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Research Article

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Study on nutritional value of two interplanting forage plants in forest

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ABSTRACT

With the industrial development, the forest area reduced gradually in China in recent years. The development of under-forest economic crops was considered as a new approach to solve this problem. Therefore, tow forage plants (Zea diploperennis and Dioscorea esculenta) were interplanted in the Camellia oleifera forest by interplanting technology of forage grass and small trees. The main nutrient contents of Zea diploperennis and Dioscorea esculenta interplanted in the Camellia oleifera forest, including moisture and volatile matter, crude ash, calcium, phosphorus, crude fat, crude fiber, crude protein, organic matter and dry weight, were determined by biochemical methods and spectrophotometry. The analytical result showed that the contents ratio of Zea diploperennis/Dioscorea esculenta about moisture and volatile matter, crude ash, calcium, phosphorus, crude fat, crude fiber, crude protein, organic matter and dry weight were 1.04, 0.49, 0.61, 0.59, 0.53, 1.24, 0.70, 1.06 and 0.99, respectively. The result indicated that the most contents of calcium, phosphorus, crude fat and crude protein of Dioscorea esculenta were higher than those of Zea diploperennis significantly, suggesting that Dioscorea esculenta had higher forage value than Zea diploperennis as interplanting under-forest forage crop.

Keywords: Under-forest forage plant; *Zea diploperennis*; *Dioscorea esculenta* (Batatas vine); Nutrition value; Under-forest Economy.

INTRODUCTION

Since the late 1990s, the forestry ecological construction had become the development emphases in China. As the environmental protection including grain for green and forestry ecological construction carrying out, the overall ecological environment improved gradually in China. But the forestry economic development had been inevitably affected due to a large forest attributed to public welfare forest. So it became an important key issue in forestry development how to coordinate the conflict and the harmonious development between forestry ecological construction and forestry economic development. In 2007, the National Forestry Bureau proposed "a perfect eco-system, a developing industrial system and a thriving cultural system" as the basic content of modern forestry. Developing a new forest industry model became the most important to promote forestry economy and keep it stable development. Under-forest economy was a compound management of forest, agriculture, and animal husbandry that should make full use of under-forest land resources and goodness. The patterns of under-forest economic construction included forest-grass model, forest-crop model, forest-edible fungus model and forest-animal model[1-3]. Forest-grass model was a multi-level artificial vegetation combined by forest and grass. And it was a small investment, quick, easy and efficient configuration mode in grain for green. Alfalfa and ryegrass are the major forage grass interplanted in the forest. The forage grass interplanted in forest had three harvests in a year. It can be sale in fresh or breeding cattle, sheep, duck and other poultry. The grass interplanted in the forest also can increase the number of soil microorganism to improve soil fertility and saline-alkali soil [4-7].

Zea diplopernnis, *Gramineae Zea,* was a class of perennial teosinte discovered in Mexico in 1978 [8]. It was perennial or annual depended on different phenological phase in China. Because *Zea diplopernnis* had advantages of strong resistance to stress, pests and diseases, scholars had tried to cultivating new varieties of Maize by transferring *Zea diplopernnis* genes. But the progress was slow by reaseons of the distant hybridization and genetic linkage [9-11]. Owing to these advantages, *Zea diplopernnis* yeild was very high with no pesticides. So it was a quality green fodder of cattle, sheep, fish and other animal. In the United States, Central America, Japan and Southeast Asia, *Zea diplopernnis* had a large planting area, and it was also cultivated in parts of China, and it had been bred a large number of new species after years of research [12-16]. *Dioscorea esculenta* originated in the Americas. Because of its high yield and easy cultivation, *Dioscorea esculenta* has become major food and forage crops in China. Batatas vine, the leaves and stems of *Dioscorea esculenta*, was an excellent livestock feed in many regions, which was rich in carotene, vitamins and mineral elements [17, 18]. These two forage grass, *Zea diplopernnis* and *Dioscorea esculenta,* also could fix soil and prevent soil erosion by interplanting in forest. In conclusion, it was in favor of forestry ecological construction and increasing forester income at the same time for interplanting *Zea diplopernnis* and *Dioscorea esculenta* in the forest. This study was carrying out in the Southern Forest-Grass Interplanted Base at Ningxiang country. Both of *Zea diploperennis* and *Dioscorea esculenta* had been interplanted in the *Camellia oleifera* forest by interplanting technology of forage grass and small trees. And the nutrient contents of *Zea diploperennis* and batatas vine interplanted in the forest, including the moisture and volatile matter, crude ash, calcium, phosphorus, crude fat, crude fiber, crude protein, organic matter and dry weight, were determinated. This study should be the foundation for the utilization of under-forest economic plants in south China.

EXPERIMENTAL SECTION

Plant material

Under-forest forage grass had been collected in the Southern Forest-Grass Interplanted Base at Ningxiang country. *Zea diploperennis* was cut when the plant height was lower than 60 cm. The two kinds of forage grass were paved dry to moisture content less than 30% in the shade. 30g *Zea diploperennis* and batatas vine were took for grinding, and sieved by 40-mesh sieve respectively. Sealed and stored at room temperature.

Standard solution used in the experiments was prepared based on national standard GB/T 601-2002 <Chemical reagent Preparations of standard volumetric solutions>.

Methods

(1) The determination of moisture and volatile matter

The determination and analysis were based on national standard GB/T 6435-2006 <Determination of moisture and other volatile mater content in feeds>

(2) The determination of crude ash

The determination and analysis were based on national standard GB/T 6438-2007 <Animal feeding stuffs-Determination of crude ash>.

(3) The determination of calcium and phosphorus

The determination and analysis were based on national standard GB/T 6436-2002 <Determination of calcium in feed> and GB/T 6437-2002 <Determination of phosphorus in feed-Spectphotometry>. The sample was decomposed by dry decomposition method after the determination of crude ash in this experiment.

(4) The determination of crude fat

The determination and analysis were based on national standard GB/T 6433-2006 <Determination of crude fat in feeds>.

(5) The determination of crude fiber

The determination and analysis were based on national standard GB/T 6434-2006 <Feeding stuffs-Determination of crude fiber content-Method with intermediate filtration>.

(6) The determination of crude protein

The determination and analysis were based on national standard GB/T 6432-1994 <Method for the determination of crude protein in feedstuffs>.

(7) The determination of organic matter
The organic matter should be oxyenolysed in 550 centigrade, and the crude ash of the sample was left after burning. So the determination of organic matter in feeds was directly calculated using the following formula.

W(%)=100-w
"w" was the content of the crude ash in feeds

(8) The determination of dry weight
Beside the dairy products, animal and plant fat forage and mineral forage, the dry weight of feeds could be calculated using the following formula.

W(%)=100-w
"w" was the content of the moisture and volatile matter in feeds

RESULTS AND DISCUSSION

The determination of nutrient content in *Zea diploperennis* and batatas vine

Table 1 following displayed nine kinds of nutrient contents of *Zea diploperennis* and batatas vine, and the ratio of *Zea diploperennis*/batatas vine. The result showed that *Zea diploperennis* and batatas vine interplanted in the forest was rich in nutrients in the Southern Forest-Grass Interplanted Base at Ningxiang country.

Table 1 The contents of nine nutritional components in *Zea diploperennis* and batatas vine 1 the *Zea diploperennis*; 2 the batatas vine

	moisture and volatile matter (%)	crude ash (%)	calcium (%)	phosphorus (%)	crude fat (g/kg)	crude fiber (g/kg)	crude protein (%)	organic matter (%)	dry weight (%)
1	12.87	5.45	0.33	0.26	19.29	235.28	11.89	94.55	87.13
2	12.39	11.16	0.54	0.44	36.32	188.93	16.98	88.84	87.61
1/2	**1.04**	**0.49**	**0.61**	**0.59**	**0.53**	**1.24**	**0.70**	**1.06**	**0.99**

Comparison of the nutrient content between *Zea diploperennis* and batatas vine

Figure 1 showed the different of all nine nutritional components contents between *Zea diploperennis* and batatas vine. The moisture and volatile matter content, crude fiber content, and organic matter content of batatas vine were less than those of *Zea diploperennis*, but the batatas vine had higher contents in calcium, phosphorus, crude fat, protein, dry matter and crude ash contents levels. By compared on the nutrient contents between *Zea diploperennis* and batatas vine, the contents ratio of *Zea diploperennis*/batatas vine were 1.04, 0.49, 0.61, 0.59, 0.53, 1.24, 0.70, 1.06 and 0.99(see in Table 1). According to this ratio, the different of moisture and volatile matter content, organic matter content and dry weight content between the two forage grass was little, but the contents of calcium, phosphorus, crude fat, protein, dry matter and crude ash of batatas vine were much higher than those of *Zea diploperennis* significantly.

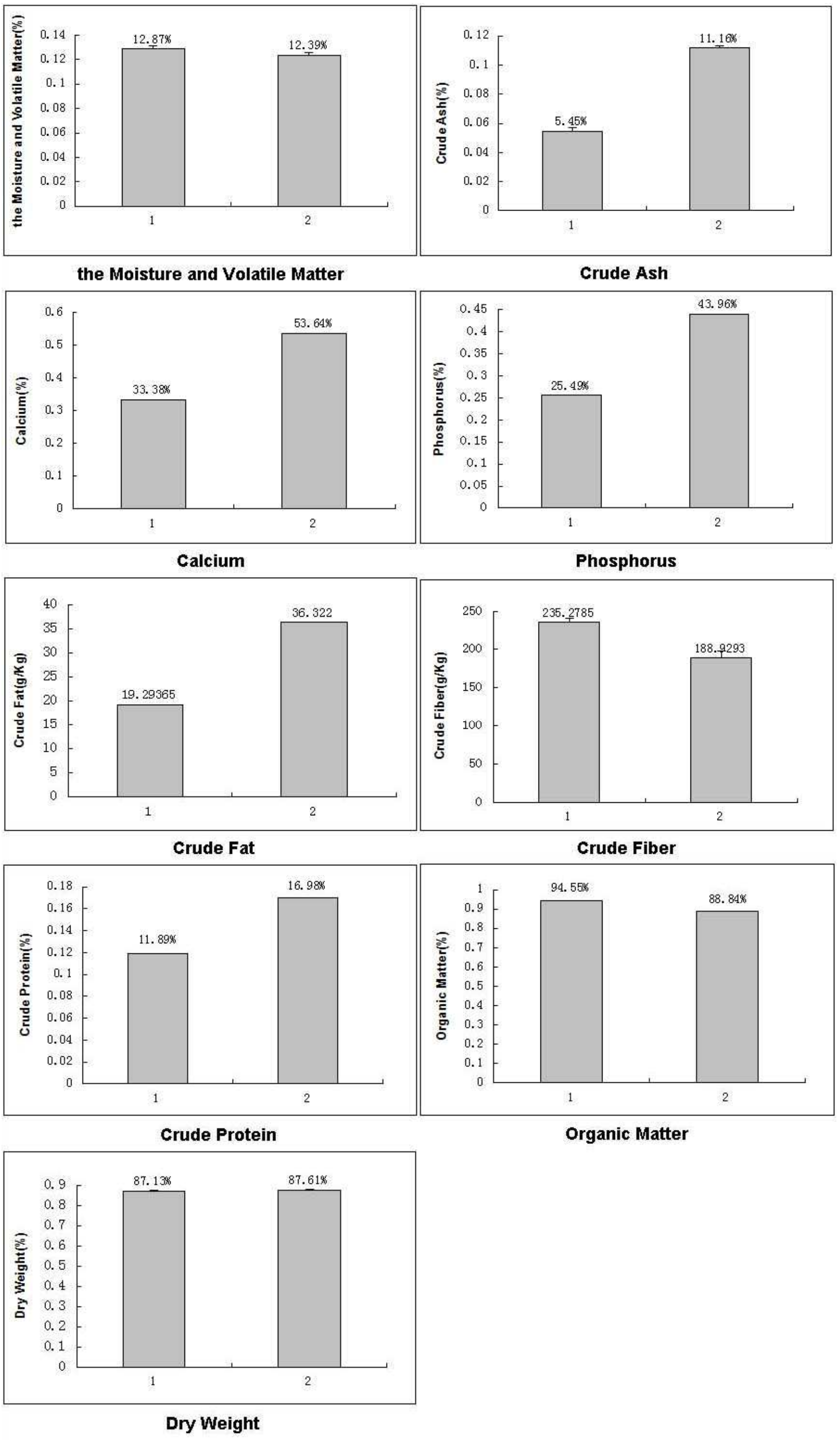

Fig.1 The nutrient content column chart of *Zea diploperennis* in the medium growing stage and the young growing stage and batatas vine
1 the *Zea diploperennis*; 2 the batatas vine

CONCLUSION

The contents of crude protein and crude fiber were important indicators of forage nutritional value. Crude protein, crude fat and carbohydrates were necessary nutrients to maintain normal physiological activities of animals. The calcium and phosphorus also played important roles in maintaining animals life. Otherwise crude fiber was the most difficult component to digest for animals [19, 20]. The forage grass which contained high level of crude protein, fat, carbohydrates and low crude fiber would be more preferred for livestock. WANG [21] studies had showed that the yield and energy of *Zea diploperennis* were the highest when grass was cut at plant height 90cm and stubble 30cm. However, the forage grass quality would be the best when the height of *Zea diploperennis* was 60cm. Its crude protein and crude fat contents should up to 14.28% and 2.05%. Our studies had also shown that the interplanted *Zea* *diploperennis*, which was lower than 60cm height, had more forage nutritive value than the one with higher height (unpublished date). In this study, the contents of crude fat, crude protein, calcium, phosphorus and crude fiber of interplanted *Zea diploperennis* were 19.29g/kg, 11.89%, 0.33%, 0.26% and 235.28g/kg respectively. And the nutritive contents of crude protein, crude fat and crude fiber of batatas vine of interplanted batatas vine were 16.98%, 36.32g/kg and 188.93g/kg. Calcium and phosphorus contents of batatas vine were 0.54% and 0.44%. *Dioscorea esculenta* was an important crop which was only second to rice, wheat and corn. Batatas vine, including stems and leaves of *Dioscorea esculenta,* was rich in dietary fiber, polysaccharides, vitamins and minerals. And its crude protein accounted for 21.1%-25.1% of its dry weight [22]. From this study, the contents ratio of *Zea diploperennis*/batatas vine about the calcium, phosphorus, crude fat and crude protein contents were 0.61, 0.59, 0.53 and 0.70 respectively. It showed that these four kinds of important nutrient contents of interplanted batatas vine were significantly higher than *Zea diploperennis*. According to the results, it suggested that the batatas vine had higher forage value than the *Zea diploperennis*.

Camellia oleifera was an important edible oil woody plant in southern of China, and was planted widely in sixteen provinces. Although China had a long history of *Camellia oleifera* cultivation, but its production and return were still low in the traditional cropping pattern. During a long period, the *Camellia oleifera* forest was not well managed due to the low level of management and serious pest diseases. Resently, people had cared about the green food more and more as living standards improved. *Camellia oleifera* also had more attentions than before. Camellia forest understory intercropping patterns had been studied in recent years [23-25]. Understory could adjust the soil microorganisms and improve soil fertility. It was beneficial to increasing forest output and revenue. The Camellia forest was a kind of five years semi-closed forest in Southern Forest-Grass Interplanted Base at Ningxiang country. *Zea diploperennis* and *Dioscorea esculenta* intercropped under Camellia forest need not too much manual management because of these forage grass having strong adaptability. And the study showed that the batatas vine was better than *Zea diploperennis* to be intercropped in the Camellia forest for having more forage nutritional value. And this study also had provided a theoretical basis for popularization of the forage grass intercropping patterns. These intercropping patterns compared to the traditional cropping patterns allowed foresters to obtain woods and a lot of forage grass for livestocks at the same time. It could improve the forest economic development and space utilization value.

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