TOXIC POTENTIAL GENERATED BY NITRATE CONCENTRATION IN FOOD AND DRINKING WATER RESOURCES

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Abstract *The paper shows the existence of a toxic potential in the rural population food resources because of their nitrate concentration in vegetables and drinking water as a result of intensive agricultural practices. For this purpose, the nitrate content of the main vegetables cultivated by farmers and that of the well water used for drinking and watering, was established. The variation of nitrate content and the estimation of nitric overload in the village areas from the south -west area of our country have been pursuit in several localities, representative for their large vegetable yields, being a major source for the town market supply. Simultaneously with the consumption of vegetables, the nitrate ingestion is completed by the consumption of drinking water having as water source the wells water representing together the daily nitrate intake. The nitric depreciation degree of the analysed food resources was determinate by percentage calculation of the maximum permissible limit exceed, specified for each analysed vegetable or water sample. Nitric toxicity through vegetable or water consumption can be estimated considering the food assortment ingested through the daily food diet and vegetable foodstuffs intake, the foodstuff nitrate content and the consumer's weight. To avoid in time, the appearance of serious toxic consequences on human health generated through body nitrate accumulation, FAO and WHO have established 3,65 mg nitrate/ kg consumer weight, as daily admitted intake of nitrate, meaning also not to exceed 50 mg nitrate/ l drinking water. The usefulness of the paper consists in preventing the consumer's nitric contamination by drinking water from rural wells and consuming overloaded vegetables with nitrates. Exceeding the toxicity limit mentioned above, may induce serious illnesses like methemoglobinemia and cancer.*

Keywords**:** *nitrate content, vegetables, well water, daily admitted nitrate intake, nitrate toxic potential*

INTRODUCTION

The daily food diet for all age categories of consumers contains vegetables and drinking water as main assortments. In accordance with several research done, concerning nitrate content of vegetables (1,2,5,9,10) it was established that vegetables, particularly leaf vegetables and some root vegetables are known as large nitrate accumulators. In areas with intensive nitrogen fertilization, they are overloaded with nitrate representing therefore the main source of nitrate accumulation in the consumer's body. Maximum permissible limits of nitrates in some vegetables and fruits are recommended by the Health Ministry of Romania in order to prevent the consumer's nitric contamination (14). Leaf vegetables are known as high nitrate concentration food resources, being supplemented in the daily diet by drinking water, represented in rural areas often by well water. Intensive nitrogen fertilization frequently causes the increase of nitrate content in groundwater, which becomes overloaded with nitrates and therefore frequently well water used as drinking water, rises the daily intake of nitrates by food. Regarding the depreciation of the groundwater, it is especially noticeable in the areas adjacent to the industrial complexes or farms with a low groundwater table, a stronger depreciation of the groundwater characteristics at a shallow level compared to the deep ones(3,6,8,10,11). It is

known that in rural areas drinking water is assured through wells where the water is provided from groundwater or shallow water. Regarding the nitrate content of food, the daily intake of nitrates may often be raised by drinking water (well water) containing high nitrates amounts, especially in rural areas (4,7,12).

MATERIAL AND METHODS

362 samples of vegetables, mostly leaf and root vegetables, like carrots, potatoes, parsley, parsnip, lettuces, red beet, horse radish, spinach, radish, celery, and cabbage were taken for analysing the nitrate content. The harvest took place from several farmer families settled in rural areas like Săcălaz, Cenad, Topolovățul Mare and Covasânț. The taken samples were transported and analysed at the Institute of Human Health, Timișoara on the same day. The nitrate content (STAS 3048/1-77 SR ISO 7890/1-98)(15) was determined by spectrophotometry at 538 nm using the GRIESS method (SR EN 12014-7:2001)(14). The nitric overload of the vegetable samples was estimated by comparing the nitrate content of each sample with the requirements stipulated in Rules-CE nb.975/1998, art.98 by the Health Ministry of Romania (13).Water samples were collected from wells and drillings located in Banat County, in areas adjacent to industrial complexes or agricultural farms, mostly having the groundwater table close to the soil surface. The drillings were localised in Topolovățul Mare and Covasânț. The nitrate content of upper and deep layers groundwater was investigated. Groundwater samples were analysed in order to determinate the dependence between the drilling depth (5,6m ; 8m ; 10m ; 55m ; 85m) and the nitrate content as well as the impact of intensive agricultural activities mainly excessive nitrogen fertilization on groundwater quality. The nitrate content (STAS 3048/1-77 SR ISO 7890/1-98) was determined by spectrophotometry at 538 nm using the GRIESS method (SR EN 12014-7:2001). The nitrate overload of the water samples was estimated taking into account the obtained results regarding the highest level of nitrates in drinking water (Rule-458/2002), in order not to exceed, by daily intake, the acceptable level of nitrates in human body meaning 50 mg nitrate/ l drinking water (11).

RESULTS AND DISCUSSION

The variation of nitrate content and the estimation of nitric overload in the villages from Banat have been pursuit in localities representative for their large vegetable yields.

Localities representative for their large vegetable yields like Săcălaz, Cenad, Topolovățul Mare and Covăsânț represents a major source for the town market supply. In accordance with table 1 in Săcălaz and Covăsânț was established a high nitrate concentration in carrots, some samples exceeding by 64% and 57% the maximum permissible limit (LMA). For potatoes the exceeds are 64% and 41% for samples taken in Cenad and Săcălaz, where most of the red beet samples exceeds the LMA representing 2000 mg NO3/kg by 36%. Analysing the lettuce samples taken from Săcălaz, an exceed of 36% was established.

Table 1

Nitrate content in vegetables species cultivated by farmers in village areas from Banat.

Analysed product/village	**Number of analysed samples**	**Nitrate content values (mg NO_3/kg)**	**Average nitrate content(mg NO_3 /kg)**	**Maximum permissible limit (LMA) (mgNO_3/kg)**	**% Exceed of LMA / analysed sample**
Carrot				400	
Săcălaz	29	115-2690	725		64
Cenad	25	159-838	303		24
Topolovăț	6	101-350	221		0
Covăsânț	44	22-1714	476		57
Potatoes				300	
Săcălaz	29	93-673	335		41
Cenad	11	100-626	293		64
Covăsânț	38	10-399	170		21
Red beet				2000	
Săcălaz	10	817-4179	2220		36
Lettuce				2000	
Săcălaz	23	118-3508	1361		36
Cenad	5	164-1694	1004		0
Cabbage				900	
Covasânț	26	121-802	336		0
Parsley				-	
Covăsânț	22	81-1285	442		-

Table 2

Nitrates content values in vegetables grown by farmers in Timis County

Analysed product	**Number of analysed samples**	**Nitrate content values(mg NO_3/ kg)**	**Average nitrate content (mg NO_3/ kg)**	**Maximum permissible limit(LMA) (mg NO_3/ kg)**	**% Exceed of LMA/ analysed sample**
Carrot	71	101-2960	375	400	34
Potatoes	46	84-674	334	300	39
Lettuce	28	118-3508	1182	2000	43
Red beet	17	254-4179	2041	2000	47
Cabbage	5	68-1030	261	900	20
Parsley	29	127-2419	774	-	-
Parsnip	14	101-1046	290	-	-
Horse radish	9	316-1820	1174	-	-
Spinach	7	149-3097	1396	2000	45
Radish	3	2095-4940	3579	-	-
Celery	3	173-1171	534	-	-

The nitric overload situation concerning the vegetables harvest grown by farmers in Timis County is shown in table 2. The highest values of nitric overload were established for the leafy vegetables, regarding spinach (exceed of LMA by 45%) and lettuce (exceed of LMA by 43%), also for red beet the exceed being of 47%. Other important values for exceeding LMA were pointed out for carrots (34%) and potatoes (39%). Although for most of the root vegetables there is no values for the maximum permissible limit (LMA) there must be required some restrictions in their consumption because the high nitrate content.

Table 3

Variation of nitrate content in Covăsânț groundwater depending on the drilling depth

Water sampling time	Nitrate content (mg/kg) / Drilling depth- 5,6m	Nitrate content (mg/kg) / Drilling depth- 8 m	Nitrate content (mg/kg) / Drilling depth- 10 m	Nitrate content (mg/kg) / Drilling depth- 55 m	Nitrate content (mg/kg) / Drilling depth- 85 m
I. quarter					
2021	324,7	132,5	47,9	36,5	4,4
2022	392,4	127,5	49,4	38,3	5,7
II.quarter					
2021	298,4	108,4	48,2	35,3	2,4
2022	293,1	98,9	88,3	30,6	1,0
III.quarter					
2021	274,3	99,4	35,8	37,6	2,0
2022	287,5	97,2	75,8	67,4	2,4
IV.quarter					
2021	284,4	109,6	34,8	38,4	1,7
2022	381,3	169,4	94,4	49,4	1,1

Simultaneous with the consumption of vegetables the daily intake of nitrates is establish by the nitrate content of the drinking water. Therefore, depth water samples used as drinking water from Topolovățul Mare(table 4) and Covăsânț (table 3) were also analysed. Water samples were analysed regarding the variation of the nitrate content depending on the drilling depth. The drillings were localised in Topolovățul Mare and Covasânț. The nitrate content of upper and deep layers groundwater was investigated. Groundwater samples were analysed in order to determinate the dependence between the drilling depth (5,6m ; 8m ; 10m ; 55m ; 85m) and the nitrate content as well as the impact of intensive agricultural activities mainly excessive nitrogen fertilization on groundwater quality. The nitrate overload of the water samples was estimated taking into account the obtained results regarding the highest level of nitrates in drinking water (Rule-458/2002), in order not to exceed, by daily intake, the acceptable level of nitrates in human body meaning 50 mg nitrate/ l drinking water (11).

Table 4

Variation of nitrate content in Topolovatul Mare groundwater depending on the drilling depth

Water sampling time	Nitrate content (mg/kg) / Drilling depth- 5,6m	Nitrate content (mg/kg) / Drilling depth- 8 m	Nitrate content (mg/kg) / Drilling depth- 10 m	Nitrate content (mg/kg) / Drilling depth- 55 m	Nitrate content (mg/kg) / Drilling depth- 85 m
I. quarter					
2021	98,3	27,8	54,3	31,6	40,5
2022	85,0	89,6	51,7	30,8	50,1
II.quarter					
2021	84,6	28,6	54,8	35,8	39,5
2022	83,3	23,4	54,4	37,8	45,6
III.quarter					
2021	82,5	24,4	52,3	36,6	34,2
2022	82,8	23,8	54,8	30,8	49,7
IV.quarter					
2021	86,7	26,3	57,4	33,6	34,2
2022	66,7	21,5	67,8	31,7	48,2

The drillings till 10 m in Covăsânț (table 3) shows a nitric overload of the water samples that makes the water unfit to be used as drinking water. The values of the LMA exceed are altering between 685% (drilling depth 5,6m), 165% (drilling depth 8m) and 89% (drilling depth 10m). The situation repeats herself for Topolovățul Mare (table 4) where only drillings deeper as a medium depth (55m) can offer a drinking water without a high nitrate content. The values of the LMA exceed are altering between 97% (drilling depth 5,6m), 79% (drilling depth 8m) and 36% (drilling depth 10m).

CONCLUSIONS

The research results concerning the nitrate content of the vegetable samples taken in Săcălaz, Cenad, Topolovățul Mare and Covasânț show a wide range of nitrate content in vegetables within the framework of the locality, the same species and between the studied species. lt is obvious the predominance of the nitrates content values that exceed the maximum allowable limit both for root and leaf vegetables. An increased percentage of the exceeds can be noticed for carrots (Săcălaz, Covăsânț, Cenad), potatoes (Săcălaz, Covăsânț, Cenad), red beet (Săcălaz), lettuce (Săcălaz) also red beet, spinach and lettuce (Timis County).Correlating this results with the nitric overload of the depth water in the village wells (drillings till 10m), some restrictions must be required in order to reduce the daily intake of nitrates by vegetables and drinking water. Therefore, the vegetables consumption with high nitric content must be diminished. For lowering the nitrate content in vegetables, we can use some preparing cooking operations such as washing, cutting away the inedible parts or boiling the vegetables. Also, it is necessary to avoid the use of low depth water as drinking water or for watering crops. For this purpose, we must use only drillings deeper as a medium depth (55m) which can offer a drinking water containing low nitrate content(till 50 mg NO_3/l water).

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