Journal of Environmental Science and Engineering A 14 (2025) 217-222
doi:10.17265/2162-5298/2025.05.001

The Heavy Metals Accumulation in the Cultivating Soil, Irrigating Water and Four Kinds of Pumpkin Planted in Bao Lam District, Lam Dong Province

An Nguyen Thi Ngoc
University of Science, Vietnam National University, Ho Chi Minh City 70000, Vietnam

Abstract: Pumpkin was used as vegetables. They are used popularly in the meals or making drinks because pumpkin contains vitamins, fiber, mineral, protein, glucose and lipid. Besides, pumpkin is not only nourishing, but also is precious drugs to cure diseases. In this article, we analyzed some ingredients including heavy metals and NO_3^- in soil, water and pumpkin samples from households in Loc Thanh Village, Bao Lam District, Lam Dong Province (pumpkin of households grown by using chemical fertilizers and pesticides). These samples showed that some heavy metals such as Cu (Copper), Pb (Plumb), Cd (Cadmium) and As (Arsen) exceeded the allowable limits. However, the pumpkin samples that we grew by using organic fertilizers showed a significant reduction in heavy metal content, within the safety limit according to Vietnamese standards. Thus, the using organic farming methods has resulted in better quality products than using chemical fertilizers and pesticides.

Key words: Pumpkin, vegetables, vitamins, minerals, meals.

1. Introduction—Cause of Research

Pumpkin: scientific name: Cucurbita maxima. Du ex Lam, Family: Cucurbitaceae [1]. Pumpkins are the nutrient foods, useful for the health and used as vegetable in the meals. Pumpkin contains a lot of fat, protein, carbohydrates; Fiber; Vitamin A; Vitamin C; Potassium; Copper; Manganese; Vitamin B2; Vitamin E; Iron, magnesium, phosphorus, zinc, folate and many B vitamins. Pumpkin is rich in nutrients but it contains very low calories. Pumpkin is grown appropriately in tropical climates. It can be grown around of year. However, pumpkin should be cultivated in the dry season rather than the cold rainy season, because cold weather will make pumpkin difficult to flower, pollinate and fruit [2-4].

During the process of cultivating pumpkin, using unsafe soil and irrigation water (for example, containing heavy metals) can lead to reduce quality of post-harvest products. One of the reasons makes unsafe products can be contaminated heavy metals. This is harmful to human health. The heavy metals such as Cu (Copper), Cd (Cadmium), Pb (Plumb), Zn (Zinc)… can be found in cultivating soil, fertilizers and chemical pesticides [5].

The harmful effects of some heavy metals can be described as follows:

Toxin of As (Arsenic): When the amount of Arsenic exceeds the allowable limit, it will affect health including kidney, liver, and lung cancer. In addition, it also causes heart diseases such as hypertension...

Toxin of Cd (Cadmium): For humans, Cd is harmful because it can destroy the kidneys. Cd is often contaminated through food and drinking water. When Cd penetrates human organs, it can cause bone fractures or cancer.

Toxin of Cu (Copper): Water containing high copper level or copper water pipes can cause copper contamination in humans or due to eating vegetables and fruits containing high copper content or using algaecides in the lake… Copper content of 1g/1kg body

Corresponding author: An Nguyen Thi Ngoc, professor, research fields: biology and environment.

weight can kill humans and the copper content of 60 to 100 mg/1kg body weight can vomit if it is short or superabundance.

Toxin of Pb (Plumb): Pb can enter the human body through the respiratory tract, skin and through the digestive process. If it stays in cells for a long time, it becomes very harmful, affecting serious health: headaches, spasms, convulsions, fainting, leading to organ damage or death.

Toxin of Zn (Zinc): Zn is the necessary nutrient but when there is an excess of Zn, the cells will be poisoned in the short time. When there is short of Zn, human can have diseases involving reproduction, liver, shin and others illnesses. Zn can also provoke cancer, and cause toxicity to the nervous system and system of immunity.

In this study, we grew pumpkins using organic fertilizers instead of chemical fertilizers, from there, analyzing the heavy metal content in pumpkin to evaluate the effectiveness of organic growing method. The goal of this study is to find a safe growing method for obtaining quality products, safe for environment, and low investment costs.

2. Materials and Methods

2.1 Materials

- Seeds of pumpkins were purchased from Hoa Sen Company.
- The experiment was implemented in Loc Thanh Village, Bao Lam District, Lam Dong Province since November of year 2017 to March of year 2018 [6].
- Pumpkin fruit sample of households surrounding experimental area.

2.2 Methods

Pumpkins were planted by using only organic fertilizers, such as: soil herbs, animal fertilizer, powder lime, ash of husk, biological fertilizer [7-9].

Plantation: The seeds were sowed since November, every year: using manures (containing 50%-60% of humidity) to take care pumpkin plants; cutting top, branches and trims the male flowers of pumpkin plants; pollinating female flowers; harvesting pumpkin fruits after 4 months of cultivating. Here, there are animals such as: rats, snakes, worms… We water every day in the sunny season and two days for one time in the rainy season.

3. Result and Discussion

3.1 Analyzing Indicators in Cultivating Soil and Water Samples

The Table 1 was showed that pH of soil was low; total N (comparing with a fixation), P (Phosphor), K (Kalium) and Mg^{2+} (Magnesium) were very low. However, Al^{3+} (comparing with a fixation) was high; Ca^{2+} (Calcium) and SO_4^{2-} (comparing with a fixation) were low. The sand, clay and flesh were high; the sponginess of soil was not much. Brief, the cultivating soil sample was poor in nutrients so it is necessary to supplement nutrient, especially, organic nutrients.

In the Table 2, pH value was average; the degree of color was high; the heavy metals such as Cu, Pb, Cd, Zn were over limit; the elements of SO_4^{2-} and PO_4^{3-} (comparing with a fixation) were high but NO_2^- (comparing with a fixation) and NH_4^+ (comparing with a fixation) were low; NO_3^- was high; Coliform and E. Coli were low.

3.2 Analyzing Indicators in Pumpkin Samples

The Table 3 exhibited that: NO_3^- content of Delica pumpkin (Column 4) was highest and round pumpkin was lowest. However, NO_3^- contents of 4 types of pumpkin were under limit value.

Wet degree in round pumpkin was highest and all of the pumpkin types were higher than limit value.

For Lipid content, it was highest in long pumpkin sample and was lowest in round pumpkin sample.

Protein in Delica pumpkin was highest and in round pumpkin was lowest.

Glucose in Haulo pumpkin was highest, and in round pumpkin was lowest.

For analyzed result of the heavy metals: all of 4 pumpkin samples, concentration of Pb and Cu were over limit value. Zn content of Haulo pumpkin was highest and round pumpkin was lowest

Table 1 Parameters of cultivating soil sample.

N^0	Parameters		Concentrations	Methods	Limitation values*
1	pH (H_2O) 1:5		5.01	Standard of VN 5979-155	6.5-8.5
2	pH (KCl) 1:5		4.35		6.0
3	EC (μS/cm)		7.9	Standard of VN 6650-2000	10-20
4	N total (%)		0.090	Standard of VN 6440-2000	0.1-0.15
5	P total (%)		0.036	AOAC 990.08-2000	0.06-0.08
6	K total (%)		0.015		0.3-1.5
7	Al^{3+} exchange (mg/100g)		9.16	Standard of VN 6496-1999	0.1
8	Ca^{2+} (mg/100g)		0.088		4.0-6.0
9	Mg^{2+} (mg/100g)		0.077		2.0-3.0
10	Emery	Sand (%)	22.4	AOAC 2000	-
		Clay (%)	39.8		
		Flesh (%)	37.8		
11	SO_4^{2-} (mg/100g)		0.861	Standard of VN 6656-2000	1.0-2.0

*According to Vietnam standard/national technical regulation on the limits of heavy metals (Vietnam Technical Regulation 8-2: 2011/Medicinal Ministry) [10].

Table 2 Parameters of water sample.

N^0	Parameters	Concentrations	Methods	Limitation values*
1	Cu (mg/l)	1.93	ACIAR-AAS 015-2007	0.03
2	Pb (mg/l)	2.72	ACIAR-AAS 015-2007	0.01
3	Cd (mg/l)	0.3	ACIAR-AAS 004-2007	0.02
4	As (mg/l)	0.4	ACIAR-AAS 001-2007	0.2
5	Zn (mg/l)	1.35	ACIAR-AAS 019-2007	0.01
6	Fe (mg/l)	0.62	Standard of VN 6177-1996	0.5
7	Al (mg/l)	1.1	ISO 12020-1997	0.5
8	Color (Pt/Co)	8.0	Standard of VN 6158-1996	1.0
9	pH H_2O	7.22	Standard of VN 6492-2000	6.5-8.5
10	Degree of muddy, dirty (NTU)	9.0	Standard of VN 6158-1996	2.0
11	Cl^- (mg/l)	2.28	Standard of VN 6194-1996	250
12	PO_4^{3-}	0.14	Standard of VN 6178-1996	0.1
13	SO_4^{2-}	1.24	Standard of VN 6200-1996	0.5
14	N-NO_2^- (mg/l)	0.02	Standard of VN 6178-1996	0.05
15	N-NO_3^- (mg/l)	0.80	Standard of VN 6180-1996	0.05
16	N-NH_4^+ (mg/l)	0.05	Standard of VN 5988-1995	0.3
17	Coliform (MPN/1,000 l)	< 0.03	Standard of VN 4882-2001	≤1,000
18	E. Coli (MPM/1,000 l)	< 0.03	Standard of VN 6846-2001	20

*According to Vietnam standard/national technical regulation on the limits of heavy metals (Vietnam Technical Regulation 8-2: 2011/Medicinal Ministry) [10].

Table 3 Parameters of pumpkin with chemical fertilizers.

N^0	Parameters	Concentrations				Methods	Limitation values*
		Long pumpkin	Delica pumpkin	Hau Lo pumpkin	Round pumpkin		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	NO_3^-(mg/kg)	157.47	351.42	142.82	81.55	AOAC & TC 2000	400
2	Wet degree (%)	90.25	90.60	93.8	95.8	10TCN 302-97	80-90
3	Lipid (%)	0.76	0.53	0.30	0.23	AOAC 87.01-1997	0.5
4	Protein (%)	2.23	2.45	1.35	0.74	AOAC 987.04-1997	0.5
5	Glucose total (%)	7.68	11.82	13.40	5.77	AOAC 974.06-1990	1.0
6	Substance of filament (%)	1.51	0.95	1.06	0.66	AOAC973.18C-1990	-
7	Pb (mg/kg)	0.04	0.04	0.04	0.04	ACIAR-AAS.015-2000	0.02
8	Cu (mg/kg)	2.10	2.79	2.87	2.64	ACIAR-AAS.007-2007	0.1
9	Zn (mg/kg)	14.39	27.33	29.13	13.23	ACIAR-AAS.019-2008	0.5
10	Cd (mg/kg)	0.02	0.02	0.02	0.02	ACIAR-AAS.004-2007	0.017
11	As (µg/kg)	<0.2	<0.2	<0.2	<0.2	ACIAR-AAS.001-2007	0.015

*According to Vietnam standard/national technical regulation on the limits of heavy metals (Vietnam Technical Regulation 8-2: 2011/Medicinal Ministry) [10].

Table 4 Parameters of pumpkin cultivated with organic fertilizer, not chemicals, not pesticides [5].

N^0	Parameters	Concentrations				Methods	Limitation values*
		Long pumpkin	Delica pumpkin	Haulo pumpkin	Round pumpkin		
1	NO_3^-(mg/kg)	140.2	311.12	118.21	69.25	AOAC & TC 2000	≤400
2	Wet degree (%)	92.47	97.84	95.4	95	10TCN 302-97	80-90
3	Lipid (%)	0.87	0.64	0.42	0.35	AOAC 87.01-1997	0.5
4	Protein (%)	2.30	2.55	1.42	1.08	AOAC 987.04-1997	0.5
5	Glucose total (%)	7.88	12.15	14.12	7.88	AOAC 974.06-1990	1.0
6	Substance of filament (%)	1.62	1.11	1.22	0.91	AOAC 973.18C-1990	-
7	Pb (mg/kg)	0.01	0.01	0.1	0.01	ACIAR-AAS.015-2000	0.02
8	Cu (mg/kg)	0.01	0.02	0.03	0.02	ACIAR-AAS.007-2007	0.1
9	Zn (mg/kg)	1.49	3.36	4.11	0.01	ACIAR-AAS.019-2008	0.5
10	Cd (mg/kg)	0.002	0.002	0.002	0.012	ACIAR-AAS.004-2007	0.017
11	As (µg/kg)	0.01	0.011	0.01	0.012	ACIAR-AAS.001-2007	0.015

*According to Vietnam standard/national technical regulation on the limits of heavy metals (Vietnam Technical Regulation 8-2: 2011/Medicinal Ministry) [10].

Cd and As contents of the pumpkin samples: same and over limit value.

At the Table 4, the pumpkin plants were cultivated without using chemical fertilizer or pesticides. They were taken care by applying the organic fertilizers such as animal fertilizer, powder lime ash of husk, biological fertilizer, algae, wild herbs (for examples Siam weed (*Eupatorium odoratum* L), Mexican Daisy (*Tridax procumbens* L), Kongolala (*Eclipta alba* Hassk). The result of analysis the pumpkin fruit sample showed that NO_3^- content of 4 pumpkin samples were lower; glucose total was higher. Especially, the heavy metal contents such as Pb, Cu, Zn, Cd, As were lower, but content of Zn was over limit value [9, 11].

4. Conclusion

Soil samples, irrigation water and pumpkin samples grown by households in Loc Thanh Village, Bao Lam

District, Lam Dong Province, using chemical fertilizers and pesticides were analyzed. These samples contained some metal content such as Cu, Pb, Cd and As... higher than the allowable limit. Meanwhile, the analysis of pumpkin samples grown by using organic fertilizers showed that the content of these heavy metals was significantly reduced and lower than allowable limit. This has shown the benefits of organic farming in agricultural production [7]. Pumpkins are necessaries for men, nutritious, but they must no heavy metals [8].

Contribution of the Author

An Nguyen Thi Ngoc: The author observed, investigated, searched everywhere about the trees, controlled the experiments, studies, wrote, prepared and presented a report.

Benefit Conflict

We declare no conflict of interest.

References

[1] Ho, P. H. 1991-1993. *Book: "The Trees of Vietnam Country."* Montreal: Montreal Publishing, 721.

[2] Thi, T. K., and Tran, N. H. 2002. *The Technique to Plant the Clean Vegetables*. Ho Chi Minh City: Agricultural Publishing, 4-6.

[3] Tam, P. T. M. 2007. *A Study to Effluence When Everyone Uses the Area Fertilizer to an Output and a Change of a Nitrate Quality in the Pe-tsai.* Ho Chi Minh City: Agricultural Publishing, 31-32.

[4] Uyen, N. V. 1995. *Garden of Clean Vegetables*. Ho Chi Minh City: Agricultural Publishing, 5, 10, 12, 40.

[5] Agriculture Board and National Research Council. 1968. *Effect Pesticide on Fruit and Vegetable Physiology*, 8.

[6] Bao Lam District. 2015. *Document about a Report of Bao Lam District, Lam Dong Province*, 5-9.

[7] Lee, S. L. 1994. *From Garden to Kitchen: Grow Your Own Fruit and Vegetables*. Singapore: National Library Board Singapore, 15.

[8] An, N. T. N. 1996. *Book: "The Necessaries Trees on Garden in the South of Vietnam."* Ho Chi Minh City: Agricultural Publishing, 18-20.

[9] An, N. T. N. 2010. *Book: "The Trees to Cure the Diseases and an Environment."* Ho Chi Minh City: Agricultural Publishing, 30-31.

[10] Medicinal Ministry. 2011. *Book: "National Technical Regulation on the Limits of Metals Contamination in Food*", 4-8.

[11] Hoa, L. T. N., and An, N. T. N. 1996. *A Production of Vegetables in Hoc Mon District*. Ho Chi Minh City: Agricultural Publishing, 28-30.

Appendix

Fig. 1 The round pumpkin.

Fig. 2 The long pumpkin.

Fig. 3 Flowers of pumpkin.