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Nutritional quality of *Pithecellobium dulce* and *Acacia cochliacantha* fruits, and its evaluation in goats

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ABSTRACT

The fruits of leguminous trees are part of the natural diet of goats; however, they should be evaluated to quantify its food and nutritional values. Chemical composition, *in vitro* gas production (with and without polyethyleneglycol (PEG-4000 MW)), *in vitro* digestibility of dry matter (IVDMD) and organic matter (IVOMD) of fruits from *Pithecellobium dulce* and *Acacia cochliacantha* were determined. The content of acid detergent fiber (ADF), neutral detergent fiber (NDF), total phenols (TP) and condensed tannins (CT) was correlated (r) with the *in vitro* gas production (IVGP), IVDMD, IVOMD and metabolizable energy (ME) of the fruits. In Exp. 1 the preference test was developed during 10 days of adaptation, plus five days of evaluation in 10 six months-old female Creole goats, with 14 ± 2.0 kg body weight (BW) that were allocated in a completely randomized design to simultaneously receive *P. dulce* and *A. cochliacantha* fruits in individual feeders to determine goats preference to any of the two fruits, and the chemical compound of fruits with dry matter intake (DMI) of goats was correlated, too. In Exp. 2 the productive performance was assessed of 25 six months-old male Creole kids (14 ± 3.0 kg BW) that were allocated in a completely randomized design to feed *ad libitum* with fruits added to experimental diets with 30% and 15% of each fruit: *P. dulce* (T1 and T2), *A. cochliacantha* (T3 and T4), and T5=control diet without fruit. The chemical composition, IVDMD, IVGP and IVOMD were different ($P < 0.001$) among fruits; the r was negative (-0.83 to -0.99, $P < 0.01$) among the contents of ADF, NDF, TP and CT with IVGP, IVDMD, IVOMD and ME. Goats preferred the fruit of *A. cochliacantha*: DMI (11.7 g/kg $W^{0.75}$, $P < 0.001$), selectivity (11.5 frequency of intake, $P < 0.01$) and preference coefficient (1.3, $P < 0.001$). DMI was positive r with the CP content ($r=0.90$, $P < 0.001$), NDF ($r=0.91$, $P < 0.001$), ADF ($r=0.91$, $P < 0.001$) and ash ($r=0.75$, $P < 0.05$) of the fruits. The productive performance was higher ($P < 0.01$) in fed kids' diets T3 and T4 with DMI 108.3 and 101.3 g/kg $W^{0.75}$, there was a higher daily weight gain of 92.4 and 137.3 g, and feed conversions 8.1 and 6.0 g, respectively. In conclusion the fruit of *A. cochliacantha* has higher nutritional value in goats that stimulated the dry matter intake; it increases the weight gain and feed conversion.

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1. Introduction

Nowadays it is necessary to improve animal production models based on vegetation to the original with reduced dependence on external inputs, where trees play an important role (Olivares et al., 2013; Rojas et al., 2012). The use of native tree biomass as an alternative to feed animals requires the evaluation of chemical composition, digestibility parameters and behavior, and productive performance of the animal to consume (Berhan and Getachew, 2009; Kumara-Mahipala et al., 2009; Mokoboki et al., 2011). Plenty of trees have been tested in cafeteria tests to assess the preference in ruminant with good results (Alonso et al., 2008, 2009).

In the tropics of Mexico usually in extensive livestock, embedded in the economy and culture of the families, there is a clear interaction: man, livestock, soil, grass and trees. In this region during the dry season the animals feed on crop residues of maize and sorghum, and native grasses that are reserved during the rainy season (Olivares et al., 2010). In the Mexican tropics 12 species of leguminous trees have been identified as forage, and the most important contribution of fruits, density and frequency as dispersed trees and live fences on ranches are *Acacia cochliacantha*, *Pithecellobium dulce* (Olivares-Perez et al., 2011). Studies should be developed to determine the nutritional quality and influence of fruits on animal performance hen fed as animal feed. Therefore the study was planned to evaluate the chemical composition, *in vitro* gas production (IVGP), *in vitro* dry matter digestibility (IVDMD) and *in vitro* organic matter digestibility (IVOMD) in *Pithecellobium dulce* and *Acacia cochliacantha* fruits, to determine female goat's preferred intake of the fruit of these trees, as well as the productive response of male kids in confinement diets with tree fruit inclusion levels of 30% and 15% on dry matter basis.

2. Material and methods

2.1. Study area

The plant material was obtained from the ranch in the communities of Sanchez Colin Vines and Llano Grande Tejupilco, a municipality of Mexico State, bordered on the south by the state of Guerrero (Pinzon Cutzamala and Tlalchapa municipalities). The experiments were conducted in the municipality of Tlalchapa which is located between 18°16′ and 18°34′ north latitude and 100°16′ and 100°38′ west longitude, at an altitude of 400 masl, having a warm humid climate with rain in summer, with an average annual rainfall of 130 mm.

2.2. Fruits and animals used in studies

Native species of fruits (*Pithecellobium dulce*, *Acacia cochliacantha*) are the major component of feed in this zone (Olivares-Perez et al., 2011). The fruit is used and harvested in the dry season, dried and ground to a meal for feeding purposes. Experimental animals were prepubertal female Creole goats and male Creole kids. Deworming was done with ivermectin (IVERMAX®TORNEL) of 0.2 mg/kg body weight (BW) subcutaneously.

2.3. Nutritional characterization of fruits

2.3.1. Chemical composition of fruits

The collected samples were mature fruits of *P. dulce* and *A. cochliacanta* (during the months of December–February 2010). Three individual samples of 0.5 kg (each one pooled from 18 trees, *i.e.* collected randomly from three transects from 6 ranches) were randomly collected. The collected samples were dried at 40 °C for 48 h in the shade to obtain a constant weight, and then ground in Willey-mill of one mm screen size. Ground samples were analyzed for dry matter (DM) by drying at 105 °C for 24 h in a forced air oven. Ash content was measured after igniting samples in a muffle furnace at 550 °C for 12 h, and organic matter (OM) by the difference between DM and ash contents (AOAC, 2000). The CP was determined by the Kjeldahl method (AOAC, 2000; ID 954.01). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined by the method of Goering and Van Soest (1970). Total phenolic content (TP) and condensed tannins (CT) were estimated according to the method described by Waterman and Mole (1994).

2.3.2. In vitro gas production of fruits

In vitro gas production (IVGP) and *in vitro* digestibility of dry and organic matter (IVDMD and IVOMD) were determined by the gas production technique, proposed by Theodorous et al. (1994), based on the Menke and Steingass method (1988) which was modified by Herrero and Jessop (1996). Rumen fluid was collected via an oral tube from three Creole male adult goats, adapted and concentrated for 30 days to a standardized diet of foliage with a ratio of 70:30. The collection was performed manually using a portable bomb (BARNANT COMPANY, USA), in the morning (07:00 h) before feeding.

Approximately one gram of fruit tree sample was weighed, with and without polyethyleneglycol (PEG-4000 MW, Sigma®) at a ratio of 2 to 1 (*i.e.*, six bottles for each fruit *P. dulce* and *A. cochliacantha* to which were added three bottles with PEG and three bottles without PEG, and three more bottles as blank with rumen fluid only), to assess the biological activity of tannins (Waghorn, 2008) in 160 mL serum bottles. Using an automatic dispenser (Jencons, Hemel Hemstead, England), 90 mL of serum reduced reading pressure technique buffer containing micro- and macro-elements. A reducing agent and a reduction indicator of resazurin were prepared in flasks at 39 °C under a CO_2 atmosphere to turn into a light pink color; 10 mL was subsequently added to rumen fluid (previously filtered on four layers of gauze) in each bottle, keeping the anaerobic environment by the addition of CO_2 and the bottles were incubated at 39 °C (Incubator, Binder Company, Germany). The readings of gas volume were recorded each hour during the first 8 h, then every 4 h until 60 h, and later at 72, 84 and 96 h of incubation, using the reading pressure technique (RPT; DELTA OHM, Italy) of Theodorous et al. (1994).