

Study of the level of nitrates in various locally grown and imported vegetables and fruits

Hiba Yousef Saleh¹ , Alaa M. Abdullah²

¹Medical Technical Institute, Al- Mansour, Middle Technical University, Iraq

²Taiba High school for girls,

general directorate of education Baghdad Al- Karkh third ministry of education

Hiba.yousif.saleh@mtu.edu.iq,

Chemistalla89@gmail.com

Abstract:

Samples of vegetables and fruits grown in open fields and local closed fields were taken and compared with vegetables and fruits imported from other countries, and different levels of nitrate were found. The study aimed to measure the percentage of toxic nitrate remaining in fruits and vegetables from different sources and local fruits and vegetables grown in greenhouses and open fields and compare them with these imported vegetables and fruits. It was found that there were different levels of nitrate higher than the permissible limit due to the deposition of pesticides and their lack of spread in the open air in crops. The examination carried out with a portable Green Test device that gives nitrate levels, and the nitrate level spectrophotometer measurements presented by UV/VIS double beam spectrophotometer at 538nm for comparison and to enhance the results obtained in this study, In addition, samples of crops examined from grown in Abu Ghraib fields, and readings were taken, and samples took from crops available in the market from different sources, and vegetables were collected from farmers from several fields grown in the open air as well as in covered fields. The study showed that the concentration of nitrates in imported fruits and vegetables such as (onions, garlic, beets, grapes, apples and strawberries) from outside the country were at high levels and exceeded the permissible limit, while local crops grown in open fields had a lower percentage of nitrite compared to those grown in covered fields in Iraq. Therefore, crops grown in open fields are more suitable for consumption than others and are considered healthy foods for humans.

Keywords : Nitrate, vegetable, fruits, fields, Green test.

دراسة مستوى النترات في مختلف الخضروات والفواكه المحلية والمستوردة

هبة يوسف صالح¹ ، د.الاء منصور عبدالله²

1 المعهد التقني الطبي، المنصور، الجامعة التقنية الوسطى، العراق

2 ثانوية طيبة للبنات، المديرية العامة للتربية بغداد الكرخ الثالثة وزارة التربية

مستخلص:

تم أخذ عينات من الخضراوات والفواكه المزروعة في الحقول المفتوحة والحقول المغلقة المحلية ومقارنتها بالخضراوات والفواكه المستوردة من دول أخرى، ووجدت مستويات مختلفة من النترات. هدفت الدراسة إلى قياس نسبة النترات السام المتبقي في الفواكه والخضراوات من مصادر مختلفة والفواكه والخضراوات المحلية المزروعة في البيوت المحمية والحقول المفتوحة ومقارنتها بهذه الخضراوات والفواكه المستوردة. وجد أن هناك مستويات مختلفة من النترات أعلى من الحد المسموح به بسبب ترسب المبيدات وعدم انتشارها في الهواء الطلق في المحاصيل. تم إجراء الفحص بجهاز Green Test المحمول الذي يعطي مستويات النترات، كما تم فحص مستوى النترات بمطياف الأشعة فوق البنفسجية/ المرئية ثنائي الشعاع عند طول موجي 538 نانومتر للمقارنة وتعزيز النتائج المتحصل عليها في هذه الدراسة، إضافة إلى ذلك تم أخذ عينات من المحاصيل المزروعة في حقول أبو غريب، وتم أخذ القراءات، وتم أخذ عينات من المحاصيل المتوفرة في السوق من مصادر مختلفة، وتم جمع الخضراوات من المزارعين من عدة حقول مزروعة في الهواء الطلق وكذلك في الحقول المغطاة. أظهرت الدراسة أن تركيز النترات في الفواكه والخضراوات المستوردة مثل (البصل والثوم والبنجر والعنب والتفاح والفراولة) من خارج البلاد كانت بمستويات عالية وتجاوزت الحد المسموح به، بينما المحاصيل المحلية المزروعة في الحقول المفتوحة كانت نسبة النترات فيها أقل مقارنة بتلك المزروعة في الحقول المغطاة في العراق. وبالتالي فإن المحاصيل المزروعة في الحقول المفتوحة أكثر ملاءمة للاستهلاك من غيرها وتعتبر أغذية صحية للإنسان.

الكلمات المفتاحية: النترات، الخضار، الفواكه، الحقول، الاختبار الأخضر.

Introduction

The residues of vegetable and fruit pesticides are considered dangerous to the health of the human body. They are chemical substances that affect health, and their increase affects the body's cells and vital organs[1]. Insecticides are toxic substances that have a role in killing single celled organisms and insects. They are used in agriculture to exterminate insects that affect the growth of cultivated plants. Research has indicated that pesticides are synthetic substances that cause harm to humanity when used long-term or over long periods. Its negative symptoms affect humans after a long period of use and consumption. Recent studies and research on cultivated products have found a high concentration of nitrite and nitrate in agricultural products, which affects the quality of the product because it impacts the health of the human consumer[2]. Nitrates are found in all fruits, vegetables, water, and other products, and humans consume them daily in different ways. Nitrate is a non-toxic chemical if taken in small quantities. However, it is chemically transformed into nitrite, which can be

a toxic substance and cause a health risk, and its excess can cause serious poisoning, causing concern when present in crops. It affects the quality of agricultural products in terms of human use of those crops. Nitrate compounds are used as fertilizers for agricultural crops. When you eat food, the nitrite metabolites present in it can cause bacteria to interact with enzymes in the mouth and digestive system to convert nitrates into nitrites [3].

The plant obtains the nitrogen necessary for its growth from the soil in the form of nitrates. Excess nitrogen accumulates in the plant's leaves and storage organs as nitrates. Nitrate is an organic compound in plants that is stored in both the roots and leaves, and the percentage of its presence depends on the type of plant nutrition and its growth conditions[4]. The high content of nitrates in humans and animals causes danger to the cells in the human body when these products are consumed as food. The nitrates that come from food are absorbed in the human digestive system and enter the blood and tissues, and a large amount of them is excreted from the body through the kidneys. Nitrates are considered low

toxicity and contribute to metabolic reactions and some of them are converted into useful compounds and when they are converted into nitrite (NO_2), they are considered highly toxic compounds and their excess in the body may cause cancer [5]. Previous studies have proven in numerous published researches the unhealthy effects on the human body, which may be due to the presence of these substances due to the use of fertilizers and pesticides containing nitrogen. It may also lead to an increase in nitrates in the soil and they ionize in the soil and with the continuous increase in fertilization, nitrates accumulate in agricultural crops. Naturally, the percentage of nitrite ranges between 1-1000 mg/kg of crop weight [6]]. Converting nitrates to nitrites and accumulating them in the body in large quantities is dangerous to the body and causes health problems in the digestive system. These substances can react with amines, leading to the formation of carcinogenic compounds such as N-nitrosamine, which accumulate in the human stomach and can cause stomach, esophageal and gallbladder cancer. The nitrate compound is also with hemoglobin in the blood and is

converted from nitrates to nitrites, causing a decrease in the transfer of oxygen to the body's tissues [7]. The maximum number of nitrates that enter the body daily is less than 3.65 mg/kg. Given the harmful effect of nitrites and nitrates, determining the percentage of these Compounds in vegetables and fruits are important in agricultural products consumed in Iraq. Therefore, the present study was conducted to measure the nitrite content in agricultural crops grown in the country and compare it with those imported from outside Iraq [8].

Nitrate ions accumulate in plants through external factors including temperature, humidity, lighting, mineral nutrition, fertilization, and irrigation methods. Farmers resort to adding fertilizers containing nitrates in order to accelerate their growth and increase their maturity, as this leads to the accumulation of nitrates in different parts of plants if these fertilizers are used excessively [9]. It is known that the health risk lies in reducing nitrates in food when they enter the body and convert them to nitrites. Nitrites turn into nitrosamines and cause many diseases such as cancer, as this substance is con-

verted in the intestines by bacteria in the intestines. In addition, nitrogenous materials can affect the environment by reaching river water and groundwater. Studies have shown that the level of nitrates in drinking water should not exceed fifty milligrams per liter of water, which is a level considered safe for the health of the consumer [10]. The mechanism of nitrate interaction with proteins in the body produces nitrosamines. If nitrates are consumed at a level higher than (250 mg/kg), methemoglobinemia occurs. Its symptoms include the inability of blood cells to carry oxygen to the body's organs, which leads to suffocation. The signs of the disease include the appearance of a blue color on the patient's body, headache, nausea, and a pale blue color covering the eyes, mouth, and lips. The Greentest Eco-a device for rapid analysis of nitrates in fresh fruits and vegetables, as well as to determine the level of radioactivity and detect salts in foods and all materials that turn into fertilizers in fruits and vegetables. Nitrates are considered one of the most harmful substances, and continuous consumption of foods with a high nitrate content may lead to the risk of co-

lon cancer [11].

Materials and procedure

A) A. We took samples of imported crops in addition to samples of crops grown in Iraq (Abu Ghraib fields) grown in closed plastic fields and grown in open farms. We measured the different exported crops with the device and took several readings after washing the vegetables well with deionized water before testing to remove impurities and dirt. We took several readings of the nitrate content in the samples using a small portable device equipped with a small screen to show the measured result, of Russian origin Nitrate Meter "Green Test" Eco, which measures residual chemicals in vegetables and fruits, produced by ANMEZ), the Green Test device measures vegetables and fruits that contain various salts that can cause harm to human health [12].

B) Dual-beam UV/Vis spectrophotometer measurements at 538 nm wavelength were used to compare imported samples as well as samples grown in Abu Ghraib fields such as (onion, garlic, beetroot, grapes, apples and strawberries). The UV spectrometer operates at a light path length in the

measuring cell of 1 cm.

two grams of samples took and added (1) ml of hydrochloric acid to it and prepared a volume of (50) ml of distilled water, added it to (1) ml of hydrochloric acid and used it as a standard solution. The absorbance was

measured at a wavelength of 538 nm and the absorbance value was compared with the values of the standard curve. The concentration of nitrates in the samples was determined by the calibration curve and we recorded the values that appeared [13].



Picture (1) Greentest device

Results and discussion

Samples of imported vegetables and fruits from outside Iraq were measured, and the results showed that they contained high levels of nitrate. Vegetables and fruits grown in local open-air fields were also measured, as well as samples of crops grown in local covered fields. The study showed that vegetables and fruits grown in local covered fields contained varying levels

that exceeded the permissible limit of nitrates, as the reason for the presence of covers on the plants leads to the accumulation of fertilizers and the failure of their waste to evaporate, as in the case of plants grown in open-air fields, where the measured level of nitrates in those fruits was at low and somewhat permissible levels. The presence of high levels of nitrates in those fruits poses a risk to human health [14]. The results also showed that most of the

plants measured that contain Impurities from fertilizers and chemical pesticides are primarily imported plants, and secondarily plants grown in covered fields in what are called (green-houses). The World Health Organization recommends that the suggested maximum daily limit for nitrate intake is 50 mg Nitrate [15], levels in crops imported from outside Iraq exceeded the permissible daily nutritional limit of (400 mg/kg) when the samples were examined and the results of the crop examination were compared with the spectrophotometer to detect nitrates. Local vegetables and fruits grown in open fields showed that the nitrate level in these plants was within or close to the permissible level [16]. In table 1 showed large quantities of nitrates in the plants measured by the device (green test). The spectroscopic results also showed through the calibration curves that the nitrate concentrations of the samples exceeded the permissible limit. The samples of these plants were vegetables and fruits imported locally from other countries, which may have used high levels of fertilizers during cultivation, or the plant may have been treated with chemical pesticides [17],

or used preservatives for the purpose of preserving it during transportation and storage, high values were recorded for both tests.

Table1: the average nitrate level in imported fruits and vegetables

Measured vegetables	Standard value (mg/kg)	First value (mg/kg)	second value (mg/kg)	third value (mg/kg)	Fourth value (mg/kg)	The average	Concentration spectrophotometer of NO_3 (mg/kg)
Onion	80	153	111	110	213	146.75	450
Garlic	70	95	98	99	105	99.25	400
Beetroot	1400	1750	1662	1740	1633	1696.25	420
Grape	60	88	82	90	85	87.5	300
Apples	60	90	88	93	87	89.5	320
Strawberry	100	154	144	150	148	149	460

Table 2 showed the level of nitrates of samples of vegetables and fruits grown in covered fields inside Iraq, which took from the Abu Ghraib fields, show a difference in the values of the nitrate level in them. This is confirmed by the results of nitrate concentrations in relation to the spectral absorption

of nitrates, which gave results close to what is in the first table. The reason for this may be the use of pesticides in covered fields which leads to the accumulation of chemicals on them as a result of not being exposed to the open field [18], which leads to their accumulation on the cultivated plants.

Table2: the average nitrate level in fruits and vegetables inside closed greenhouses

Measured vegetables	Standard value (mg/kg)	First value (mg/kg)	second value (mg/kg)	third value (mg/kg)	Fourth value (mg/kg)	The average	Concentration spectrophotometer of NO ₃ (mg/kg)
Onion	80	90	111	96	99	99	400
Garlic	70	92	92	94	99	94.25	380
Beetroot	1400	1550	1562	1740	1633	1621.25	400
Grape	60	78	82	88	75	80.75	210
Apples	60	77	78	93	87	83.75	200
Strawberry	100	123	137	132	134	131.5	420

The results showed in Table 3 of local vegetables and fruits grown in open fields took from the farms of Abu Ghraib/Iraq that the level of nitrates is within the permissible level and this indicates that open fields are the best option for agriculture and the production of good agricultural crops in terms of human consumption.

Table1: the average nitrate level in fruits and vegetables in the open field

Measured vegetables	Stan- dard value (mg/kg)	First value (mg/kg)	second value (mg/kg)	third value (mg/kg)	Fourth value (mg/kg)	The aver- age	Concentration spectropho- tometer of NO ₃ (mg/kg)
Onion	80	83	80	85	84	83	200
Garlic	70	77	72	66	78	73.25	90
Beetroot	1400	1450	1362	1400	1420	1408	100
Grape	60	67	62	61	59	62.25	70
Apples	60	60	63	69	70	65.5	80
Strawberry	100	101	107	110	107	106.25	150

The results showed that the nitrate values in the samples of imported garlic grown in covered fields are somewhat high when compared to the nitrate values in garlic grown in open green farms, which are close to the permissible values as shown in the tables of imported samples and the tables of samples taken from covered fields inside the country. The values also indicated that vegetables and fruits grown in open fields contain nitrates, but the permissible values are as determined by the World Health Organization [19]. In addition, we concluded that the nitrate values in imported strawberries were 149 mg, and the nitrate value in strawberries grown in local closed fields was 132 mg, which are high values compared to

the nitrate values in strawberries grown in the open air, which are close to the permissible limits. We conclude from this study that plants grown in open fields contain lower levels of nitrates and are considered edible fruits and beneficial to human health [20]. Compared to the results of nitrate values measured in the portable device with nitrate concentration values for spectral absorption, values exceeding 50 mg/kg are considered high values and may pose a risk to the body, according to what was determined by the World Health Organization [21]. The reason for the presence of nitrates in high quantities may be due to the increase in the quantities of chemical fertilizers in order to increase the speed of plant

growth and the incorrect method of using fertilizers that eliminate insects and living organisms that hinder plant growth, which may leave long period toxic residues on agricultural crops. A study indicated that human exposure to nitrogen pollution from nitrates in food and water and nitrogen oxides in the surrounding air leads to an increased risk of myocardial infarction, respiratory problems and asthma. High levels of nitrates were identified in drinking water and high quantities were found in drinking water, as several studies indicated. [22]. The presence of nitrates in crops imported from outside Iraq may be due to the use of preservatives to preserve crops during transportation and storage, which contain nitrates which causes an increase in the number of nitrates on those crops. Studies have indicated this, as the health risks to citizens from exposure to nitrates were evaluated through the consumption of some vegetables that were analyzed, such as (cucumbers, carrots, tomatoes, potatoes, lettuce, cauliflower, onions, and mushrooms) to determine the nitrate contents. The estimated daily intake values for some vegetables exceeded the acceptable daily intake

of nitrates[23].

Conclusions

The study found that nitrate levels exceed the permissible limit due to the large number of chemical fertilizers. To reduce the number of nitrates in food, most of which may contain harmful fertilizer residues, we suggest the need to reduce the number of pesticides and chemicals during agriculture by farmers inside Iraq and the need to educate and guide farmers when using these pesticides to reduce the risks of fertilizer and chemical residues accumulated on cultivated plants. Fruits and vegetables should also be washed well with water, and it is preferable to soak them in cold, slightly salted water for 30-40 minutes, as this reduces the percentage of nitrates by exchanging salt with nitrates. The study recommends the need to know the source of agricultural products imported from outside Iraq and to increase the encouragement of local agriculture in open fields and to eat these fruits more than imported fruits.

References

- [1] Uddin, Rayhan, et al. "Study of nitrate levels in fruits and vegetables to assess the potential health risks in Bangladesh." *Scientific Reports* 11.1 (2021): 4704.
- [2] Brkić, Danijel, et al. "Nitrate in leafy green vegetables and estimated intake." *African Journal of Traditional, Complementary and Alternative Medicines* (2017)v. 14.3. p. 31-41.
- [3] Ziarati, P., and S. Arbabi-Bidgoli. "Investigation of cooking method on nitrate and nitrite contents in crops and vegetables and assess the associated health risk." *International journal of plant, animal and environmental sciences* (2014)v. 4.2. p. 46-52.
- [4] Ranasinghe, R. A. S. N., and R. A. U. J. Marapana. "Nitrate and nitrite content of vegetables: A review." *Journal of pharmacognosy and phytochemistry* (2018)v. 7.4 .p. 322-328.
- [5] Raczuk, Jolanta, Wanda Wadas, and K. Glozak. "Nitrates and nitrites in selected vegetables purchased at supermarkets in Siedlce, Poland." *Roczniki państwowego zakładu higieny* (2014) v. 65.1
- [6] Kadach, Stefan. "Inorganic Nitrate Metabolism Within The Human Body: Dietary Nitrate Supplementation and Factors Influencing NO Bioavailability." (2024).
- [7] Alzahrani, H. S., et al. "The role of dietary nitrate and the oral microbiome on blood pressure and vascular tone." *Nutrition research reviews* 34.2 (2021): 222-239.
- [8] HANIN, Noerul; LESTARI, Dyan Puji. Determination of Nitrite in the Kapuas Besar River by Spectrophotometric Method. In: *Proceeding International Conference on Religion, Science and Education*. 2023. p. 795-800.
- [9] Ranasinghe, R. A. S. N., and R. A. U. J. Marapana. "Nitrate and nitrite content of vegetables: A review." *Journal of pharmacognosy and phytochemistry* (2018)v. 7.4. p. 322-328.
- [10] Jana, J. C., and P. Moktan. "Nitrate concentration of leafy vegetables: A survey of nitrite concentrations in retail fresh leafy vegetables from daily markets of different locations." *ISABB Journal of Food and Agricultural Sciences* (2013)v. 3.1.p. 1-5.
- [11] Afali, S. F., and Rezvan Elahi. "Measuring nitrate and nitrite concentrations in vegetables, fruits in Shi-

raz.” *Journal of applied sciences and environmental management* (2014) v. 18.3 .p.451-457.

[12] Naas, Hadi Abudul Jaleel, and Hiba Yousef Saleh. “Toxic residue of chemical elements in different fruits as a result of excessive fertilization and misuse of agricultural pesticides in Iraq.” *Plant Archives* (2020)v. 20.2 .p. 1549-1551.

[13] Ali, Roshna Akram, Karzan Abdulla Muhammad, and Othman Kareem Qadir. “A survey of nitrate and nitrite contents in vegetables to assess the potential health risks in Kurdistan, Iraq.” *IOP Conference Series: Earth and Environmental Science*. Vol. 910. No. 1. IOP Publishing, 2021.

[14] Klemo, Marsida, and Bledar Biti. “Nitrate Concentration in Plant Products of Albanian Market.” *KNOWLEDGE-International Journal* (2018)v. 28.4 .p. 1289-1294.

[15] Bahadoran, Zahra, et al. “Nitrate and nitrite content of vegetables, fruits, grains, legumes, dairy products, meats and processed meats.” *Journal of Food Composition and Analysis* (2016)v. 51 .p.93-105.

[16] Pirsaeheb, M., et al. “The measurement of nitrite and nitrate contents

of tomato from the vast plain of Kermanshah State of Iran.” *International Journal of Agriculture and Crop Sciences* 7.15 (2014): 1553.

[17] Alhulaefi, Shatha S., et al. “Effects of dietary nitrate supplementation on oral health and associated markers of systemic health: a systematic review.” *Critical Reviews in Food Science and Nutrition* (2024): 1-16.

[18] OCHMIAN, Ireneusz Dariusz, Józef Grajkowski, and Milosz Smolik. “Comparison of some morphological features, quality and chemical content of four cultivars of chokeberry fruits (*Aronia melanocarpa*).” *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* (2012)v. 40.1 .p. 253-260.

[19] Habermeyer, Michael, et al. “Nitrate and nitrite in the diet: how to assess their benefit and risk for human health.” *Molecular nutrition & food research* (2015)v. 59.1 .p.106-128.

[20] da C Pinaffi-Langley, Ana Clara, et al. “Dietary nitrate from plant foods: a conditionally essential nutrient for cardiovascular health.” *Advances in Nutrition* 15.1 (2024): 100158.

[21] Ward, Mary H., et al. “Drinking water nitrate and human health: an updated review.” *International journal*

of environmental research and public health (2018):v. 15.7 .p.1557.

[22] Brender, Jean D. “Human health effects of exposure to nitrate, nitrite, and nitrogen dioxide.” *Just enough nitrogen: Perspectives on how to get there for regions with too much and too little nitrogen* (2020)p.283-294.

[23] Qasemi, Mehdi, et al. “Characteristics, water quality index and human health risk from nitrate and fluoride in Kakhk city and its rural areas, Iran.” *Journal of Food Composition and Analysis* 115 (2023): 104870.