of fertilizers was higher than standard suggested level. Mean different of nitrite content in mechanized and conventional methods and type of product was significant ($p<0.05$).
	In mechanized farms		49.1	-	
	In Traditional farms	Tomato	1024.1	-	
	In mechanized farms		5651.6	-	
Eftekhari et al. (2014) [23]	Shirvan	Spinach	6234	139.6	
	Ghochan		6369	132.2	
	Birjand		6595.5	115	
	Kerman		6009	127.8	
	Sarasiab		5940	143.3	
	Mahan		3594	80.20	
	Ravar		5286	107.8	
	Zabol		4135.5	129.8	
	Yazd		5286	107.8	
	Boroojerd		6099	101.8	
North of Iran					
Shokrzade et a.l (2007) [29]	Ghaemshahr	Leek	77	ND	The average of nitrate and nitrite content in all of the samples was less than standard limit.spinach sampeld from sari had significantly lower nitrate content than 2 other cities.
	Babol	Spinach	313	ND	
	Sari		346	ND	
Eftekhari et al. (2014) [23]	Sari	Spinach	5715.2	92.94	
	Tonekabon		5106	140.06	

South of Iran					
Shahlaei et al. (2007) [30]	Ahvaz	Cabbage	428.3-503.8	4.21	The highest and lowest nitrate content were for tomato and mint respectively.in the almost of the vegetables the nitrate content was higher than limited values.
		Lettuce	862-583.1	4.16	
		Spinach	748-886.5	2.96	
		radish leave	179-495.6	3.03	
		Cress	434.2-678.5	4.38	
		Fennel	313.3-654.1	2.58	
		Basil	948.8-996.2	2.56	
		Mint	154.5-349.6	1.51	
		Coriander	310.1-569.4	2.12	
		Parsley	358.6-374	2.23	
		Carrot	251.9-458.3	3.29	
		Pepper	574.5-622.5	6.96	
		Celery	887.4-2169	3.66	
		Onion	248.4-1263	4.93	

Table 1. Continued.

Shahlaei et al. (2007) [30]	Ahvaz	Garlic	197.7-229.3	2.72	The highest and lowest nitrate content were for tomato and mint respectively.in the almost of the vegetables the nitrate content was higher than limited values.
		Tomato	1644-1681	9.52	
		Cucumber	813.3-999.3	4.97	
		Potato	155-213.8	1.83	
		Eggplant	652.4-864.5	6.94	
Rousta et al. (2010) [31]	Shiraz	Carrots	4641	-	Nitrate level in more vegetable was higher than standard.
		Lettuce	105	-	
		Cucumber	673	-	
		Tomato	942	-	
		Potato	657	-	
Afali et al. (2014) [32]	Shiraz	Carrot	60.60	8.50	Nitrate concentration in east of shiraz was higher than others. That may be in relation to harvest time, season, Vegetation, save time.
		Turnip	37.80	6.45	
		Onion	36.9	6.09	
		Green beans	50.88	7.64	
		Pepper	42.6	6.56	
		Torre	74.4	6.75	
		Savory	73.2	9.9	
		Celery	46.08	6.3	
		Mint	74.8	8.7	
		Parsley	46.4	8.78	
		Lettuce	54.7	7.8	
		Spinach	44	6.6	
		Dill	54	7.4	
		Basil	55.8	8.8	
		Tarragon	50.4	8.4	
		Leeks	37.2	7.7	
		cabbage	56.4	6.9	
		Purple cabbage	48.2	7.65	
		Eggplant	66.93	8.63	
		Potato	73.40	8.1	
		Cucumber	56.066	6.84	
		Tomato	33.6	5.6	
		Tomato	7.82	1.81	
		Watermelon	26.61	5.5	
		Cantaloupe	58.98	28.36	
		Melon	33.64	7.65	
Keshavarz et al. (2015) [33]	Shiraz	Spinach	336.54	26.49	HPLC method was used to measure the nitrite and nitrate levels.

Table 1. Continued.

Gholami et al. (2013) [34]	Dezfol	Coriander	2317	-	Results of analyses indicated that the highest amount of nitrate was seen in the samples from north of Dezful. . Moreover, nitrate concentration was reported more than permitted in coriander. As well, nitrate concentration tested in the morning and afternoon samples showed significant difference and the highest difference was related to north and western of Dezful.
		Torre	1474	-	
Eftekhari et al. (2014) [23]	Fasa	Spinach	3393	96.36	
	Shiraz		6211.5	125.3	

Table 2. Nitrite and nitrate (mg / kg) in different types of vegetables supplied in centre of Iran.

Reference	City	Type of vegetable	Nitrate, mg/kg	Nitrite, mg/kg	Others note
Sobhan et al . (2010) [35]	Esfahan	Spinach	1620-47235	-	Maximum and minimum nitrate concentration In leafy greens was dill (2120.9 mg/kg) and spinach (20.7 mg/kg). Onion (237.7 mg/kg) and cucumber (89 mg/kg) were maximum and minimum of nitrate in vegetables glandular.
		Basil	5513-7695	-	
		onion	2135-8440	-	
		Fenugreek	909-15800	-	
		Leeks	2390-5590	-	
		Cabbage	3650-5550	-	
		Lettuce	2210-3640	-	
		carrot	982-12700	-	
		Tomato	104-152	-	
		Potato	701-4450	-	
		Cucumbers	255-330	-	
Kafeshani et al. (2013) [36]	Esfahan (Zayandeh rood)	Leeks Lettuce	230.66 173.8	ND ND	Mean different of nitrate in spinach and parsley was significant.
		Parsley	319	ND	
		Spinach	321.25	ND	
		Onion	45.25	ND	
		Cucumbers	30	ND	
		Tomato	30.66	ND	
		Potato	64.25	ND	
	Esfahan (Well water)	Leeks	161.83	ND	
		Lettuce	275.71	ND	
		Parsley	312.5	ND	
		Spinach	311	ND	
		Onion	28.41	ND	
		Cucumbers	26.73	ND	
		Tomato	26.66	ND	
		Potato	116.9	ND	

Table 2. Continued.

Reference	City	Type of vegetable	Nitrate, mg/kg	Nitrite, mg/kg	Others note
Rahmani et al. (2013) [37]	Esfahan	Dill	989.8-6297.9	-	The concentration of nitrates in leafy vegetables to herbs was more glandular. In general, leafy vegetables (except spinach) and herbs gland (except cucumbers) had nitrate concentrations higher than usual nitrate in the plant.
		Mint	872.4-3386.1	-	
		Fenugreek	821.9-3400.3	-	
		Chard	1555.3-2210.3	-	
		Coriander	1068.6-1759.0	-	
		Parsley	914.9-2181.15	-	
		Torre	694.0-2181.5	-	
		Onion	239.1-872.4	-	
		Tomato	17.7-296.7		
		Potato	105.4-204.6		
Saeedifar et al. (2014) [38]	Tehran	Eggplant	279.76	-	Nitrate level in south of Tehran was higher than others zones.
Bahadoran et al. (2016) [39]	Tehran	Leafy vegetables	276.53	5.13	Vegetables with the highest nitrate concentrations (mg 100 g_1) included radish (625), beetroot (495), tarragon (424), lettuce (365), mint (279), and celery (261). nitrate/nitrite contents of some vegetables were higher than the previous report
		Roots	348.57	4.77	
		Starchy vegetables	51.23	5.13	
		Other vegetables	88.54	4.82	
Pormoghim et a.l (2010) [40]	Tehran	Lettuce	1123.46	-	Order of nitrate concentration was leafy greens> vegetables glandular> Vegetable plant.Nitrate level in lettuce was according to standard and its mean different of nitrate content with Potato and Tomato was significant ($p<0.05$).
		Potato	155.65	-	
		Tomato	188.41	-	
	Khorasegan	Spinach	9325	-	
	ziar	Leeks	5410	-	
	hanshoie		4710	-	
	khorasegan	Basil	7695	-	
	dastgerd		5513	-	
	Yaraan		15600	-	
	Jarghoie		7370	-	
	Ziar	Fenugreek	909	-	
	Ghriden		15800	-	
	Gort		1925	-	
	Varsian		3590	-	
	Ayad in		5420	-	
	Asfina		2440	-	
	Abad asghar		4700	-	
	Bagh parandegan		3730	-	
	Jozdan	Onion	4960	-	
	Khorasegan		4600	-	
	Dashti		2135	-	
	Darche		2320	-	
	Felavarjan		8440	-	

Table 2. Continued.

Eftekhari et al. (2014) [23]	Mina dasht	Cabbage Lettuce Turnip	2413	-	
	Baghe parande		550	-	
	Ghahdarijan		2335	-	
	Mina dasht		3650	-	
	Baghe parande		3640	-	
	Darche		2210	-	
	Ziar		2880	-	
	Dastgerd		5830	-	
	Darche		7810	-	
	Yazd abad		13300	-	
	Khorasegan		3460	-	
	Felavarjan		12900	-	

nitrite and nitrate of 150 leafy vegetables and their risk assessment showed that nitrate in spinach and lettuce is higher than the standard limit. Nitrite levels also varied from 28.5 to 19.5/19 [44]. Investigating studies on lettuce and eggplant in Iran, nitrate pollution of these products was not exceeded by standards [16, 30, 35-36, 38, 40]. Also, the amount of nitrate in potatoes in most cities was higher than the limit, so that Isfahan had the highest rate of pollution among the cities of Iran with 74.1-11.68-fold [37].

Spinach is highly regarded by farmers and nutritionists due to its resistance to contamination rooting rapid growth and nativeness. Spinach nitrate contamination has been reported in most Iranian cities [18, 35]. So that, the lowest and the highest amounts of rape exceeded the standard limit in coronans was 46.45 and 0.05 times in Varamin. However, the results of studies in Kermanshah [1], Isfahan [36], Fasa [23], Sari, Ghaemshahr and Babol [29], Ahvaz [30], Shiraz [32], and Ardabil [17] do not indicate any nitrate contamination of spinach. It should be noted

Table 3. Range of nitrogen contamination in different cities of Iran.

Type of vegetable	Nitrate concentration (mg/kg)		Nitrite concentration (mg/kg)	
	Minimum (city)	Maximum (city)	Minimum (city)	Maximum (city)
Lettuce	54.7 (Shiraz)	2210-3460 (Esfahan)	4 (Ahvaz)	7.8 (Shiraz)
Tomato	0.32 (Kermanshah)	5651.6 (Khorasan razavi)	0.125 (Mahidasht)	11.19 (Kermanshah)
Carrot	60.6 (Shiraz)	982-12700 (Esfahan)	-	-
Spinach	83 (Tabriz)	1620-47235 (Esfahan)	6.6(Shiraz)	99.17(Kermanshah)
Leek	191 (Tabriz)	4710 (Hanshoyeh)	-	-
Potato	2.43 (Tabriz)	701-4450 (Esfahan)	-	-
Onion	28.4 (Esfahan)	7335 (Ziar)	0.25 (Dorood Faraman)	6.6(Shiraz)
Cucumber	26.73 (Esfahan)	999 (Ahvaz)	0.1 (Mahidasht)	5.3 (Ahvaz)
Water melon	0.58 (Kermanshah)	31.65 (Mahidasht)	-	-
Melon	0.6 (Kermanshah)	91.1 (Mahidasht)	-	-
Mint	74.8(Shiraz)	872.4-3386.1 (Esfahan)	1.13 (Ahvaz)	8.7 (Shiraz)
Coriander	115 (Kermanshah)	1068.6-1759(Esfahan)	-	-
Celery	1.2(Kermanshah)	46.08 (Shiraz)	-	-
Eggplant	66.93(Shiraz)	864 (Ahvaz)	-	-
Cabbage	48.2(Shiraz)	3650-5550 (Esfahan)	-	-

that the level of pollution to nitrite exceeds the standard limit in any of the studied products in Iranian cities. In the study of celery greens in Kermanshah and Ahvaz, nitrate pollution was found to be lower than the limit [16, 30]. While the amounts of nitrate pollution of cabbage vegetables in Minadasht, Isfahan, and Ardebil were 4.67, 11.1-7.3, and 2.8 times more than standards, respectively, and in Shiraz and Tabriz were less than standard [17, 18, 32-33, 35]. In this study, tomato was a product that was less polluted by nitrogen fertilizers and only in Khorasan Razavi was nitrate content 18.3 times higher than the standard [28]. The results of these studies confirmed the high nitrate content in leafy vegetables compared to the other group of vegetables, which had the highest nitrate in radish and celery leaves, as well as high nitrite concentrations in tomato and radish tubers and low levels of it in lettuce. Crude spinach with low nitrate content but high nitrite content showed that this could be due to the weather conditions, the amount of fertilizer used, and other conditions of growth. Nitrate concentrations in leafy vegetables were higher than those of the tuber and in the tuber vegetables more than the fruits [29, 36, 38, 40]. In general, the nitrate enters the body through pepper, mint, potatoes, and eggplant, and the minimum nitrate is devoted to savory vegetables such as onions and tomato [32]. Nitrate in leafy vegetables of Ahvaz was lower than the standard level. So these vegetables are harmless and can be consumed. In Kermanshah [22] the average nitrate in all tomato samples from Mian Darband was lower than the standard. Therefore, these products have a virtual nitrate level for various applications such as tomato paste production. The results of the measurements also showed that the rate of nitrogen fertilizers in most farms was more than the fertilizer recommendation. Excessive use of nitrogen, in addition to reducing yield, can increase nitrate concentrations in vegetables with excessive concentrations of undesirable properties for this product. In addition, excessive use of nitrogen fertilizers may increase part of it in the form of nitrate, which has been a long-term threat to human health. According to studies, a high level of nitrite and nitrate in the diet is known to be a cause of gastric cancer.

The existence of high nitrite and nitrate in some products has been observed [45]. The nitrate average in potatoes distributed in Kermanshah was more than acceptable. High levels of nitrate can be attributed to the high consumption of nitrogen fertilizers, agronomic factors, the mechanization of agriculture, genetic sagriculture (e.g. soil type, dosage, and chemical forms of nitrogen availability of other nutrients, herbicide, etc.) and moisture [46]. Proper management practices such as the right manure selection seek soil testing and the elimination of subsidies for chemical fertilizers and the use of organic materials and biological fertilizers in order to reduce the risk of nitrate accumulation and the safe keeping of manufactured products [31, 34, 42]. Regarding the above, it is recommended to reduce of use of nitrate fertilizer in lands for prevention of methemoglobinemia, especially in the diet of children. On the other hand, due to the high supply of some products in the market due to low prices and high per capita consumption by people, especially in children, this is somewhat impossible. Therefore, it is necessary to have sufficient supervision on how to plant and harvest and import the products to be examined [16]. Considering that nitrate and nitrite levels in some of the foodstuffs studied are higher than the EU, it is recommended that control measures to reduce contamination and regular monitoring of products supplied by food and drug deputies of medical universities of the country should be considered promptly.

Conclusion

Since the various processes do not guarantee the absence of nitrogen compounds, the presence of this dangerous and highly toxic substance in vegetables is extremely important. Vegetables free of nitrogen compounds are desired for communities, but achieving this ideal is not easy. Accordingly, standards and rules have been set to reduce this substance in vegetables. Of course, the limits determined by the standard are widely variable and delicate scientific principles are involved in their regulation. It seems that the presence of the substance studied is related to nitrogen fertilizers and it is worth considering that in Iran there is almost no health control on the quality of vegetables. In order to achieve the desired quality, the cultivation conditions should be carefully monitored. Solutions to reduce nitrogen compounds should be considered, including the lack of nitrogen fertilizer and continuous and accurate monitoring of the handling and maintenance of vegetables by experienced experts. The prevalence of nitrates and nitrite in vegetables has imposed irreparable risks to human health. So, periodic and continuous control is vital. Although environmental and nutritional factors are an important parameter in the level of infection, the extent to which these factors are not well understood is not known.

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