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Feeding Experiences of *Paulownia Spp*. Leaves: Potential Forage Source for Domestic Animals

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Abstract

Paulownia spp. is a very adaptable, fast growing and multi-purpose agroforestry tree. This species is a genus of Asian hardwood trees which have been cultivated there for the past 3000 years. They are native to much of China, south to northern Laos and Vietnam, and long cultivated elsewhere in eastern Asia, notably in Japan and Korea. *Paulownia* plays a very critical role in providing timber, fuel wood, fodder and food in many countries of the World. Besides its fast-growing nature and several utilization opportunities, *Paulownia* leaves have similar feeding value to other forage crops. Due to previous studies, it has been reported that *Paulownia* leaves are suitable for feeding to domestic animals.

Keywords: *Paulownia sp*; Composition; Forage; Protein Source

Introduction

Interest in *Paulownia* is gaining momentum around the world, due to its fast-growing nature, the ability to take up nutrients and the potential for intercropping [1,2]. Several research projects have been done in the last decades due to the adaptation, utilization, production etc. of *Paulownia* species and hybrids around the World [3-5]. According to these researches, one can conclude that *Paulownia* species and hybrids can produce and show extremely good results in growth rates, biomass production and CO_2 (and dust) absorption, as well [6,7].

With optimal conditions in terms of light and moisture, *Paulownia* is reported to be one of the fastest growing trees in the world [8]. It is mainly suggested to use hybrids of *Paulownia* species as the basic trees for forestation and intercropping systems [9,10]. Several kinds of hybrids have been selected during the last few decades around the World, according to the environmental conditions and local circumstances (e.g. temperature, salinity, water supply etc.).

Paulownia tomentosa is a great bee forage plant because it can produce pollen and nectar too. The flower blooming is in the spring (from April to May) and 700 kg honey is expected from 1 hectar *Paulownia tomentosa* field [11]. Besides that, flowers of *Paulownia fortunei* can attract plenty of insect species (*Apis mellifera*, *A. dorsata*, *Megachile bicolour*, carpenter and solitary bees) and assure nectar and pollen that other *Paulownia* varieties [12].

Paulownia leaves are reported to have a similar feeding value to alfalfa and are suitable for combining with wheat straw or hay for feeding to cattle, sheep or goats [10,13]. World Paulownia Institute [13] stated that if trees are planted at 540 trees/ha, *Paulownia* will produce 1220 kg DM/ha with 20 % protein and 60 % digestibility. A *Paulownia* tree that is 8-10 years old is reported to have 100

kg fresh leaves, with 2.8-3 % Nitrogen (N) and 0.4 % potash. Chemical composition of the *Paulownia* leaf is also detailed as 7.8% ash, 22.6% protein, 91.4% organic matter, 0.6% phosphorus, 2.1% calcium, 0.6% iron, 0.9% zinc, with 15-18 MJ/kg metabolizable energy [14]. The potential of the leaves as an ensiled fodder crop for Northern Ireland may warrant investigation, perhaps in mini-silos. When the leaves fall, they can be a valuable source of organic matter and nutrients for the soil and can also be used for compost [1,15].

Use of *Paulownia* leaves as potential feed for domestic animals is a relatively new approach and research field. The genus of *Paulownia* is potential forage in the goat nutrition system. Six genotypes of *Paulownia* (*P. fortunei, P. tomentosa, P. elongata* and three clones of *P. elongata*) were compared to investigate the growth of the seedlings and browse preference of Boer does. The clones had more brances and were taller than seedling. In the seedling group, *P. fortunei* produced higher degree of brancing (87.0 cm) and taller herbage (2.2) in the second year. There were no significant differences are mortality (average 4.8 %). Preference trends were not noticed during the two separate grazing sessions among the six *Paulownia* genotypes [16]. Dried *Paulownia elongata* as a feed supplement was added to yearling sheep feed to investigate changes of some blood parameter. The counts of leukocyte and erythrocyte were significantly reduced 2.5 hour after intake. During the feeding trial, blood glucose value significantly decreased, probably because of the changes in proportion of fatty acids. The experimental diet increased the total serum protein amount [17]. Stewart, et al. [18] provided evidence to the suitability of growing *P. elongata* trees as a multipurpose crop in middle Georgia, U.S. They collected fresh leaf samples from 30 months old *P. elongata* trees, for drying and making 75 % and 95 % *Paulownia* pellets. In this study, the estimated digestible dry matter (DDM) for *Paulownia* based feed pellets is 65.20%.

Al-Sagheer, et al. [19] examined the nutrition effects of two *Paulownia tomentosa* leaf meal (PLM) (15 % and 30 % in the feed) in 5-week-old New Zealand White rabbit males. In the case of nutrient digestibility, no significant differences were found. Total protein values increased in rabbits, too. The high-density lipoprotein (HDL) concentration significantly increased, while the low-density lipoprotein (LDL) value decreased in each experimental group. PLM diet had no negative affect on the blood biochemistry parameters and did not influence the carcass traits. Feed intake (90.27 g) and feed conversion ratio (3.63 g/g) were lower in the 15 % PLM diet compare to 30 % PLM and control groups. The antimicrobial properties of *Paulownia tomentosa* appeared, because the total bacterial and fungi counts were reduced in the basal PLM feed, same trend was found in the cecum. Results of Wang, et al. [20] showed that polysaccharides from *Paulownia fortunei* flowers (PFFPS) can amend the immune system because of the improvement of the cellular and the humoral immunity in chicken. All PFFPS groups (40, 20, and 10 mg/mL) represented higher leukocyte counts and lymphocyte ratios than cyclophosphamide or phosphate-buffered saline groups. Values of bodyweight, thymus, bursa of Fabricius and spleen weight were the most favourable among all of the groups, therefore it is stated that PFFPS can increase the growth rate and improve the immune status of healthy and immunosuppressed chickens [20]. Other *in vivo* chicken investigation demonstrated that polysaccharides from *Paulownia tomentosa* (PTFP) can enhance the cellular immune mechanisms against Newcastle disease. The highest lymphocyte proliferation rate and adjuvant activity are appeared at the concentration of 12.5 mg/kg PTFP. Humoral immunity was triggered in PTFP groups too, especially with PTFP at concentration 25 mg/kg. Therefore 12.5 or 25 mg/kg PTFP is the appropriate dose to significantly increase the response of the immune system [21]. Additionally Popova, et al. [22] determined the antimicrobial activity of freash *Paulownia elongata* leaf and silage from these leaves *in vitro*. It was found that the minimum inhibitory concentrations (MICs) of the aqueous extract of fresh leaves was 80.6±19.5 μg/mL. The MICs value of the silage was lower (58.3±13.9 μg/mL), therefore the antimicrobial effect of that is higher, probably because of the lower value of pH. *Paulownia elongata* leaves and silage showed antimicrobial activity against common pathogens (*Salmonella enterica, Pseudomonas aeruginosa, Streptococcus pyogenes, Candida albicans*) *in vitro*, so the application of *Paulownia elongata* as a livestock forage would be beneficial to the animal health.

Investigation of the nutritional values of fresh *Paulownia spp.* hybrid leaves (*P. elongata, P. fortunei and P. tomantosa*) it was found that the dry matter of *Paulownia* leaves is relatively low (286.4 g/kg dry matter, DM) [10]. It is lower than the values reported for tree leaves (46-66 % of kg DM) by Azim. The crude protein content was medium high (117.5 g/kg DM) for a fresh forage, and similar than that reported for *Paulownia spp.* (160-200 g/kg DM), by Mueller, et al. [16] and Stewart, et al. [18]. This value compares favourably with other values reported by Addlestone, et al. [23] for leguminous browse species such as *Robinia pseudoacacia*.

The fatty acid composition was also determined by Bodnar, et al. [10]. The main fatty acids were palmitic acid (C16:0), oleic acid (C18:1n9c), linoleic acid (C18:2n6) and linolenic acid (C18:3n3). In our study, the green plant α-linolenic acid concentration in total fat was 24.6 %, the n-6/n-3 ratio was less than 1. The α-linolenic acid concentration of green maize reached 30 % [24], grass is also rich in α-linolenic acid account for about 40-50 % of the total fat in grass [25,26]. In terms of the n-3 fatty acids composition was suitable for improving the contents of milk health promoters.

Conclusion

The nutritive value of the fresh *Paulownia* is relatively high (177.5±4.9g CP/kg DM) and it could be considered as good PUFA source as grass for the ruminants. In terms of the crude protein contents, particularly in terms of the fatty acid composition was suitable for use as feeding by sheep, goat or cattle. However, in practical feeding situations, sheep on low crude fibre content forage crops must have access to a source of roughage (straw, hay) adequate for maintenance of proper rumen activity.

Finally, one can conclude that *Paulownia* leaves could be used as forage of domestic animals in some parts of the World, similar to China, where the leaf of *Paulownia spp.* is collected in autumn and fed by cattle, sheep and pigs. Nowadays, mostly fresh leaves are fed by the animals, but some results show that the pellet form can be also a good solution.

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