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NITRATE AND NITRITE LEVELS OF SOME FRESH VEGETABLES IN EGYPT AND THE EFFECT OF PROCESSING ON THESE LEVELS

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ABSTRACT

The present work is concerned with the determination of nitrate and nitrite levels in some fresh vegetables and follow the effect of cooking and freezing in order to decrease the content of nitrate and nitrite. Fresh vegetables were purshased from 3 governorates during 2000-2001 (cabbage, cauliflower ,carrot, spinach, squash, lettuce cucumber, green bean, tomato, peppers, parsely, mushroom and potatoes) and the nitrate and nitrite levels were determined .

The results can be summarized as follow:-

1. The fresh vegetable samples (lettuce, spinach and cabbage) have higher nitrate level ranging (200-1100),(70-980) and (65-820) mg / Kg, respectively, whereas cauliflower, potatoes carrots and green bean have moderate nitrate level ranging(53-680), (53-590), (100-501) and (35-280) mg / Kg, respectively, while cucumber, mushroom, tomato, peppers and parsley have low nitrate level ranging (18-125), (6-32), (16-42), (8-25) and (35-79) mg / Kg, respectively.
2. The fresh vegetable samples (cauliflower, carrots and spinach) have high nitrite level ranging (0.0-30), (0.0-33) and (0.4-55) mg/Kg respectively, whereas cabbage, squash, lettuce, cucumber, green bean, parsely and mushroom have moderate nitrite level ranging (0.0-0.5), (0.0-0.7), (0.0-3),(0.0-0.5), (0.0-0.5), (0.0-0.7) and (0.0-0.2) mg/kg, respectively. While tomato and peppers have no nitrite level.
3. The cooking process reduced the nitrate level in vegetables. The reduction was found in cauliflower (86 – 90%), spinah (77 – 87%), carrots (66 – 81%), cabbage (60 – 78%) and green bean (58 – 71%).
4. Also, the cooking process reduced the nitrite level in vegetables. The reduction was found in cabbage (80 – 100%), cauliflower, carrots and spinach (90 – 100%) and green bean (87 – 100%).
5. The nitrate and nitrite levels didn't change in case of cabbage and green bean during frozen storage for up to 5 weeks, then a trend toward decreased nitrate level and at the same time, an increase in nitrite level was observed from the nineth week to eleventh week, whereas, the nitrate and nitrite levels didn't change in case of cauliflower, carrot and spinach for up to 3 weeks then a trend toward decreased nitrate level and at the same time, an increase in nitrite level was observed from the fifth week to the eleventh week. So, the cooking process is important in order to decrease the nitrate and nitrite contents in vegetables, while it was found that the freezing process is related to the number of weeks, so it is recommended that the freezing process didn't exceed 3 weeks in case of cauliflower, carrot and spinach, and 5 weeks in case of cabbage and green bean due to the decrease in nitrate content followed by an increase in nitrite content after these periods of freezing.

INTRODUCTION

Recently, concern over the amounts of nitrate and nitrite in our diet has been due to the relationship between nitrate and nitrite, and infant methemoglobinemia. Currently, the role of nitrites in formation of the carcinogenic nitrosamines has led to some public apprehension regarding the nitrite content of our food. These interrelationships have recently been reviewed by the National Research Council (1972), Fassett (1973), and the National Academy of Sciences (NAS,1981).

Nitrate is abundant in food primarily because plants take up nitrogen from the soil in this ionic form.

The National Academy of Sciences (NAS, 1981) estimated that vegetables provide 87 % of the nitrate in a normal diet. Fresh and cured meat, dairy products, Fruits and grains provide the remainder. The occurence of nitrate in food may be considered hazardous because nitrate can be reduced to nitrite either in improperly stored food, in the gastrointestinal tract and by the microflora of the human mouth (Breimer,1982).

According to the World Heath Organization (1978). The provisional tolerable Limit of weekly nitrate intake per person 1532 mg, so risks of nitrate reaction products on the health have lead to regulatory action limiting the nitrate content of certain vegetable product a decrease in nitrate intake from vegetables was recommended by NAS (1981).

In Germany since 1995 spinah products containing more than 2000 mg NO_3 /Kg have not been allowed on the market.

Recently, this and other limits for several vegetables and vegetable products became legally valid in all countries of the European Union (EUROPEAN Union,1997).

A reliable reduction of the nitrate content can be achieved only during processing (NAS,1981).

In vegetables that need to be cooked, the effect of the boiling is of concern (Huarte- Mendicoa *et al.* 1997).

Industrial processing can also effect on nitrate and nitrite contents (Bednar *et al.*, 1991), blanching being one of the main change factors (Sistrunk, 1980). As fresh vegetables are frequently replaced by frozen ones, their nitrate and nitrite contribution should also be taken into account.

The objective of this study was to determine nitrate and nitrite levels in fresh and frozen vegetables and the effect of cooking on both types of products.

MATERIAL AND METHODS

I- Sampling

Fresh vegetables (cabbage, canliflower, carrots, spinach, squash, lettuce, cucumber, green bean, tomato, peppers, parsely, mushroom and potatoes)were purshased from 3 governorates (Giza, Cairo and Kaliobia), Three samples of each fresh vegetable were colleted daily from each

governorate for 3 months during 2000 - 2001 (90 samples / vegetable /2years, total samples being 540)

2. Preparation of samples:-

2-1 preparation of fresh vegetables

Fresh vegetables were cleaned to get rid of any dust and washed by spraying with deionized water containing no detectable nitrate or nitrite and analyzed immediately.

2-2 preparation of processed vegetables :-

2-2-1 cooked samples

100 g of fresh vegetables, were boiled in 500 ml of deionized water for 5 mins., cooking ,liquids were drained after boiling, cooled at room temperature and filtered through whatman No 40. Both cooking liquids and cooked samples were analyzed immediately.

2-2-2 Frozen samples

The cooked samples previously prepared were kept in polyethylene bags and frozen at – 18 °C and analyzed at 1,3,5,7,9 and11weeks.

3. Dterination of Nitrate and Nitrite

Nitrate and nitrite levels in fresh and processed vegetables were determined according to the method of Sen and Donaldson (1978) using sulfanilic acid and N-(1-Naphthyl) ethylenediamine dihyrochloride and ng the absorbance at 550 nm.was detected.

RESULTS AND DISCUSSION

1. Nitrate in Fresh vegetables

Table (1) presents the levels of nitrate content in 13 fresh colleted vegetables from three governorates during 2000 – 2001.

Table (1) Nitrate content of fresh vegetables (mg / kg) fresh weight during the year 2000 – 2001

	Giza		Cairo		Kalubia	
	Mean	Range	Mean	Range	Mean	Range
Cabbage	320	(81-820)	260	(68 – 730)	250	(65 – 710)
Cauliflower	205	53 – 665	207	68 – 620	202	62 – 680
Carrots	175	105 – 501	140	100 – 450	125	102 – 420
Spinach	360	115 –948	270	70 –840	305	80 – 980
Squash	205	175 – 678	189	64 – 675	195	76 - 540
Lettuce	520	200 – 1100	460	245 – 1020	490	280 – 968
Cucumber	65	24- 125	52	18 – 115	59	20 –124
Green bean	115	40 –280	103	42 – 265	96	35 – 240
Tomato	26	20 – 42	21	16 – 39	25	18 – 40
Peppers	15	12 – 25	11	8 –21	13	10 –23
Parsely	59	40 – 70	51	35 – 65	53	37 – 79
Mushroom	10	8 -- 32	7	6 – 28	8	7 – 30
Potatoes	190	57 – 590	155	53 – 559	175	55 - 578

2. Nitrite in Fresh vegetables

Table (2) shows the levels of nitrite in 13 fresh vegetables collected from three governorates during 2000-2001. Nitrite contrations ranged from 0.0 mg / kg (tomato and green bean) to 2.5 mg / kg spinach fresh weight.

Acodring to the data presented in Table (2), cauliflower, carrots and spinach have high nitrite contents ranging from (0.0 – 30), (0.0 – 30) and (0.5 – 55) mg / kg , respectively , whereas cabbage , squash, potatoes, lettuce, cucumber , green bean, parsely and mushroom have intermediate nitrite content ranging from (0.0–0.5), (0.0-0.7) , (0.0 – 3), (0.0 – 0.5), (0.0 – 0.5), (0.0 – 0.5), (0.0 - 0.7) and (0.0 – 0.2) mg / kg, respectively, while tomato and peppers bean have no nitrite content.

In fertilizer response studies report a range for spinach of 1.6 – 2.0 ppm fresh weight, also, Russian data (Rooma 1971) for ten vegetables are all less than 1.4 ppm. So, it is obvious that the nitrite data of vegetables previously studied are in agreement with the values reported in the literature.

In other cases analysis of green vegetables group gave a mean of 3.4 mg / kg for nitrite (MAFF 1992).

On the basis of the data presented here in, there is no cause for concern regarding the nitrite content of commercial fresh, frozen, or canned vegetables as available to the consumer, but it must be kept in mind that prolonged storage of opened, thawed, cooked, or uncooked vegetables on their storage under improper conditions many lead to conversion of part of their nitrate to nitrite under certain abusive storage conditions, nitrite may accumulate but nitrosamines were not detected (Heisler *et al.*., 1974).

Table (2) Nitrāte content of fresh vegetables (mg / kg) fresh weight during the year 2000 – 2001

Location	Giza		Cairo		Kalubia	
Vegetables	Mean	Range	Mean	Range	Mean	Range
Cabbage	0.097	0.0 – 0.5	0.089	0.0 – 0.46	0.089	0.0 – 0.47
Cauliflower	0.95	0.0 – 30	0.91	0.0 – 27	0.88	0.0 – 25
Carrots	1.1	0.0 – 30	1.1	0.0 – 33	0.98	0.0 – 28
Spinach	2.5	0.5 – 55	2.1	0.4 – 49	2.3	0.4 – 51
Squash	0.26	0.0 – 0.7	0.23	0.0 – 0.6	0.024	0.0 – 0.6
Lettuce	0.6	0.0 – 3	0.4	0.0 – 2.8	0.4	0.0 – 2.6
Cucumber	0.29	0.0 – 0.5	0.26	0.0 – 0.5	0.22	0.0 – 0.46
Green bean	0.35	0.0 – 0.5	0.3	0.0 – 0.48	0.32	0.0 – 0.5
Tomato	0.0	0.0	0.0	0.0	0.0	0.0
Peppers	0.0	0.0	0.0	0.0	0.0	0.0
Parsely	0.32	0.0 – 0.7	0.31	0.0 – 0.7	0.3	0.0 – 0.67
Mushroom	0.07	0.0 – 0.2	0.07	0.0 –0.2	0.06	0.0 – 0.17
Potatoes	0.28	0.0 – 0.5	0.24	0.0 – 0.45	0.22	0.0 – 0.45

4. Nitrite in cooked samples

Table (4) shows the levels of nitrite in some raw vegetables, the effect of cooking samples in deionized water reduced the nitrite concentration in vegetables.

Table (3) Nitrate content in raw and cooked samples (mg / kg) fresh weight) and % nitrate loss on cooking

Vegetables	Numbers of samples analysis	Raw samples	Cooked samples	% Nitrate cooking loss
Cabbage	30	160 – 860	36 – 340	60 – 78
Cauliflower	30	207 – 665	28 – 66	86 – 90
Carrots	30	100 – 501	34 – 93	66 – 81
Spinach	30	115 – 980	26 – 125	77 – 87
Green bean	30	40 – 280	17 – 82	58 - 71

The reductions found in cabbage (80-100%), cauliflower, carrots and spinach(90 – 100%) and green bean (87 – 100%).
There are many papers Meah *et al.* (1994) and Haurte – Mendicoa *et al.* (1997) which evidence a significant decrease of nitrite following a blanching operation .

Table (4) Nitrite content in raw and cooked samples (mg / kg) fresh weight) and % nitrite loss on cooking

Vegetables	Numbers of samples analysis	Raw samples	Cooked samples	Nitrate cooking loss
Cabbage	30	0.0 – 0.5	0.0 – 0.1	80 – 100
Cauliflower	30	0.0 – 30	0.0 – 3	90 – 100
Carrots	30	0.0 – 33	0.0 – 3.4	90 – 100
Spinach	30	0.0 – 55	0.0 – 5.6	90 . 100
Green bean	30	0.0 – 0.5	0.0 – 0.067	87 - 100

5- Nitrate and nitrite in frozen vegetables

Table (5) shows nitrate and nitrite contents in frozen vegetables. Nitrate and nitrite contents didn't change during frozen storage for up to 5 weeks in case of cabbage and green beans (320 and 205 mg / kg, respectively), 3 weeks in case of cauliflower, carrot and spinach (70, 356 and 475 mg / kg, respectively).

A trend towards decreased nitrate level after freezing was observed in all cases and at the same time, an increase in nitrite level was observed. For cabbage and green beans a decrease in nitrate level was observed in the seventh week ranging from 320 to 278 and from 205 to 189 mg / kg NO_3 , respectively with an increase in nitrite level ranging from zero to 0.71 and from zero to 0.4 for cabbage mg / kg NO_2, respectively. At the nineth week and the eleventh week, nitrate level decreases to 268 and 265, resepectively and an increase in the nitrite level to 1.43 and 1.67 mg / kg, respectively was noticed. For green beans, the nineth and eleventh week, nitrate level decreases to 174 and 159 mg / kg, respectively, and an increase in the nitrite level to 1.74 and 1.9 mg / kg, carrots and spinach, adecrease in nitrate level was observed in the fifth week ranging from 70 to 3.5 , 356 to 149 and 475 to 273 mg / kg NO_3, respectively, with an increase in nitrate level ranging from 0.0 to 4.8, 0.0 to 0.71 and 0.0 to 0.48 mg / kg NO_2 respectively.
For cauliflower, the seventh, ninth and eleventh week, nitrate level decrease to 2.8, 2.1 and 1.48 mg / kg, respectively, and an increase in the nitrite level

to 9.6 and 9.8 mg / kg, respectively was observed. For carrots, the seventh, nineth and eleventh week, nitrate level decrease to 109, 94 and 84 mg / kg, respectively, and an increase in the nitrite level to 6.2, 7.4 and 7.6 mg / kg, respectively. For spinch, the seventh, nineth and eleventh week, nitrate level decrease to 240, 232 and 225 mg / kg, respectively, and an increase in the nitrite level to 1.9 , 2.3 and 2.7 mg / kg, respectively, was observed. Generally, it can be concluded that a decrease in nitrate levels followed by an increase in nitrite was observed.

Abo Baker al (1986)noticed the decrement of nitrate levels in spinach, cabbage, beans, okra, peas, carrots and potatoes frozen for up to 6 months at – 8°C . Niedzielski and Mokrosinska (1993) observed a drop of 47.5 % in the nitrate content of frozen Brussels sprouts as compared to the fresh product as a consequence of the effect of blanching.

Table (5) Nitrate and Nitrite content in some frozen vegetables mg / kg

Frozen	1 week		3 week		5 week		7 week		9 week		11 week	
vegetables	No3	No2	No3	No2	No3	No2	No3	No2	No3	No2	No3	No2
Cabbage	320	0.0	319	0.0	319	0.0	278	0.71	268	1.43	265	1.67
Green ean	205	0.0	205	0.0	204	0.0	189	0.4	174	1.1	159	1.9
Cauliflower	70	0.0	70	0.0	3.5	4.8	2.8	9.3	2.1	9.6	1.48	9.8
Carrots	356	0.0	355	0.0	149	0.71	109	6.2	94	7.4	84	7.6
Spinach	475	0.0	474	0.0	273	0.48	240	1.9	232	2.3	225	2.7

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مستوى النترات والنيتريت فى بعض الخضروات الطازجة فى مصروتأثير التصنيع على هذه المستويات

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استهدفت هذه الدراسة دراسه محتوى النترات والنيتريت فى بعض الخضروات الطازجة وكذلك دراسة تأثير عمليات الطبخ والتجميد على هذه المستويات لخفض محتواها من النترات والنتيريت عن المحتوى الموجود ه عليه فى الخضروات الطازجة. لذلك تم تجميع بعض الخضروات الطازجة من ٣ محافظات فى مصر خلال عام ٢٠٠٠ – ٢٠٠١ وهى الكرنب والقرنبيط والجزر والسبانخ والكوسة والخس والخيار والفاصوليا الخضراء والطماطم والفلفل الأخضر والبقدونس والمشروم والبطاطس وتم تقدير النترات والنيتريت فيها

ويمكن تلخيص النتائج فيما يلى:-

١-احتوت عينات الخضار الطازجة الخس والسبانخ والكرنب على كميات عالية من النترات (٢٠٠-١١٠٠) و(٧٠ – ٩٨٠) و(٦٥- ٨٢٠)ملليجم / كجم على الترتيب واحتوى القرنيط والبطاطس والجزر والفاصوليا الخضراء على كميات متوسطة (٥٣ – ٦٨٠) و (٥٣ – ٥٩٠) و(١٠٠ – ٥٠١) و (٣٥ – ٢٨٠) ملليجم / كجم على الترتيب. بينما احتوى الخيار والمشروم والطماطم والفلفل الأخضر والبقدونس على كميات منخفضة (١٨ – ١٢٥) و(٦- ٣٢) و(١٦ – ٤٢) و (٨-٢٥)و (٣٥- ٧٩) ملليجم / كجم على الترتيب.

٢-احتوت عينات الخضار القرنبيط والجزر والسبانخ على كميات مرتفعة من النيتريت (صفر – ٣٠) و(صفر –٣٣) و (٤و- ٥٥) ملليجم / كجم على الترتيب واحتوى الكرنب والكوسة والخس والجرجير والخيار والفاصوليا الخضراء والبقدونس والمشروم على كميات متوسطة من النيتريت وهى(صفر – ٥و) (صفر – ٧و) و(صفر – ٣) و(صفر- ٥و) و(صفر- ٥ و) (صفر-٧و) و(صفر – ٢و) ملليجم / كجم على الترتيب.بينما كانت عينات الطماطم والفلفل الأخضر خاليه تماما من النتريت.

٣-خفضت عملية السلق محتوى النترات فى الخضروات المسلوقه وهى الكرنب والقرنبيط والجزر والسبانخ والفاصوليا الخضراء بنسبة (٨٦ – ٩٠%) فى القرنبيط و(٧٧ – ٨٧%) فى السبانخ و(٦٦ – ٨١%) فى الجزر و(٦٠ – ٧٨ %) فى الكزنب و(٥٨ –٧١%) فى الفاصوليا الخضراء

٤-أيضا خفضت عملية السلق محتوى النتيريت فى الخضروات المسلوقة فى الكرنب بنسبة (٨٠ – ١٠٠%) وفى القرنبيط والجزر والسبانخ بنسبة (٩٠-١٠٠ %)وفى الفاصوليا الخضراء بنسبة (٨٧ – ١٠٠).

٥-ثبت مستوى النترات والنيتريت فى كلامن الكرنب و الفاصوليا الخضراء المجمدة حتى الاسبوع الخامس من التجميد ثم بدأ حدوث نقصان فى مستوى النترات وزيادة فى مستوى النيتريت فى الأسبوع السابع وحتى الاسبوع الحادى عشر.بينما ثبت مستوى النترات والنيتريت فى كلا من القرنبيط والجزر والسبانخ حتى الاسبوع الثالث من بداية التجميد ثم بدأ حدوث نقصان فى مستوى النترات وزيادة فى مستوى النيتريت من الاسبوع الخامس وحتى الاسبوع الحادى عشر.

ولذلك تعتبر عملية السلق مهمة لخفض محتوى النترات والنتيريت فى الخضروات بينما وجد أن عملية التجميد مرتبطة بعدد الاسابيع التى يتم فيها تجميد الخضروات ولذا يوص بعدم زيادة مدة التجميد عن ٣ أسابيع فى حالة تجميد كلا من القرنبيط والجزر والسبانخ وعن ٥ أسابيع فى حالة تجميد الكرنب والفاصوليا الخضراء حيث أنه وجد نقصان فى محتوى النترات يتبعها زيادة فى محتوى النيتريت إذا زادت مدة التجميد عن هذه المدة.