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Metal Accumulation in Carrots, Soil and Irrigating Water Samples

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Abstract: Carrots have an important role for a life of the men. Everybody can use carrots in the meals or the drinks, he uses carrots such as the medicaments to cure many diseases, too. Carrots are very necessary, we can tell the following effects: carrots help improve eyesight, especially, carrots contain vitamin A, essential nutrients for health of the eyes. When our bodies have the vitamin A deficiency in the long time, visual cells in the eye retina can been hurt, make dry eyes, cause the visual disturbances and it is serious that everyone does not see. Carrots support to cure the diabetes; help strengthen the immunity; improve the health cardiovascular; help beautiful healthy skin; can reduce the risk of cancer. Besides, everyone drinks carrot juice to stimulate hair growth and stabilize blood pressure. Carrots contain a lot of beta carotene, fiber, vitamin K1, potassium as well as antioxidants and are grown popularly in all regions of Vietnam. The cultivating soil, irrigating water and carrot samples were collected in Loc Thanh village, Bao Lam district, Lam Dong province and some indicators were analyzed. The results showed that the soil sample was poor in nutrient by N, P, K indicators that were lower than the standards; but pH, Al^{3+} and Fe^{3+} were higher than the standards. The water sample did not contain the toxic heavy metals such as: As, Pb, Cd; but the indicators of Cu, Zn, Fe were higher than the standards. For the carrot sample, the indicators of As, Pb, Cu, Zn exceeded the allowable threshold; the contents of lipid and protein were lower than the standards but NO_3^- was within allowable standards. However, analysis of carrot samples grown by us using organic methods showed that some heavy metal indicators such as: As, Pb, Cu were lower than allowable standards. This showed that it is necessary to choose the type of soil, water and organic method for growing carrots in order to harvest good quality carrots and safety for users. We studied an environment of soil, water and analyzed the carrots to find a nutrition level, nutritional value and the metal accumulation in order to improve a life of men.

Key words: Carrots, heavy metals, cultivating soil, irrigating water, accumulation.

Abbreviations

pH	Potential of hydrogen
N	Nitrogen
P	Phosphor
K	Kalium
Fe	Ferrum, iron
Al	Aluminum.
Ca	Calcium
Mg	Magnesium
Cu	Copper
Pb	Lead
Cd	Cadmium
As	Arsenic
Zn	Zinc
SO_4^{2-}	Sulfate
PO_4^{3-}	Phosphate
NO_2^-	Nitrite
NO_3^-	Nitrate
NH_4^+	Ammonium

1. Introduction

Carrots have a scientific name: *Daucus carota* L, family Apiaceae [1]. Carrots are the crop with high nutritional and economic value, they are used for fresh eating and processed into commodity products. Carrots contain a lot of beta carotene, fiber, vitamin K, potassium as well as antioxidants. In Vietnam, carrots are grown in all regions and quite a popular food source in meals. In addition, carrots have been exported to Malaysia, Thailand, Middle Eastern countries and Korea... [2].

For the vegetables, there have been many studies on growing methods, but still not enough attention to the accumulation of toxic compounds in products, especially heavy metals. Some heavy metals have

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been determined to be very harmful to humans such as Cu, Cd, As, Zn, Pb... if they present in vegetables with concentrations exceeding the allowable threshold [3-5].

In this article, we presented the results of analyzing soil, water, and post-harvest carrot samples from household farmers in Loc Thanh village, Bao Lam district, Lam Dong province. At the same time, we experimented growing carrots using organic methods (using growing substrate, irrigating water that did not contain toxic heavy metals and using organic fertilizer completely), and analyzed the components in carrots to show the difference between the two methods of carrot cultivation [6].

2. Materials and the Method of Research

2.1 Materials

1. The cultivating soil, irrigating water samples were collected in Loc Thanh village, Bao Lam district, Lam Dong province.

2. Seeds of carrot were purchased from Hoa Sen Company.

3. The experiment was implemented in hilly soil area in Loc Thanh village, Bao Lam district, Lam Dong province, from February to December of year 2022, 2023.

4. Carrot samples were collected from vegetable growing households surrounding.

2.2 Methods

We planted carrots which were grown by using many types of organic fertilizers, including wild herbs, manure fertilizer, powder lime, ash of husk, biological fertilizer [7, 8]. Carrot seeds are lightly crushed, crumpled thoroughly, mixed with humus, placed in the sink, kept moist for two nights, sowed the seeds and covered with straw. Carrots were watered once a day until the carrots sprout, then watered once a week. After 3-3.5 months, the carrots were harvested.

3. Result and Discussion

3.1 Analyzing Indicators in Cultivating Soil and Water Samples

Table 1 showed the result of analysis of the heavy metals of the soil samples.

Table 1 Parameters of cultivating soil sample.

No.	Parameters	Concentrations		Methods	Limitation values*
		Sample 1-Hill base	Sample 2-Hill top		
1	pH (H_2O) 1:5	6.04	6.38	Standard of VN 5979-1995	6.5-8.5
2	pH (KCl) 1:5	4.35	4.58		6.0
3	EC (µS/cm)	7.9	22.9	Standard of VN 6650-2000	10-20
4	N total (%)	0.090	0.087	Standard of VN 6445-2000	0.1-0.15
5	P total (%)	0.038	0.044		0.06-0.08
6	K total (%)	0.015	0.020	AOAC 990.08-2000	0.3-1.5
7	Fe exchange (mg/100g)	28.36	20.12		0.1
8	Al^{3+} exchange (mg/l00g)	9.16	2.37		0.1
9	Ca^{2+} (mg/100g)	0.088	0.083	Standard of VN 6496-1999	4.0-6.0
10	Mg^{2+} (mg/100g)	0.078	0.059		2.0-3.0
11	Emery Sand (%)	2.4	4.3	AOAC 2000	-
	Emery Clay (%)	59.8	59.3		
	Emery Flesh (%)	37.8	36.4		
12	SO_4^{2-} (mg/100g)	0.861	0.887	Standard of VN 6656-2000	1.0-2.0

* Vietnam standard/National technical regulation on the limits of heavy metals contamination in food (Vietnam Technical Regulation 8-2: 2011/Medicinal Ministry) [9].

Table 2 Parameters of water sample.

No.	Parameters	Concentrations	Methods	Limitation values*
1	Cu (mg/L)	1.85	ACIAR-AAS 015-2007	0.03
2	Pb (mg/L)	-	ACIAR-AAS 015-2007	0.01
3	Cd (mg/L)	-	ACIAR-AAS 004-2007	0.02
4	As (μg/L)	-	ACIAR-AAS 001-2007	0.2
5	Zn (mg/L)	3.51	ACIAR-AAS 019-2007	0.01
6	Fe (mg/L)	0.92	Standard of VN 6177-1996	0.5
7	AI (mg/L)	-	ISO 12020-1997	0.5
8	Color (Pt/Co)	9.0	Standard of VN 6158-1996	1.0
9	pH	7.22	Standard of VN 6492-2000	6.5-8.5
10	Degree of muddy, dirty (NTU)	2.9	Standard of VN 6184-1996	2.0
11	Cl^- (mg/L)	2.22	Standard of VN 6194-1996	250
12	PO_4^{3-} (mg/L)	0.011	Standard of VN 6178-1996	≤ 0.1
13	SO_4^{2-} (mg/L)	1.21	Standard of VN 6200-1996	≤ 0.5
14	$N\text{-}NO_2^-$ (mg/L)	-	Standard of VN 6178-1996	0.05
15	$N\text{-}NO_3^-$ (mg/L)	-	Standard of VN 6180-1996	0.05
16	$N\text{-}NH_4^+$ (mg/L)	0.50	Standard of VN 5988-1995	0.3
17	*Coliform* (MPN/100mL)	< 0.03	Standard of VN 4882-2001	≤ 1,000
18	*E. coli* (MPN/100mL)	< 0.03	Standard of VN 6846-2001	20

* Vietnam standard/National technical regulation on the limits of heavy metals contamination in food (Vietnam Technical Regulation 8-2: 2011/Medicinal Ministry) [9].

In Table 1, pH of soil was low, total N, K and P were very low. Ca^{2+} was low, Mg^{2+} was very low; Fe was high; Al^{3+} and SO_4^{2-} were low, but they were non-harmful. The sand was rare, clay and flesh were high, and porosity of soil was not much. In general, hill soil is poor in nutrients, so it is necessary to supplement nutrients, especially organic nutrients [10-12].

In Table 2, pH value was average, degree of color was rather high. The heavy metals such as Cd, Pb, As did not appear, the contents of NO_2^-, NO_3^- did not also appear. The elements of Cu, Zn, Fe, Cl^-, SO_4^{2-}, were over limit. The contents of *Coliform* and *E. coli* were low.

3.2 Analyzing Indicators in Carrot Sample

In Table 3, the water content of carrot sample was high. The substance of filament was low. The contents of lipid and protein were lower than limit value, but total glucose was much higher than limit value. For carrot sample that was grown by not using organic fertilizer [8], the heavy metals including As, Pb, Cu, Zn were over limit, Cd did not appear and the concentration of NO_3^- was low. But when carrot was grown by using organic fertilizers (wild herbs such as sensitive plants in Fig. 2, manure fertilizer, biological fertilizer… the heavy metals such as: As, Pb, Cu, Zn were reduced.

In general, the most of analyzed indicators and concentrations showed that the soil and irrigating water samples did not meet plant growing standards [14]. The carrot sample grown by chemical fertilizers also did not meet quality standards as the content of some heavy metals was still higher than the standard (for example, As, Pb, Cu, Zn). However, the carrot sample was grown by us with using organic fertilizers showed that many heavy metals such as: As, Pb, Cu were lower than the allowed standard. This confirmed carrot grown by organic methods produce safer products than inorganic methods [4, 5].

Table 3 Parameters of carrots (Daucus carota L. Apiaceae) [13].

No.	Parameters	Concentrations		Methods	Limitation values*
		No organic fertilizer	Organic fertilizer		
1	Wet degree (%)	88.6	89.12	Standard of VN 6647-2000	80-90
2	Substance of filament (%)	2.02	2.95	AOAC 973.18C-1990	-
3	Total lipid (%)	0.22	0.25	AOAC 871.01-1997	0.5
4	Total glucose (%)	7.52	7.91	AOAC 974.06-1990	1.0
5	Protein (%)	0.29	0.35	AOAC 987.04-1997	0.5
6	As (mg/kg)	0.040	0.01	AOAC 986.15	0.015
7	Cd (mg/kg)	-	-	AOAC 999.11	0.017
8	Pb (mg/kg)	0.045	0.01	AOAC 999.11	0.02
9	Cu (mg/kg)	1.21	0.09	AOAC 999.11	0.1
10	Zn (mg/kg)	126.06	2.61	AOAC 999.11	0.5
11	NO_3^- (mg/kg)	37.51	19.05	Standard of VN 7767 – 2007	≤ 250

* Vietnam standard/National technical regulation on the limits of heavy metals contamination in food (Vietnam Technical Regulation 8-2: 2011/Medicinal Ministry) [9].

Fig. 1 We classify carrots.

Fig. 2 The author presents carrots.

4. Conclusion

Samples of soil, irrigating water and carrots collected from Loc Thanh village showed that the soil samples had low pH; indicators of N, P, K were very low, and Fe^{3+} content was high. This proved that the cultivating soil was poor in nutrients. The irrigating water sample did not contain toxic heavy metals such as Pb, As, Cu but some other indicators exceeded allowed standards. In particular, carrot sample had As, Pb, Cu, Zn higher than the allowed standard; indicators of lipid and protein were lower than the allowed standard; indicators of lipid and protein were lower than the allowed standard. With the method of organic fertilizer [13, 15], it was good, because heavy metals were lower. However, the carrot sample grown by organic method had some indicators lower than allowable standard, such as heavy metals As, Pb, Cu. In brief, carrots are very precious, and necessary because there are many vitamins that can improve the health of men; we must use usually carrots in the meals, especially, carrots can cure the diseases [16].

Conflicts of Interest

We declare no conflicts of interest.

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