Performances of growing Muscovy ducks fed on diets supplemented with Quebracho tannin powder

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Summary

Vegetal tannins, extracted from the wood of *Schinopsis lorenzii* trees, was administered on the feed for growing ducklings to evaluate the effect on productive performances and nitrogen content in plasma and excreta. Ducks belonged to local strains of Muscovy duck, not selected for growth speed. Ninety 42 days old male Muscovy ducks were distributed in 9 open-air sandy ground pens (10 males/ pen; density 0.56 ducks/ sqm) and fed *ad libitum* on a commercial growing mash feed supplemented with three levels of Quebracho-tannin (MGM-S product, manufactured by Unitan s.a.i.c.a., Buenos Aires): 0%, 1.5%, 2.5%. The experimental diets were randomly assigned to pens (30 ducks/ diet). Data on weight gain, feed conversion, plasma total protein level, excreta dry matter, slaughtering traits at 84 days of life were collected.

Tannins added in the diets did not depress duck growth, and neither leg abnormalities nor mortality were observed. After six weeks of treatment weight gain and live weight were similar among groups, as well as slaughtering traits. Tannin level did not influence plasmatic total protein and excreta dry matter.

Introduction

Tannins are naturally occurring plant polyphenols compounds, located mainly in the cell vacuoles or surface wax where they do not interfere with plant metabolism. They are widely distributed in plant kingdom and widely distributed in plant parts, too. Tannins are common in fruits (grapes, blueberry, blackberry, persimmon,...), in tea, in grasses (sorghum, field bean, pea, ...), in legume trees such as *Acacia spp., Sesbania spp., Ceratonia spp*. Many plant tissues contain tannins: in seeds they have bactericidal properties and contribute to maintain seed dormancy; in roots they are probably a chemical barrier to penetration and colonization by plant pathogens; in unripe fruits and in leaves they serve to reduce palatability and, thus, protect against predators; in the heartwood of conifers they may be a contribute to the natural durability of wood by inhibiting microbial activity (Butler, 1989, Haslam,1989).

After plant cell breakdown and death they act and have metabolic effects on plant predator or pathogen thus to be considered a plant molecular defender strategy against herbivores, granivores, insects and bacterial, fungal and viral infection. Tannins presence is detected by precipitation of protein due to tannin capacity to bind protein and form complexes, as well as with other natural polymers as starch and cellulose. This property leads an astringent taste in oral cavity (tannin-salivary glicoproteins interaction) and consequently a repellent effect in the user and a reduced palatability of feed. In gastrointestinal tract lumen tannins cause a decrease in organic matter and fibre digestion due to: protein and carbohydrates complexes, digestive enzymes activity inhibition, structural changes in the amino acid transport proteins and fluidity changes of brush-border membrane (Butler, 1989, Haslam,1989, King *et al.*, 2000).

The chemical structure of tannins allows to distinguish tannins in two groups: *Hydrolysable tannins* whose molecule is usually composed in a D-glucose central core partially or totally esterified with phenolic acids, such as gallic or ellagic acids. This tannin group must be esterified in more than two hydroxyl groups of the glucose to exhibit strong bounds with proteins. They are hydrolysed under mild acid or mild base treatments producing glucose and phenolic acids. So after gastric digestion, these compounds can be absorbed and produce animal poisoning, showing hemorrhagic gastroenteritis, necrosis of liver and kidney proximal tubules. The second group of tannins are the *Proanthocyanidins* which are large molecules, polymers of flavans, as 3-flavanols (catechin), 4-flavanols, 3,4-flavandiols linked through carbon-carbon bonds determining a condensed chemical structure. They are widely present in lignified tissues, in the teguments of unripe fruits. Due to their large size and resistance to hydrolytic digestive enzymes such tannins are not absorbed from gastrointestinal tract (Jimenez-Ramsey *et al.*, 1994). Thus they seem to produce their deleterious effect within the gastrointestinal lumen when ingested. Interaction with feed protein and carbohydrates, digestive enzymes inhibition, changes in structure of amino acid transporter proteins and damages to mucosa of gastrointestinal tract have been observed (King *et al.*, 2000). Proanthocyanidins may condense producing amorphous insoluble products (flabophens) when exposed to acids. Globally, toxic and antinutritional effects of tannins are put in evidence principally by depression of growth, reduced nutrient digestibility, excretion of proteins and amino acids, skeletal abnormalities.

As the demand for food rises, tanniniferous plants must play an increasingly important part in the diet of animals when providing significant protein supplements or alleviating competition between man and livestock for energy sources. Among cereals, sorghum is an important example of alternative cereal to maize for use in animal feed either because it shows greater resistance to drought than does maize or wheat (Gualtieri and Rapaccini,1990). However the nutritional value of grains containing tannins is reduced for non-ruminant animals, a wide variation in responses to sorghum tannins in domestic fowl is observed, as reviewed by Nyachoti *et al.* (1997).

Tannins extracted from the heartwood of Quebracho tree (*Schinopsis* sp.), is a source of condensed tannins too. A commercial product (manufactured by Unitan s.a.i.c.a., Buenos Aires), completely free from chemical additives, prepared and tested for the feeding of small ruminants (Salawu *et al.*, 1997, Salawu *et al.*, 1999, Villalba *et al.*, 2002) is available on the market. Little is known for its effects on avian species (Hewitt *et al.*, 1997, Liukkonen-Anttila *et al.*, 2001, Marzoni *et al.*, 2005). Therefore, the objective of the present study is to examine eventual detrimental or positive effects of these vegetal compounds in diets for growing ducks.

Material and methods

Ninety male 42-day-old ducks belonged to local strains of Muscovy duck (*Cairina moschata*), not selected for improving their productive performances, were randomly distributed in nine 18m^2 open-air sandy pens (ten males/ pen) and assigned to three dietary groups of 30 birds each. One group was fed on a mashed commercial growing diet (control diet), and the other two were fed on the same diet with the addition of two levels of quebracho-tannin powder, 1.5% (Q.T.1.5 diet) and 2.5% (Q.T.2.5 diet) respectively.

Table 1 Chemical composition and metabolizable energy of the control diet.

Chemical analysis		
Dry matter	%	90.42
Crude protein	% (dry matter basis)	20.46
Ether extract	% d.m.b.	4.03
N-free extract	% d.m.b.	66.82
Crude fibre	% d.m.b.	3.16
Ash	% d.m.b.	5.56
Metabolizable energy	MJ/kg	12.52

The quebracho-tannin powder, a commercial product use in the feed animal industry (MGM-S product, manufactured by Unitan s.a.i.c.a., Buenos Aires), extracted from the heartwood of *Schinopsis* sp., is characterised for containing 58% tannins, 20% phlobaphens, 14% non-tannic compounds and 8% water. Feed and water were supplied *ad libitum*. The protein source was heated soybeans and the chemical characteristics and energetic value of the control diet is reported in table 1. Feed was analysed in duplicate and mean results tabulated (AOAC,1990).

Every fourteen days, body weight changes were individually recorded and feed consumption from each pen registered. Five weeks after the beginning of the trial, eighteen blood samples per dietary group were collected from the vena *cutanea ulnaris* into EDTA Vacutainers to evaluate the total protein content of plasma by using the Lowry assay (Lowry *et al.,* 1951); plasma aliquot from three birds were pooled, thus, 6 samples for each dietary group were analysed. Three days later, at the age of 80 days, 12 ducks/ group were caged for 18 hours (from 16:00 till 10:00). Each cage housed 2 males of the same pen and under each cage a tray was used to collect the excreta. The dry matter of the excreta was determined by the AOAC (1990).At the end of the trial (84 days of age), samples of excreta collected from the ground were submitted for parasitological examination. At the same time, five birds inside each dietary group were sacrificed. Slaughtering traits and length measurements of small intestine and caeca were recorded.

Data were analysed by one-way analysis of variance to test the effect of the different diets using the JMP software (2002). Percentage data were arcsine transformed prior to analysis.

Results and conclusions

No mortality was observed during the trial. The use of Quebracho tannins did not cause leg abnormalities unlike Elkin *et al.* (1978), who observed swelling of the hock joints in chicks fed on high tannin sorghum grain diets. Probably the differences of avian species, age, tannin source as well as amount of non-tannin phenolic compounds absorbed from gastrointestinal tract (King *et al.*, 2000) might be the reason of these different results.

In the present study, the Quebracho tannin at the two tested levels, did not depress the ducks' growth (Table 2 and Table 3). As observed in game birds by Liukkonen-Anttila *et al.* (2001) and Marzoni *et al.* (2005), the MGM-S product seemed to affect slightly the productive performances of avian species characterised for the rusticity. Probably rusticity allows bird to overcome some of the antinutritional effects of tannins by performing changes in digestive physiology, such as the intestine lengthening (Liukkonen-Anttila *et al.*, 2001); another hypothesis to explain the absence of detrimental effects of MGM-S Quebracho tannins could be the feeding behaviour of ducks, as proposed by Elkin *et al.* (1990): usually ducks consume the feed previously suspended in the water, in this way feed tannins can be detoxicated. Moreover, in our trial the Quebracho tannin levels seem to affect mildly the feed digestibility, maybe due to the protein-rich commercial feed we administered to the ducks.

Table 2 Live body weight at different ages of male Muscovy ducks fed on the experimental diets (n=30).

		Duck's age (d)			
Diet		***42***	***56***	***70***	***84***
	Live body weight (g)				
Q.T. 1.5	mean	1655.6	2667.7	3272.3	3769.1
	s.d.	*± 186.17*	*± 170.23*	*± 193.95*	*± 206.93*
Q.T. 2.5	mean	1673.7	2624.1	3314.8	3765.3
	s.d.	*± 173.47*	*± 241.93*	*± 320.91*	*± 282.07*
Control	mean	1709.4	2724.0	3433.9	3786.9
	s.d.	*± 196.30*	*± 220.68*	*± 263.17*	*± 286.49*

As showed in the tables, diet groups did not differ from each other in live body weight at different ages (Table 2), as well as global daily weight gain (Table 3). Nevertheless the presumed reduced palatability of the tannin diet due to the astringency feature of tannins, the highest (P<0.01) daily feed consumption appeared in the Q.T.2.5 group during the six weeks of trial. Besides, the similar daily weight gain comparing to the other groups, let us suppose that rusticity of this rural strain of Muscovy duck allowed birds to overcome the possible lower nutrient utilisation by increasing the feed consumption and/or acting strategy in the method of eating to alleviate the tannin effect on palatability, as observed by Elkin *et al.* (1990).

Table 3 ***In vivo*** **productive performances of the growing male Muscovy ducks fed on the experimental diets (n=30).**

		Duck age interval (d)			
Diet		***42-56 d***	***56-70 d***	***70-84 d***	***42-84 d***
	Daily weight gain (g/d)				
Q.T. 1.5	mean	72.3	43.2 ^{B}	35.5 ^{A}	50.3
	s.d.	*± 7.97*	*± 7.76*	*± 9.70*	*± 5.35*
Q.T. 2.5	mean	67.9	49.3 ^{A}	32.2 ^{A}	49.8
	s.d.	*± 12.63*	*± 9.97*	*± 10.25*	*± 6.40*
Control	mean	72.5	50.7 ^{A}	25.2 ^{B}	49.5
	s.d.	*± 8.39*	*± 6.19*	*± 10.58*	*± 5.57*
	Daily feed consumption (g/d)				
Q.T. 1.5	mean	241.9	227.5 ^{C}	227.7 ^{b}	232.4 ^{B}
	s.d.	*± 10.53*	*± 11.71*	*± 11.15*	*± 4.64*
Q.T. 2.5	mean	259.4	278.4 ^{A}	252.2 ^{a}	263.3 ^{A}
	s.d.	*± 10.67*	*± 4.70*	*± 4.78*	*± 3.37*
Control	mean	241.3	249.3 ^{B}	236.4 ^{ab}	242.3 ^{B}
	s.d.	*± 7.77*	*± 10.92*	*± 9.99*	*± 8.45*
	Feed conversion efficiency				
Q.T. 1.5	mean	3.35	5.29	6.52	4.62
	s.d.	*± 0.04*	*± 0.36*	*± 0.92*	*± 0.09*
Q.T. 2.5	mean	3.89	5.66	7.91	5.30
	s.d.	*± 0.36*	*± 0.58*	*± 0.73*	*± 0.34*
Control	mean	3.57	5.20	11.02	5.17
	s.d.	*± 0.35*	*± 0.38*	*± 4.14*	*± 0.43*

A, B, C: $P<0.01$; *a, b*: $P<0.05$

Considering these ducks belonged to a strain not selected for growth capacity and meat production, *in vivo* productive performances from 42 days to 84 days of life resulted interesting (Table 3).

During the first two weeks of tannin administration (duck age: 42-56d), similar values of daily weight gain were observed among groups. However, Q.T.2.5 group grew 6% less than the other two groups despite its feed consumption, which was just a little bit higher. This might lead to suppose that the ducks were undergoing the antinutritional effect of the Quebracho tannin. Significant differences ($P<0.01$) in growth rate appeared in the following two weeks period (56-70day), due to a strong decrease of growth rate of the Q.T.1.5 group when comparing to the other two groups (43 grams/day vs. 50 grams/day). At the same time, the Q.T.1.5 group showed the lowest feed consumption, indicating a slow but evident trouble for the tannin presence. During the last two weeks of life (70d-84d interval), a marked decrease (50%) in daily weight gain was observed in the control group (25 grams/day), comparing to 56-70day period. At that time, the tannin groups were still growing 32-35 grams per day. It is evident that a compensatory growth of ducks fed on the tannin diets was still occurring.

Feed conversion efficiency showed a dramatic increase in value during the last two weeks of life in each group, indicating the end of the high productive period. Anyway, during the last six weeks of growth the Muscovy duck global FCE resulted around 5, a value we find of great interest considering it comes from a duck strain not selected for growth speed and whose breeders are conserved since the ‘70s at the Avian Experimental Station of the Department of Animal Production of the University of Pisa.

After six weeks of treatment five ducks from each group were sacrificed to evaluate slaughtering traits (Table 4). Only the ready to cook carcass incidence showed significant differences ($P<0.05$) among groups. The Q.T.1.5 duck resulted in the highest percentage of RCC and both ducks fed on tannin diets showed a slightly lower incidence of all discard portions.

Table 4 Slaughtering traits and length of gut parts (mean ± s.d.) of male Muscovy duck at 84 days old (n=5).

		Diet group		
		Q.T. 1.5	Q.T. 2.5	Control
Live Body weight (bw)	g	3779.6 ± *59.67*	3778.0 ± *140.26*	3734.2 ± *212.80*
Ready to cook carcass (RCC)	% bw	62.6 ^{a} ± *1.04*	61.0 ^{ab} ± *1.50*	59.7 ^{b} ± *1.63*
Empty gizzard	% bw	1.8 ± 0.20	1.9 ± 0.09	1.9 ± 0.25
Liver	% bw	1.6 ± 0.24	1.7 ± 0.19	1.8 ± 0.26
Breast muscles	%RCC	21.1 ± *1.81*	20.5 ± *2.11*	20.9 ± *1.77*
Legs and thighs	%RCC	20.9 ± *0.51*	21.2 ± *0.85*	22.1 ± *1.00*
Small intestine length	cm	193.2 ± 5.68	201.1 ± 17.99	205.7 ±13.57
Total Caeca length	cm	33.5 ± 8.54	39.3 ± 5.20	42.5 ± 2.91

a,b: P<0.05

No significant differences in length of gut parts were observed among groups in this trial. Similar findings were obtained in growing pheasants after a 60 days MGM-S diet supplementation (Marzoni *et al.*, 2005), while longer small intestine after a 4 weeks trial in adult grey partridges was observed by Liukkonen-Anttila *et al.* (2001). Macroscopic observation of gut mucosa did not reveal hemorrhagic damage as well as increasing in size of organs as pancreas, liver and kidney. The absence of helminth in duck excreta did not allow to distinguish a different parasitic resistance among groups, unlike to what was observed in other species (Salawu *et al.*, 1997, Salawu *et al.*, 1999; Marzoni *et al.*, 2005).

Plasma total protein content (table 5) showed no differences among groups, corresponding with 4.5 g/dl obtained by Harr (2002) in adult *Anas sp.*. Since plasma total protein is a good indicator of the animal's nutritional status, this data confirms that MGM-S seems not to influence protein metabolism.

Table 5 Duck plasma total protein and dry matter of excreta (mean ± s.d.) after five weeks of trial (n=6).

Diet group	Plasma	Excreta
	total protein g/dl	dry matter %
Q.T. 1.5	4.33 ± *0.234*	47.4 ± *8.87*
Q.T. 2.5	4.38 ± *0.248*	49.0 ± *9.52*
Control	4.50 ± *0.126*	45.3 ± *6.34*

Dry matter content of excreta (table 5) showed similar values among groups, even if a slightly lower watery excreta was observed in ducks fed on tannin diets.

In conclusion, MGM-S powder did not have detrimental effects on the growing Muscovy ducks as well as effects on productive performances seemed to be very slight, when using a dietary inclusion of up to 2.5% Quebracho tannins and a protein content of feed relatively high.

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Feed intake: Feed intake pattern of Pekin ducks under this study was presented in Table 2. The present study revealed significantly (p<0.0001) lowest feed intake in high ME-low CP (Diet-4) treatment group while highest feed intakes were observed in Diet-1 and Diet-3 groups containing both increased ME and CP level.Â Comparison of growth performance, carcass yield and composition, and fatty acid profiles of Pekin and Muscovy ducklings fed diets based on food wastes. Can. J. Anim. Performance of Slow Growing Male Muscovy Ducks Exposed to Different Dietary Levels of Quebracho Tannin. Annelisse Castillo 1, Achille Schiavone 1, Maria Grazia Cappai 2, Joana Nery 1,*, Marta Gariglio 1, Stefano Sartore 1, Alessandro Franzoni 1 and Margherita Marzoni 3.Â Simple Summary: Different inclusion levels of Quebracho tannin (QT) in the diet of growing male Muscovy ducks of a slow growing type were explored under free range conditions. As a result of the dietary treatments tested in this trial, the growth performance or the total blood proteins were not affected. Four groups of rabbits were fed with a different diet: a control diet (C); a control diet with coccidiostat (CC), and two experimental diets with 0.3% (T0.3) and 0.6% (T0.6) chestnut and quebracho tannins mix. For microbial analysis, culture-dependent and culture-independent methods were employed. Live performances were not significantly affected by tannins mix supplementations, as well as culturable microbial loads of E. coli, Enterobacteriaceae, Bacteroides spp. and Bifidobacterium spp. C. perfringens was always under the detection limit. A consistent result was obtained by qPCR.Â This work highlights the potential antimicrobial effect of chestnut and quebracho tannins mix in an in vivo system revealed by molecular analysis. Download full-text PDF. Source. The aim of the present study was to evaluate the effect of different levels of dietary Quebracho tannins (QT) on growth and production performance in slow-growing type Muscovy ducks. For this purpose, a 42-d trial was carried out on 126 male ducks (42-d old at start), fed on three levels of dietary QT inclusion in the diet (0% as control diet, vs. 1.5% vs. 2.5% on an as fed basis). Birds were reared under free-range conditions. A linear increase in feed intake as a function of QT inclusion in the diet was observed ($p < 0.05$). No difference as to final body weight, overall average daily weight gain (ADG) and total feed conversion ratio (FCR) in relation to dietary treatments was observed. Carcass yields were positively improved in QT birds ($p < 0.05$).