The Effect of Washing and Processing of PB-Polluted Vegetables towards their Levels of PB and Vitamin C

Hening Widowati, Widya Sartika Sulistiani, Agus Sutanto, Miftachul Huda, Arieff Salleh Rosman

This research tried to find out the effect of washing and processing of Pb-polluted kale in Metro, Lampung, Indonesia, where the farm is by the highway, use heavy-metal-contained fertilizer and pesticide. Plantedfor 20 days, various washing treatments were given (once, twice, and 3 times, 5 second each: unwashed as a control); and processing treatments (2 minutes steamed, 2 minutes boiled, 3 minutes stir-fried, and unprocessed as a control). The level of Pb and Vitamin C were examined using UV-Vis spectrophotometer and Column Chromatography in Chemical Analysis, Laboratory University of Muhammadiyah Malang. The Univariate Analysis of Variance showed a significant result (p<0.00) which indicates that both treatments decrease the Pb and Vitamin C within the kale. Post Hoc Multiple Comparisons and Duncan also showed a significant result. Regression Test showed that various treatments gave a different contribution to Pb and Vitamin C level. Together, the treatments reduce 94.7% of Pb level; meanwhile, the washing only contributes 54.7%, processing only 25.6%, and the rest 19.7% is determined by vegetables types and parts. Together, both treatments reduce 97.5% of Vitamin C level; the washing only contributes 0%, processing only 26.6%, and the rest 73.4% is determined by the type and parts of vegetables.

Keywords : About four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

Providing food that have good quality and give the best benefit to our health is very important since it affect the quality of the human being who eats that. Islamic doctrine tells people to pay attention to their food. The food should be halal (halal in ingredients and way to earn it) and good in quality (delicious, healthy, free from excrement, and save to consume). Based on those criteria, the food should fulfilled the nutrition needs, save and healthy, and proportional in quantity.

Vegetables are one of important food type for human body, especially in the physiological process. Vegetables provide vitamins, minerals, water, and fiber that play very important role in the physiological process. The presence of vegetables allows a good digestion process so the nutrition can be absorbs optimally.

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Besides that, the vitamins within the vegetables also play an important role in human body. They keep our vitality, and as antioxidant, they protect our bodies from free radicals and carcinogenic substances. Therefore, vegetables become daily needs, unnegotiable. Vegetables are even better if they are prepared in fresh condition and hygienic.

The research conducted by Widowati [1]; [2];[3];[4],[5];[6], revealed that they are different level of protein, vitamin A and vitamin C within the vegetables based on where there were planted on, a polluted or clean area. That research also shows that heavy metals pollution affects the nutrition level within the vegetables. Furthermore, it is important to find out whether washing and processing the vegetables will give a significant impact to the level of Pb absorbed as well as preserve the vitamin C within the vegetables. Considering the mechanism of carcinogenic materials within an organism as explained by [7], which antioxidant will affect the mechanisms, those materials will cause severalchanges inside the organism. Moreover, [8] also explained that antioxidants would act as a substance that inhibits the oxidative harm of the targeted molecules. So many factors affect the level of protein and free radicals within the plants [9]. The loss of vitamin within the plants indicates there are an antioxidants mechanism takes place.

It is known that tolerant species are equipped by defense mechanism that related to antioxidant cell and enzyme. The mechanism protects several vital physiological process in order to avoid damages caused by reactive oxygen, which produced by heavy metal stress condition [10]. There are reports of oxidant enzyme hyperactivity and the accumulation of antioxidant cell in some plants that stressed by Cu and Pb pollution [11]. Some Cu-resistant species are found both in non-contaminated and contaminated areas [12]. Based on [13], Cu-tolerant is connected to the function of glutathione as it is an antioxidant substance that can fight the free radicals and peroxide hydrogen formed by Cu excess.

Once absorbed by the plants, Cu will affect, directly or indirectly,the growth and metabolism of the plants [14]. The effects depend on the concentration, minerals type, pH number, and plant species. The highest the concentration is, and the longer the exposure is, the effect of Pb will get more severe. In some cases, low concentration of this metal actually triggers the metabolism [15].

However, the excess of Pb can: (a) affect the seed germination; (b) cause the slow growth, chlorosis, and root destruction [14]; (c) reduce the stomatal conductance and stomata size (even it also can increase the number of stomata) [16]; [d] lower some enzyme activities [15]; (e) obstruct the photosynthesis since there are disruption in electron transfer [14]; (f) lower the respiration; and (g) interfere the minerals and water, change the hormone status as well as affect the membrane permeability and structure [14].

Ames in [7], showed that plants can protect themselves from injuries caused by oxygen oxidative process around them by producing a lot of ß-carotene. This can decrease the endogen carcinogenic formation. The potency of carcinogenic activities of some heavy metals especially Ni and Cd are known already (Furst, 1977; Sunderman, 1977, in [7]).

Free radicals can destruct cell membrane, change the DNA, change the chemical substance inside the body, increase the cancer risk, and deactivate the protein. In the other hand, antioxidant substances (vitamin A, vitamin C, vitamin E, zinc and selenium) can improve the cells, neutralize the free radicals, which naturally produced by biochemical reaction within the body. Vitamin C prevents oxidation in liquid-based molecules, while vitamin E dissolve in lipid works in lipid cells and cholesterol circulation.

Based on the fact that heavy metal pollution has spread everywhere and affect vegetables habitat as well as get into their tissues, this research than conducted in order to: 1) finding out the effect of washing and processing towards heavy metals content and nutrient level (vitamin C); and 2) finding out how much those treatment contribute (together and partially) in lowering the heavy metal and vitamin C content. This research will gain some information and knowledge to be applied. This information, in the end, will be a practical guide to solve the pollution effect in vegetables so they can be safely consumed. Furthermore, people can also maintain the nutrient level so the main function of vegetables, such as; healthy food, vitamin source, antioxidant, and keeping a good digestion process; can be preserved.

II. METHODS

The research conducted an experiment of Pb-polluted kale washing and processing variation.

Factor 1. Washing factor	Factor 1. Processing						
	Replication 1				Replication 2		
	A	B	C	D	A	B	C	D
(W0) unwashed	AW0U1	BW0U1	CW0U1	DW0U1	AW0U2	BW0U2	CW0U2	DW0U2
(W1) 1 time washing	AW1U1	BW1U1	CW1U1	DW1U1	AW1U2	BW1U2	CW1U2	DW1U2
(W2) 2 times washing	AW2U1	BW2U1	CW2U1	DW2U1	AW2U2	BW2U2	CW2U2	DW2U2
(W3) 3 times washing	AW3U1	BW3U1	CW3U1	DW3U1	AW3U2	BW3U2	CW3U2	DW3U2

Factor 1: vegetable processing

A. Fresh, unprocessed

B. Steamed (in non-magnetic stainless steel saucepan for 5 minutes after 2 minutes the water was boiling)

C. Boiled (in non-magnetic stainless steel saucepan for 2 minutes in boiling water)

D. Stir-fried (in hot pan with a bit of cooking oil for 3 minutes)

Factor 2: washing (0; 1; 2; 3 times of washing 5 second each) (W0; W1; W2; W3)

U1 Replication 1; U2 Replication 2

The treatments then followed by analysis of Pb content and vitamin C level in Chemical Analysis Laboratory, University of Muhammadiyah Malang. Statistically, hypothesis test was done quantitativelyusing Univariate Analysis of Variance, Post Hoc Multiple Comparisons and Duncan. SPSS program was used to reveal the effect of washing and processing variation, difference between treatments, and the contribution number of those treatments variation in decreasing the Pb and vitamin C content.

III. RESULTS AND DISCUSSION

Description of Washing and Processing Effect to Pb Content
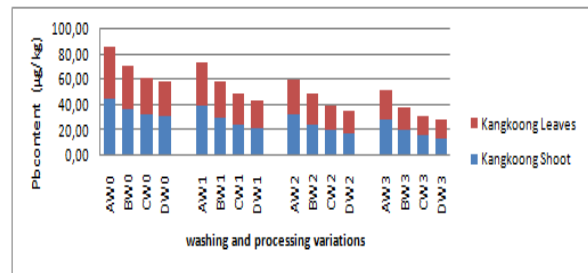

Figure 1. Pb Content of Kale Shoot and Leaves in Washing and Processing Treatments Variations

Description of Various Processing of Unwashed Samples Effect to Pb Content
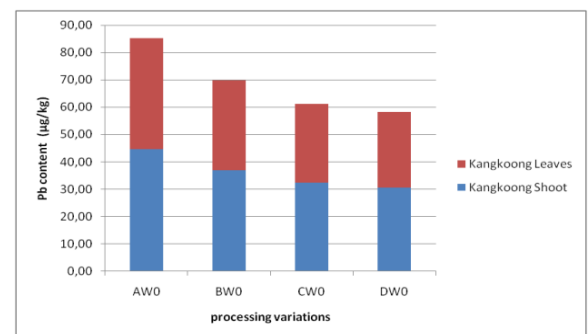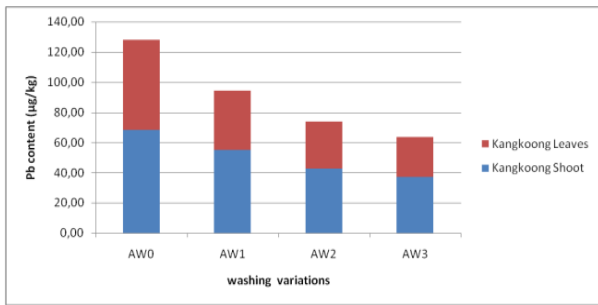

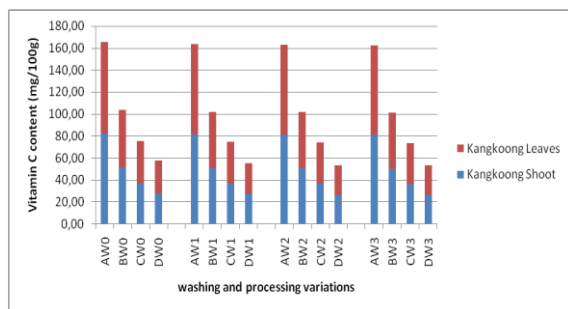**Figure 2. Pb Content of Kale Shoot and Leaves in Unwashed Processing Variations**

Description of Washing Variation of Unprocessed Samples Effect to Pb Content

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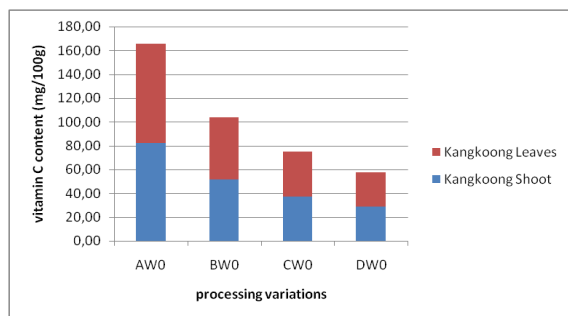**Figure 3. Pb Content of Kale Leaves in Unprocessed Washing Variations**

Those figures (Fig. 1, 2, 3) showed that the variation of washing and processing treatments are likely decrease the Pb content.

Description of Washing and Processing Effect to Vitamin C Content

Figure 4. Vitamin C Content of Kale Shoot and Leaves in Washing and Processing Variations

Description of Various Processing of Unwashed Samples Effect to Vitamin C content

Figure 5. Vitamin C Content of Kale Shoot and Leaves in Unwashed Processing Variations

Description of Various Washed Unprocessed Samples Effect to Vitamin C Content
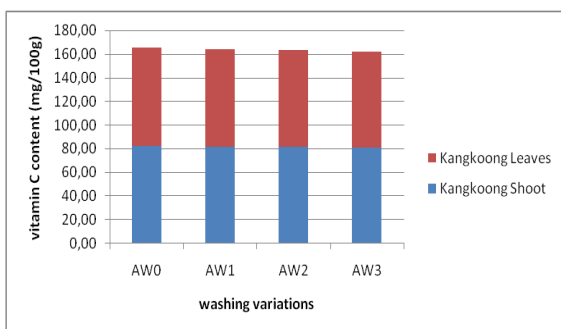
Figure 6. Vitamin C Content of Kale Leaves in Washed Unprocessed Variations

Those Figures (Fig. 4, 5, 6) showed that washing variation alone does not affect the vitamin C content, whilst processing variation alone affects it.

Data Analysis and Hypothesis Test Results
The results of SPSS analysis are shown below:

Y EFFECT	SIGNIFICANT EFFECT (ANOVA)			% CONTRIBUTION EFFECT (REGRESSIONS)			SIGNIFICANT REGRESSIONS	
	PARTIAL		INTERACTIONS	INTERACTIONS	PARTIAL			
	X1	X2	X1-X2	X1-X2	X1	X2	X1	X2
Y2 (Pb content)	.000**	.000**	.010*	94.3	54.7	25.6	.000**	.000**
Y5 (vitamin C content)	.006**	.00**	.000**	95	0	26.6	.931 ns	.**

Table 2. Hypothesis Test Recapitulation

Annotation:
X1: Washing variation, 0=unwashed, 1= 1 time washing, 2= 2 times washing, 3= 3 times washing
X2: Processing variation, A= fresh/unprocessed, B= steamed, C=boiled, D= stir-fried
Y1: Pb Content
Y2: Vitamin C Content
ns: non-significant
*: significant; **: very significant

The result of data analysis and hypothesis test showed there are significant effect of processing and washing treatments to Pb and vitamin C content. Together and partially, washing and processing affect the decreasing of Pb. Meanwhile, in terms of vitamin C, processing give a significant results but not the washing.

As it is explained by [17], in family degree, heavy metal pollution can be handled either by washing or heating in boiling degree for a short time (1-5 minutes). By doing these, heavy metal poluution can be reduced. Furthermore, [18] said that cooking in high temperature is one of many ways that commonly used to process the food. Some of cooking methods are boiling, steaming and stir-frying. Boiling is a process of cooking using boiling water (100°C), where water is used as a conductor. Steaming is a cooking method that uses water vapor, which produced by boiling water, as a medium. Finally, stir-frying is a heating process using a bit of water and cooking oil.

Moreover, boiling causes the metal binding within the plants release its binding, so bound Pb inside the plants tissue can be released [19]. A research [20], found that Pb content of vegetables can be decreased by boiling them for 3, 5 and 7 minutes. The number is decreased from 1.494 ppm into 1.302 ppm, 1.300 ppm and 1.287 ppm respectively. Even though sensory qualities (color, textures and general acceptance) are getting lower, subjectively respondents still can eat the vegetables [21]. The longer of washing and processing are the lower of Pb content within the vegetables. It is because those treatments damage the plasm membrane and organelle membrane so the accumulated heavy metals unravel from the plant tissues [22]. Boiling can also break down the metal bond inside the plant tissues.

It is because the high temperature can push the substance that bound the heavy metal to discharge the bond (Winarno, 2004) [19].

The data showed that there is a significance in general interaction (sig.p <0.01). This tells us that together, washing and processing can decrease the content of Pb within the vegetables. By paying attention to how vegetables are processed, the nutrition content also can be preserved. To cut of the heavy metal pollution, vegetables have to be washed several times. Washing will not reduce vitamin C content. Fresh and unprocessed vegetables contain the most of nutrient content. However, due to pollution in the vegetables, it wise to choose the best methods to process the vegetables. This research found that steaming is the best method. Respectively, from the best to the worst, cooking methods that affect the nutrition content are steaming, boiling, and stir-frying.

IV. CONCLUSION

It can be concluded that: 1) washing and processing can affect and decrease the Pb content in kale; 2) processing can reduce vitamin C content, but not washing.

Practical Application

It can be suggested that: 1) to diminish the pollution in vegetables surface, washing should be done several times; 2) nutrient content would not be diminished by washing the vegetables; 3) the best method of cooking should be chosen to maintain the nutrient content of vegetables since cooking processes can affect vitamin C content, respectively are steaming, boiling and stir-frying.

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