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Assessment of the accumulation of nitrate in cultivated vegetables in Thu Dau Mot, Binh Duong

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ABSTRACT

Vegetables are the major source of dietary Nitrate that have a range of variations in Nitrate. The presence of Nitrate in vegetables is often associated with harmful effects on human health. The study investigated Nitrate intake of vegetables in Phu My ward, Hiep An ward, and Tuong Binh Hiep ward in Thu Dau Mot city by UV-VIS Molecular Absorption Spectrometer to determine of Nitrate concentration with measurement wavelength of 410 nm. The vegetable samples were collected in the field-trip based on TCVN 9016:2011 and the Nitrate concentration was determined according to TCVN 8742:2011 (Vietnam Ministry of Sciences and Technology, 2011). The results showed that there were 3 fresh spinach samples, 3 bok choy samples, containing the Nitrate concentration that exceeded the WHO standard of Nitrate contents in vegetables. These results warn the farmers and policy administrators of Thu Dau Mot city to recommend some solutions to control Nitrate concentration in vegetables produced in Binh Duong province.

Keywords: *bok choy, fresh spinach, Nitrat, Thu Dau Mot, vegetable*

1. Introduction

Vegetables are an indispensable food in family meals. Vegetables are not only provided with essential Vitamins, fiber, minerals, and trace elements, but also a valuable source of medicinal herbs that contribute to human health protection. In recently, vegetable production and consumption facing with the problems is very serious, which is the insecurity of vegetable products. Presently, the issues of unsafe vegetables have been and become a matter of special concern to the community as well as local authorities.

The number of food poisoning cases originating in vegetables is quickly increasing day by day. In humans about 25% of ingested Nitrate is secreted in the saliva and approximately 20% of the secreted salivary Nitrate is later converted to Nitrite by microorganisms on the tongue. Therefore, normal individuals about 5–7% of ingested Nitrate can be detected as salivary Nitrite (LundberG et al., 1994).

Located in the Eastern part of the Southern region of Vietnam and being the part of the Southern Key Economic Zone, Binh Duong province is one of the provinces with rapid economic growth rate and dynamic industrial development in Vietnam. Along with the industrial development of the province, Thu Dau Mot city is one of the economic centers of Binh Duong including many industries such as Song Than 3, Phu Gia, Kim Huy, Dai Dang, VSIP -II, and An Hoa. Thu Dau Mot city is a major financial, cultural and political center in the Southern Key Economic Zone, with a population of 2,456 million in 2020. Thu Dau Mot city is an area where several vegetables are grown like sweet cabbage, red amaranth, bok choy, fresh spinach, and water spinach that are consumed in large quantities .

Nitrate plays an important role in the nutrition and function of plants. The Nitrate concentration in vegetables depends on a number of factors including species variation, season, light, temperature, planting technique and fertilizer used (WHO). However, plant crops especially tend to absorb Nitrate more than required (Ahamed., 2009). Nitrates are relatively non-toxic. They are discussed in toxicology due to their metabolic products, which are converted via nitrite to N-nitro compounds, especially N-nitrosodimethylamine (NDMA).

The aims of the study determine the accumulated Nitrate concentration in some vegetables which are planted in Thu Dau Mot city.

2. Research materials and methods

2.1. Materials

Research subjects: Nitrate and vegetables (Sweet cabbage, red amaranth, bok choy, fresh spinach, water spinach).

Research material: sweet cabbage, red amaranth, bok choy, fresh spinach, water spinach.

Research Chemical: Salicylic-Acid $C_7H_6O_3$ (Merk), KNO_3 (Merk), NaOH (China, 96%), H_2SO_4 (China, 98%).

2.2. Methods

Study area and sample collection: Samples were taken in 3 wards including Phu My, Hiep An, and Tuong Binh Hiep. The sample sites were selected based on customers as well as local citizens and authorities. All the samples were selected randomly at the time

of their biological maturity during the growing season (from February 2020 to August 2020). The samples were placed in a plastic bag and transferred to the laboratory of Thu Dau Mot University after being labeled. The samples were kept overnight at a temperature below 4°C until the analysis on the following day (TCVN 9016:2011).

Figure 1. *The study area: Tuong Hiep Binh (1), Hiep An (2), Phu My (3)*

TABLE 1. Information about vegetable samples in Thu Dau Mot city

Wards	Number of samples	Coordinates	
Tuong Binh Hiep	15	$11^0$00’13.90’’N	$106^0$38’39.68’’E
Hiep An	15	$11^0$00’40.55’’N	$106^0$35’36.78’’E
Phu My	15	$11^0$02’09.95’’N	$106^0$41’15.16’’E

Sample preparation: The non-edible parts were removed, and the samples were subjected to cutting and homogenization using a cutter and homogenizer, respectively. Then, the homogenized samples were immediately stored at –20°C before the analysis. 200 mL of deionized water was added to 10g of the homogenized sample in a 250 mL Erlenmeyer flask. The flask was then moved to a boiling water bath for 20 min at 80°C, the sample was continued to be microwaved for 7 minutes at 850W (TCVN 8742:2011).

2.3. Evaluation methodology

Nitrate–N stock standard: Solution of 500mg/L was prepared from KNO_3. Working standard solutions with Nitrate concentration 5, 20, 40, 60, 80, and 100mg/L were prepared by diluting the standard with distilled water and were stored at 4^0C.

Determination of Nitrate: Take 10ml (Sample preparation) into 50ml Erlenneyer flask, and mix thoroughly with 1ml salicylic acid (5% w/v). After 20 minutes at room temperature, 1ml H_2SO_4 (98%) and 7ml NaOH (30% w/v) were added slowly with a pipette to raise the pH above 12. Samples were cooled to temperature room, the Nitrate concentration in the solution was determined using UV-VIS J770 and measurement wavelength of 410nm. All experiments were carried out in three replicates. The Nitrate content in milligram/kg fresh weight (mg NO_3^-/kg fresh weight) is calculated by the formula:

$$mg\ NO_3/kg\ fresh\ weight = \frac{a \times V \times 1000}{V' \times m}$$

Where:

V: Volume of sample solution after extraction (ml);

V': Volume of solution taken out for Nitrate determination (ml);

a: Nitrate content present in V' volume of sample solution (mg)

m: mass of fresh weight for analysis (g)

Standard limit of Nitrate in each sample is adopted from the World Health Organization.

3. Results and Discussion

Vegetables are recognized to provide a significant portion of Nitrates in the nutritional regime. The samples analyzed in this present study were categorized and presented with their respective Nitrate content.

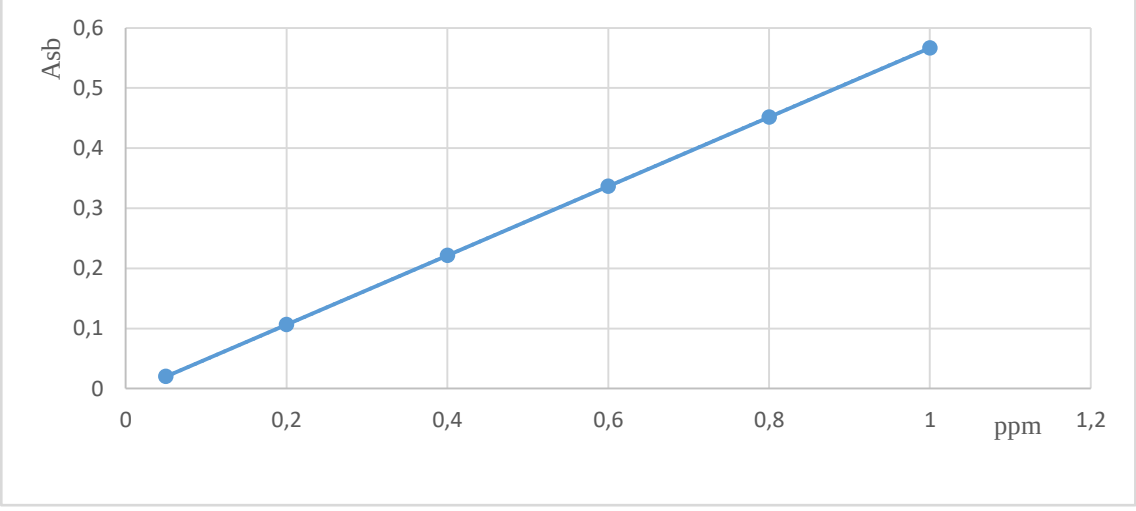

Figure 2. *Standard curve of Nitrate*

The linear regression equations for Nitrate standard curve were calculated as y = 0.5754x + 0.0088 (R^2 = 0.9977); where *y* is the value of peak area and *x* is the value of various concentrations of standard solutions using the UV-VIS

TABLE 2. Concentrations of Nitrate in the tested vegetables

Date	Samples	Phu My ward NO_3^- (mg/kg fresh weight)	Hiep An ward NO_3^- (mg/kg fresh weight)	Tuong Binh Hiep ward NO_3^- (mg/kg fresh weight)
16/02/2020	Sweet cabbage	217.0	142.5	202.5
	Red amaranth	433.6	270.3	390.3
	Bok choy	327.8	**525.2**	90.5
	Fresh spinach	**532.4**	370.4	**507.1**
	Water spinach	315.0	259.0	298.1
20/05/2020	Sweet cabbage	229.5	450.4	346.3
	Red amaranth	119.8	378.1	336.9
	Bok choy	366.7	**513.3**	**528.5**
	Fresh spinach	340.8	422.7	380.6
	Water spinach	216.4	462.8	402.6
18/082020	Sweet cabbage	406.6	226.4	287.3
	Red amaranth	340.7	425.0	483.4
	Bok choy	505.8	421.9	406.8
	Fresh spinach	99.0	**546.6**	434.2
	Water spinach	425.0	429.1	400.4

As can be presented in Table 2, Nitrate was present in all vegetable research samples. The Nitrate concentration in vegetable samples varied in the range of 90.5-546.6mg/kg, the highest concentration of Nitrate was determined in fresh spinach (546.6 mg/kg) followed by bok choy (528.5mg/kg), and water spinach (462.8mg/kg). Average content of Nitrate (n = 9) in fresh spinach (425.98mg/kg) > bok choy (420.61mg/kg) > water spinach (356.49mg/kg) > red amaranth (353.12) > sweet cabbage (278.722mg/kg).

According to the results of the study on Nitrate accumulation in Cabbage soup and some vegetables by Phan Thi Thu Hang (2008), the results of the study were similar: the average Nitrate content in vegetables was from 290.1mg/kg to 426.7mg/kg (fresh weight).

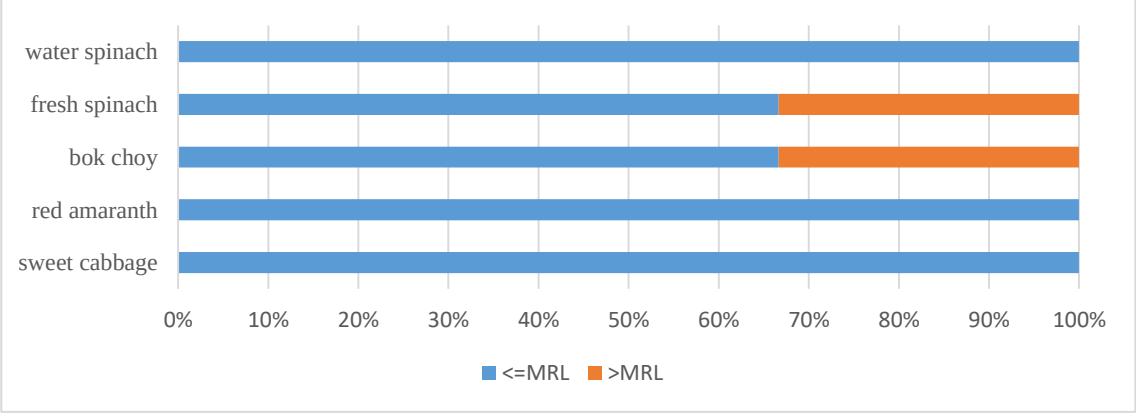

Figure 3. *Comparison of Nitrate residues in vegetable samples with the Maximum Residue Levels (MRL)*

When compared with the maximum allowable Nitrate residue level (MRL) for spinach safety, as specified by the World Health Organization showed (Figure 3): 100% samples of sweet cabbage, red amaranth and water spinach was lower than the limited threshold, 3/9 (accounting for 33.33%) of fresh spinach and bok choy samples exceeded the safe threshold.

4. Conclusion

The results of the study indicated that 45 vegetables samples of sweet cabbage, red amaranth, fresh spinach, bok choy and water spinach were collected at Phu My ward, Hiep An ward, Tuong Binh Hiep ward in Thu Dau Mot city. The study was conducted by UV-VIS, measuring a wavelength of 410nm to detect Nitrate concentration in all Vegetable samples. There were 3 fresh spinach and 3 bok choy samples which had Nitrate content exceeding the standard of theWorld Health Organization.

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