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NITRATE CONTENT IN FRUITS AND VEGETABLES FROM COMMERCIAL CHAINS IN BULGARIA

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Abstract: *The aim of this monitoring is to evaluate the nitrate content in vegetables and fruits from the commercial chain in Bulgaria. The vegetables were purchased from the food chains in June and July. The measurements of NO_3^- ions were carried out with a Greentest appliance, Model ECO 5. Four samples from the conducted monitoring were with higher NO_3^- amount that is allowed for trade and accepted as healthy (potato, radish, and strawberries). The content of NO_3^- in fresh potato were 645 mg/kg at the accepted safety level 250 mg/kg. The level of nitrates also was higher in the both samples of radish 3700 mg/kg and 2934 mg/kg at accepted level as safety for consumption 1500 mg/kg. This small survey suggests that on the market in the country are still in the trade food products with not enough good quality.*
Keywords: *nitrates, food safety, vegetables, fruits.*

1. INTRODUCTION

Nitrates as most of the other inorganic substances are relatively toxic and the health effect depended mostly of the amount that is digested. The content of NO_3^- is an important quality characteristic of vegetables, because they constitute the major source that formed daily dietary intake from 300 to 940 mg/g [1], more than 80% of dietary nitrates consumption [2], [3], and [4].
Nonetheless, of restrictions and regulations accepted to control and minimize nitrate intake from human food, there are still vegetables on the EU market with exceeded levels. The assessment of human population nitrate exposure in Italy confirm that the acceptable daily intake was higher than the settled limits of 3.7 mg/ kg bw per day and that the ingestion of nitrates from vegetables mainly generate the highest exposure to people of all ages [5].
The current study aims to evaluate the nitrate content in the vegetables and fruits from the commercial chain in BG during summer season.

2. METHODS

The vegetables were purchased from the food chains in June and July. The measurements of NO_3^- ions were carried out with a Greentest appliance, Model ECO 5, for measuring the level of nitrates in fresh fruits and vegetables, as well as harmful substances contained in meat and fish. The appliance is certified and calibrated based on more than 1,000 studies of leading labs using spectrometric equipment. It has certificates: SGS, CCIC-SET, EMC, LVD, and SQC. Min/max amount of measured nitrate concentration: 0-9999 mg/ kg, with permissible error: <10%.

3. EXPERIMENTAL

All samples were vegetables and fruits bought from the food chain supermarkets in BG, but not all of them were with clarified origin, nevertheless all of them had permission to be sell in EU market. The strawberries (2) sample was from Bulgaria, Plovdiv. The radish (1) sample was from Italy.
All measurements were repeated ten times per sample, processed with Excel using ANOVA – one tail, and standard descriptive analysis. The averaged values with variables, minimum and maximum in a single sample are represented in the results.

4. RESULTS AND DISCUSSION

The investigation is part of the research project with the goal to evaluate and screen the quality of the food from BG market. In order to assess the nitrate content of vegetables in the BG market, the random monitoring was conducted several times in different seasons. The results from the assay conducted June and July are represented in the Table 1.

Table 1. Nitrates content in vegetables (Measurements June & July, 2019)

Nutritional product	Acceptable level for consumption [mg/kg]	Average measured amount [mg/kg]	Min value [mg/kg]	Max value [mg/kg]	Standard Deviation [mg/kg]	Coefficient of variation %
Fresh potatoes	250	645*	390	900	160.78	24 %
Carrots	400	<30	<30	50	N/A	N/A
Radish (1)	1500	3700*	2100	7900	1675	45 %
Radish (2)	1500	2934*	840	5300	1214	41 %
Tomatoes	300	48	< 30	90	32.12	33 %
Strawberries (1)	100	148*	40	300	102.72	69 %
Strawberries (2)	100	58.33	40	90	19.40	33 %
Banana	200	95	< 30	200	52.75	56 %
Cucumber	400	38	< 30	60	11.35	30 %
Onion	80	32.5	< 30	45	5.40	17 %
Cherry	50	<30	N/A	N/A	N/A	N/A
Apricot	60	<30	N/A	N/A	N/A	N/A

*- exceed it the acceptable value;

According to the nitrate content, the vegetables are classified in 5 groups:

- **Very low (<200 mg/kg)** – *Pea, Swiss chard, Pepper, Potato, Summer squash, Sweet potato, Tomato, Watermelon, Mushroom, Melon, Green bean, Onion, Garlic, Brussels sprouts Eggplant, Broad bean, Asparagus, Artichoke;*
- **Low (200-500 mg/kg)** – *Broccoli, Carrot, Cauliflower, Cucumber, Pumpkin, 'Puntarelle' chicory;*
- **Middle (500–1000 mg/kg)** – *Cabbage, Savoy cabbage, Turnip, Dill (Anethum graveolens);*
- **High (1000–2500 mg/kg)** – *Parsley, Leek, Leaf chicory, Kohlrabi (Brassica oleracea var. gongylodes), Fennel (Foeniculum vulgare), Escarola, Endive (Cichorium endivia), Chinese cabbage, Celeriac;*
- **Very high (>2500 mg/kg)** – *Rocket, Spinach, Swiss chard, Red beetroot, Radish, Lettuce (Lactuca sativa), Lamb's lettuce, Cress (Lepidium sativum), Chervil (Anthriscus cerefolium), Celery (Apium graveolens).*

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Vegetables with high contend of nitrates belong to families that accumulate nitrates as *Brassicaceae* (rocket, radish, mustard), *Chenopodiaceae* (beetroot, Swiss chard, spinach) and *Amarantaceae*; and also *Asteraceae* (lettuce) and *Apiaceae* (celery, parsley) known as species with high nitrate contents [1].
For the assessment were chosen vegetables from different classes according to the nitrate content and groups that are listed above. Four samples from the conducted monitoring were with higher NO_3^- amount that is recommended (Table 1, Figures 1 and 2).

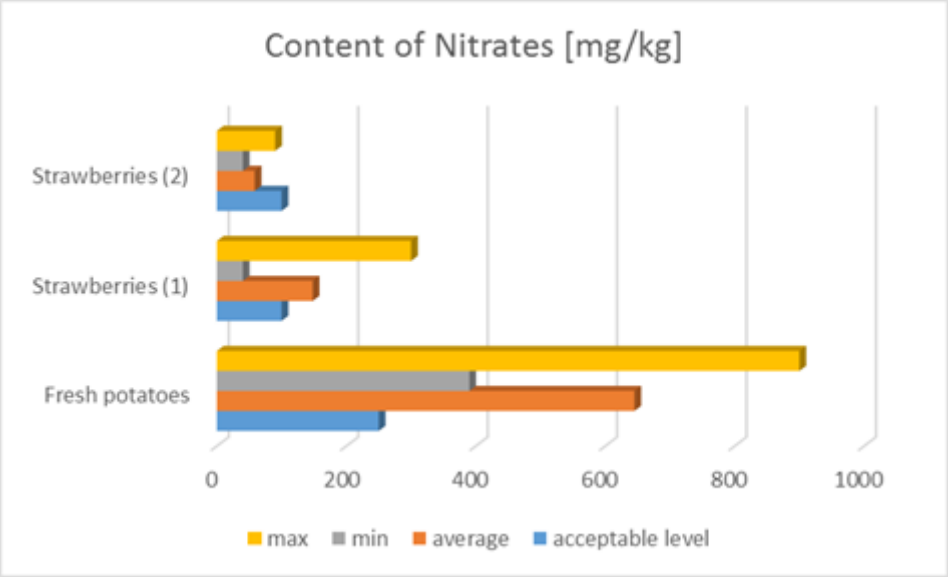

Figure 1. Content of Nitrates in vegetables from
commercial chains in BG – listed as vegetables with middle nitrate content

Table 2. Maximum levels for NO_3^- [mg /kg] in some vegetables

		Maximum levels NO_3^- [mg /kg]	
1.1	Fresh spinach (*Spinacia oleracea*)		3 500
1.2	Preserved, deep-frozen or frozen spinach		2 000
1.3	Fresh Lettuce (*Lactuca sativa* L.) (protected and open-grown lettuce) excluding lettuce listed in point 1.4	Harvested 1 October to 31 March: lettuce grown under cover lettuce grown in the open air Harvested 1 April to 30 September: lettuce grown under cover lettuce grown in the open air	 5 000 4 000 4 000 3 000
1.4	'Iceberg' type lettuce	Lettuce grown under cover Lettuce grown in the open air	2 500 2 000
1.5	Rucola (*Eruca sativa*, *Diplotaxis sp.*, *Brassica tenuifolia*, *Sisymbrium tenuifolium*)	Harvested 1 October to 31 March: Harvested 1 April to 30 September:	7 000 6 000
1.6	Processed cereal-based foods and baby foods for infants and young children		200

Commission Regulation (EU) No 563/2002 sets limits for nitrates only for leafy vegetables, which was amended two times in 2006 (EC Regulation No 1882/2006) and in 2011 with Commission Regulation (EU) No 1258/2011 (Table 2).
In some countries are set limits to maximum levels of nitrate for trade of some vegetables (beetroot, cabbage, carrot, celery, endive, Lamb's lettuce, potato, radish and rocket) which form the main source of total dietary exposure of nitrate [1]. For example, for potato in Germany the content should be less than 200 mg/kg fresh matter (fm), while in Poland there is a maximum limit of 183 mg/kg fm. In that study the content of NO_3^- in fresh potato were 645 mg/kg at the accepted safety level 250 mg/kg (Figure1).
The level of nitrate in radish was higher in the both samples (Table 1), 3700 mg/kg and 2934 mg/kg at accepted as safety level for consumption 1500 mg/kg (Figure 2).

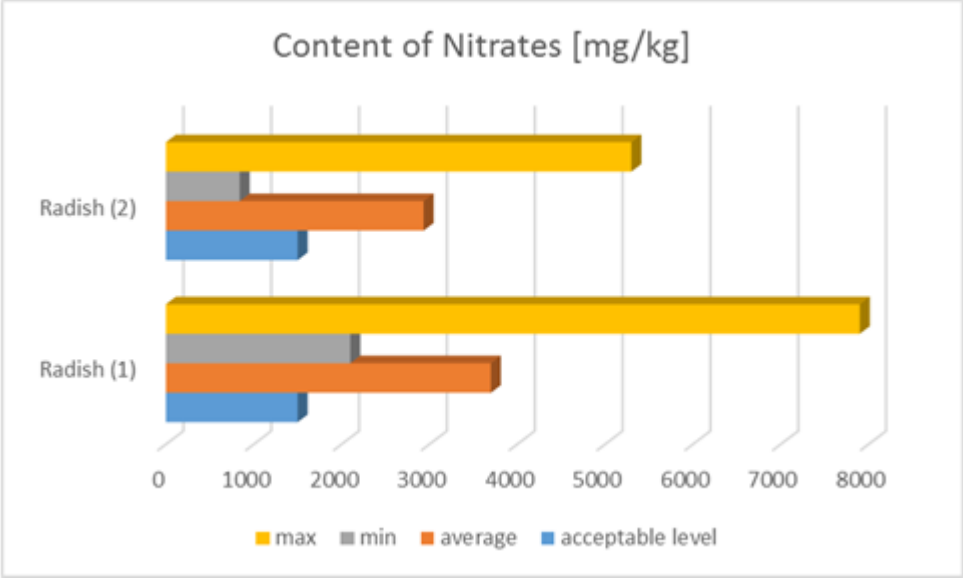

Figure 2. Content of Nitrates in vegetables from commercial chains in BG – listed as vegetables with high content of nitrates

The reduction of nitrates in the radish sample was insignificant about 153 mg/kg, after holding in water and splashed few times for 24 hours. The reduction of dietary nitrate consumption is a desirable preventive measure of potential long-term human health risks, and that will rise the benefit of fruit and vegetable digestion [1]. Hence, with applying good practices for agriculture cultivation and with the increasing of the control and monitoring programmes that can be handle and done in the future.

5. CONCLUSIONS

The obtained results undoubtedly confirm that on the food chain market in BG are still in the trade food products with not enough good quality, besides of the monitoring inspections and the tidy control that exist.
The Greentest appliance, Model ECO 5 give possibility to check the nitrate content in very easy and quickly manner that allow to screen and obtain reliable big data for short time.
The programmes for monitoring and control should be inevitable part of that contest for better and healthy food, as well as spreading the results from effective good agriculture practices.

6. ACKNOWLEDGMENTS

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