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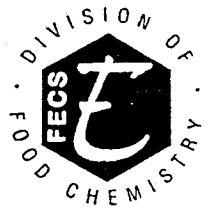

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Nitrate and Nitrite Content of Some Vegetables Farmed by Both Conventional and Organic Methods

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SUMMARY

Three vegetables (chicory, green salad and rocket) from a conventional farm and an organic one were examined for their nitrate and nitrite content. The organic products showed nitrate values generally higher than the conventional products; moreover, the nitrate level maintained nearly constant in the various subsequent cuts from the same sowing, in particular as far as the organic products are concerned. The nitrite values were not detectable in all samples considered.

INTRODUCTION

The quality of fruits and vegetables depends on several parameters, such as sensorial characteristics, appearance and firmness, nutritive value and safety of use. Safety of use is related to the presence of both environmental pollutants (pesticide residues, heavy metals) and natural substances that may show antinutritive or toxic effects. Nitrates play an important role among the substances of the latter category. Plants take up most nitrogen as nitrate ion; the subsequent nitrate accumulation in the plant depends on several factors, in particular the nitrogenous manuring, but also the farming season, the exposure to the light, the harvesting time (1-6). Moreover, the cultivation in a greenhouse often favours a higher nitrate accumulation in respect of the cultivation in the open field under the same other conditions (2-5,7,8). Nitrates may be reduced to nitrites during transport, storage and culinary preparation (1,5,6,8,9). Nitrites may react with aliphatic amines to give carcinogenic nitrosamines. For this reason, some Countries fixed a maximum allowable level of nitrate content in some fruits and vegetables (3,4,6,8). FAO/WHO fixed an allowable daily intake of 3.7 mg of nitrates/Kg of body weight for the adult (10).
In this paper the results relative to nitrate and nitrite content of some vegetables from two farms of the Friuli-Venezia Giulia region (Italy) are presented. The former farm makes use of conventional methods of cultivation and the latter of organic ones.

MATERIALS AND METHODS

Sampling

Three vegetables (chicory, green salad and rocket) were picked from a conventional farm and an organic one, located at a distance of about 2 Km. The vegetables were farmed in greenhouses having an area of about 1000 m^2 in the conventional farm and about 350 m^2 in the organic one. The greenhouses of the two farms showed the same both structure and system of air replacement (and consequently internal temperatures were very similar in the two cases). Moreover, the greenhouses showed the same type of roofing (ethylene/ethyl vinyl acetate

(EVA) copolymer with 14-18% of EVA).The three vegetables farmed in the open field by the same conventional farm were occasionally picked, as well.

Sample Processing

Just after harvesting, the vegetables were cleaned, washed three times with tap water and dried with a manual kitchen centrifuge. About 25 g were exactly weighed and freeze-dried. About 0.4 g of the freeze-dried material were added with 200 ml of deionized water and then homogenized for 10 min in an OmniMixer apparatus. The obtained solution was filtered on filter paper; the first 10 ml were discarded. A 5-ml volume of the filtrate was passed through a 3-ml LC18 column, previously activated with 2 ml of methanol and 2 ml of water, to retain the coloured pigments. The last 3 ml eluted were collected for the subsequent determination; a dilution of the aqueous eluate was carried out in case of need.

Ion Chromatography

A Dionex 2010 i ion chromatograph, equipped with an auto-sampler, an integrator and a conductometric detector, was used. An AS4A stainless-steel column (250 x 4 mm I.D.) and a G4A precolumn (50 x 4 mm I.D.) were employed. Analyses were carried out at room temperature with a 1:1 (v/v) 0.0019 M Na_2CO_3 - 0.00085 M $NaHCO_3$ mixture as the eluent, at a flow rate of 2 ml/min. 0.040 M H_2SO_4 as the regenerant and a fibre suppressor were used; the injected volume was 50 µl. A calibration curve was employed to obtain the nitrate concentration from the area of the chromatographic peak.

Nitrite Determination

Nitrite determination was performed by the method of Griess. 10 ml of the aqueous eluate from the LC18 column were added with 0.5 ml of Griess reagent. A spectrophotometric determination at 520 nm was carried out after 20 min. A calibration curve was employed to obtain the nitrite concentration from the absorbance value.

RESULTS AND DISCUSSION

Three vegetables were taken into account, as vegetables usually show greater nitrate concentrations in respect of fruits (1,3-5,8). Researches already carried out by other Authors to compare the nitrate content in conventional and organic products gave contradictory results. A decrease of the nitrate content in the organic products was observed in some cases (11-13); significant differences between conventional and organic products were not obtained by other Authors (13-16), whereas in some other cases the organic products showed a higher nitrate content (13,17). These contradictory results may be partly explained in the light of the great number of parameters that may influence the nitrate level of the product.

In our case the vegetables to be analyzed were picked early in the morning, in a narrow interval of time, in the two farms, in order to reduce to a minimum the influence on nitrate and nitrite content of factors such as climate, soil type and composition, time and conditions of harvest, exposure to the light. Vegetables of the same variety having sowing dates as much close as possible were picked in the two farms, in order to minimize the influence of both the stage of maturity and the physiological age of the plant. Moreover, subsequent cuts of the same products were sampled to verify the changes of nitrate and nitrite content over time. The results obtained are summarized in Tables 1, 2 and 3.

As may be seen, a rather high nitrate content was generally observed; the organic products showed figures slightly higher than the conventional products. The values for the vegetables farmed in a greenhouse were included between 1969 and 6249 mg/Kg of product for

Table 1: Changes of nitrate content (mg/Kg of wet weight) in chicory farmed in a greenhouse as influenced by both type of product and cut harvested.

conventional farm		organic farm	
sowing date 96.03.20		sowing date 96.03.25	
1st cut (96.04.23)	1969	1st cut (96.04.23)	3090
		2 nd cut (96.05.09)	2980
sowing date 96.05.07		3 rd cut (96.05.21)	3132
1 st cut (96.05.21)	3575	4 th cut (96.05.29)	3507
2 nd cut (96.05.29)	3578	5 th cut (96.06.04)	3426
sowing date 96.06.04		sowing date 96.05.03	
1 st cut (96.07.02)	6249	1 st cut (96.05.21)	3919
		2 nd cut (96.05.29)	3511
sowing date 96.06.08		3 rd cut (96.06.04)	2529
1 st cut (96.07.09)	5135	4 th cut (96.06.11)	3375
		5 th cut (96.06.18)	2752
sowing date 96.06.07*		6 th cut (96.05.25)	3567
1st cut (96.07.16)	1792		
		sowing date 96.06.24	
sowing date 96.07.05		1 st cut (96.07.16)	4089
1 st cut (96.07.23)	2139	2 nd cut (96.07.23)	2956
		3 rd cut (96.07.29)	3975
sowing date 96.07.29*		4 th cut (96.08.05)	3942
1 st cut (96.08.19)	3096	5 th cut (96.08.12)	3639
2 nd cut (96.08.26)	1228		
sowing date 96.07.30			
1 st cut (96.08.19)	3202		
sowing date 96.08.03			
1 st cut (96.08.26)	4368		
sowing date 96.08.21*			
1 st cut (96.09.17)	3147		
2 nd cut 96.09.30)	612		
3 rd cut (96.10.29)	192		
sowing date 96.08.26			
1 st cut (96.09.17)	4347		
sowing date 96.08.23			
1 st cut (96.09.17)	4683		
sowing date 96.08.27			
1 st cut (96.09.24)	3611		

*product cultivated in the open field

Table 2: Changes of nitrate content (mg/Kg of wet weight) in green salad farmed in a greenhouse as influenced by both type of product and cut harvested.

conventional farm		organic farm	
sowing date 96.04.29*		sowing date 96.03.23	
1 st cut (96.06.04)	1185	1 st cut (96.04.23)	2252
		2 nd cut (96.05.09)	3269
sowing date 96.05.27*		3 rd cut (96.05.21)	3341
1 st cut (96.06.25)	178	4 th cut (96.05.29)	3268
		5 th cut (96.06.04)	2682
sowing date 96.06.04*		sowing date 96.05.03	
1 st cut (96.07.09)	2842	1 st cut (96.05.29)	3811
2 nd cut (96.07.16)	972	2 nd cut (96.06.04)	2602
		3 rd cut (96.06.11)	4185
sowing date 96.07.05			
1 st cut (96.07.23)	1270		
2 nd cut (96.07.29)	2104		
sowing date 96.07.31*			
1 st cut (96.08.26)	3284		
2 nd cut (96.09.02)	895		
3rd cut (96.09.09)	422		
sowing date 96.08.21*			
1 st cut (96.09.17)	709		
2 nd cut (96.09.30)	155		
3 rd cut (96.10.29)	497		

*product cultivated in the open field

conventional chicory and between 2529 and 4089 mg/Kg for organic chicory; between 1270 and 2104 mg/Kg for conventional salad and between 2252 and 4185 mg/Kg for organic salad; between 1592 and 4639 mg/Kg for conventional rocket and between 3906 and 5858 mg/Kg for organic rocket. However, the fact has to be highlighted that no manuring was carried out in the conventional farm, whereas dung and chicken excrements were employed in the organic farm in rather large amounts (100 Kg of dung and 200 Kg of chicken excrements in each greenhouse before sowing), thus supplying a likely overload of fertilizing elements to the soil.
In most cases the nitrate level maintained nearly constant in the various cuts, in particular as far as the organic products are concerned; the differences observed might be caused by different conditions of exposure to the light at the harvesting time. This could be due to I) a particularly slow mineralization of organic nitrogen in the case of organic manuring (6,15) as well as to II) a particular way of soil preparation before sowing, that could make the soil neither very porous nor permeable in the case of the organic farm.

Table 3: Changes of nitrate content (mg/Kg of wet weight) in rocket farmed in a greenhouse as influenced by both type of product and cut harvested.

conventional farm		organic farm	
sowing date 96.05.07		sowing date 96.03.25	
1 st cut (96.05.29)	3415	1 st cut (96.04.23)	4395
2 nd cut (96.06.04)	3284	2 nd cut (96.05.09)	4197
sowing date 96.05.18		sowing date 96.05.03	
1 st cut (96.06.18)	2973	1 st cut (96.06.11)	3906
2 nd cut (96.06.18)	1592	2 nd cut (96.06.18)	4085
		3 rd cut (96.06.25)	4209
sowing date 96.06.04		4 th cut (96.07.02)	5858
1 st cut (96.07.02)	2211	5 th cut (96.07.09)	5134
2 nd cut (96.07.09)	2389		
sowing date 96.08.09		sowing date 96.06.24	
1 st cut (96.09.02)	1834	1 st cut (96.07.16)	4110
2 nd cut (96.09.09)	1760	2 nd cut (96.07.27)	5469
		3 rd cut (96.07.29)	4407
sowing date 96.08.23			
1 st cut (96.09.17)	3748		
2 nd cut (96.09.24)	4639		
sowing date 96.08.27			
1 st cut (96.09.24)	3650		
2 nd cut (96.09.30)	3833		
sowing date 96.07.25*			
1 st cut (96.09.02)	2106		
2 nd cut (96.09.09)	571		
sowing date 96.08.21*			
1 st cut (96.09.17)	3586		
2 nd cut (96.09.30)	3757		

*product cultivated in the open field

The figures relative to the three vegetables farmed in the open field were generally the lowest ones between all the samples examined. This confirms that, as is well known, the products farmed in a greenhouse show a nitrate level higher than the same products farmed in the open field, under the same other conditions (2-5,7,8).

The nitrite content was not detectable in all samples by both ion chromatography and spectrophotometry and therefore probably devoid of practical significance.

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