Effects of feeding the seeds of *Prosopis laevigata*, *Acacia schaffneri* and *Ceratonia siliqua* on the performance of broiler chicks

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Abstract

The aim of the present study was to assess the nutrient contents and potential feeding value in the diet of broiler chicks of the seed of three tree species, mesquite *(Prosopis laevigata),* Schaffneri´s wattle *(Acacia schaffneri)* and the carob tree *(Ceratonia siliqua)*. The dry matter (DM), ash, crude protein (CP), amino acid and fatty acid concentrations of the seeds were determined. Growth performance was measured in terms of weight gain, feed intake and feed conversion ratio. Sixty-four day-old Cobb broiler chicks were randomly assigned to the following treatments: control diet; control + *P. laevigata*; control + *A. schaffneri* and control + *C. siliqua*. The diets were formulated to contain 200 - 210 g CP/kg and 13.39 MJ ME/kg, with approximately 60 g CP/kg diet originating from the respective seeds. *Prosopis laevigata* contained the highest protein level (394 g/kg DM), followed by *A. schaffneri* (229 g/kg DM) and *C. siliqua* (183 g/kg DM). The concentration of linoleic acid in the fat was found to be the highest in all three species, followed by oleic acid. The methionine concentration in the seed of the three species was low compared with that in soybean meal. Weight gain and feed intake of the chicks were significantly higher in the control diet and there were no significant differences between *P. laevigata* and *A. schaffneri*. Chicks receiving *C. siliqua* had the lowest weight gain. Feed conversion ratio was the lowest in the control diet, with no significant differences between the *P. laevigata* and *A. schaffneri* treatments, while *C. siliqua* had the highest feed conversion ratio. It is concluded that the seeds of the two species, *P. laevigata* and *A. schaffneri*, could partially replace commercial feed ingredients as protein and energy sources in diets of poultry kept under subsistence farming conditions in rural areas of Mexico.

Keywords: Wild seeds, mesquite, Schaffneri´s wattle, carob, small-scale poultry production, backyard
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Introduction

Backyard poultry production or so-called small-scale poultry production in rural areas of Mexico is an important activity because poultry production presents a source of animal protein and economic income to the kinds of producers that have very low income and cannot afford to buy commercial feed or basic grains such as maize or sorghum for their animals (García *et al*., 2007; Segura *et al*., 2007). In the arid and semi-arid regions in Mexico some indigenous forest resources are found, such as mesquite (*Prosopis laevigata* (Willd.) M.C. Johnst.) and Schaffneri´s wattle (*Acacia schaffneri*; Underwood), and the carob (*Ceratonia siliqua* L), an introduced tree species. These species are of great importance in feeding animals, mainly small ruminants. Backyard poultry production is characterized as being traditional, with a low level of technology. The birds are fed kitchen left-overs, crop residues, some wild grains, etc. The result is a very low productive and reproductive performance, such as low hatch weight, delay in hens reaching sexual maturity and high mortality (Segura *et al*., 2007). The crude protein (CP) level of some species of *Prosopis* is high and can reach levels of up to 720 g/kg (Escobar *et al*., 1987; Freyre *et al*., 2003). It could be used as a protein source to improve poultry growth performance.

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In these areas, the use of maize in poultry diets is limited since maize is utilized mainly for human consumption. Consequently, there is a need to find alternative feedstuffs for livestock. These feedstuffs must be available at a low cost to improve the nutritional status of the people in rural areas, particularly children, who tend to suffer from malnutrition (Aguilar *et al*., 2000). The objective of the present study was to determine the nutrient contents and effectiveness of feeding to broiler chicks the seeds of two indigenous tree species, the mesquite and Schaffneri´s wattle, and the introduced carob tree.

Materials and Methods

The experiment was approved by the Academic Committee of the Desert Zone Research Institute (DZRI) of the Autonomous University of San Luis Potosí, according to the regulations established by the Animal Protection Law enacted by the State of San Luis Potosi, Mexico. Mature pods of the mesquite (*P. laevigata* Willd., M.C. Johnst.), Schaffneri´s wattle (*A. schaffneri* Underwood) and carob (*C. siliqua* L) trees were collected in the botanical gardens of the DZRI during the summer season (June–July). The seeds were

Table 1 Chemical composition of experimental diets containing *Prosopis laevigata*, *Acacia schaffneri* and *Ceratonia siliqua* seed (dry matter basis)

	Diet			
	Control	Control + *P. laevigata*	Control + *A. schaffneri*	Control + *C. siliqua*
Ingredients (g/kg)				
Maize	540	530	380	330
Soybean meal (44% CP)	365	230	260	250
Canola oil	35	30	60	60
Cornstarch	40	40	40	40
Meat meal	15	13	13	13
Mineral and vitamin premix[1]	5	5	5	5
P. laevigata		152		
A. schaffneri			242	
C. siliqua				302
Lysine HCL	1.2	1.2	1.2	1.2
Methionine OH	2.8	2.8	2.8	2.8
Chemical composition, (g/kg)				
Dry matter	889	884	860	860
Crude protein	212	209	205	207
Crude fibre	37	39	55	59
Ash	58	55	36	36
Fat	61	63	88	94
Metabolisable energy (MJ/kg)	13.63	13.56	13.43	13.56
Calcium	9.8	9.8	9.8	9.8
Methionine	4.9	4.9	4.9	4.9
Lysine %	10.1	10.1	10.1	10.1
Methionine + cysteine	7.6	7.6	7.6	7.6
Phosphorus	4.0	4.0	4.0	4.0

[1] Mineral/vitamin mix contained (per kg final diet): 1.8 mg thiamine; 3.6 mg riboflavin; 11.5 mg pantothenic acid; 35 mg niacin; 3.5 mg pyridoxine; 0.6 mg folic acid; 0.2 mg biotin; 10 mg vitamin B_{12}; 0.9 mg retinyl palmitate; 50 mg cholecalciferol; 36.8 mg all-rac-a-tocopheryl acetate; 5 mg menaquinone.
Mineral mix contained (per kg final diet): 0.2 mg selenium; 8.1 mg copper; 40.7 mg zinc; 62 mg manganese; 105.4 mg iron; 0.35 mg iodine.

milled in a Thomas Wiley mill, using a 1 mm screen, to perform chemical analyses. The dry matter (DM), organic matter (OM), ash and CP contents were analysed according to the methods of the AOAC (1990). Crude fibre (CF), neutral detergent fibre (NDF) and acid detergent fibre (ADF) (Van Soest, *et al*., 1991) were analysed using a fibre analyser (ANKOM model A200) with filter bags (ANKOM model F-57). The determination of palmitic (C16:0), stearic (C18:0), oleic (C18:1), linoleic (C18:2) and linolenic (C18:3) acids in the fat was performed by gas chromatography, using a capillary column (60 m, AT-Wax), according to Van Pee *et al.* (1981). Amino acid analysis was performed by HPLC (Waters 717 Plus (Milford, MA., USA), with a Waters 2475 fluorescent detector (Milford, MA., USA) and a Waters PDA 2996 photodiode arrangement (Milford, MA., USA). Separation was performed on an AccQ Tag (3.9 x 150 mm, 4 mm particle size) chromatographic column (Milford, MA., USA).

For the growth performance trial, 64 day-old Cobb broiler chicks were randomly assigned to the following treatments: control diet; control + *P. laevigata*; control + *A. Schaffneri*; and control + *C. siliqua*, and divided into 16 chicks per treatment consisting of 4 replicates of 4 chicks each. The chicks were allocated to identical brooder battery cages (Petersime Inc.) in a temperature-controlled room. Feed and water were offered *ad libitum*, and orts were measured daily. The diets were formulated to meet or exceed NRC (1994) nutrient requirements for the first four weeks of age, and contained 200 - 210 g CP/kg and 13.4 MJ ME/kg (Table 1). Metabolisable energy was estimated by the prediction equation:

The percentage inclusion of the seed in the diets of *P. laevigata*, *A. schaffneri* and *C. siliqua* covered 60 g/kg of the correspondent requirement of total protein requirement. Performance was measured as weight gain, feed intake and feed conversion ratio and was recorded every week. The experiment lasted for four weeks. Data from the growth performance trial were analysed as a completely randomized design. Analysis of variance and mean comparisons (P <0.05) were performed using PROC GLM and Tukey Post-hoc-test (SAS, 1990).

Results and Discussion

The results of the chemical analysis of the raw seeds are shown in Table 2. The most significant value is the CP content with the highest value for *P. laevigata*, at 394.1 g/kg DM. This protein level was higher than those reported by Freyre *et al.* (2003) and Yusuf *et al.* (2008) in studies performed with different species of mesquite, *P. rustifolia*, *P. laevigata* and *P. africana*, which contained 338, 353 and 226 g CP/kg DM, respectively. The nutrient content of *A. schaffneri* has apparently not been reported previously. However, the protein content was similar to that of coconut, sunflower and safflower meal, which are used in poultry nutrition (Cuca *et al*., 1996). For *C. siliqua*, the CP content of 183.9 g/kg was similar to levels reported by Ortiz *et al.* (2004) and Gubbuk *et al*. (2010).

The seeds of the three tree species differed in fibre content, with the highest level in *C. siliqua,* followed by *A. schaffneri,* and *P. laevigata.* In all three species the fibre levels were higher than in soybean meal and other grains. In all three species the linoleic acid concentration was the highest of the fatty acids analysed, with *P. laevigata* at 52.6%, followed by *A. schaffneri* and *C. siliqua* at 52.3% and 50.1% in the fat, respectively. The essential fatty acid content in the seeds used for feeding broilers is important for the appropriate development of the growing chick (Maynard *et al.*, 1989). The linoleic and oleic acid concentrations in the fat of the seeds of the three species were similar to values in maize (55.8% and 27.1%) and soybean meal (53.0% and 22.4%), respectively (FEDNA, 2003). This means that the seeds analysed in the present study could be a good source of nutrients for broiler production. The fatty acid profile of the seeds of *P. laevigata* was similar to that reported by Saunders & Becker (1989) for *P. glandulosa.* However, this value was higher than the value reported by Ikechukwu *et al.* (1998) for *P. africana.* In the case of *C. siliqua*, the linoleic and linolenic acid concentrations were higher than values reported by Orhan & Sener (2002) and Dakia *et al.* (2007).

There were differences in lysine, arginine and tryptophan concentrations of the three species. The methionine concentration in the three species was low in comparison with levels present in soybean meal and maize. However, their lysine concentrations were similar (NRC 1994). In a study by Ortega (1996) on *P. juliflora*, methionine concentration was higher than that measured in the present study for *P. laevigata.* The methionine concentration for *P. laevigata* in the present study was similar to concentrations in *P. Africana*, as reported by Proll *et al.* (1998) and Yusuf *et al*. (2008). In *C. siliqua* the lysine concentration found in this study was lower than Dakia *et al*. (2007) reported.

Table 2 Chemical composition of *Prosopis laevigata*, *Acacia schaffneri* and *Ceratonia siliqua* seeds (dry matter basis

Parameter	*P. laevigata*	*A. schaffneri*	*C. siliqua*
Chemical analysis (g/kg)			
Dry matter (DM)	925	925	918
Crude protein	394	229	184
Crude fibre	76	161	147
Neutral detergent fibre	329	287	420
Acid detergent fibre	118	194	156
Ash	51	47	41
Fat	65	43	63
Lysine	68	61	59
Methionine	6	6	7
Tryptophan	9.6	9.8	10
Arginine	92	45	13
Cysteine	22	15	14
Fatty acids (% of fat)			
Palmitic acid (C16:0)	12.7	10.4	11.2
Stearic acid (C18:0)	6.1	6.6	3.8
Oleic acid (C18:1)	21.9	22.7	28.9
Linoleic acid (C18:2)	52.6	52.3	50.1
Linolenic acid (C18:3)	6.7	8.0	6.0

The performance data is presented in Table 3. Total weight gain and feed intake was the highest (P <0.05) in the control diet, while chicks fed the *C. siliqua* diet had the lowest weight gain. Similar results were found for feed conversion ratio, with the highest feed conversion ratio recorded in the chicks fed the diet containing *C. siliqua* (P <0.05).

Table 3 Growth performance of broiler chickens fed diets containing *Prosopis laevigata*, *Acacia schaffneri* or *Ceratonia siliqua*

	Control	Control + *P. laevigata*	Control + *A. schaffneri*	Control + *C. siliqua*	SEM
Final body weight (g)	856^{a}	649^{b}	604^{b}	254^{c}	32.1
Total weight gain (g)	787^{a}	588^{b}	540^{b}	193^{c}	42.3
Total feed intake (g)	1730^{a}	1558^{b}	1385^{c}	635^{d}	79.2
Feed conversion ratio	2.19^{c}	2.65^{b}	2.56^{b}	3.29^{a}	0.23

^{ab} Means within the rows with different superscripts are significantly different at P <0.05.

In the treatment containing *C. siliqua*, feed intake was very low (P <0.05) compared with the other treatments. This could be owing to anti-nutritional substances present in the seed, which, in some cases, can cause a viscose environment in the hindgut of the chick, resulting in low digestibility and absorption of nutrients (Ortíz *et al*., 2004). Yusuf *et al.* (2008) reported that chemical and thermal treatments improved the digestibility of prosopis seed meal. This suggests that the digestibility of seed from indigenous trees might be improved by subjecting them to some treatments. The seeds from several indigenous tree species are utilized in rural areas as alternative feedstuffs. In order to increase the use of these seeds, more research is necessary to characterize these feedstuffs in terms of their digestibility and possible contents of anti-nutritional factors and to investigate feasible methods in a small-scale poultry production system for treating and processing these products in order to improve their nutritional value.

Conclusion

According to the results obtained for *P. laevigata* and *A. schaffneri*, their seed could be utilized in backyard production system in rural areas in Mexico to partially replace expensive protein and energy feed source in poultry diets. These seeds are readily available in these areas.

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