Content of Nutritional Elements in Sudangrass and Ryegrass Determined by ICP-AES

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Abstract The sudangrass (*Sorghum sudanense*) and ryegrass (*Lolium multiflorum* L.) rotation is a new type of cropping system，which has developed rapidly in recent years in the south of China. The contents of nutritional elements for forage grass in the sudangrass and ryegrass rotation system were determined by ICP-AES. The results showed that there were abundant and essential nutritional elements for animals in sudangrass and ryegrass. The contents of P，K，Ca，Mg，S，Fe，B，Cu，Zn and Mn for sudangrass were 0.20%～0.29%，1.94%～2.57%，0.62%～0.97%，0.39%～0.69%，0.12%～0.18%，108.35～180.12，3.04～5.96，6.17～10.02，20.37～31.36 and 46.80～101.29 mg·kg^{-1}，respectively. The contents of P，K，Ca，Mg，S，Fe，B，Cu，Zn，Mn for ryegrass were 0.39%～0.70%，3.77%～5.07%，0.61%～0.84%，0.28%～0.47%，0.32%～0.41%，291.65～632.20，2.13～3.23，13.29～15.19，30.73～42.98 and 92.08～156.04 mg·kg^{-1}，respectively，and there were differences between various periods in nutritional elements in the two forage grasses. The application of ICP-AES could reflect fast and efficiently the content of nutritional elements for forage grass as animals feed.

Keywords ICP-AES；Sudangrass；Ryegrass；Nutritional elements
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Introduction

There is an abundant forage and rainwater in the south of China，which has assured the development of fish and livestock[1]. Both sudangrass (*Sorghum sudanense*) and ryegrass (*Lolium multiflorum* L.) are the important forage grasses for fish and livestock，and its areas under cultivation are increasing gradually，So，the sudangrass and ryegrass rotation has become a new type of cropping system in the south of China[2,3]. The sudangrass，a kind of gramineous forage grass which is originated from Sudan Plateau in Africa，is also known as wild sorghum. It is adaptable and drought-resistant，with more tillers，high yield，rapid regeneration and rich nutritive. Thus sudangrass is a high yield and quality of forage crops with great promotional value[4,5]. The ryegrass is a perennial gramineous forage grass，and possesses the properties of strong regeneration，high yield，and rich protein，minerals and vitamins. Its leaves are also more，and its palatabili-

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ty and digestibility are better. It is also recognized as better feed for a kind of herbivorous fish and livestock[4, 7, 8]. Both sudangrass and ryegrass are important forage grass for fish and livestock, however, it was hardly reported that the two forage grasses contained necessary nutrients for animals. Therefore, we determine the nutrients content of sudangrass and ryegrass by equipment of inductively coupled plasma atomic emission spectroscopy (ICP-AES), and need understand deeply the important nutritive value of the two forage grasses for feed of fish and livestock. It also provides guidelines for promotion of fodder crops and rational development of agricultural structure diversities.

1 Materials and Methods

1.1 Instrument and reagents

The ICAP6300 equipment is the full spectrum of direct reading inductively coupled plasma atomic emission spectroscopy (THEROM, USA). Solid-state generator frequency is 27.12 MHz, optical resolution at 200 nm is 0.007 nm, and it also includes RACID86 charge injection detector.

All containers in the experiment were soaked for 24 h with 10% nitric acid, and were washed with ultra-pure water (Aquapro system). Concentrated HNO_3 and $HClO_4$ were excellent pure level of reagents. Water in laboratory was prepared with Aquapro system.

1.2 Experiment site and materials

The field experiment was located at Agricultural Research Station of Datonghu Administration District, Honghu, Hubei province, China (30°3′N, 113°45′E). The soil was derived from alluvial sediments of Yangtze River and classified as fluvio-aquatic soil. The field experiment of sudangrass (*Sorghum sudanense* cv. Yanchi) grown in summer and ryegrass (*Lolium multiflorum* cv. Abundant) grown in winter was conducted in the rotation. Sudangrass and ryegrass were directly broadcast sowing in each plot, and were 112.5 kg·ha^{-1} for sudangrass and 37.5 kg·ha^{-1} for ryegrass. The sudangrass season was from 20 May to 26 September 2006 and it was harvested for 4 times. The ryegrass season was from 10 October 2006 to 29 March 2007 and it was harvested 4 times.

1.3 Analysis methods

Sample pretreatment: Before each harvesting in the rotation, we sampled fresh grasses, which were weighted, deactivated for half hour at 105 ℃, dried for 48 h at 60 ℃. Dry samples were ground and then stored in the sealed bags for nutritive elements analysis.

Digesting samples by wet ashing method[9,10]: the sample of 0.500 0 g was weighed precisely and placed in 50 mL digestive tube. The tube was added with 10 mL mixed liquid with concentrated HNO_3 and $HClO_4$ (V_{HNO_3} : V_{HClO_4} = 4 : 1), and sealed overnight. Afterward, the tube was heated at 140～180 ℃ on the infrared digestive oven. At last, NO_2 was excluded and white gas appeared, then with cooling, constant volume of 50 mL was obtained, followed by filtering after shaking. At the same time, blank determination was also done. The filtrate was determined for nutrients content of sudangrass and ryegrass with ICP-AES, and the operating parameters were referred to the instructions of ICAP6300.

2 Results

2.1 Nutritional elements content of sudangrass

Sudangrass contained abundant nutritive elements in the sudangrass and ryegrass rotation (Table 1). In our experiment, the contents of P, K, Ca, Mg, S, Fe, B, Cu, Zn and Mn for sudangrass were 0.20%～0.29%, 1.94%～2.57%, 0.62%～0.97%, 0.39%～0.69%, 0.12%～0.18%, 108.35～180.12, 3.04～5.96, 6.17～10.02, 20.37～31.36 and 46.80～101.29 mg·kg^{-1}, respectively. The contents of P, K, Ca, Mg, Fe and Mn for sudangrass were higher than those of other elements, and there was also difference between nutritive element contents of different periods for sudangrass.

Table 1 Content of nutritional elements for sudangrass

Element	Value	RSD/%	Value	RSD/%	Value	RSD/%	Value	RSD/%
P/%	0.29	16.1	0.30	9.4	0.24	5.4	0.20	11.7
K/%	2.57	4.4	2.32	12.8	1.94	7.2	2.07	19.5
Ca/%	0.66	9.0	0.97	7.2	0.62	9.8	0.76	22.3
Mg/%	0.39	16.7	0.69	10.9	0.46	10.1	0.49	24.8
S/%	0.12	18.0	0.18	8.5	0.13	15.6	0.13	9.6
Fe/(mg·kg^{-1})	140.96	20.0	186.12	14.4	108.35	8.4	140.24	22.2
B/(mg·kg^{-1})	5.96	23.4	3.53	13.4	3.04	16.4	3.88	18.7
Cu/(mg·kg^{-1})	6.17	18.6	10.02	3.9	8.44	16.0	6.39	22.8
Zn/(mg·kg^{-1})	20.37	22.6	31.36	12.1	23.50	13.1	25.77	17.7
Mn/(mg·kg^{-1})	51.93	23.5	101.29	15.3	48.17	20.0	46.80	13.1

2.2 Nutritional elements content of ryegrass

During the ryegrass season in this rotation (Table 2), the contents of P, K, Ca, Mg, S, Fe, B, Cu, Zn and Mn for ryegrass were 0.39%～0.70%, 3.77%～5.07%, 0.61%～0.84%, 0.28% ～ 0.47%, 0.32% ～ 0.41%, 291.65 ～ 632.20, 2.13 ～ 3.23, 13.29 ～ 15.19, 30.73 ～ 42.98 and 92.08～156.04 mg·kg^{-1}, respectively. It was observed that the contents of P, K, Ca, Mg, S, Fe and Mn for ryegrass were higher than that of other elements, and the contents of P, K, S, Fe and Mn for ryegrass were higher than those of other elements, and the contents of P, K, S, Fe and Mn for ryegrass were higher than those of sudangrass in the same period. Furthermore, there was also difference between nutritive element content of different periods for ryegrass.

Table 2 Content of nutritional elements for ryegrass

Element	Value	RSD/%	Value	RSD/%	Value	RSD/%	Value	RSD/%
P/%	0.40	10.7	0.39	9.5	0.70	8.6	0.61	7.6
K/%	3.78	12.7	3.77	6.2	4.99	14.9	5.07	11.7
Ca/%	0.72	15.2	0.61	9.6	0.79	15.5	0.84	18.7
Mg/%	0.33	17.7	0.28	9.8	0.40	21.5	0.47	20.9
S/%	0.36	1.6	0.32	6.9	0.47	12.2	0.41	22.4
Fe/(mg·kg^{-1})	632.20	3.4	576.04	14.1	291.65	22.6	463.58	9.3
B/(mg·kg^{-1})	2.57	22.8	3.12	15.9	2.13	5.6	3.23	11.4
Cu/(mg·kg^{-1})	13.91	17.8	13.38	15.6	15.19	16.5	13.29	14.7
Zn/(mg·kg^{-1})	30.73	21.3	31.89	7.0	36.70	20.6	42.98	4.7
Mn/(mg·kg^{-1})	101.05	21.3	92.08	13.8	156.04	12.5	149.59	12.0

3 Discussion

Sudangrass and ryegrass rotation was a new type of cropping system in the south of China, and the demand for feed supported by the two forages increased gradually in actual production. The determination of nutritive elements for forage by ICP-AES could reflect quickly and efficiently the contents of nutritive elements for forage grass which animals demanded. The method with ICP-AES had the advantages of low detection limits, high precision, small matrix effects, wide linear range and simultaneous multi-element determination[11, 12]. The microelements contained in crops were important components of animal organs, and participated metabolisms. For example, Fe is the essential components of hemoglobin, myoglobin and many enzymes, and Cu could promote the increase of blood, and Mn is essential to skeletal development, brain and reproductive function[13-15]. In our experiment, it was observed that sudangrass and ryegrass contained abundant nutritive elements which animals demanded, i.e. P, K, Ca, Mg, S, Fe, B, Cu, Zn and Mn. Furthermore, there were also differences between the nutrient contents of different periods. Sudangrass and ryegrass have better nutritional value as feed, and could provide efficiently necessary nutrient elements for fish and livestock.

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