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Measuring of Cadmium Content in Sorghum(*Sorghum bicolor* (L.) Moench)

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수수 (*Sorghum bicolor* (L.) Moench)의 카드뮴 함량 측정 방법

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요 약

수수 (Sorghum bicolor (L.) Moench)의 미량 광물 (微量鑛物) 성분의 한가지인 카드뮴을 원자흡광분광분석기 (이하 분광기)를 이용하여 바탕선을 수정하는 방법 (BGC)으로 분석했다. 실험은 가) 비료 무시용구인 대조구 (對照區), 나)정수장(淨水場) 슬러지를 부숙 (腐熟)시킨 구, 다) 정수장(淨水場) 슬러지에 질소, 인산, 칼륨 비료 (肥料)를 시용한 구, 라) 부숙 (腐熟)시킨 정수장 (淨水場) 슬러지에 질소, 인산, 칼륨 비료 (肥料)를 시용한 구의 네 가지였고, 처리조건 (處理條件)은 카드뮴을 분석할 때에 분광기의 버너의 높이를 3 mm, 6 mm, 9 mm로 조정하여 측정 조건으로 했는데, 흡광도 (吸光度)의 변화 범위 (變化範圍)와 흡광도의 표준편차 (標準偏差)가 크며, 바탕선의 크기가 작은 쪽이 카드뮴 측정 (測定)에 유리 (有利)한 것으로 나타났다. 본 실험 (本實驗) 결과(結果), 3 mm와 6 mm 버너 높이에서 9 mm 높이보다 카드뮴 측정에 유효(有效)하며, 3 mm와 6 mm 중에서는 6 mm 버너 높이가 보다 적당한 것으로 나타났다.

(**Key words** : Absorbance, Burner height, Cadmium, Sorghum)

Ⅰ. INTRODUCTION

Cadmium (Cd)'s property is different from copper (Cu) or nickel (Ni), because zinc (Zn) or cadmium (Cd) are not transition metals (Baek and Zeong, 1991). There is considerable current interest in Cd in plant nutrition. And Cd is toxic both to plants and animals. The basic cause of the toxicity probably lies in the much higher affinity of Cd for thiol (SH) in enzymes and other proteins. The presence of Cd therefore disturbs enzyme activity (Mengel and Kirkby, 1978).

And we have analyzed Cd content of some French soil on utilization of background correction (BGC) mode with an atomic absorption spectro-

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photometer (Kim et al., 2000). We have carried out analyses of trace metals of Cu, Ni in sorghum hybrid (*Sorghum bicolor* (L.) Moench) on BGC mode with an atomic absorption spectrophotometer, and knew that the content of trace metals have varied during our previous studies with analysing conditions (Choi et al., 2007; Kim et al., 2007). For Cu analysis the level of standard solution concentration was important, while for Ni the duration time after the start was important for the right measure (Park et al., 2008).

The atomic absorption spectrophotometry (AA) was established around the year of 1960, and inductively coupled plasma/mass spectrometry (ICP / MS) was after the year of 1980 (Kim, 2004). This fact means that AA method is older than ICP / MS, however, AA is cheaper and more widely used than ICP / MS apparatus. A kind of ICP method, ICP-AES (inductively coupled plasma atomic emission spectrometry) is good in sensitivity, exactness, etc. However, there are a lot of causes for error, and therefore there is possibility of greater fault than AA, atomic absorption spectrophotometry (Haraguchi, 1993). Haraguchi (1993) wrote that observing height and (signal/background) ratio are important for optimal analysis of trace metals on inductively coupled plasma (ICP) apparatus.

In the present experiment, we considered on the effect of burner height of the atomic absorption spectrophotometer on measuring of Cd content of the forage. The reason for setting the different burner heights of 3 mm, 6 mm and 9 mm is as follows:

If you cook the chestnut in the cauldron with a gas-burner, the distance between the flame from the gas-burner and the cauldron is very important. When the temperature was too hot with the improper distance, the chestnut will be broken. On the other hand the nut will not be well-steamed with the lower temperature on the case of another improper distance. Therefore, it is necessary to find out the proper distance between the burner and the cauldron. Here, in our experiments, the distance is burner height. In most cases of experiments, 6 mm burner height is used as recommended except 10 mm height for calcium (Ca). So it is necessary to find out a measuring method in order to know the appropriate burner height for each metal.

Ⅱ. MATERIALS AND METHODS

The experimental field was situated at a mountainous site with an altitude of 260 meters in Joongbu University, at Kumsan county in ChungcheongNam province. The period of field experiment was from May to November of 1993. The field was newly established on May 26, 1993. On a randomized block design there were 6 treatments with 3 replications. Here, in the present report we have utilized 4 treatments; Control, Compost, Alum + NPK and Compost + NPK. The alum sludge and fertilizers were applied on June 7 and June 17, respectively. The seeds of sorghum hybrid, Pioneer 931 (*Sorghum bicolor* (L.) Moench) were sown on June 23. And the forage was harvested on November 4, 1993. The other materials and methods for the sorghum hybrid (*Sorghum bicolor* (L.) Moench) were already described in our previous reports (Chang et al., 1993; Kim et al.,

1997; Kim and Chang, 2000).

The cadmium (Cd) content was measured after 3 hours warming up, as the result of Ni report (Park et al, 2008). The analysis of Cd was carried out in a laboratory at Department of Companion Animal and Animal Resources Science in Joongbu University from October 2, 2007 through March 6, 2008. Eleven samples were air-dried and milled for analysis of Cd. Then, a half gram each of milled sample was taken twice, total 22 samples were extracted for 18 hours by 25 ml of 1M hydrochloric acid, and extracts was diluted with distilled water, filtered and filled up to 50 ml, the others are up to 100 ml. While this extracting method was utilized for K or Mg determination (Kim et al., 1986; Kim et al., 1987; Kim 1988), it was used for Cd element on the present experiment. The Cd analysis was made with an atomic absorption/ flame emission spectrophotometer (AA-680, Shimadzu Co. Ltd., Kyoto), with the method of atomic absorption spectrometry (Pinta et al., 1979). The condition was as follows: Model of the atomic absorption spectrophotometer AA-680, hollow cathode (HC) lamp 7 mA, slit 0.30 nm, wave length 228.8 nm, mode back ground correction (BGC), flame air acetylene (acetylene 2.0 litre/ min, air 8 litre/min), respectively. And the treatments were the difference of burner height; 3 mm, 6 mm, and 9 mm.

Mother solution of Cd 1,000 ppm was purchased from Anapex Co. (Daejeon). In order to draw calibration curve of standard solutions for Cd, the solutions were calculated three times with the spectrophotometer as follows: from the 1,000 ppm Cd, standard solutions (0.00 ppm, 0.04 ppm, 0.40 ppm) were prepared to contain 1/4 volume of 1 M HCl. Standard solutions were used on the 3 burner heights for calibration curve, and each two values were obtained during the analysis on the BGC mode with the spectrophotometer; absorbance values both for standard solutions and for samples, respectively.

For comparing those results on the three different burner heights, mean and standard deviation of absorbance and of background values were calculated. And means of paired samples were compared by T-test (Son and Park, 1999).

Ⅲ. RESULTS AND DISCUSSION

Table 1 shows the standard solution and their absorbances for Cd content of sorghum hybrid (*Sorghum bicolor* (L.) Moench) upon the three different burner height. The absorbance values of respective Cd standard solutions were similar on 3 mm, 6 mm and 9 mm burner heights. The range of 3 standard solutions was similar.

Fig. 1 shows absorbances for Cd content of the sorghum hybrid on 3 mm, 6 mm and 9 mm burner heights. Here, the absorbances on 3 mm and 6 mm were distinct, that means the ranges on 3 mm and 6 mm were wider than those on 9 mm burner height.

Table 2 shows the absorbance and background values during Cd analyses using the samples of sorghum hybrid with an atomic absorption spectrophotometer on the three different burner heights. At 9 mm burner height the absorbance values reached under background values, at 3 mm height most of absorbances were above their background values. At 6 mm burner height all absorbance values except one value (Compost

Table 1. Standard solution and their absorbances for Cd content of sorghum hybrid (*Sorghum bicolor* (L.) Moench) upon the three different burner height

Burner height	Absorbance (/10.000) and Cd content	
3 mm	Absorbance(X)	Cd content (Y)
	20	0.00 ppm
	90	0.04 ppm
	540	0.40 ppm
6 mm	Absorbance(X)	Cd content (Y)
	30	0.00 ppm
	90	0.04 ppm
	810	0.40 ppm
9 mm	Absorbance (X)	Cd content (Y)
	10	0.00 ppm
	90	0.04 ppm
	900	0.40 ppm

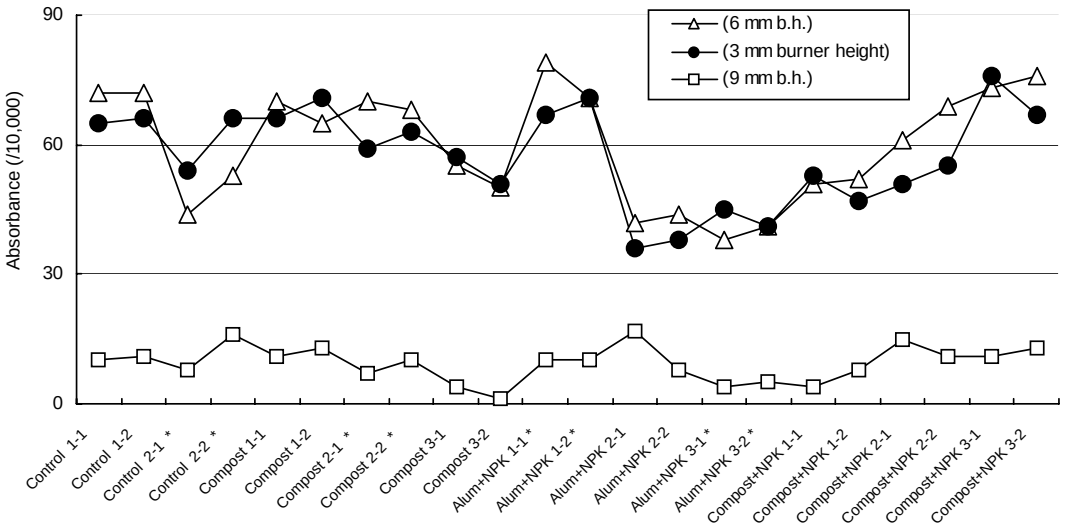

Fig. 1. The absorbance for Cd content of the sorghum hybrid on 3, 6, 9 mm burner heights.

+ NPK 1-2) exceeded the background values.

Table 3 shows the effects of burner height on the range, the mean, the standard deviation (SD) of absorbances and the mean of background values during Cd analyses with an atomic absorption spectrophotometer. It's for Cd content of sorghum hybrid (*Sorghum bicolor* (L.) Moench). It is considered that the larger value of the range, the mean, and the SD of absorbances are linked to the better analysis (Table 3). Here, 3 mm and 6 mm burner heights seemed to be better than 9 mm height to the analysis. And the

Table 2. The absorbance and background values during Cd analyses with an atomic absorption spectrophotometer on the three different burner heights using the samples of sorghum hybrid (*Sorghum bicolor* (L.) Moench)

Treatment No.	(3 mm burner height)	(6 mm b.h.)	(9 mm b.h.)
	Absorbance 1* (Background 1)	Absorbance 2* (BG 2)	Absorbance 3* (BG 3)
Control 1-1	65 (50)	72 (50)	10 (40)
Control 1-2	66 (50)	72 (40)	11 (50)
Control 2-1 **	54 (30)	44 (20)	08 (50)
Control 2-2 **	66 (30)	53 (30)	16 (50)
Compost 1-1	66 (40)	70 (20)	11 (40)
Compost 1-2	71 (40)	65 (20)	13 (40)
Compost 2-1 **	59 (50)	70 (20)	07 (40)
Compost 2-2 **	63 (40)	68 (20)	10 (40)
Compost 3-1	57 (40)	55 (30)	04 (40)
Compost 3-2	51 (40)	50 (30)	01 (30)
Alum+NPK 1-1 **	67 (40)	79 (40)	10 (40)
Alum+NPK 1-2 **	71 (50)	71 (50)	10 (40)
Alum+NPK 2-1	36 (30)	42 (10)	17 (30)
Alum+NPK 2-2	38 (40)	44 (30)	08 (30)
Alum+NPK 3-1 **	45 (40)	38 (0)	04 (10)
Alum+NPK 3-2 **	41 (40)	41 (10)	05 (20)
Compost+NPK 1-1	53 (40)	51 (40)	04 (20)
Compost+NPK 1-2	47 (40)	52 (60)	08 (40)
Compost+NPK 2-1	51 (40)	61 (0)	15 (40)
Compost+NPK 2-2	55 (40)	69 (0)	11 (40)
Compost+NPK 3-1	76 (50)	73 (30)	11 (40)
Compost+NPK 3-2	67 (50)	76 (30)	13 (50)

* : these values were obtained on 3 mm, 6 mm, and 9 mm burner height of the AA-680 spectrophotometer, respectively.

** : filled up to 50 ml, the others are up to 100 ml.

Table 3. Effects of burner height on the range, the mean, the SD of absorbances and the mean of background values during Cd analyses using sorghum hybrid (*Sorghum bicolor* (L.) Moench) with an atomic absorption spectrophotometer 1)

	Burner height		
	3 mm	6 mm	9 mm
Range of 22 absorbances (/10,000)	36 ~ 76	38 ~ 79	1 ~ 17
Mean of 22 absorbance values (/10,000)	57.5 a	59.8 a	9.40 b
SD of 22 absorbance values (/10,000)	11.3	13.0	4.13
Mean of 22 background values (/10,000)	41.3 a	26.3 b	37.2 a

SD : standard deviation.
The same characters horizontally between the means show the not-significance statistically at 5% level.

smaller value of the mean of background is estimated to be better. And among these three burner heights, the analysis on 6 mm was the preferable. The results were similar to the description of Haraguchi (1993), who has written that the ratio of (signal/background) is important for trace metals' analyses on an Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES).

Consequently we think that not only these conditions for widening the range, the mean, and the SD values of observed absorbances but also the condition for lessening the mean of background values is necessary in order to obtain the better measuring of Cd.

As a conclusion in the present research, the 6 mm height, with the larger values of the mean and the SD of the absorbances and with the smaller value of mean of backgrounds, seemed to be the best for the Cd analysis among the three burner heights with the atomic absorption spectrophotometer.

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Ⅴ. ABSTRACT

We have studied effect of water treatment sludge (WTS) on trace metals of sorghum hybrid (*Sorghum bicolor* (L.) Moench). In the present report it was for cadmium (Cd) content on background correction (BGC) mode with an atomic absorption spectrophotometer. The four treatments were Control, Compost, Alum + nitrogen, phosphorus, potassium (NPK), Compost + NPK. In the analysis, burner height of the atomic absorption spectrophotometer was adjusted to three levels; 3 mm, 6 mm, 9 mm. As a conclusion, 3 mm and 6 mm burner height conditions were better than 9 mm height for Cd analysis. And the conditions for widening the range, the mean, and the standard deviation (SD) values of observed absorbances as well as the condition for lessening the mean of observed background values are necessary for getting the better measuring of Cd. At the present experiment, 6 mm burner height condition is the best among the three burner heights.

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