

EVALUATING ADULT DIETARY INTAKES OF NITRATE AND NITRITE IN POLISH HOUSEHOLDS DURING 2006-2012

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ABSTRACT

Introduction. Nitrates and nitrites commonly occur throughout nature as well as in foodstuffs. Their excess consumption can however pose health risks, for example, arising from methaemoglobinaemia or from the formation of N-nitrosamines.

Objectives. To determine whether the levels of domestic nitrate and nitrite consumption are safe in Polish households during 2006-2012.

Material and methods. Appropriate consumption data was obtained from the Central Statistical Office in Poland (GUS), whilst nitrate and nitrite intakes were estimated from nationally available data on foodstuff content taken from the literature.

Results. Mean nitrate and nitrite intakes were respectively 147 mg NaNO₃ and 3.26 mg NaNO₂/per person/day, corresponding to 41% and 45% of the ADI (acceptable daily intake). Statistically significant differences in intakes were observed between types of households, with the highest seen in those of retired subjects; however the ADIs were not exceeded.

Conclusions. Domestic intakes of nitrates and nitrites were found to be at safe levels; nevertheless control over their intake should be maintained because of potentially adverse health threats.

Key words: nitrates, nitrites, intake, households

STRESZCZENIE

Wprowadzenie. Azotany(V) i (III) występują zarówno w przyrodzie jak i w żywności. Nadmierne ich spożycie może powodować zagrożenie zdrowia, np. methemoglobinemię lub może przyczynić się do powstawania N-nitrozoamin.

Cel badań. Celem badań było oszacowanie pobrania azotanów(V) i azotanów(III) z żywnością w gospodarstwach domowych w Polsce w latach 2006-2012.

Material i metody. Oszacowanie pobrania azotanów(V) i azotanów(III) w gospodarstwach domowych wykonano na podstawie danych o spożyciu żywności Głównego Urzędu Statystycznego (GUS) oraz zebranych krajowych danych z piśmiennictwa dotyczących zawartości tych związków w produktach spożywczych.

Wyniki. Średnie pobranie azotanów(V) i azotanów(III) w latach 2006-2012 wynosiło 147 mg NaNO₃/os/dobę (41% ADI) i 3,26 mg NaNO₂/os/dobę (45% ADI). Pobranie azotanów(V) i azotanów(III) różniło się istotnie statystycznie w badanych typach gospodarstw domowych. Największe średnie pobranie zarówno azotanów(V) jak i azotanów(III) zaobserwowano w gospodarstwach emerytów, jednak wartości ADI nie zostały przekroczone.

Wnioski. Średnie pobranie azotanów(V) i azotanów(III) w gospodarstwach domowych w latach 2006-2012 kształtowało się na bezpiecznym poziomie, niemniej jednak należy kontrolować pobranie tych związków z dietą ze względu na ryzyko możliwych negatywnych skutków zdrowotnych.

Słowa kluczowe: azotany (V), azotany (III), pobranie, gospodarstwa domowe

INTRODUCTION

Both nitrates and nitrites are widespread and naturally occurring ions, mainly arising from organic decomposition of nitrogenous substances. They are found also in mineral salts as well as water. In the latter,

their presence is due to the run-off from industry or agriculturally used fertilisers and constitutes the main environmental source [10]. Nitrates can also be present in foodstuffs, depending on the product type, resulting from the technological method of manufacture; for e.g. in the making of cured meats or from using fertiliser for

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plant cultivation. Nitrates have been shown to be decidedly less toxic than nitrites, where the latter arises from nitrate reduction and may cause methaemoglobinaemia [14]. In addition, nitrites can enzymatically react with primary (I), secondary (II) and tertiary (III) amines (via nitro-reductase), together with amino acids, amides, indoles and phenylamines forming N-nitrosoamine products that are well recognised to be carcinogens [9].

The study aims were to estimate nitrate and nitrite intakes from foodstuffs in adults living in defined household groups throughout Poland during 2006-2012. These were then related to ADI values.

MATERIAL AND METHODS

The study was conducted using foodstuff consumption data from 2006-2012, within Polish household budgets, as made available by the Central Statistical Office in Poland. The following household group categories were selected; manual and non-manual workers, farmers/farm labourers, those self-employed, retired persons and pensioners. Using national data, mainly from the last seven years, the average nitrate and nitrite contents in foodstuffs was obtained from which consumption and intakes were calculated for

each of the defined groups. Technological food losses and meal leftovers were not taken into account. In order to relate the findings to ADI for each household type, the following nitrate/nitrite values established by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) were used; respectively 5.0 mg NaNO₃ and 0.1 mg NaNO₂/kg body mass /24 hours [5], adopting the average persons adult body mass in Poland [11]. The structure of nitrate and nitrite intakes could be presented as well as their sources the total intakes were taken as being 100%.

Statistical analyses was performed by the 'Statistica 10' computer programme using ANOVA, taking P<0.05 as the critical value for significance.

RESULTS

The mean nitrate intake during 2006-2012 was 147 mg NaNO₃/person/24hours, which decreased by 8% throughout this time (Table 1). Statistically significant differences between household groups were noted (p<0.05), with pensioners having the highest nitrate intakes (198 mg NaNO₃/person/24hours). Lower values (by respectively 7% and 9%) were observed for farmers/farm labourers and retired persons. All other groups

Table 1. Dietary nitrate intakes in households during 2006-2012

Years	Type of household						
	Total	Manual workers	Non-manual workers	Farmers	Self-employed workers	Retired persons	Pensioners
mg NaNO ₃ /per person/day							
2006	154	132	131	195	134	206	185
2007	151	130	131	186	131	203	185
2008	149	131	130	187	130	198	181
2009	149	130	128	189	130	198	180
2010	144	127	124	182	124	194	175
2011	142	124	124	172	119	193	180
2012	141	125	121	175	121	191	170
x	147	128a	127a	184b	127a	198c	179b
±SD	5	3	4	8	5	5	5

* mean± standard deviation; results flagged with identical letters did not differ significantly

Table 2. Dietary nitrate intakes in households during 2006-2012 compared with ADI values in adults

Years	Type of household						
	Total	Manual workers	Non-manual workers	Farmers	Self-employed workers	Retired persons	Pensioners
% of adult ADI							
2006	43	36	36	54	37	57	51
2007	42	36	36	51	36	56	51
2008	41	36	36	52	36	55	50
2009	41	36	35	52	36	55	50
2010	40	35	34	50	34	54	48
2011	39	34	34	48	33	53	50
2012	39	34	33	48	34	53	47
x	41	35a	35a	51b	35a	55c	49b
±SD	1	1	1	2	1	1	1

had substantially lower intakes by 35-36%. None of the household groups exceeded the nitrate ADI, which on average were found to be 41% of this value (Table 2). The highest of the ADI (55%) was in the retired persons group, whilst the lowest (35% ADI) was seen for both the manual and non-manual workers group and those self employed; differences being significant.

It was found that vegetables and their processed products were the main foodstuff sources for nitrate (88%); Figure 1.

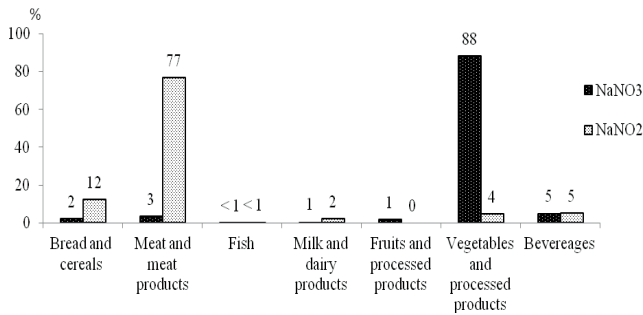


Fig. 1. Foodstuff sources of dietary nitrates and nitrites in households (%)

It was also found, that out of the vegetables listed above, 1/3 of the nitrate source came from the ‘other vegetables’ category that included lettuce, leafy and stem vegetables, cauliflower types, pumpkins, peppers,

kohlrabi, courgettes, peas, sweet corn as well as root and tuber vegetables. Potatoes constituted 1/4th of the nitrate source and beetroots and cabbage were 15% (Figure 2).

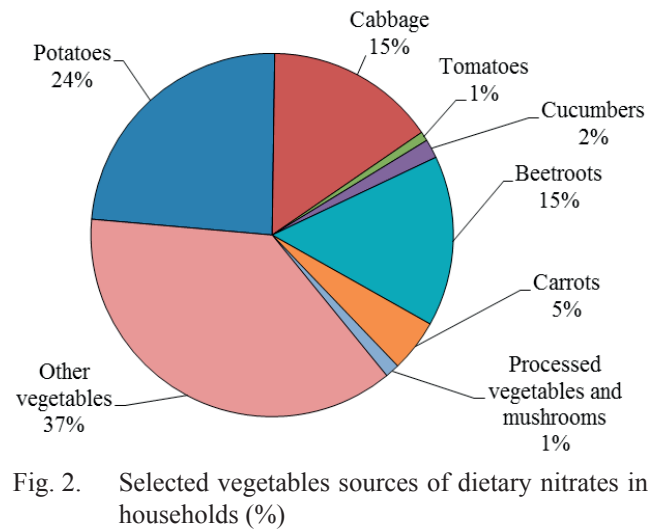


Fig. 2. Selected vegetables sources of dietary nitrates in households (%)

Nitrite intakes were significantly different between the selected household groups ($p < 0.05$); Table 3. Likewise as for nitrates, intakes of nitrites were highest in the retired persons group at 3.92 mg NaNO₂/person/24-hours, whilst the lowest were in the pensioners and farmers group (by 4% and 5% respectively and differences being statistically significant). In all the other household

Table 3. Dietary nitrite intakes in households during 2006-2012

Years	Type of household						
	Total	Manual wokers	Non-manual workers	Farmers	Self-employed workers	Retired persons	Pensioners
mg NaNO ₂ /per person/day							
2006	3.23	3.02	2.87	3.77	2.88	3.82	3.59
2007	3.20	3.04	2.86	3.74	2.81	3.79	3.61
2008	3.18	3.02	2.85	3.72	2.80	3.80	3.70
2009	3.36	3.20	2.97	3.82	2.93	4.07	3.89
2010	3.31	3.17	2.92	3.76	2.86	4.03	3.87
2011	3.31	3.17	2.92	3.76	2.86	4.03	3.87
2012	3.21	3.08	2.85	3.45	2.82	3.89	3.84
x	3.26	3.10a	2.89b	3.72c	2.85b	3.92d	3.77c
±SD	0.07	0.08	0.04	0.12	0.05	0.12	0.13

Table 4. Dietary nitrite intakes in households during 2006-12 compared with ADI values in adults

Years	Type of household						
	Total	Manual workers	Non-manual workers	Farmers	Self-employed workers	Retired persons	Pensioners
% of adult ADI							
2006	45	42	40	52	40	53	50
2007	44	42	39	52	39	52	50
2008	44	42	39	51	39	52	51
2009	46	44	41	53	40	56	54
2010	46	44	40	52	39	56	53
2011	46	44	40	52	39	56	53
2012	44	42	39	48	39	54	53
x	45	43a	40b	51c	39b	54d	52c
±SD	1	1	1	2	1	2	2

groups (i.e. manual, non-manual workers and the self employed) nitrite intakes were respectively 21%, 26% and 27% lower than those for retired persons.

The intake of nitrites in all groups did not exceed the ADI and varied between 39% of this value for the self employed to 54% in pensioners; average 45% (Table 4).

Over three quarters of the nitrite foodstuff source was meat and its processed products (Figure 1), including cold meats and other processed meat products (cold poultry meat, offal, tinned meat, delicatessen products and other culinary specialities, e.g. meat in aspic); Figure 3. High quality cold meats and sausages made up 1/5th of the nitrite intake source.

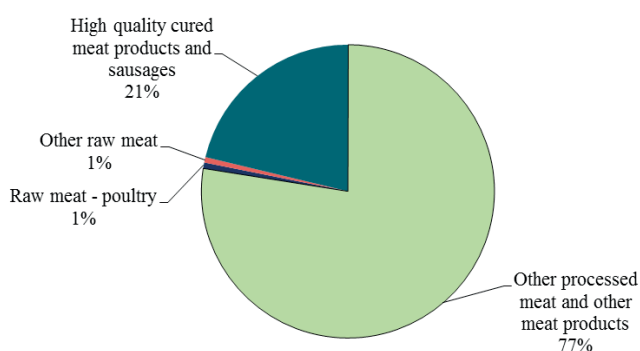


Fig. 3. Meat and meat product sources of dietary nitrites in households (%)

DISCUSSION

The amount of nitrate and nitrite intakes depends not only on the original content in foodstuffs, but also by the method of cooking used and the proportion of source foods consumed within a given diet [7]. Other studies have shown very wide variations in nitrate intakes, as for instance between New Zealand and Japan; 72 vs 1545 mg NaNO₃/person/24hours, respectively representing 20% and 500% of the ADI. For nitrite intakes this correspondingly ranged from 0.84 mg NaNO₂/person/24hours in New Zealand to 1.6 mg in Korea; respectively 14 and 38% of the ADI) [2, 12, 13].

In Europe, the ranges for nitrate intakes were between 215 and 626 mg NaNO₃/person/24hours (respectively 71 and 205% of the ADI), whilst for nitrites from 0.29 to 1.14 mg NaNO₂/person/24hours; respectively 5 and 20% of the ADI [4]. Analogous results from Poland, during 2006-12, were 132 to 190 mg NaNO₃/person/24hours and 3.0 to 3.5 mg NaNO₂/person/24hours [15]. The average nitrate intakes within these years were 6% less compared to previous studies, whereas those for nitrites were 3% higher. Moreover, the current study has demonstrated twice higher nitrate and nitrite foodstuff intakes in households compared to those observed in students aged 21 – 24 years [16].

Within Polish households, the nitrate and nitrite intakes have not changed over the years and are maintained at safe levels of around half the ADI. It should however be stressed that certain population groups, especially children and the elderly, are more vulnerable to the effects of nitrates/nitrites and their reactant products. In this respect vegetarians are also a susceptible group, as their main dietary foodstuffs are by definition vegetables, which constitute a rich source of these nitrates/nitrites, compared to those adopting traditional diets. It is thereby estimated that nitrate intakes are three times higher in vegetarians [3, 9, 14].

Excessive nitrite intakes may adversely impact health such as in causing methaemoglobinaemia. Nevertheless, both they and their products also produce beneficial effects on the human body such as on the cardiovascular system, lowering blood pressure and decreasing erythrocyte adhesion and aggregation [4, 12, 17]. Eating vegetables rich in nitrite also decreases the oxygen demand during sub-maximal work whilst consuming leafy vegetables lowers the risk of diabetes in women [1, 6].

CONCLUSIONS

1. Nitrate and nitrite intakes, during 2006-2012, for adults living in various types of households were at appropriate levels of 127 – 198 mg NaNO₃ and 2.85 – 3.92 mg NaNO₂/person/24 hours.
2. ADI values for both nitrates and nitrites were not exceeded in any of the studied types households; the mean observed intakes were 41 – 45% of the ADI values.
3. The main dietary source of nitrates was vegetables and their products (88%), whilst for nitrites these consisted of cold and processed meats; both at 77%.
4. Observed nitrate and nitrite intakes were at levels safe for health however their dietary intakes should nevertheless be monitored because of the adverse health effects arising when such levels are exceeded.

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Conflict of interest

The authors declare no conflict of interest.

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