

THE CONCENTRATION OF NITRATES IN CAULIFLOWER AND BROCCOLI UNDER DIFFERENT FERTILITY REGIMES

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Abstract

Cauliflower and broccoli are the vegetables that are grown and consumed around the world. The concentration of nitrate largely determines the quality of the vegetables. As the elevated content of consumed nitrates can significantly affect the health of humans and especially children, it is necessary to examine the influence of different organic and mineral fertilizers on nitrate content in these vegetables as well as the influence of the presence or absence of mulch. In the present study nine types of organic, mineral and combined fertilizers have been applied to cauliflower and broccoli with and without the presence of mulch. The content of nitrates, depending on the applied fertilizer, differed significantly, up to 4.4 times in cauliflower with mulch, or up to 3 times in broccoli without mulch. Proper fertilization and use of mulch can make a significant contribution to making vegetables a health-safe food.

Introduction

Although vegetables are considered as healthy food, their inadequate quality can greatly affect human health in terms of increasing the risk of chronic illness, cancer, cardiovascular diseases, and many others (Nerdy and Putra, 2018). The concentration of nitrates is a parameter that can largely determine the quality of vegetables and, depending on concentration, places it in potentially dangerous food for human health. Nitrates have been linked to diseases like ovarian, colon, rectal, bladder, stomach, esophageal, pancreatic, gastrointestinal and thyroid cancer, leukemia and non-Hodgkin lymphoma (Afzaly and Elahi, 2014).

In addition to the fact that fertilization plays an important role in achieving high yields, it plays a very significant role in achieving a good quality. Taking this into account, it is necessary to examine effect of different concentrations and types of fertilizers, as well as application of mulch, on the nitrate content in broccoli and cauliflower.

Experimental

Broccoli (variety Corvet) and cauliflower (variety Snezna grudva) were grown under 9 fertilization schemes (Table 1), each of which was conducted in two variants - unmulched and mulched with plastic foil.

Before the onset of the experiment, agrochemical properties of soil and chemical composition of applied manure were analyzed (Table 2 and Table 3).

The concentration of nitrate was assessed by spectrophotometric method (Giné et al, 1983).

Table 1. Fertilization treatments of broccoli and cauliflower

No	Fertilizer	Applied dose (t/ha)	Fertilizer (mineral)	Applied dose (kg/ha)
1.	Control	-	-	-
2.	Beef manure	20	-	-
3.	Pig manure	20	-	-
4.	Beef manure	20	NPK	300
5.	Pig manure	20	NPK	300
6.	Beef manure	20	NPK	500
7.	Pig manure	20	NPK	500
8.	-	-	NPK	300
9.	-	-	NPK	500

Table 2. Agrochemical properties of soil before experiment setting (Bogdanović et al., 2011)

Depth (cm)	pH		% CaCO ₃	% humus	% N	mg P ₂ O ₅ 100g ⁻¹	mg K ₂ O 100g ⁻¹	NH ₄ -N kg ha ⁻¹	NO ₃ -N kg ha ⁻¹
	H ₂ O	KCl							
0-30	7.6	7.0	4.59	3.12	0.16	21.9	22.1	28.0	36.1
30-60	7.8	7.0	5.42	2.96	0.15	14.3	21.0	23.4	41.6

Table 3. Chemical composition of applied manure (Bogdanović et al., 2011)

Manure type	pH		%N	%P	%K
	H ₂ O	KCl			
Well-rotted beef manure	6.9	6.6	1.2	1.82	0.33
Composted pig manure	7.9	7.7	1.3	3.58	1.68

Statistical analysis was performed using STATISTICA 13.3 [StatSoft, University Licence, University of Novi Sad, 2019]. Means of replicates and evaluation of the significance of differences between means were determined by descriptive statistics and ANOVA analysis, followed by LSD *post hoc* test ($\alpha=0.05$).

Results and discussion

Different doses of mineral and organic fertilizers significantly influenced the nitrate content in broccoli and cauliflower (Table 4. and Figure 1. and 2.)

Table 4. Descriptive statistics for the concentration of nitrates ($\mu\text{gNO}_3^-/\text{g DM}$) in broccoli and cauliflower

Variable	Descriptive Statistics								
	Valid N	Mean	Sum	Min	Max	Variance	Std. dev	Coef. var	Std. Error
Broccoli	36	1132.4	40766.8	598.0	1792.2	116638.3	341.5	30.1	56.9
Cauliflower	36	616.7	22201.3	192.0	1398.7	75703.1	275.1	44.6	45.8

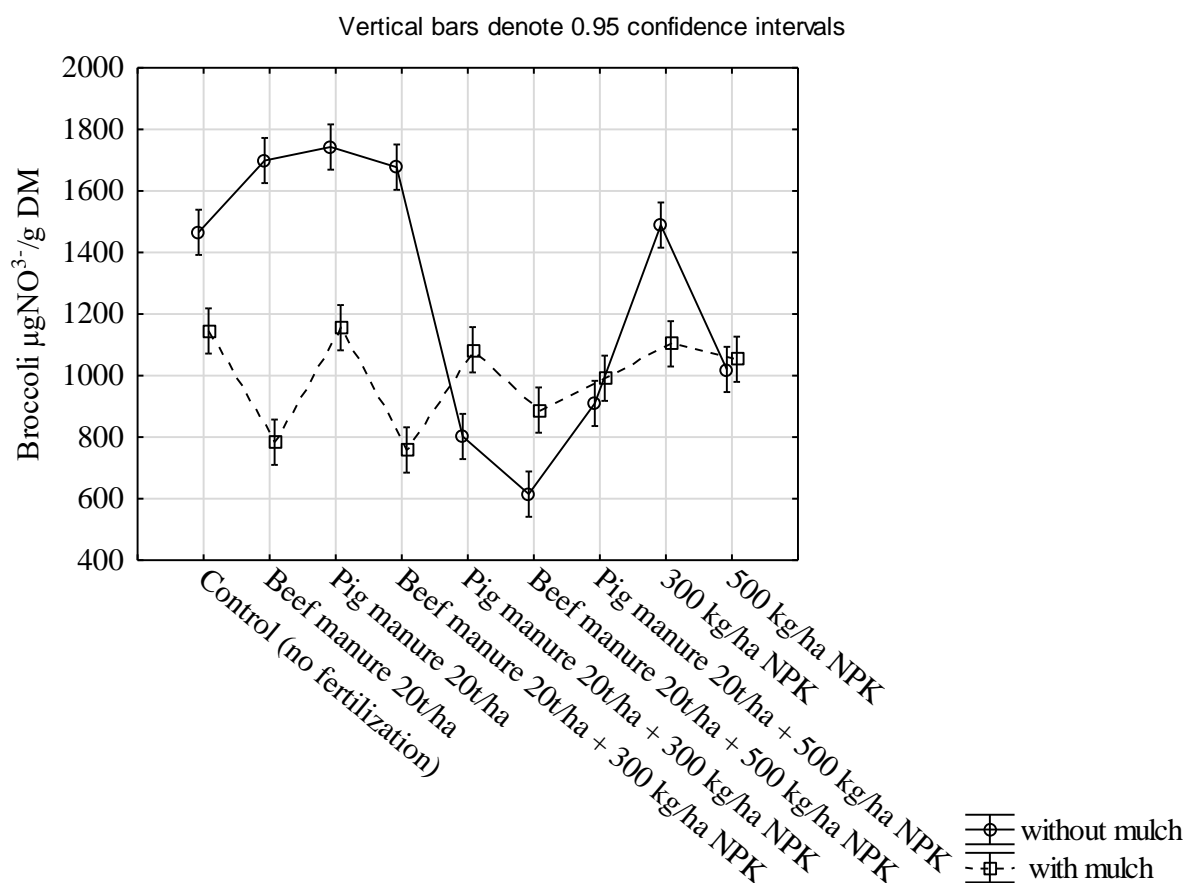


Figure 1. The concentration of nitrates in broccoli exposed to different fertilization schemes in the presence or absence of mulch

In 67% of broccoli fertilization treatments, the use of mulch had a positive effect as nitrate concentrations were significantly lower (Figure 1). The combination of organic and mineral fertilizers gave the best result in broccoli without mulch, because concentration of nitrates decreased. The use of mulch and beef manure alone and in combination with 300 kg of NPK also showed good results in terms of a better quality of broccoli. In cauliflower were found larger differences in nitrate content depending on the type of fertilizer with mulch (Figure 2). In broccoli, nitrate concentrations varied by as much as 2.9 times. In the presence of mulch, concentrations were lower and less variable in the nitrate content of plants in the presence of different fertilizers, unlike cauliflower. For cauliflower, there is as much as 4.3 times the difference between the highest and the lowest concentration of nitrate (Pig manure 20 t⁻¹ ha + 500 kg/ha NPK and 300 kg/ha NPK, respectively).

The European Food Safety Authority recommended the acceptable daily intake of nitrate in the human body and for an adult it amounts to 3.7 mg/kg body weight/day, i.e. for a person with bodyweight of 60 kg, it is 222.0 mg/day (Brkić et al, 2017). Therefore, if people consume the recommended amount of vegetables (up to 150 g/day), all these variations in nitrates (2,59-24,19 mg/150 g portion of vegetable/day) do not pose the risk for health.

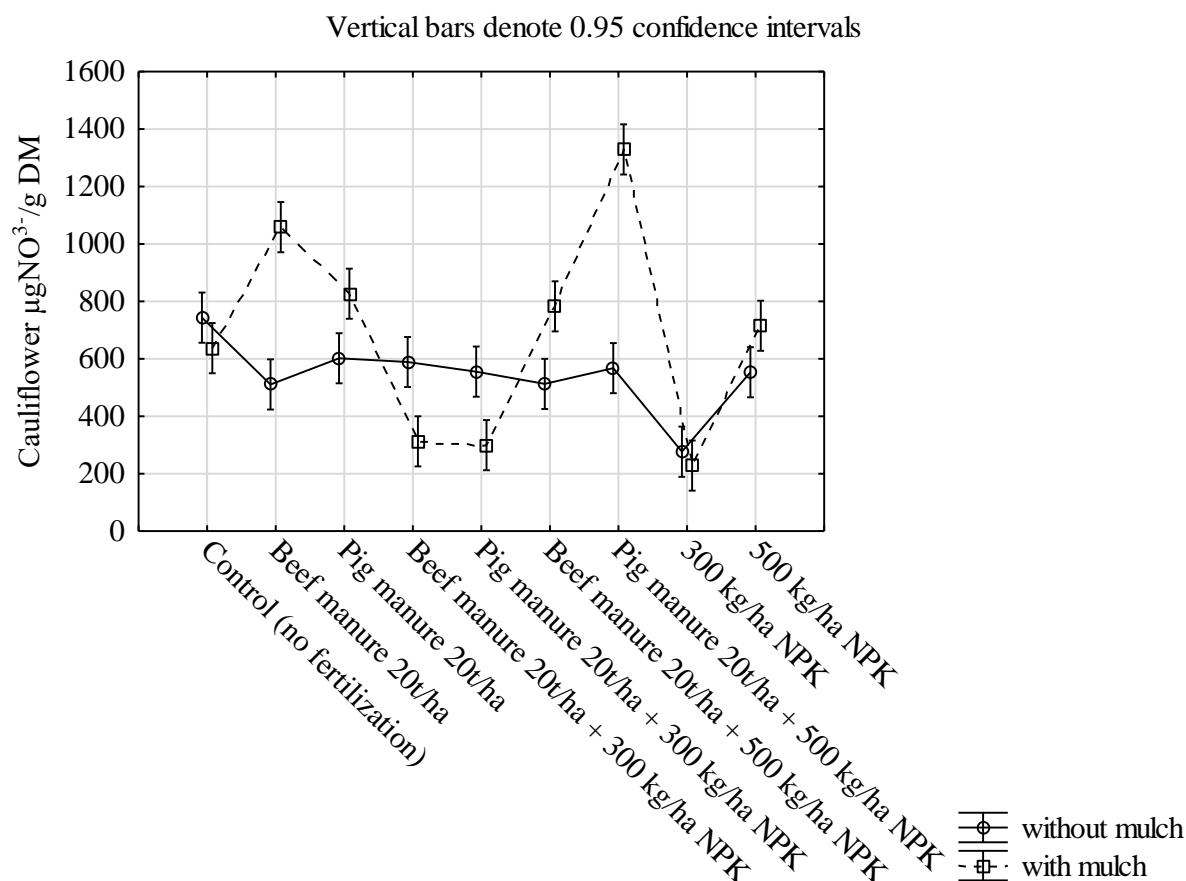


Figure 2. The concentration of nitrates in cauliflower exposed to different fertilization schemes in the presence or absence of mulch

Conclusion

The promotion of healthy diet is in focus nowadays, which imposes the need for production of vegetables that contain as little nitrate as possible, which is under high influence of fertilization. In the present paper the combination of mineral and organic fertilizers gives the best result in the sense of quality of broccoli and cauliflower. The mulch with plastic foil also significantly affected the nitrate concentration in the investigated vegetables. Besides the concentration of nitrates, it would be useful to examine the effect of the other types of fertilizers and mulching materials on the accumulation of active biomolecules such as antioxidants, which are also important features of quality.

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References

- [1] S. F. Afzali, R. Elahi, *J. Appl. Sci. Environ. Manage.* 18 (2014) 451-457.
- [2] D. Bogdanović, Ž. Ilin, R. Čabilovski, D. Marinković, *Letopis naučnih radova* 35, 1, (2011) 57-66.
- [3] D. Brkić, J. Bošnjir, M. Bevardi, A. Gross Bošković, S. Miloš, D. Lasić, A. Krivohlavek, A. Racz, A. Mojsović-Čujić, N. Uršulin Trstenjak, *Afr. J. Tradit. Complement Altern. Med.* 14 (2017) 31-41.

- [4] M.F. Giné, B.F. Reis, E.A.G. Zaatto, F.J. Krug, A.O. Jacintho, *Anal. Chim. Acta*, 155 (1983) 131-138.
- [5] N. Nerdy, E de Lux Putra, *Orijent J. Chem.* 34 (2018) 2983-2991.