Assessing nutritive value and *in vitro* ruminal dry matter digestibility of paper mulberry (*Broussonetia papyrifera* L.) at the different cutting heights

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**Abstract.** Paper mulberry (*Broussonetia papyrifera* L.) is a type of emerging feed and very popular with its high nutrition and low-cost value. Purpose of the experiment was to evaluate the nutrient contents, amino acids content and *in vitro* ruminal dry matter digestibility of paper mulberry cut at four different heights (60, 90, 120, and 150 cm). Paper mulberry harvested at 60 and 90 cm increased the content of crude protein water-soluble carbohydrate, calcium and total amino acids (P<0.05). There were 10 of 16 kinds of amino acids at relatively high content at 120 cm (P<0.05) while phosphorus content was the highest (P<0.05). The harvesting height of 150 cm showed higher content of neutral detergent fiber and acid detergent fiber than the other treatments (P<0.05). No significant difference appeared in the content of hydrolysable tannins (P>0.05), but the lowest content of condensed tannin was measured at 150 cm (P<0.05). In terms of *in vitro* ruminal dry matter digestibility, the sample cut at 150 cm was the lowest in all samples (P<0.05). In summary, the recommended choice of harvesting at 90 cm gave the best quality paper mulberry raw material.

1. Introduction
Leaves of paper mulberry (*Broussonetia papyrifera* L.) have high nutrition value and contain many kinds of bioactive components. Experiments have shown that the crude protein of paper mulberry has high degradation rate in the rumen of cows [1]. Therefore, this kind of unconventional woody forage is considered to be of great development value [2]. In practical production of paper mulberry, higher harvesting height means higher yield, while basic study of nutritive value with different harvest heights as feed material was rare. The aim of this research was to evaluate the effect of mowing height on nutrient compositions, variation of amino acid content and *in vitro* ruminal dry matter digestibility of whole-plant paper mulberry.

2. Material and methods

2.1. Material
The tissue culture seedling of paper mulberry was transplanted to the field of China Agricultural University, Zhuozhou of Hebei Province (115°57’ E, 39°29’ N), China on May 26th, 2019. Plant grew
without fertilizer and materials were harvested at the first time in the first year of planting and cut at different heights from August to October, including 60, 90, 120, and 150 cm.

2.2. Methods
Materials were chopped with lengths of 1 to 1.5 cm by a hand forage chopper and mixed well. Each treatment has three replications. After that, 500g of each sample were dried in an oven at 65℃ for 48 h, then kept at room temperature for 24 h, and ground to pass through 40-mesh sieve. Neutral detergent fiber (NDF), acid detergent fiber (ADF), water soluble carbohydrate (WSC), crude fat (EE, ether extract), CP (crude protein), Ca (Calcium), P (Phosphorus), HT (Hydrolysable Tannin), CT (Condensed Tannin) were determined according to the methods reported by Ni K [3] and Li D [4], respectively. The statistical analyses were performed using JMP software (Tukey’s HSD test, version 10; SAS Institute, Tokyo, Japan) to examine the differences between different treatments.

3. Results and discussion
The content of nutrient value was shown in Table 1. Mowing heights have significant influence on most of values. When the plant cut at 150 cm, the NDF and ADF was significantly higher than other mowing heights, but the content of CP was much lower at both 120 cm and 150 cm while it is significantly higher at 90 cm (P < 0.05). The content of WSC and CT was higher when the paper mulberry cut at 90cm (P < 0.05). There was no significant difference in EE and HT between groups. In addition, IDM in the sample of 150cm was significantly lower than other groups.

Table 1. Chemical compositions and in vitro ruminal dry matter digestibility of paper mulberry

| Chemical Compositions | 60   | 90   | 120  | 150  |
|-----------------------|------|------|------|------|
| NDF (% DM)            | 43.89b | 42.77b | 42.60b | 48.29a |
| ADF (% DM)            | 34.18b | 34.24b | 33.49b | 38.85a |
| WSC (% DM)            | 8.21bc | 9.15a  | 8.16bc | 5.83c  |
| EE (% DM)             | 7.13  | 7.64  | 7.24  | 6.91   |
| CP (% DM)             | 15.24ab| 16.02a | 14.32b | 14.76ab|
| Ca (mg/g)             | 17.64a | 17.21a | 15.55b | 13.84c |
| P (% DM)              | 0.29a  | 0.27b  | 0.29a  | 0.24c  |
| HT (mg/g)             | 7.98  | 7.14  | 8.42  | 7.39   |
| CT (mg/g)             | 24.41ab| 30.37a | 27.11a | 19.15b |
| IDM (% DM)            | 49.77a | 47.71ab| 49.30a | 44.70b |

NDF= neutral detergent fiber; ADF= acid detergent fiber; WSC= water soluble carbohydrates; EE= crude fat (ether extract); CP= crude protein; Ca= Calcium; P= Phosphorus; HT= Hydrolysable Tannin; CT= Condensed Tannin; IDM= in vitro ruminal dry matter digestibility.

As shown in Table 2, the content of all of amino acids increased while mowing height varied from 60 cm to 90 cm but decreased from 90 cm to 150 cm. Ten of seventeen amino acids in 90 cm harvested samples were significantly higher than those in other groups. Additionally, the samples cut at 90cm had higher content of TAA compared with 150cm, whereas no significant differences of Asp, Ser, Met, Ile, Tyr and Phe contents were found.

4. Conclusion
Despite several differences were found between different harvest heights, the nutritional quality and IDM of paper roughly were similar to traditional forages. The results suggested that TAA of paper mulberry harvested at 90 cm and 120 cm was higher than the other two. Considering the content of CP and WSC, the recommended choice of mowing height was 90 cm.
### Table 2. Variation of amino acids content of paper mulberry

| Content (% DM) | Mowing Heights (cm) |       |       |       |
|---------------|---------------------|--|-----|-----|-----|
|               | 60                  | 90  | 120 | 150 |
| Asp           | 1.24                | 1.35| 1.23| 1.11|
| Thr           | 0.58\(^a\)         | 0.62\(^a\) | 0.59\(^a\) | 0.50\(^b\) |
| Ser           | 0.50                | 0.52 | 0.52 | 0.45 |
| Glu           | 1.56\(^a\)         | 1.69\(^a\) | 1.53\(^a\) | 1.27\(^b\) |
| Pro           | 0.54\(^{ab}\)      | 0.58\(^a\) | 0.53\(^{ab}\) | 0.48\(^b\) |
| Gly           | 0.68\(^b\)         | 0.78\(^a\) | 0.70\(^b\) | 0.59\(^c\) |
| Ala           | 0.81\(^{bc}\)      | 0.90\(^a\) | 0.85\(^{ab}\) | 0.74\(^c\) |
| Cys           | 0.27\(^b\)         | 0.33\(^{ab}\) | 0.34\(^{ab}\) | 0.42\(^a\) |
| Val           | 0.87\(^b\)         | 0.98\(^a\) | 0.89\(^{ab}\) | 0.84\(^b\) |
| Met           | 0.20                | 0.27  | 0.20  | 0.22 |
| Ile           | 0.75                | 0.88  | 0.76  | 0.72 |
| Leu           | 1.21\(^{ab}\)      | 1.35\(^a\) | 1.23\(^{ab}\) | 1.13\(^b\) |
| Tyr           | 0.50                | 0.58  | 0.57  | 0.51 |
| Phe           | 0.76                | 0.81  | 0.80  | 0.77 |
| Lys           | 0.72\(^{ab}\)      | 0.77\(^a\) | 0.70\(^{ab}\) | 0.62\(^b\) |
| His           | 0.25\(^{ab}\)      | 0.27\(^a\) | 0.25\(^{ab}\) | 0.22\(^b\) |
| Arg           | 0.59\(^a\)         | 0.65\(^a\) | 0.59\(^a\) | 0.49\(^b\) |
| TAA           | 12.02\(^{ab}\)     | 13.31\(^a\) | 12.24\(^{ab}\) | 11.07\(^b\) |

Asp, asparaginic acid; Thr, threonine; Ser, serine; Glu, glutamic acid; Pro, proline; Gly, glycine; Ala, alanine; Cys, cystine; Val, valine; Met, methionine; Ile, isoleucine; Leu, leucine; Tyr, tyrosine; Phe, phenylalanine; Lys, lysine; His, histidine; Arg, arginine; TAA, total amino acid.

\(^{ab}\) Means within lines with different superscript letters differ significantly from each other (p < 0.05).

### References

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