NITRIC FOOD POLLUTION AS A RESULT OF INTENSIVE MINERAL NITROGEN FERTILIZATION

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Abstract: *The study reveals the most important nitrate sources of agricultural origin which often pollute food stuffs and drinking water. In areas with intensive nitrate fertilization and livestock breeding, crops and depth water become overloaded with nitrates. The nitrate content of carrot, spinach, lettuce, cabbage and parsley experimentally fertilized with various doses of nitrogen was measured at their harvest. Field experiments were performed treating soil with six doses of nitrogen applied as a mineral fertilizer (urea, ammonium nitrate, potassium nitrate) and organic fertilizer (manure). The nitrate content of spinach, lettuce and cabbage leafs, also carrot root and vegetative organs of parsley was determined at harvest time. The upper and deep layers of ground water in some settlements of Banat County were also sampled and analysed for nitrates, using the Griess method (spectrophotometric method). Nitrate contamination in areas of intensive agricultural activities as well as nitric overload due to intensive animal breeding were studied on depth water samples. The obtained results showed linear correlation between the nitrogen amount used as fertilizer or generated by intensive animal breeding and the nitrate content of vegetables and water samples. The values of the nitrate content in vegetables altered and depended also on the analysed vegetable species. Nitrogen added as organic fertilizer (manure) generates at harvest time low nitrate content in vegetables. Therefore the organic fertilizer should be preferred to mineral fertilization, if the agricultural technology admits it. The usefulness of the paper lies in preventing the consumer's nitric stress by food and water consumption. The importance of the obtained results consists in informing potential consumers about the nitric accumulation prevalent in leaf and root vegetables also in depth water resources in areas of intensive fertilization with mineral nitrogen or industrial animal breeding. In order to prevent high nitrate concentration in leaf and root vegetables, the nitrogen fertilizer dose to be applied should be calculated on the basis of specific consumption of the species and also the features and fertility of the soil. The climatic conditions, the vegetation period of the crop and the harvest time are also relevant, since they deeply influence the reduction of nitrates.*

Key words: *nitrogen dose, vegetables, depth water**,** nitrate content, nitric overload;*

INTRODUCTION

In all age categories of consumers, the daily food diet contains vegetables and drinking water. It was established that vegetables, particularly leaf vegetables and some root vegetables represent the main source of nitrate load to human body (DANEK-JESIK, 1990; BIBICU,1994; RĂDULESCU and GOIAN,1999). In addition to nitrates of vegetable origin, the daily intake of nitrates may often be raised by drinking water (well water) contaminated with nitrates in some rural areas.

In order to establish the main reasons of nitric overload in vegetables and well water, the influence of the nitrogen dose and fertilizer type on their nitrate content was investigated.

The main objective of this study is to present the nitrate content altering as a result of the experimented nitrogen fertilizer type and doses in the vegetative organs of vegetables as well as in the well water of areas with intensive agricultural activities or animal breeding.

MATERIALS AND METHODS

Field experiments were performed applying on soil various doses of nitrogen (50, 100, 150, 200, 250, 300 kg/ha) as mineral fertilizer (urea, ammonium nitrate, potassium nitrate) or organic fertilizer (manure).The nitrate content of spinach, lettuce, cabbage, parsley and carrot harvested from those plots was determined. At the particular vegetables, parts to be ingested by the consumer (the leaf and/or the root) were analysed. The type of nitrogen source (urea, ammonium nitrate, potassium nitrate, manure) and the vegetation period (spring and autumn) were taken into account. The investigations covered three crop years.

The water samples were taken from wells and drillings located in the rural regions of Banat County where the agricultural activities were intensive. The nitrate content of the upper and deep layers of ground water was investigated.

The nitrate content was determined by spectrophotometry at 538 nm using the GRIESS method (sulphanilamide 1-naphthyl-ethylenediamine) after reduction of nitrate to nitrite by spongy metallic cadmium in columns (ROMANIAN STANDARDS, 1977, 1983).

RESULTS AND DISCUSSION

The most important aspects concerning the factors influencing the nitrate content are treated below.

The nitrate content in the carrot root increased proportionally to the nitrogen dose applied for all the three mineral fertilizers used (urea, ammonium nitrate, potassium nitrate). Among them, potassium nitrate showed the highest increase (Fig.1.).

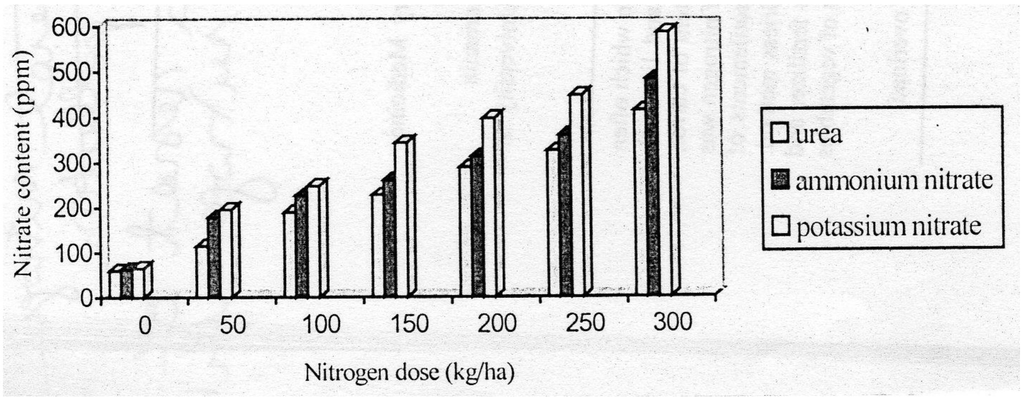

Fig.1. The influence of the mineral nitrogen fertilizer type and dose on the nitrate content in carrot roots

Comparatively, fertilizing spinach with manure (0,5 %N) and ammonium nitrate(33,5%N) the highest nitrate content was found for mineral fertilization. Nitrogen in manure is in organic form, which is not immediately accessible for the plant. Therefore, the nitrate concentration is much lower in the spinach leaves when using manure as fertilizer (Table 1.).

The climatic conditions during the growth of the plants are also very important because of their influence on the reduction reaction of nitrate. Light and solar radiation increased the speed of the reduction reaction. In autumn and winter months, the shorter day time increased the nitrate concentration in lettuce leaves of greenhouse crops or autumn crops (Fig.2.)

Table 1.

Nitrate content of spinach fertilized with various amounts of manure or ammonium nitrate

Manure dose (t/ha)	Nitrate content (ppm)	Ammonium nitrate (kg N/ha)	Nitrate content(ppm)
0	**550**	**0**	**600**
20	**620**	**100**	**1076**
30	**700**	**150**	**1100**
40	**825**	**200**	**1250**
60	**980**	**300**	**1708**

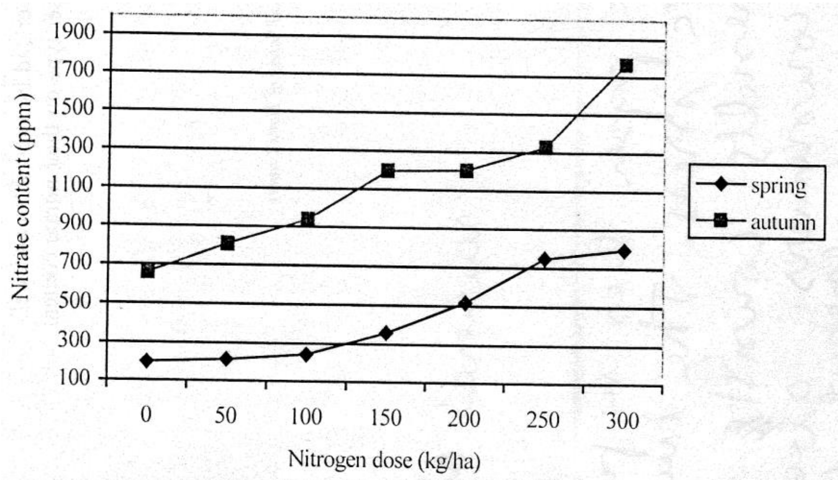

Fig. 2. Dependence on the vegetation period of the nitrate content in lettuce fertilized with ammonium nitrate

The nitrate content in the external and internal leaves of the cabbage largely differed. The internal leaves contained higher amounts of nitrate because of the slowness of the nitrate reduction due to the absence of light (Fig.3.). The leaves of parsley concentrated more nitrate than the roots (Table 2.).

Table 2.

Nitrate distribution in the vegetative organs of parsley fertilized with ammonium nitrate

Nitrogen dose (kg/ha)	Root nitrate content(ppm)	Leaf nitrate content (ppm)
0	**317**	**670**
50	**368**	**820**
100	**503**	**869**
150	**589**	**869**
200	**630**	**886**
250	**689**	**1145**
300	**966**	**1179**

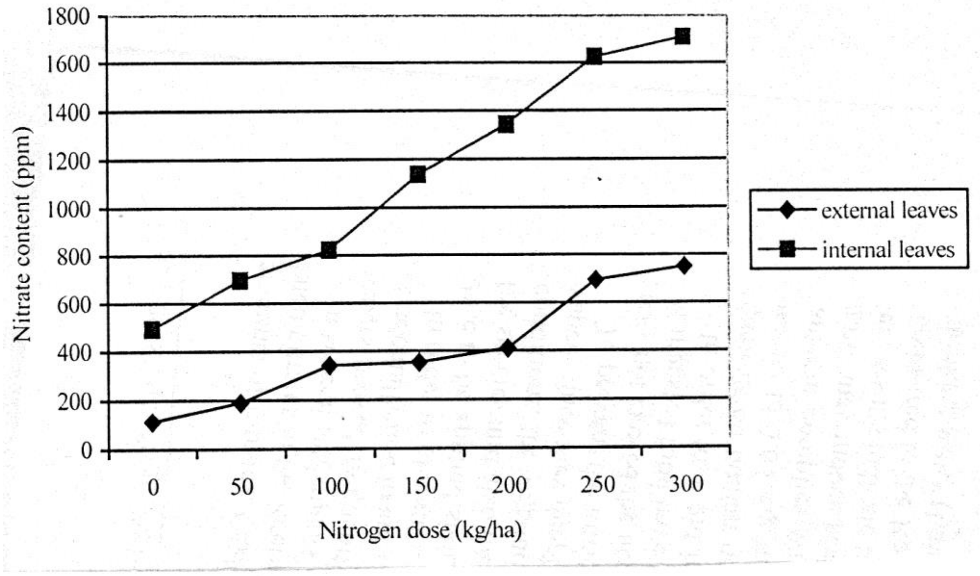

Fig. 3. Nitrate distribution in the cabbage head varying with the nitrogen dose administered as ammonium nitrate

In several rural regions of Banat County, the upper layer of ground water was compromised because of the intensive agricultural activities. In all samples taken from wells in 9 areas, the nitrate content exceeded the level allowed for drinking water, which is 50 mg NO_3/l (LAW,2002) (Table 3.).

Table 3.

Nitrate contamination in the upper layers of depth waters in areas of intensive agricultural activities in Banat County

Settlement	Nitrate content(ppm)	Excess over the maximum allowed (%)
Jimbolia	56	12
Bobda	94	88
Dinias	55	10
Urseni Unip	98	96
Folea	58	16
Tormac	138	176
Nitchidorf	600	1100
Margina	88	76

Not only the upper layers of the groundwater were compromised but also most of the drillings made at 40-60 m depth in the vicinity of the livestock breeding farms. In some rural localities, the groundwater could not be used as drinking water because of the high nitrate excess (Table 4.).

Table 4.

Nitric overload of depth waters in Banat County due to intensive animal breeding

Settlement	Nitrate content(ppm)	Excess over the maximum allowed(%)
Alios	**100**	**100**
Masloc	**120**	**140**
Pischia	**130**	**160**
Sanandrei	**140**	**180**
Periam	**120**	**140**
Peciu Nou	**1110**	**2120**
Deta	**96**	**92**

CONCLUSIONS

The present results show that the nitrate content of the samples is most of all directly proportional to the amount of nitrogen used as fertilizer. The critical dose of nitrogen fertilizer is different from one vegetable species to the other. The allowed nitrate levels in the ingested vegetables also varies (ROMANIAN STANDART, 1983).The maximum accepted nitrate concentrations for lettuce, spinach, cabbage and carrot are 2000, 2000, 900 and 400 ppm $NO_{3,}$ respectively. Taking into account these requirements, the critical doses of fertilizer as nitrogen amount is 200 kg/ha for carrot and 100 kg/ha for cabbage. The obtained values of nitrate content in lettuce, spinach and parsley do not exceed the maximum acceptable ones for either of the experimental doses.

Nitrogen added as organic fertilizer (manure) generates low nitrate contents in vegetables at harvest time. Therefore the organic fertilizer should be preferred to mineral fertilization, if the agricultural technology admits it. Vegetables cultivated as greenhouse crop or autumn crop contain high nitrate amounts and should, therefore, be consumed in lower quantities in order to avoid exceeding the daily acceptable nitrate intake. In root vegetables, the leaves (parsley) contain the highest amounts of nitrates. Cabbage as a leaf vegetable concentrates most of the accumulated nitrates in the internal leaves.

In several settlements of Banat County the upper-layer and average depth groundwater proved frequently to be compromised due to intensive nitrogen fertilization and industrial animal breeding.

In order to prevent high nitrate concentration in vegetables, the fertilizer nitrogen dose to be applied should be calculated on the basis of the specific consumption of the species and also the soil features and fertility. The climatic conditions, the vegetation period of the crop and the harvest time are also of relevance, since they deeply influence the reduction of nitrates in vegetables.

To prevent the nitric impact on the consumers' health, the daily intake of nitrates may not exceed the acceptable level. To this end, the nitrate content and the amount of ingested food have to be taken into account. In order to avoid in time the appearance of nitrate-induced serious consequences on human health, FAO and WHO have set the daily acceptable intake of nitrate to 3.65 mg nitrate/kg body mass (SELENKA AND BRAND-GRIMM, 1976). This amount complies with the toxicity limit of nitrate intake. Exceeding the toxicity limit may induce serious illnesses like methaemoglobinaemia and cancer.

The present results indicate that in the investigated region nitric overload can be estimated as compared to the Romanian limit values for both vegetables (REGULATION, 1994) and drinking water (LAW 458/2002).

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