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COMPARATIVE STUDY OF THE LEGISLATIVE-NORMATIVE ACTS IN THE CONTROL OF NITRATES IN LEAFY GREENS

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Abstract. The content of nitrates in foods of plant origin permanently comes into notice of consumers, society. Nitrates in large quantities are harmful to the human body, especially children. The legislation of the Republic of Moldova, which regulates the maximum acceptable limit (MAL) of nitrates, namely Government Decision No 115 on *The control of nitrates in foods of plant origin*, was brought into line with European legislation just in September 2020. In the present study, some aspects related to these normative changes were analyzed. It was determined that the vast majority of spinach samples from local agricultural market exceed 1.1-1.6 times the MAL of nitrates with reference to national legislation and 1.9-2.7 times concerning the legislation of the Russian Federation. Rucola practically falls within the limits established in the national legislation, the MAL being 6000 mg nitrate·kg^{-1}, but it exceeds by far (in 2.1 times) the MAL established in the Russian Federation. Fresh salad falls within the limits set by national and international laws.

Keywords: *vegetable products, agricultural policies, maximum acceptable limit (MAL), lettuce, spinach, rucola.*

Rezumat. Conținutul de nitrați din alimentele de origine vegetală se află permanent în atenția consumatorilor, a societății. Nitrații în cantități considerabile dăunează organismului uman, în special copiilor. Legislația Republicii Moldova, care reglementează limita maximă acceptabilă (LMA) de nitrați, și anume, Hotărârea de Guvern nr. 115 *Privind controlul nitraților în alimentele de origine vegetală*, a fost aliniată la legislația europeană chiar în septembrie 2020. În prezentul studiu s-au analizat unele aspecte legate de aceste modificări normative. S-a stabilit că marea majoritate a probelor de spanac de pe piața agricolă locală depășesc de 1,1-1,6 ori LMA de nitrați cu referire la legislația națională și de 1,9-2,7 ori referitoare la legislația Federației Ruse. Rucola se încadrează practic în limitele stabilite în legislația națională, LMA fiind de 6000 mg nitrat.kg-1, dar depășește de 2,1 ori LMA stabilită în Federația Rusă. Salata proaspătă se încadrează în limitele stabilite de legile naționale și internaționale.

Cuvinte-cheie: *produse vegetale, politici agricole, limita maximă acceptabilă (LMA), salată, spanac, rucola.*

Introduction

Under the changes of the last millennium, the Republic of Moldova is to implement new strategies, policies, and objectives on food safety. It is necessary to provide the country's population with quality food and according to the consumer's demand, to integrate ourselves into the global food market [1], especially the agricultural one. Mild favorable climate and high-quality soils determined Moldova's agricultural specialization, particularly in the production of high-value crops like fruits and vegetables [2].

Vegetables are an important component of the human diet, but contribute 75-80% of the total daily intake of nitrate, with high levels in lettuce, spinach, celery, beetroot, turnip greens, etc [3]. Nitrate by itself is relatively non-toxic; however, it may be endogenously transformed to nitrite, which can react with amines and amides to produce N-nitroso compounds. These compounds have been related to an increased risk of diseases. Excessive nitrate can also block iodide uptake of the sodium iodide symporter in a competitive manner. For this reason, nitrate in vegetables has received increasing attention [4].

Despite the progress achieved in the good agricultural practice to reduce the presence of nitrates in leafy vegetables (lettuce, spinach, rucola) and a strict application of this good agricultural practice, it has been established impossible to achieve in a consistent way nitrate levels below the certain maximum level in all European regions. The reason is that the climate and in particular the light conditions are the main determinant factor in the presence of nitrates in leafy vegetables. These climate conditions cannot be managed or changed by the producer [5].

The Panel on Contaminants in the Food Chain (CONTAM) of the European Food Safety Authority (EFSA) has evaluated the risks to human health from dietary nitrate exposure resulting from vegetable consumption. It has been demonstrated that the critical driver for high dietary exposure to nitrate is not the absolute amount of vegetables consumed but the type of vegetable (e.g. leafy vegetables) and the concentration of nitrate related to the conditions of production [6]. The Panel concluded that exposure to nitrate at the current or envisaged maximum levels in spinach cooked from fresh spinach is unlikely to be a health concern, although the risk for some infants eating more than one spinach meal per day cannot be excluded [7, 8]. Overall, the estimated exposures to nitrate from vegetables are unlikely to result in appreciable health risks, therefore the recognized beneficial effects of consumption of vegetables prevail. The Panel recognized that there are occasional circumstances e.g. unfavorable local/home production conditions for vegetables, which constitute a large part of the diet, or individuals with a diet high in vegetables such as rucola, which need to be assessed on a case-by-case basis [6].

Thus, the European Union supports the politics of reducing the presence of nitrates in food products, but at the same time suggests to increase the maximum level for nitrates in fresh spinach, rucola, and lettuce without endangering public health.

In September 2020, the legislative basis of the Republic of Moldova within the control of nitrate content in foodstuffs of plant origin [9] was updated, repealing the maximum permissible limits taken from the rules laid down for leafy greens in the Russian Federation [10]. The adaptation of that law for products available on the local agricultural market shall be verified. The paper aimed to investigate the nitrate content of local and imported green vegetables sold on the market of the Republic of Moldova to establish the compliance of the maximum acceptable limit (MAL) of nitrates with national and international legislative requirements.

Methods and materials

Experimental research was carried out with fresh Lettuce, Spinach and Rucola purchased in the Republic of Moldova. The tested plant materials samples came from both domestic and imported producers, mainly Italy.

The most common modes used to determine the nitrates and nitrites content in plant products are spectrophotometric and ionometric methods [11, 12]. These methods shall create the necessary framework for the application of the provisions of Article 8 of Regulation (EEC) No 2081/92 [13].

Commission Regulation (EC) No 1881/2006/EC laying down the maximum levels for certain contaminants in foodstuffs [5] and the provisions of Regulation No 1882/2006 [14] laying down detailed rules for the application of Council Regulation (EEC) No 2081/92 on the common organisation of the market in foodstuffs, as last amended by Regulation (EC) No 1493/1999 [15], should be amended accordingly. Commission Regulation (EC) No 1882/2006/EC laying down the methods of sampling and analysis for the official control of nitrate levels in certain foodstuffs [14].

For experimental research, the ionometric method [16] was used to determine the nitrate content in vegetables.

The ionometric method consists of extracting nitrate ions with an aluminium and potassium alaun solution – $AlK(SO_4)_2 \cdot 12\ H_2O$ and subsequently determining the logarithm of nitrate ion concentration using an ionoselective electrode.

The method shall not be accepted if the chloride content exceeds more than 25 times the nitrate content in the analysed material.

The inferior limit for the identification of nitrates constitutes 6 mg in 1 dm^3 solution analysed. The safe limit for determining nitrates in the sample analysed is 30 $mg \cdot kg^{-1}$. The method is used to determine nitrates in agricultural products.

If the analysis used a sample weighed from the crushed sample, then the mass fraction of nitrates in the material used in parts per million shall be calculated by the formula [16]:

$$x = \frac{\left(V + \frac{\omega H}{100 \cdot 1}\right) \cdot 10^{-pC_{NO_3^-}} \cdot 10^6}{1000H}$$

where: H - sample mass, g,
V - volume of extracted solution, cm^3,
1000 - dm^3 to cm^3 conversion factor,
ω - the mass fraction of water in samples, %;
100 - conversion rate % in units;
1 - water density, $g \cdot cm^{-1}$;
10 - the coefficient of conversion of unit fractions into units of millions, $mg \cdot kg^{-1}$.

The samples have been prepared for analysis as follows: leaves with traces of soil, inedible and damaged outer leaves are removed from plants, washed and dried between sheets of filter paper, then in the air. After drying, the samples were shredded with the laboratory homogenizer.

Results and discussions

The analysis of of plant origin foodstuffs present in the territory of Republic of Moldova was carried out (Table 1), for which the maximum permissible limit of nitrate content was recently reviewed.

Table 1

Nitrate content in leafy greens available on the local agricultural market of Republic of Moldova, P = 0,8

Raw Materials	Nitrate content, mg $NO_3 \cdot kg^{-1}$ product				Maximum acceptable limits, mg $NO_3 \cdot kg^{-1}$product
	Producers				
	local product		imported product		
	Producer RM1	Producer RM2	Producer UE3	Producer UE4	
Lettuce (*Lactuca sativa L.*) ω*** = 95,2±0,5%	2044±36	1571±19	1728±13	1549±10	2000 (grown in the open air) [9*] 2500 (grown under cover) [9*]
					2000 (grown in the open air) [10] 3000 (grown under cover) [10]
					harvested 1.04 – 31.09 3000 (grown in the open air) [7, 9**] 4000 (grown under cover) [7, 9**]
					harvested 1.10 – 31.03 4000 (grown in the open air) [7, 9**] 5000 (grown under cover) [7, 9**]
Spinach (*Spinacia oleracea*) ω*** = 92,3±0,3%	2363±34	5431±58	4714±68	3692±78	3500 (grown in the open air) [9*] 3500 (grown under cover) [9*]
					2000 (grown in the open air) [10] 3000 (grown under cover) [10]
					3500 (fresh) [7, 9**] 2000 (frozen) [7, 9**]
Rucola (*Eruca sativa*) ω*** = 91,9±0,4%	6210±30	6285±15	6120±62	6270±30	not specified [9*]
					2000 (grown in the open air) [10] 3000 (grown under cover) [10]
					6000 *harvested 1.04 – 31.09* [7, 9**]
					7000 *harvested 1.10 – 31.03* [7, 9**]

Note: * GD No 115/2013 before last review

** GD No 115/2013 modificated from September 2020

*** ω - the mass fraction of water in samples, %

Table information (Table 1) shows that lettuce produced in Republic of Moldova and imported one fall within the limits set by national and international legislation. The MAL of 4000 mg $NO_3 \cdot kg^{-1}$ in the legislation approved in 2020 is practically twice as high as the values determined in the researched samples.

The majority of spinach samples RM2, EU3, EU exceed 1.1-1.6 times the MAL of nitrates with reference to national norms and 1.9-2.7 times concerning Russian Federation legislation.

Rucola practically falls within the limits established in the national legislation, the MAL being 6000 mg $NO_3 \cdot kg^{-1}$, but it exceeds by far (in 2.1 times) the MAL established in the Russian Federation, being 2000 mg $NO_3 \cdot kg^{-1}$.

Conclusions

1. The reviewed legislation of the Republic of Moldova on nitrate content and EU legislation generally establish much higher maximum acceptable limits for nitrates than Russian Federation laws.
2. Producers, offering fresh salad and rucola to the local agricultural market, fall within the limits laid down by national legislation, 4000 mg $NO_3 \cdot kg^{-1}$ and 6000 mg $NO_3 \cdot kg^{-1}$ respectively, but not the norms of the Russian Federation.
3. Although spinach is a product with a high biological value, it shows an increased nitrate content, because of producers that apply in abundance nitrogen mineral fertilizers to obtain richer harvests.

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