

# HEAVY METAL RESIDUES IN COCONUT AND SOIL FROM COCONUT ORCHARDIN RATCHABURI, THAILAND

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**Abstract** - This research aimed to investigate heavy metal residues in coconut and soil from coconut orchard. Cd, Cr, Cu, Fe, Pb and Zn were determined in coconut and soil from coconut orchard. The result showed that Cd, Cr, Fe, Pb and Zn were found in coconut meat and coconut juice. Cu was also found in coconut meat but was not found in coconut juice. For soil, Cu, Fe, Pb and Zn were detected. Interestingly, 29.03%, of coconut meat samples were found to have higher metal concentration than the allowable limit set by WHO for Fe in food. Moreover, in coconut juice samples, the concentration of Cr, Pb and Cd found 25.80%, 96.77% and 100% of coconut juice samples, respectively which were higher than the permissible limit recommended by WHO and Thailand. The heavy metal residues in coconut and soil might derive from pesticides and chemical fertilizer. Therefore, organic farming can be the best alternative agriculture system for agriculturist to reduce harmful contaminant in agricultural product and environment which safe for consumer.

**Index Terms** - Heavy metal residues, Coconut meat, Coconut juice, Coconut Orchard

## I. INTRODUCTION

Thailand has been developing on base an agricultural country. Large amount of pesticides(fungicide, herbicide, insecticide) has been imported to Thailand for agriculture[1]. The increasing of imported pesticides, herbicides and chemicals verified that agricultural area in Thailand has been using pesticide and chemical fertilizer for long time. Agricultural land that often use pesticide and herbicide and chemical fertilizer cancause the contamination of pesticides, herbicides and chemical substances in soil and agriculture products. Inappropriate use of pesticides and chemical fertilizer have been considered to be the most probable reason of contamination in environment. Heavy metals are well known that they are commonly used as an ingredient in pesticides and chemical fertilizer. Thus, soil and agricultural product may be contaminated with heavy metals. Due totheir hardly degradation and long half-life, heavy metals are extremely persistent in environment. Human and animal might be exposed heavy metals through food chain [2].The adverse health effects of heavy metals were well known such as allergies, hyperpigmentation and induction of cancer.

Ratchaburi province is predominantly an agricultural province. Pesticides and herbicides were used in agricultural area to protect insect, fungi and weed. As well as, chemical fertilizer was applied to increase agricultural product. Therefore; heavy metals may contaminate in soil and agricultural product. Coconut is the one of economic crops of Ratchaburi province.Hence, coconut orchard was chosen as the study area which need to consider the contamination of pesticides and heavy metals in soil and coconut that might be harm to human health. Hence, this study aim to investigate heavy metal residues (Cadmium, Chromium, Copper, Iron, Lead and Zinc) in coconut

meat, coconut juice and soil from coconut orchard.The observed concentrations of heavy metal residues, in coconut meat, coconut juice and soil were compared with the recommended limit as established by international and national regulation.

## II. METHODS

### A. Sample collection and preparation

31 soil samples were collected throughout the coconut orchard followed by soil sampling procedure and then dried for 3-4 days [3]. Coconut samples were also collected by 3 coconuts from each coconut trees at the same point of soil sampling.Coconut meat from 3 coconutswhich were collected from each coconut tree were pooled together as 1 sample. Coconut juice from 3 coconuts which were collected from each coconut tree were pooled together as 1 sample. 31 coconut meat samples was dried by oven before digestion. For digestion, each dried soil sample was ground and sieved through 200 mesh size.Each dried coconut meat sample was ground and sieved through 60 meshes.0.5 g of each dried fine soil sample/0.5 g of each dried coconut meat was weighted. Then, 0.5 ml of HClO<sub>4</sub>/HNO<sub>3</sub> (2:1) was added in eachsampleand left overnight. Samples were heated at 85±5 °C until the brown smoke disappeared. Afterward, digestion was continued at 128 ±3 °C for 3-4 hrs. Then, temperature was gradually increased to 200±20 °C and digested until the final volume of sample was 1 ml. Then, samples were left overnight. 5 ml of deionized water was added to samples and then, samples were filtratedthroughpaper filter Whatmanno.42. The volume of samples were adjusted by adding deionized water until the volume was 25 ml [4].

### B. Analytical method for Heavy metal concentration

Soil samples, coconut meat samples and coconut juice samples from section A were determined the

concentration of heavy metals (Cd, Cr, Cu, Fe, Pb and Zn) by atomic absorption spectrometry (GBC, Avanta Σ system 2000/3000).

### III. RESULTS AND DISCUSSIONS

#### A. Heavy metals residues in coconut

Cd, Cr, Cu, Fe, Pb and Zn were determined in coconut meat samples and coconut juice samples. The determination heavy metal residues result showed that Cd, Cu, Cr, Fe, Pb and Zn were found in coconut meat as shown in Fig. 1. The concentration of heavy metals determined were in sequence Fe > Zn > Pb > Cu > Cr > Cd. The concentration of Cd, Cr, Cu, Fe, Pb and Zn were found in range of 0.01-0.18 mg/kg ( $X = 0.08 \pm 0.04$  mg/kg), 0.04-0.98 mg/kg ( $X = 0.41 \pm 0.23$  mg/kg), 0.21-0.84 mg/kg ( $X = 0.46 \pm 0.15$  mg/kg), 7.55-29.75 mg/kg ( $X = 13.65 \pm 4.64$  mg/kg), 0.28-0.41 mg/kg ( $X = 0.33 \pm 0.08$  mg/kg) and 1.58-3.86 mg/kg ( $X = 2.23 \pm 0.51$  mg/kg, respectively.

The concentration of Cd, Cr, Cu, Pb and Zn residues found in coconut meat were lower than the allowable limits recommended by world health organization (WHO) and Thailand for Cd, Cr, Cu, Pb and Zn in food whereas 29.03% of coconut meat samples were found to have higher metal concentration than the permissible limit set by WHO for Fe in food, respectively as shown in table 1 [5-6]. For coconut juice, Cd, Cr, Fe, Pb and Zn were found but Cu was not detected as shown in Fig. 2. The concentration of Cd, Cr, Fe, Pb and Zn were ranging from 0.02-0.03 mg/l ( $X = 0.02 \pm 0.01$  mg/l), 0.03-0.12 mg/l ( $X = 0.05 \pm 0.01$  mg/l), 0.10-0.21 mg/l ( $X = 0.16 \pm 0.031$  mg/l), 0.04-0.22 mg/l ( $X = 0.14 \pm 0.04$  mg/l) and 0.12-0.16 mg/l ( $X = 0.14 \pm 0.01$  mg/l), respectively. However, the concentration of heavy metals residue found in coconut juice samples in this study was lower

than other study [7]. Surprisingly, 100 % of coconut juice samples (31 coconut juice samples) found Cd residues exceed the tolerable limits established by WHO (0.005 mg/l) and Thailand (0.005 mg/l) for Cd in drinking water as shown in Table 2 [8-9]. The concentration of Pb residues in coconut juice samples found 100 % of coconut juice samples were above than the permissible limit recommended by WHO which set as 0.05 mg/l for Pb in drinking water as shown in Table 2 [8-9]. The concentration of Cr residues in coconut juice samples found 25.80 % of coconut juice samples were higher than WHO and Thailand standard which set as 0.05 mg/l for Cr in drinking water as shown in Table 2 [8-9]. Cd and Pb have been recognized as a major public health risk. Cd and Pb are the strong toxic metals at even low concentrations. Cd has been known as a cancer induction substance. Pb is known that affecting the central nervous, hematopoietic, hepatic and renal system producing serious disorders. Therefore; it is necessary to be careful and avoid to consume coconut juice contaminated with Cd and Pb.

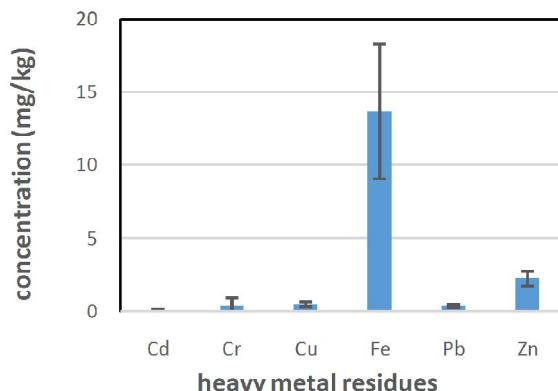


Fig. 1 Heavy metal residues in coconut meat.

Table 1 Heavy metal residues in coconut meat samples.

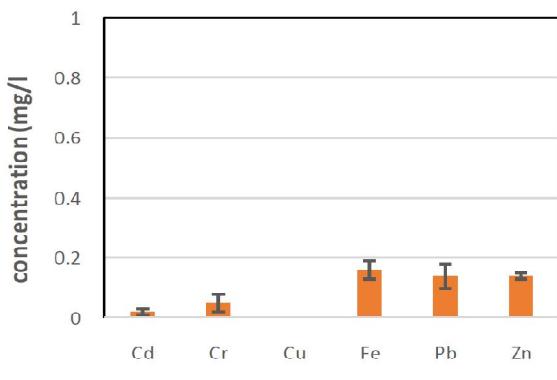
Remark : \* Above WHO and Thailand standard

\*\* Above WHO standard

Sample no.	concentration (mg/kg of coconut meat)					
	Cd	Cr	Cu	Fe	Pb	Zn
1	0.17	0.24	0.67	15.14**	ND	2.81
2	0.08	0.46	0.84	14.64	0.40	3.69
3	0.13	ND	0.76	10.75	0.38	3.86
4	0.08	ND	0.62	11.31	0.32	1.99
5	0.06	ND	0.32	11.49	0.41	2.37
6	0.10	ND	0.53	13.33	0.31	2.37
7	0.05	ND	0.65	19.33**	ND	2.42
8	0.06	ND	0.53	15.25**	0.28	2.49
9	0.04	0.37	0.28	17.46**	0.41	2.16
10	0.05	0.38	0.51	9.73	ND	2.49
11	0.05	0.3	0.39	10.93	0.17	2.08
12	0.14	0.58	0.46	15.74**	ND	2.14
13	0.06	0.98	0.61	25.07*	ND	1.96
14	0.09	0.74	0.64	17.84*	ND	2.85
-	-	-	-	-	-	-

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15	0.18	0.25	0.3	7.81	ND	2.11
16	0.07	0.33	0.5	12.04	ND	2.37
17	0.08	ND	0.5	16.08	ND	2.29
18	0.08	0.37	0.33	9.89	ND	2.25
19	0.09	0.19	0.55	12.56	ND	2.25
20	0.10	0.49	0.35	9.41	ND	1.98
21	0.05	0.51	0.35	10.53	ND	1.85
22	0.08	0.72	0.43	15.15**	ND	1.84
23	0.07	0.22	0.52	10.07	ND	1.85
24	0.07	0.15	0.42	13.5	ND	1.74
25	0.01	0.04	0.41	14.12	ND	1.69
26	0.15	ND	0.3	7.55	ND	1.72
27	0.09	ND	0.46	10.29	ND	1.93
28	0.03	ND	0.32	29.75*	ND	1.70
29	0.06	ND	0.24	11.27	ND	2.11
30	0.09	ND	0.33	11.15	ND	1.58
31	0.03	ND	0.21	13.83	ND	2.22
WHO	3	-	-	15	2	-
Thailand	2	-	20	20	1	100



**Fig. 2 Heavy metal residues in coconut juice**

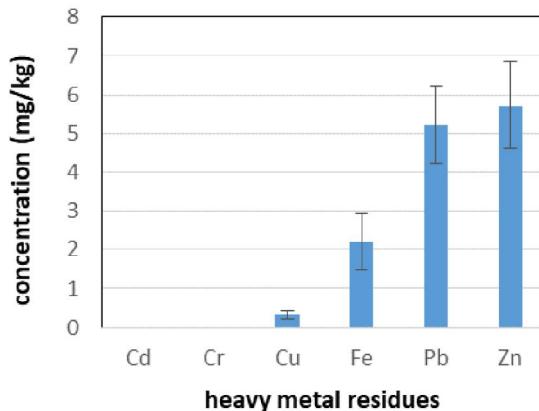
**Table 2 Heavy metal residues in coconut juice samples.**  
Remark : \* Above WHO and Thailand standard  
\*\* Above WHO standard

Sample no.	concentration (mg/L)					
	Cd	Cr	Cu	Fe	Pb	Zn
1	0.03*	0.04	ND	0.10	0.11*	0.14
2	0.03*	0.04	ND	0.11	0.06*	0.14
3	0.03*	0.04	ND	0.16	0.07*	0.13
4	0.03*	0.03	ND	0.13	0.11*	0.10
5	0.03*	0.09*	ND	0.14	0.10*	0.13
6	0.03*	0.03	ND	0.19	0.13*	0.15
7	0.03*	0.03	ND	0.14	0.22*	0.15
8	0.03*	0.03	ND	0.14	0.19*	0.14
9	0.03*	0.12*	ND	0.21	0.15*	0.15
10	0.02*	0.01	ND	0.17	0.22*	0.14
11	0.02*	0.05	ND	0.18	0.16*	0.15
12	0.02*	0.07*	ND	0.16	0.22*	0.16
13	0.03*	0.08*	ND	0.17	0.04**	0.13
14	0.03*	0.01	ND	0.17	0.16*	0.15
15	0.03*	0.05	ND	0.17	0.16*	0.14
16	0.03*	0.04	ND	0.14	0.10*	0.13
17	0.03*	0.01	ND	0.19	0.20*	0.13
18	0.03*	0.12*	ND	0.16	0.17*	0.16
19	0.03*	0.10*	ND	0.23	0.12*	0.13
20	0.03*	0.03	ND	0.16	0.16*	0.14
21	0.03*	0.02	ND	0.20	0.11*	0.16
22	0.03*	0.09*	ND	0.16	0.12*	0.14
23	0.03*	0.06*	ND	0.18	0.14*	0.13
24	0.03*	0.04	ND	0.13	0.12*	0.13
25	0.03*	0.03	ND	0.18	0.15*	0.14
26	0.03*	0.04	ND	0.17	0.17*	0.12
27	0.03*	0.04	ND	0.16	0.13*	0.13
28	0.03*	0.04	ND	0.16	0.17*	0.15
29	0.03*	0.05	ND	0.16	0.14*	0.15
30	0.03*	0.03	ND	0.21	0.14*	0.15
31	0.03*	0.03	ND	0.16	0.14*	0.16
WHO	0.003	0.05	2	-	0.01	-
Thailand	0.005	0.05	1	0.3	0.05	5

\*\* Above WHO standard

**B. Heavy metals residues in soil from coconut orchard.**

Cu, Fe, Pb and Zn were found in soil from coconut orchard whereas Cd and Cr were not detected in soil from coconut orchard as shown in fig. 3. Heavy metal residues concentrations in soil can be presented in descending order as follows: Zn>Pb> Fe > Cu. The concentration of Cu, Fe, Pb and Zn were in range of 0.03-0.68 mg/kg ( $\bar{X} = 0.33 \pm 0.18$  mg/kg), 1.14-3.74 mg/kg ( $\bar{X} = 2.20 \pm 0.73$  mg/kg), 3.27-7.27 mg/kg ( $\bar{X} = 5.22 \pm 1.00$  mg/kg) and 3.87-8.74 mg/kg ( $\bar{X} = 5.71 \pm 1.13$  mg/kg), respectively. All heavy metal residues found in soil samples (Cu, Fe, Pb and Zn) do not exceed the allowable limits established by international and national regulations as shown in Table 3 [10-11].



**Fig. 3 Heavy metal residues in soil form coconut orchard.**

**CONCLUSION**

The heavy metal residues found in coconut meat, coconut juice and soil might derive from pesticides, herbicides chemical fertilizer. Moreover, some heavy metal residues were above the limitation of threshold value recommended by international and national regulation such as Pb and Cd. Even though, they were found at low concentration but their toxic accumulation in human body should be

concerned. Continuous consumption of food, fruit, vegetable and water that was contaminated with heavy metal as a result of the accumulation of heavy metal in body and harmful to health.

Therefore, organic farming is an alternative agriculture system for agriculturist by using organic fertilizers (e.g. composting) and organic pesticides which can reduce the contamination in environment and agricultural products. Moreover, human are safe from the risk of food, fruit, vegetable and water consumption.

**Table 3 Heavy metal residues in coconut juice samples.**  
Remark : \* Above WHO and Thailand standard

Sample no.	concentration (mg/kg of soil)					
	Cd	Cr	Cu	Fe	Pb	Zn
1	ND	ND	0.47	2.05	3.74	5.1
2	ND	ND	0.33	ND	4.17	4.21
3	ND	ND	0.51	1.86	5.87	5.15
4	ND	ND	0.55	3.19	3.89	4.1
5	ND	ND	0.51	2.35	3.43	7.21
6	ND	ND	0.29	2.09	5.12	5.59
7	ND	ND	0.68	2.56	5.35	6.03
8	ND	ND	0.36	2.37	4.79	4.8
9	ND	ND	ND	3.28	3.27	5.14
10	ND	ND	0.26	1.86	5.07	4.37
11	ND	ND	0.3	1.54	5.06	6.23
12	ND	ND	0.1	1.72	4.94	4.64
13	ND	ND	0.03	1.33	3.36	3.87
14	ND	ND	0.2	1.14	6.14	4.39
15	ND	ND	ND	1.87	4.57	5.69
16	ND	ND	ND	1.36	4.12	4.96
17	ND	ND	ND	1.72	5.71	5.44
18	ND	ND	ND	1.36	4.97	7.56
19	ND	ND	ND	ND	5.61	5.36
20	ND	ND	ND	3.22	5.62	6.67
21	ND	ND	ND	ND	5.12	5.46
22	ND	ND	ND	2.41	5.36	5.2
23	ND	ND	ND	2.59	7.27	7.34
24	ND	ND	ND	2.88	6.47	7.19
25	ND	ND	ND	3.74	6.29	5.9
26	ND	ND	ND	3.38	6.03	5.56
27	ND	ND	ND	2.93	6.12	6.53
28	ND	ND	ND	1.27	6.37	8.74
29	ND	ND	ND	1.39	6.36	5.53
30	ND	ND	0.06	2.63	6.22	7.18
31	ND	ND	ND	1.6	5.5	5.93
European	3	150	140	-	300	<50
Thailand	0.15	80	45	-	55	70

Remark : \* Above WHO and Thailand standard

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