

***Tithonia diversifolia*, its possibilities in cattle rearing systems**

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Information about the performance of different plant materials of *Tithonia diversifolia* collected in the central-western region of Cuba is offered. A technology for biomass production, cut performance, grazing and for its use in the biological and physiological performance of animals used in the cattle development is presented. Plants materials destined to animal feeding are also presented. They offer options for biomass production in cut (5, 10, 16 and 23) or grazing (3, 5, 10, 23 and 24). In calves, the inclusion of *Tithonia* forage meal allows gains over 700 g/animal/d, with liveweight superior to 100 kg at four months of age and good health. Up to 50 % of the protein material of the concentrate may be substituted by meal of this plant to feed lactating goat kids and reach daily weight gain of 60-90 g. The substitution of feedstuff by 5 and 10 % of *Tithonia* foliage meal provides acceptable gains in the weaning (201 g/animal/d) and growing-fattening stage (528 g/d), for the small and middle swine production. The use of *Tithonia* foliage meal contributes to improve the health of the animals consuming it. This offers the possibility of having other shrubs to be used in silvopastoral systems.

Key words: *green materials, biomass production, biological and physiological performance of calves, goats and pigs.*

Introduction

Tithonia diversifolia is a herbaceous plant of the family of compounds (Asteracea), from Central America (Nash 1976 and Murgueito 2005) and introduced in the rest part of Latin America and the Caribbean. This species is part of the Cuban flora and has been naturalized with the common name of Margaritona. It is also known in Cuba as giant margarita and island margarita (Roig 1928 and Roig 1974). This plant has great root volume, special ability for recovering the nutrients from the soil, although they are scarcely presented, wide adaptation range and of distribution in the tropical area. It is from the sea level up to 2400 m of altitude, in places with rainfall between 800 and 5000 mm/year. It tolerates the acidity and low fertility of the soil. It has rapid growth, its biomass production varies between 30 and 70 t/ha of green forage (Mahecha and Rosales 2005 and Zapata and Silva 2010). It has a proper foliage nutritional value (Ibrahim *et al* 2005) and may accumulate as many proteins in its leaves (up to 33%) as legumes. It has high values of phosphorous, high DM digestibility and oils in leaves and flowers. It has 39.8 % of total sugars and may reach high C concentration in its air biomass, greater than 77 t/ha/year.

Also, the golden button (*Tithonia diversifolia*) has been recognized as a useful plant for improving the general fertility of the soils, mainly when handling it as green manure (Crespo *et al.* 2011), either buried on the soil or as a companion crop (alle and cropping) (Ríos 2002). This plant avoids the erosion (Murgueitio and Ibrahim 2004).

It is used in living fences, as flora for beekeeping, in medicine and bovine silvopastoral systems. It is also used as

cutting forage in the feeding of pigs, sheep, rabbits, bovines and buffaloes. It has potential for the feeding of ruminants and non-ruminants (Mahecha and Rosales 2005 and Wambui *et al.* 2006) and it is a high-nutritive value forage (De Souza Junior 2007).

In spite of the observations about the use of *Tithonia diversifolia* in animal feeding, especially by farmers, few researches have been conducted in this field (CIPAV 2009).

When considering the forage potential (quantitative and qualitative) of this species, considered promising for sustainable systems of agricultural production, widening the scientific assessment of the productive response of its foliage in animal feeding of ruminants and non-ruminants in Cuba is necessary. Facing this reality, the decision of developing a research project at the Institute of Animal Science with plant materials of *Tithonia diversifolia*, collected in the central-western region of Cuba was taken.

The objective of this study was to review the main results obtained in the agronomical assessment and the biological performance of these materials in the animal feeding.

Development

Assessment of Tithonia diversifolia materials collected. When studying the growth of 29 materials of *Tithonia diversifolia*, collected in the central-western region of Cuba through multivariate analysis, it was proved that 81.16 % of the variability is explained in the rainy season, while 94.34 % is explained in the dry one. The variables of higher preponderance were the total, green yellow, dried and fallen leaves/plant and stems/plant, all with positive ratio. During the rainy

season, the two conglomerates with higher measured indicators showed that the principal component leaf, like that of structure are included in the materials 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 22, 23, 24 and 26 (group 1). This may indicate that the means performance is similar in this period. Nevertheless, there was another group in which the component leaf highlighted in the materials 14, 17 and 29 (group 3), and the component structure in 4, 13, 19, 21, 25 and 27 (group 2). In the dry season, in both component, the materials classified such as 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 19, 21, 22, 23, 24, 25, 26, 28 (group 1) and 29 (group 4) highlight. In this period, there are no materials apart from this common pattern of the measured plant indicators, representing 68.9 % of the whole materials collected. In the rainy season, the group 3 had the highest values of the development. The numbers reached for the stem width (7.3 mm), number of flowers/plant (152) and number of fallen leaves/plant (414) were indicated as undesired characters. In the dry season, the group 4 had the highest values for all the measurements. This was not always positive for indicators like the number of fallen leaves (558) and the height of the first green leaf (52 cm).

Assessment of the biomass production potential. The sowing of *Tithonia* must be conducted with the stem laying on the depth of the furrow, using either the basal or middle part. There are plant materials of high (3, 5 and 23), middle (10, 16 and 24) and low (13, 17 and 25) behaviour size. This was evident when conducting an integrate analysis of the variables height of the first green leaf, stem width and leaf characteristics. In respect to its use as green manure, the plant may be used with six weeks of age, without distinction between June and August, with dosages of 12 t/ha in fresh basis, increasing the successor forage yield and improving the physical and biological indicators of the soil. Higher yield was achieved for forages at distances of 0.5 m between furrows for both seasons. The plant must be cut at heights between 10 and 15 cm, with cutting frequency of 60 and 80 d in the rainy and dry season, respectively. The animals did not like only three out of the materials assessed (15, 20 and 28). *Tithonia* must be sown for grazing at distance of 3-4 m between furrows. The beginning of grazing must be at a height between 1.00-1.50 m, after the establishment cut. The system may be exploited with bovine animals (2 LAU/ha, with occupation time of two days) with 60 and 90 resting days in the rainy and dry season, respectively. In these cases, the animals spend at about 20-50 % grazing.

Assessment of the productive potential of the species and its effect on the digestive physiology of bovines and sheep. The more outstanding nine plant materials had a proper chemical composition and secondary metabolites that may modify the digestive use of the ruminants. Ages between 70 and 90 d allow higher use of the nutrients. There are not big differences between the

digestibility. This plant allows its use in the management of ruminal ecology, the reduction of methanogens and protozoa population and in increasing the population of cellulolytic bacteria when used at a rate of 10 % of the total dry matter. Besides, the combination of *T. diversifolia* with *Pennisetum purpureum* cv. Cuba CT-115 at a rate of 15:85 allows higher fermentative capacity of the Cuba CT-115 variety. Its inclusion increases the efficiency and rate of the CT-115 gas production that could favor the nutrients availability for the rumen microorganisms.

Study of the nutritive potential of Tithonia diversifolia for the feeding of young ruminants and goat kids. It was demonstrated that the intake and rumination characteristics of calves were favored by the inclusion of *Tithonia diversifolia* meal in the integral diet. The study of the intake preference habit demonstrated that the calves spend 60-80 % to feeds ingestion, between 8.00 a.m. and 8.00 p.m., in spite of the type of diet. The performance reached in the biological test allowed daily mean gains between 739 and 783 g/a/d and of 109 and 117 kg of average LW at 120 d, in the combinations of *Tithonia diversifolia* meal and hay. Besides, they were over those expected in the models used. The use of *Tithonia diversifolia* meal in the integral diet (5, 10 and 15 %) allowed proper health indicators of the calves during the study. It should be highlighted the hemoglobin levels were of 110.0-130 g L⁻¹ at 120 d, indicating that this plant material seems to contribute to these indicators with beneficial components. This meal in the integral diet allows the calves reach liveweight daily mean gains superior to 700 g/ha/d (739 to 783 g/a/d), as average, at 120 d.

It is possible to substitute up to 50 % of this forage species in an integral diet for goat kids during the first stage of life as protein supplement. When favoring the voluntary intake of DM and at the same time improving the productive and efficiency parameters of the ration, daily weight gains of 60-90 g/animal are achieved in the pre-ruminant stage.

Assessment of the productive potential of the species and its effect on the digestive physiology of pigs. It is possible to substitute 20 % of the control feedstuff traditionally used in diets for growing-fattening of pigs by *Tithonia* meal with 80 d of age without disarranging either the morphometry of the gastrointestinal tract or the blood and health indicators. The population of proteolytic bacteria and fungi increased with the *Tithonia* levels. The feedstuff substitution by 5 % and 10 % of *Tithonia* foliage meal originated acceptable gains in the weaning and growing fattening categories, respectively, for the small and medium swine production. Besides, no trichuris or coccidias were observed in the fecal feces of the animals receiving 20 % of *Tithonia* meal in the ration.

Assessment of the economical effect of Tithonia diversifolia on cattle feed production. The analysis

shows that the cost level (in national currency) was very inferior for the sowing destined to grazing (443.74) in respect to that of the forage area (790.93), which demands higher amount of resources. The economical assessment of the meal elaboration shows an investment of 108.84/t in national currency, while the total cost of the integral diet once the components of the diet programmed with the meal were mixed goes up to 480.24 (Cuban pesos). The indicators cost/kg, benefit/cost and cost/Cuban pesos produced for the diets assessed with the inclusion of *Tithonia* and for the control were very similar in calves. The results in pigs have indicated the possibility of substituting part of the feedstuff by *Tithonia* meal, as the feeding costs/animal for the diets with *Tithonia* meal are lower. The total feeding/gaining unit was superior for these treatments. Similar performance was presented for the other indicator studied. All this shows the possibility of using these diets with *Tithonia* for the small and medium production. These are encouraging results, although further studied to assess the evolution of the animals and the exploitation costs during a longer period of time are needed.

Conclusions

From the economical point of view, these experiments report, for the first time, about the integral study of the growth and development characteristics of 29 plant materials collected of *Tithonia diversifolia* in different regions of Cuba. The variability found could be strategically used in further programs of varietal improvement. Besides, information about the capacity of this plant to multiply by gamic seed under the Cuban conditions is given.

The possibility of having a group of *Tithonia* materials collected in Cuba that may be grazed by bovines is informed. Aspects related with its chemical content and secondary metabolites are deepened. This allows having other shrub plants to be used in silvopastoral systems.

Tithonia is a promising plant when used for managing the ruminal microbial ecology, reducing the methanogen and protozoa population and increasing the population of cellulolytic bacteria.

An integral study of the chemical and physical characterization of *Tithonia diversifolia* plant material 10 was conducted with these experiments as well as its effect on physiological, biochemical, productive and of health indicators of growing pigs.

It is also a contribution to the knowledge of secondary metabolites and the total polyphenoles content of the *Tithonia* foliage meal, plant material 10, was counted at different cutting ages.

Indicators of the gastrointestinal tract morphology of pigs receiving *Tithonia* foliage meal in substitution of commercial feedstuff were obtained.

It was proved that the inclusion of *Tithonia diversifolia* foliage meal may be an alternative solution

to the anti-parasites products for growing pigs.

An alternative feed widely distributed in the tropical areas is proposed with these studies. It has few nutritional demands and good nutritive potential that may be used in growing pigs and calves production at small and medium scale, as well as economical advantages from the importation substitution point of view.

From the economical point of view, the use of *Tithonia* forage meal will propitiate undoubtedly economical advantages as it may substitute certain amounts of feedstuff without affecting physiological, productive and health indicators.

The social benefit of these results is the integral study offered to producers, researchers and pre and post graders about the potentiality of an abundant feeding source in the tropics like *Tithonia diversifolia* and its effect on the physiological, productive and health indicators on growing pigs, calves and goats.

The use of this plant allows mitigating the methane emissions from the ruminal fermentation to the atmosphere, contributing, thus, to reduce the effect of this gas as greenhouse effect.

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