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Full Length Research Paper

Sorghum cobalt analysis on not determined wave length with atomic absorption spectrophotometer on background correction mode

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This study was to know the better wave length on measuring cobalt content in forage sorghum hybrid (*Sorghum bicolor*) with an atomic absorption spectrophotometer. The analysis was on background correction mode with three wave lengths; 240.8, 240.7 (determined wave length or recommended wave length) and 240.6 nm, respectively. The larger absorbance value on the 240.7 nm, apparently, it might be considered as a good wave length but the smaller background value was a more important factor for the analysis as was shown on 240.6 nm. Correlation coefficients between the values on 240.7 nm: 240.6 nm and between them (240.8 nm: 240.6 nm) were higher and this common 240.6 nm was considered the better wave length.

Key words: Atomic absorption spectrophotometer; background correction mode, cobalt analysis, forage sorghum, not determined wave lengths.

INTRODUCTION

Cobalt is present in plant and animal tissues at relatively low concentrations, typically below 0.1 ug/g on a dry weight basis and deficiency symptoms are likely to occur where levels of cobalt in the pastures are below 0.1 mg kg^{-1} DM (dry matter) (McDonald et al., 1985). Cobalt concentrations have been measured by a variety of techniques including atomic absorption spectrometry (AAS), atomic emission spectrometry, neutron activation analysis, chemiluminescence and colorimetry (Bakkaus et al., 2005; Donati et al., 2006 Safarzadeh et al., 2011). Of those techniques widely available to the biochemist, AAS is the most rapid, versatile and reliable. If available, the Zeeman background correction system is somewhat preferable. With atomic absorption spectrometry (AAS), concentrations of 0.1 to 7 ppm can be quantitated accurately (Shapiro and Martin, 1988). The technique for atomic absorption is considered complete and it is not necessary to experience more. While the techniques is not until now established on some basic factors, for example range of standard solutions, warming time, burner height, electric current etc. Therefore we carried out some experiences for those factors (Park et al., 2008a, b, 2009b). In this study we wanted to know the effect of wave length on the analysis and to find out the right wave length for cobalt analysis with the atomic absorption spectrophotometer method. And this problem on wave length might exist also on the inductively coupled plasma spectroscopy (ICP) method. The wave length generally employed for cobalt determination is 240.7 nm (Shapiro and Martin, 1988).

We carried out this study to know whether the wave length of 240.7 nm were right or not for the cobalt analysis. And we concluded that the other wave length, 240.6 nm was the right one for the cobalt analysis on the background correction condition.

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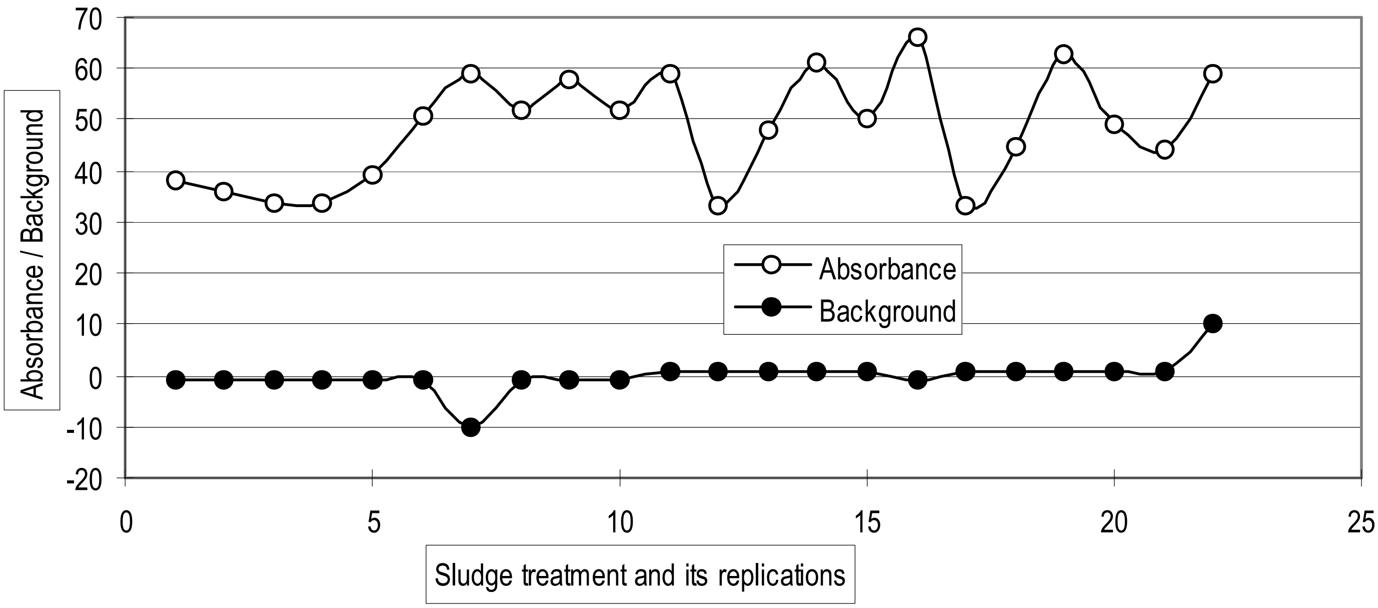

Figure 1. Absorbance and background values during Cobalt analyses of forage sorghum with atomic absorption spectrophotometer depending on measuring order (1/10,000) on 240.6 nm wave length.

MATERIALS AND METHODS

The experiment was conducted in mountainous area with an altitude of 260 m at Joongbu University, Kumsan, ChungcheongNam-do, Korea from May to November of 1993. There were 4 treatments with 3 replications in randomized complete block design. The treatments were as follows: control, compost, Alum + NPK and Compost + NPK. The alum sludge and fertilizers were applied on June 7 and 17, 1993 respectively. Sorghum hybrid seed of Pioneer 931 was sown in June 23 and forage was harvested in November 4, 1993 (Kim et al., 1997). A short description of the sample preparation for the sorghum hybrid (*S. bicolor* (L.) Moench) was provided in our previous reports (Kim et al., 1997; Kim and Chang, 2000). We measured cobalt content in the sorghum hybrid with atomic absorption spectrophotometer: their absorbance and back ground values. These analyses were with AA-680 (Shimadzu Co. Ltd., Japan). The mode was BGC (background correction); wave length, 240.8, 240.7 and 240.6 nm respectively. The recommended wave length is 240.7 nm for Co analysis, and the slit, 0.2 nm; the lamp current, 3 mA; the burner height, 6 mm. Eleven samples were air-dried and milled for Co analysis using an atomic absorption/flame emission spectrophotometer (AA-680, Shimadzu Co. Ltd., Kyoto) as described by Pinta et al. (1979).

RESULTS AND DISCUSSION

Figure 1 shows the absorbance (Abs) and background (BG) during Co analysis of sorghum hybrid on measuring order with atomic absorption spectrophotometer; on BGC mode and data were adjusted from those of Park et al. (2009a). Two values of absorbance and background differed greatly on 240.8 nm while these two values on 240.7 nm (recommended wave length) and on 240.6 nm (not recommended wave length) changed similarly. But the values on 240.7 nm increased with the measuring time advance but it is not considered important that the value itself is large. Though both of them, the absorbance and background values were the smaller values on 240.6 nm, they might be more reasonable. Here, apparently, the larger absorbance values were obtained on the 240.7 nm, the wave length might be considered in error as a favorable wave length. But the smaller background value seems to be a more important factor on the Co analysis; it was shown on the 240.6 nm wave length condition. In our previous report (Park et al., 2009a), it was done through several ratios among 4 factors: mean of absorbance (AM), standard deviation of absorbance (AS), mean of background (BM) and standard deviation of background (BS). The result at 240.6 nm was considered better than that of 240.7 or 240.8 nm wave length for the cobalt (Co) analysis. Table 1 shows the direct cobalt content of sorghum (*S. bicolor* (L.) Moench) and correlation among the items on three wavelengths with the atomic absorption spectrophotometer depending on measuring order. They were adjusted from the absorbance values on our previous result (Park et al., 2009a). Here, we can see that the values on the wavelength of 240.7 nm were higher, those on 240.6 nm the second, while those on 240.8 nm were in the negative ranges. The values on 240.7 nm had the significant correlation with the measuring order (n). They might in other words not be the real value while the values on 240.8 nm might not be real neither. The table show the correlation coefficient among the items. Park et al. (2009b) suggested these two things: the higher correlation value was responsible and the better condition for the analysis of the trace metal.

Table 1. Direct cobalt content of sorghum (*Sorghum bicolor* (L.) Moench) on three wavelengths with atomic absorption spectrophotometer depending on measuring order from absorbance value and correlation among the items (ppm Co).

S/N	Treatment and replication	Wave length		
		240.8 nm (A)	240.7 nm (B)	240.6 nm C)
1	Alum + NPK 3-1 $	-0.021	0.094	0.014
2	Alum + NPK 3-2 $	-0.036	0.169	0.01
3	Alum + NPK 2-1	-0.043	0.175	0.006
4	Alum + NPK 2-2	-0.016	0.16	0.006
5	Control 2 -1 $	0.001	0.137	0.016
6	Control 2 - 2 $	-0.026	0.188	0.041
7	Compost 3 - 1	0.029	0.21	0.058
8	Compost 3 - 2	-0.031	0.261	0.044
9	Compost + NPK 1 - 1	-0.016	0.261	0.056
10	Compost + NPK 1 - 2	-0.013	0.268	0.044
11	Compost + NPK 2 - 1	-0.005	0.279	0.058
12	Compost + NPK 2 - 2	0.014	0.304	0.003
13	Compost 2 - 1 $	-0.036	0.296	0.035
14	Compost 2 - 2 $	-0.018	0.253	0.063
15	Compost 1 - 1	-0.046	0.347	0.039
16	Compost 1 - 2	0.001	0.369	0.073
17	Compost + NPK 3 - 1	-0.033	0.352	0.003
18	Compost + NPK 3 - 2	-0.026	0.384	0.029
19	Control 1 - 1	0.011	0.38	0.067
20	Control 1 - 2	-0.028	0.429	0.037
21	Alum + NPK 1 - 1 $	-0.023	0.414	0.027
22	Alum + NPK 1 - 2 $	0.016	0.397	0.058
Mean ± standard deviation (10^{-3})		-15.68±20.41	278.5±97.78	35.77±22.61
Correlation between the Co content and the order of measuring number.		r(n:A) = 0.1507 NS &	r(n:B) = 0.9656 (p< 0.01)	r(n:C) = 0.4041 NS &

+: adjusted from our previous data (Park et al., 2009a), #: measuring order (n), $: filled up to 50 ml, the others were up to 100 ml, &; statistically not significant at 5% level.

In this study, correlation coefficients at r (240.7 nm: 240.6 nm) and r (240.8 nm: 240.6 nm) were higher. Therefore, 240.6 nm, the common wave length where the two higher correlation coefficients appeared is the better analyzing method in a viewpoint of wavelength as was shown on Cd content in a viewpoint of burner height (Park et al., 2009b). Figure 1 shows the absorbance and background values during cobalt analyses of forage sorghum with atomic absorption spectrophotometer depending on measuring order (1/10,000) on 240.6 nm wave length. The difference between absorbance and background values were smaller than that on 240.7 nm wave length in Figure 2. The absorbance values did not depend on measuring order as was shown in Table 1. Figure 2 shows the absorbance and background values during Cobalt analyses of forage sorghum with atomic absorption spectrophotometer depending on measuring order (1/10,000) on 240.7 nm wave length. The difference between absorbance and background values were greater than that on 240.6 nm wave length in Figure 1. The absorbance values depended on measuring order as shown in Table 1. Figure 3 shows the absorbance and background values during cobalt analyses of forage sorghum with atomic absorption spectrophotometer depending on measuring order (1/10,000) on 240.8 nm wave length. The difference between absorbance and background values were to those on 240.6 nm wave length, but some of the absorbance and the background values mixed. It is considered that the 240.7 nm wavelength was good only with the absorbance values while 240.6 nm wave length was better with the stable background values (Park et al., 2009a). In an unpublished data of Kim SA, the corresponding author in INA-PG in France during the period of 1998 to 1999

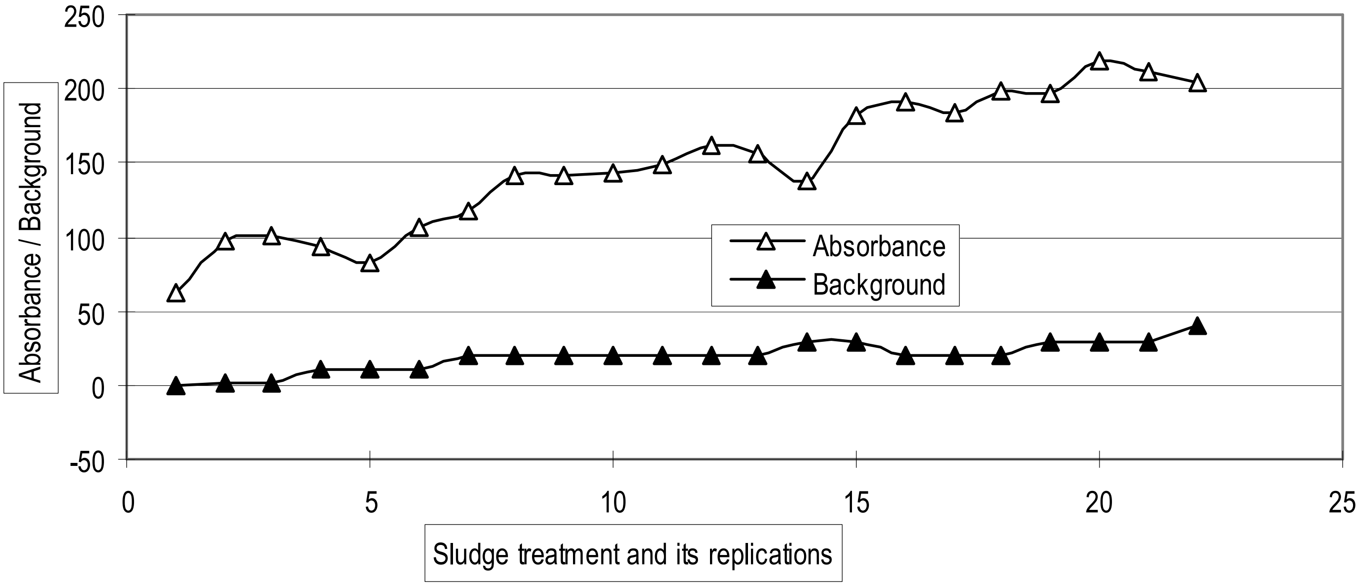

Figure 2. Absorbance and background values during Cobalt analyses of forage sorghum with atomic absorption spectrophotometer depending on measuring order (1/10,000) on 240.7 nm wave length.

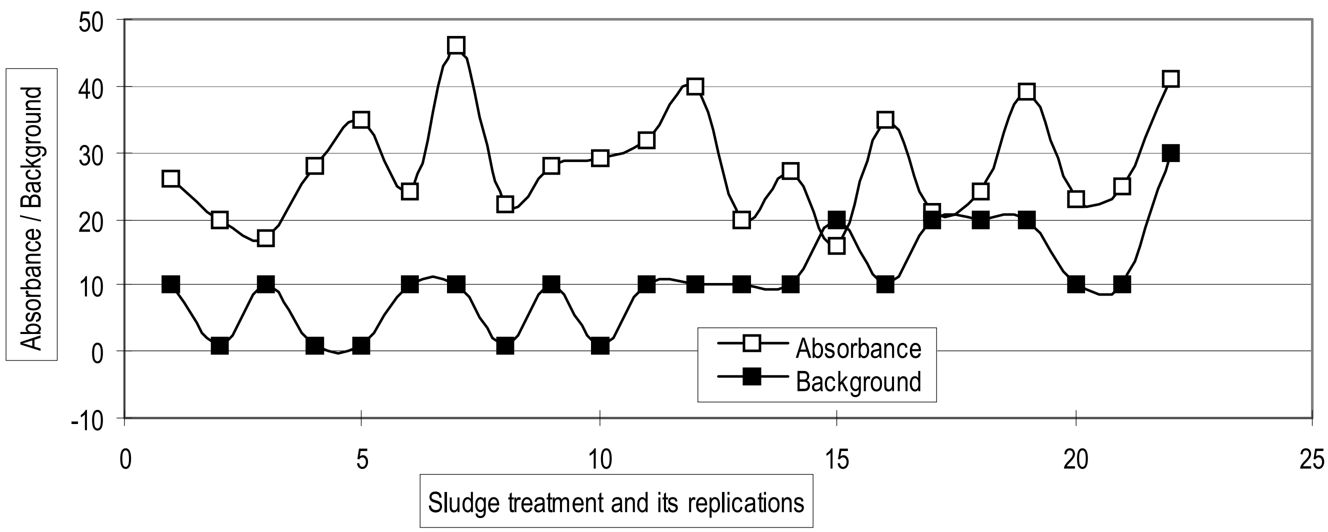

Figure 3. Absorbance and background values during Cobalt analyses of forage sorghum with atomic absorption spectrophotometer depending on measuring order (1/10,000) on 240.8 nm wave length.

discovered that there was another better wave length for plumb with an AA spectrophotometer. Kim found that the recommended wave length for plumb, 283.3 nm did not seem to be good for the Pb element but 283.4 nm was the better for Pb analysis.

Table 2 shows the real cobalt content of sorghum (*S. bicolor* (L.) Moench) on three wavelengths with atomic absorption spectrophotometer. The Co content tended to be high on compost or compost + NPK; there was a variance among the replications. And the Co content was low on Alum + NPK. The mean Co content of the plant ranged from 1.2 to 10.4 mg kg^{-1} DM.

Conclusion

Using forage sorghum hybrid (*Sorghum bicolor*) with an atomic absorption spectrophotometer, we carried out this study to know whether the wave length of 240.7 nm were right or not for the cobalt analysis. And we conclude that

Table 2. Real cobalt content of sorghum (*Sorghum bicolor* (L.) Moench) on three wavelengths with atomic absorption spectrophotometer.

Treatment and replication	Wave length								
	240.8 nm			240.7 nm			240.6 nm		
	Absorbance (10^{-5})	Direct content (mg/kg DM) +	Real content (mg/kg DM)	Absorbance (10^{-5})	Direct content (mg/kg DM) +	Real content (mg/kg DM)	Absorbance (10^{-5})	Direct content (mg/kg DM) +	Real content (mg/kg DM)
Alum + NPK 3 -1 $	26	-0.021	-2.1	63	0.094	9.4	38	0.014	1.4
Alum + NPK 3 -2 $	20	-0.036	-3.6	98	0.169	16.9	36	0.01	1
Alum + NPK 2 -1	17	-0.043	-8.7	101	0.175	35.1	34	0.006	1.2
Alum+NPK 2 - 2	28	-0.016	-3.2	94	0.16	32.1	34	0.006	1.2
Control 2 - 1 $	35	0.001	0.17	83	0.137	13.7	39	0.016	1.6
Control 2 - 2 $	24	-0.026	-2.6	107	0.188	18.8	51	0.041	4.1
Compost 3 - 1	46	0.029	5.9	117	0.21	42	59	0.058	11.7
Compost 3 - 2	22	-0.031	-6.2	141	0.261	52.3	52	0.044	8.8
Compost + NPK 1 - 1	28	-0.016	-3.2	141	0.261	52.3	58	0.056	11.3
Compost + NPK 1 - 2	29	-0.013	-2.6	144	0.268	53.6	52	0.044	8.8
Compost + NPK 2 - 1	32	-0.005	-1.1	149	0.279	55.8	59	0.058	11.7
Compost + NPK 2 - 2	40	0.014	2.8	161	0.304	60.9	33	0.003	0.78
Compost 2 - 1 $	20	-0.036	-3.6	157	0.296	29.6	48	0.035	3.5
Compost 2 - 2 $	27	-0.018	-1.8	137	0.253	25.3	61	0.063	6.3
Compost 1 - 1	16	-0.046	-9.2	181	0.347	69.5	50	0.039	7.9
Compost 1 - 2	35	0.001	0.34	191	0.369	73.8	66	0.073	14.7
Compost + NPK 3 - 1	21	-0.033	-6.7	183	0.352	70.4	33	0.003	0.78
Compost + NPK 3 - 2	24	-0.026	-5.2	198	0.384	76.8	45	0.029	5.8
Control 1 - 1	39	0.011	2.3	196	0.38	76	63	0.067	13.4
Control 1 - 2	23	-0.028	-5.7	219	0.429	85.8	49	0.037	7.5
Alum + NPK 1 -1 $	25	-0.023	-2.3	212	0.414	41.4	44	0.027	2.7
Alum + NPK 1 - 2 $	41	0.016	1.6	204	0.397	39.7	59	0.058	5.8
(Mean/standard deviation of 22)			(-2.48/3.728)			(46.8/22.72)			(5.99 /4.535)

+: Values shown on Table 1, $: filled up to 50 ml, the others were up to 100 ml.

the other wave length, 240.6 nm was the right one for the cobalt analysis on the background correction condition.

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