ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF
POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 8 (1): 40-46, 2009
ISSN 1682-8356

Effects of Dietary Energy Level and Tanniferous *Acacia karroo* Leaf Meal Level of Supplementation at Finisher Stage on Performance and Carcass Characteristics of Ross 308 Broiler Chickens in South Africa

J.W. Ng'ambi, P.M. Nakalebe, D. Norris, M.S. Malatje and C.A. Mbajiorgu
Department of Animal Production, University of Limpopo,
Private Bag X 1106, Sovenga 0727, South Africa

Abstract: The study was conducted to determine the effect of dietary energy level and tanniniferous *Acacia karroo* leaf meal level of supplementation at finisher stage on performance and carcass characteristics of male and female Ross 308 broiler chickens. Three hundred and sixty, 21 days old male and female broiler chickens were assigned to twelve treatments with three replications of ten birds in a 2 (sex) x 3 (dietary energy level) x 3 (tanniniferous *Acacia karroo* leaf meal level) factorial, complete randomized design. Supplementation with *Acacia karroo* leaf meal had no effect on diet intake, digestibility and live weight of broiler chickens. However, supplementation with 9 and 12 g of *Acacia karroo* leaf meal per kg DM feed reduced fat pad weights in male broiler chickens by 26 and 29% points, respectively. Similarly, supplementation with 9 and 12 g of *Acacia karroo* leaf meal per kg DM feed reduced fat pad weights in female chickens by 26% points. These reductions were achieved without any significant reduction in feed intake and digestibility. However, the physiological explanation for this effect is not clear and it, thus, merits further investigation.

Key words: Ross 308 broiler chickens, *Acacia karroo*, Fat pad, digestibility, nitrogen retention

INTRODUCTION

The broiler chicken industry is an important source of animal protein in Limpopo province in comparison with cattle and pigs (Boer *et al*., 2001). However, extensive genetic selection towards a fast-growing chicken has led not only to a dramatic shortening of the growing period, but also to excessive carcass fatness, which consequently lowers meat yield and feed efficiency. In addition, fat deposition has become a serious threat in the breeder flocks since obesity also leads to infertility (Friedman-Einat *et al*., 1999). Excessive fatness is one of the undesirable consequences of selection for increased growth of modern broiler chickens. Accumulation of fat in carcasses of broiler chickens represents waste product to consumers who are increasingly concerned about the nutritional and health aspects of their food (Mahmoud and Mihaly, 1998). Fat amount, fat quality and cholesterol content in food are important consideration when the relationships between fat and the risk of some cardiovascular diseases and cancer are evaluated (Ahn *et al*., 1995; Cherian and Wolfe, 1996). The latter consideration is important because results of many human studies have related high dietary fat intake to the incidence of cardiovascular diseases and cancer (Lichtenstein, 1999). Excess body fat deposition in broiler chickens is now of concern to both producers and consumers. Due to increasing public demand for low fat and low cholesterol products, interest in manipulating the lipid composition of poultry meat via dietary means has become important (Hargis and Elswyk, 1993; Sacks, 2002). It is widely acknowledged that there is a need for low intakes of cholesterol and saturated fats (Evans *et al*., 2002). The control of lipid deposition in broiler chickens aimed at efficient lean poultry meat production is of current interest (Fisher and McNab, 1997). Tannins have been associated with reduced carcass fat content in grazing lambs, relative to lambs grazing white clover only (Purchase and Keogh, 1984). However, the effects of tannins on broiler chicken fat content are not known. Therefore, the objective of the present study was aimed at determining whether ingestion of tannins at finisher stage would reduce fat content in broiler chickens.

MATERIALS AND METHODS

Study area: This experiment was conducted between October and December, 2006 at the University of Limpopo Experimental farm, Limpopo Province, South Africa. The farm is located 10 km northwest of the Turfloop Campus. The ambient temperatures around this area are above 32°C during summer and around 25°C or lower during the winter season. Average annual rainfall is between 446.8 and 468.4 mm.

Collection, drying and storage of plant material: *Acacia karroo* leaves were hand-harvested early each morning for one week at the University of Limpopo main campus in May, 2006. The leaves were then shade dried and stored in-doors for 14 days prior to grinding. The dried leaves were ground, using 2 mm screen and stored in air-tight bags until needed for feeding as a supplement in the experiment.

Table 1: Experimental treatments

Treatment	
ME_1T_0	Male broiler chickens fed low energy (13.2 MJ ME/kg DM) diet without tanniniferous *Acacia karroo* leaf meal supplementation
ME_1T_9	Male broiler chickens fed low energy (13.2 MJ ME/kg DM) diet with 9 g tanniniferous *Acacia karroo* leaf meal per kg diet.
ME_1T_{12}	Male broiler chickens fed low energy (13.2 MJ ME/kg DM) diet with 12 g tanniniferous *Acacia karroo* leaf meal per kg diet
ME_2T_0	Male broiler chickens fed high energy (13.8 MJ ME/kg DM) diet without tanniniferous *Acacia karroo* leaf meal supplementation
ME_2T_9	Male broiler chickens fed high energy (13.8 MJ ME/kg DM) diet with 9 g tanniniferous *Acacia karroo* leaf meal per kg diet.
ME_2T_{12}	Male broiler chickens fed high energy (13.8 MJ ME/kg DM) diet with 12 g tanniniferous *Acacia karroo* leaf meal per kg diet
FE_1T_0	Female broiler chickens fed low energy (13.2 MJ ME/kg DM) diet without tanniniferous *Acacia karroo* leaf mealsupplementation
FE_1T_9	Female broiler chickens fed low energy (13.2 MJ ME/kg DM) diet with 9 g tanniniferous *Acacia karroo* leaf meal per kg diet.
FE_1T_{12}	Female broiler chickens fed low energy (13.2 MJ ME/kg DM) diet with 12 g tanniniferous *Acacia karroo* leaf meal per kg diet
FE_2T_0	Female broiler chickens fed high energy (13.8 MJ ME/kg DM) diet without tanniniferous *Acacia karroo* leaf meal supplementation
FE_2T_9	Female broiler chickens fed high energy (13.8 MJ ME/kg DM) diet with 9 g tanniniferous *Acacia karroo* leaf meal per kg diet.
FE_2T_{12}	Female broiler chickens fed high energy (13.8 MJ ME/kg DM) diet with 12 g tanniniferous *Acacia karroo* leaf meal per kg diet

Birds, treatment, design and data collection: Three hundred and sixty, 21 days old Ross 308 broiler chickens were used in the experiment. Prior to this experiment, the chickens were feed a 22% CP starter diet that would satisfy their nutritional requirements according to the NRC (1994). On commencement of the experiment, the chickens were randomly assigned to twelve dietary treatments (Table 1) with three replications, each having 10 birds in a 2 (sex) x 2 (energy levels) x 3 (tanniniferous acacia leaf meal levels) factorial arrangement in a complete randomized design (SAS, 2000). Thus, 36 floor pens (1.5 m^2/pen) were used in total. The birds were offered ad-libitum feed and fresh water. The daily lighting program was 24 h. The experiment was terminated when the birds were 42 days of age.

The initial live weights of the chickens were taken at the start of the experiment. Thereafter, daily mean live weights and feed intake were measured until the end of the experiment. Daily growth rates and feed conversion ratio were calculated. Mortality was measured throughout the experiment. Digestibility was done between ages of 36 and 42 days. Digestibility was conducted in specially designed metabolic cages having separated watering and feeding trough. Four birds were randomly selected from each replicate and transferred to metabolic cages for the measurement of apparent digestibility. A 3 days acclimatization period was allowed prior to a 3 days collection period. Droppings voided by each bird were collected on a daily basis at 09.00 h. Care was taken to avoid contamination from feathers, scales, debris and feeds.

At 42 days of age all remaining broiler chickens per pen were slaughtered by cervical dislocation to determine the carcass characteristics. Breast meat yield and abdominal fat were weighed. Fat surrounding the gizzard and intestines extending to the bursa were considered as abdominal fat (Mendonca and Jensen, 1989). At the end of each slaughtering, meat samples from each breast part of the slaughtered bird were taken and stored in the refrigerator until analyzed for dry matter and nitrogen.

Nutrient analysis: Dry matter and nitrogen contents of the diets, refusals, faeces and meat samples were determined as described by AOAC (2000). The gross energy of the diets and excreta samples were determined using an adiabatic bomb calorimeter (Gaallenkamp, University of Pretoria, South Africa) The apparent Metabolisable Energy (ME) contents of the diets were calculated (AOAC, 2000). Total phenolics were determined using Folin Ciocalteau method and expressed as tannic acid equivalent (% DM) (Waterman and Mole, 1994). Condensed tannins were determined using Butanol-HCL method and expressed as leucocyanidin equivalent (%DM) (Porter *et al.*, 1986). Protein-binding capacity by filter paper was determined using the methods described by Dawra *et al.* (1988). Radial diffusion was determined using the methods described by Hagerman (1987). Reaction of Polyethylene Glycol (PEG) with tannins was determined according to the methods described by Silanikove *et al.* (1994).

Statistical analysis: Effects of sex, dietary energy level and level of *Acacia karroo* leaf meal supplementation on diet intake, growth rate, feed conversion ratio, digestibility, nitrogen retention and carcass characteristics were analyzed using the General Linear Model (GLM) procedures of statistical analysis of variance (SAS, 2000). Where there was a significant F-test ($p<0.05$), the Duncan's Multiple Range Test was used to determine the significance of differences among the means (Duncan, 1955). Regression analyses were used to determine the relationship between tanniniferous feed supplementation level and animal performance indices (fat pad, digestibility and nitrogen retention) (SAS, 2000).

RESULTS

The high and low energy diets contained 18.2 and 17.6 MJ energy per kilogram DM, respectively and 180 g crude protein per kilogram DM diet (Table 2).

Results of the nutrient composition of *Acacia karroo* leaf meal are presented in Table 3. *Acacia karroo* contained

Table 2: Nutrient composition of the grower diets (units are g/kg for dry matter, g/kg DM for protein and MJ/kg DM for energy)

	Dietary treatments					
Nutrients	E_1T_0	E_1T_9	E_1T_{12}	E_2T_0	E_2T_9	E_2T_{12}
Dry matter	917	919	916	918	918	919
Energy	17.6	17.7	17.6	18.2	18.2	18.3
Protein	180	181	180	182	180	182

E_1T_0: Low energy diet without tanniniferous *Acacia karroo* leaf meal level supplementation,
E_1T_9: Low energy diet with 9 g of tanniniferous *Acacia karroo* leaf meal level of supplementation/kg DM.
E_1T_{12}: Low energy diet with 12 g of tanniniferous *Acacia karroo* leaf meal level of supplementation/kg DM,
E_2T_0: High energy diet without tanniniferous *Acacia karroo* leaf meal level of supplementation,
E_2T_9: High energy diet with 9 g of tanniniferous *Acacia karroo* leaf meal level of supplementation/kg DM,
E_2T_{12}: High energy diet with 12 g of tanniniferous *Acacia karroo* leaf meal level

Table 3: Tannin analysis of *Acacia karroo* leaf meal by total phenolics (TP), polyvinylpolypyrrolidone (PVPP), radial diffusion (RD), extracted condensed tannins (ExCT), unextracted condensed tannins (UNExCT), polyethylene glycol (PEG) and precipitable phenolics by filter paper method (PPFP), dry matter and crude protein

Nutrient composition	*Acacia karroo*
Dry matter (g/kg)	90.70
Crude protein (g/kg DM)	120.00
Tannin contents by method of:	
TP (% DM)*	1.51
PVPP (% DM)	0.57
RD (mm^2)	4.00
ExCT (% DM)**	4.52
UnExCT (% DM)**	3.72
PEG (mg/g)	0.39
PPFP (ig)	0.24

*Percentage DM tannic acid equivalent, **Percentage DM Leucocyanidin equivalent

120 g crude protein per kg DM, 1.5 % DM total phenolics, 4.5% DM extracted condensed tannins and 3.72% DM unextracted condensed tannins. The analysis by polyvinylpolypyrollidone, radial diffusion, polyethylene glycol and precipitable phenolics by filter paper showed that *A. karroo* leaf meal had 0.57% DM, 4.00 mm^2, 039 mg/g and 0.24 µg, respectively.

The effects of dietary energy level and tanniniferous *A. karroo* leaf meal level of supplementation and their interactions on feed intake, growth rate and feed conversion ratio of male and female Ross 308 broiler chickens from 22-42 days of age are presented in Table 4. Dietary energy level, tanniniferous *A. karroo* leaf meal level of supplementation, sex and their interactions had no effect ($p>0.05$) on growth rates and feed conversion ratio of broiler chickens. Within the same sex, dietary energy level and tanniniferous *A. karroo* leaf meal level of supplementation had no effect ($p>0.05$) on feed intake of broiler chickens. However, when compared on the same diet, male broiler chickens had higher ($p<0.05$) feed intake than female chickens.

Table 4: Effect of dietary energy level and tanniniferous *Acacia karroo* leaf meal level of supplementation on feed intake (g DM/bird/day), growth rate (g/bird/day) and feed conversion ratio (FCR) (g feed/g live weight gain) of male and female Ross 308 broiler chickens from 22-42 days of age

Treatment	Feed intake	Growth rate	FCR
ME_1T_0	119.7^{ab}	57.1	2.0
ME_1T_9	117.6^{abc}	54.3	2.1
ME_1T_{12}	116.0^{abc}	46.2	2.5
ME_2T_0	122.8^{a}	51.9	2.3
ME_2T_9	120.7^{ab}	48.0	2.5
ME_2T_{12}	117.8^{abc}	43.9	2.5
FE_1T_0	111.8^{cde}	51.1	2.1
FE_1T_9	110.6^{de}	46.6	2.3
FE_1T_{12}	107.8^{e}	44.8	2.4
FE_2T_0	111.8^{cde}	42.6	2.5
FE_2T_9	113.2^{cde}	46.7	2.4
FE_2T_{12}	107.9^{e}	47.7	2.1
SE	2.19	2.96	0.12

$^{a, b, c, d, e}$Means in the same column not sharing a common superscript are significantly different ($p<0.05$), SE: Standard error

Results of the effect of dietary energy level and tanniniferous *Acacia karroo* leaf meal level of supplementation and their interactions on dry matter digestibility, crude protein digestibility, metabolisable energy and nitrogen retention of male and female broiler chickens between 36 and 42 days of age are presented in Table 5. Dietary energy level, tanniniferous *A. karroo* leaf meal level of supplementation and sex had no effect ($p>0.05$) on dry matter and CP digestibilities, metabolisable energy and nitrogen retention in broiler chickens.

Dietary energy level, tanniniferous *A. karroo* leaf meal level of supplementation and sex had no effect ($p>0.05$) on carcass weight, dressing percentage, breast meat and thigh weights of broiler chickens (Table 6). Tanniniferous *A karroo* leaf meal supplementation had effects on fat pad weights. Broiler chickens supplemented with *A karroo* leaf meal had lower ($p<0.05$) fat pad weights than those not supplemented. However, sex of the chickens had no effect ($p>0.05$) on fat pad weights. Dietary energy level, *A. karroo* leaf meal level of supplementation and sex had no effect ($p>0.05$) on crude protein content of breast meat samples of male and female broiler chickens (Table 7).

A series of linear regressions that predict fat pad content, crude protein retention and dry matter digestibility in male and female Ross 308 broiler chickens from tanniniferous *Acacia karroo* leaf meal level of supplementation are presented in Table 8. *Acacia karroo* leaf meal level of supplementation was poorly correlated with fat pad of male (r^2 = 0.329) and female (r^2 = 0.071) broiler chickens fed a low energy diet. Moderate relationships (r^2 = 0.689) were observed between *Acacia karroo* leaf meal level of supplementation in broiler chickens fed a low energy diet. A similar trend was observed when the chickens

Table 5: Effect of dietary energy level and tanniniferous *Acacia karroo* leaf meal level of supplementation at finisher stage on dry matter digestibility(decimal), crude protein digestibility, metabolisable energy (ME) and nitrogen-retention of male and female Ross 308 broiler chickens between 36 and 42 days of age

Treatment	DM digestibility	CP digestibility (decimal)	ME (MJ/kg DM)	N-retention (g/bird/day)
ME_1T_0	0.58	0.88	10.88	3.20
ME_1T_9	0.51	0.87	9.88	3.00
ME_1T_{12}	0.49	0.87	10.15	3.03
ME_2T_0	0.58	0.88	11.55	3.20
ME_2T_9	0.47	0.87	9.46	2.80
ME_2T_{12}	0.50	0.87	10.05	2.73
FE_1T_0	0.60	0.90	11.22	3.20
FE_1T_9	0.53	0.88	10.37	3.10
FE_1T_{12}	0.56	0.87	10.51	2.80
FE_2T_0	0.61	0.90	12.40	3.20
FE_2T_9	0.55	0.87	10.64	3.10
FE_2T_{12}	0.54	0.87	11.39	3.10
SE	0.02	0.01	0.41	0.16

SE: Standard error

Table 6: Effect of dietary energy level and tanniniferous *Acacia karroo* leaf meal level of supplementation on carcass parts (g) and dressing (%) of male and female Ross 308 broiler chickens at 42 days of age

Treatment	Carcass weight	Dressing (%)	Fat pad	Breast	Thigh
ME_1T_0	1579	80	38^a	362	120
ME_1T_9	1642	77	28^{bc}	355	119
ME_1T_{12}	1704	79	27^c	366	126
ME_2T_0	1634	78	39^a	366	120
ME_2T_9	1549	79	29^{bc}	337	121
ME_2T_{12}	149	75	28^{bc}	322	120
FE_1T_0	1474	79	38^a	352	117
FE_1T_9	1498	78	28^{bc}	366	116
FE_1T_{12}	1501	81	28^{bc}	333	113
FE_2T_0	1376	76	38^a	322	107
FE_2T_9	1454	77	28^{bc}	317	111
FE_2T_{12}	1236	66	28^{bc}	319	107
SE	85.98	4.09	2.75	19.5	5.03

$^{a, b, c}$: Means in the same column not sharing a common superscript are significantly different ($p<0.05$), SE: Standard Error

Table 7: Effect of dietary energy level and tanniniferous *A.karroo* leaf meal level of supplementation on crude protein contents (% DM) of breast meat samples of male and female Ross 308 broiler chickens at 42 days of age

Treatment	Crude protein (%)
ME_1T_0	26.60
ME_1T_9	20.50
ME_1T_{12}	22.00
ME_2T_0	20.90
ME_2T_9	20.80
ME_2T_{12}	21.00
FE_1T_0	20.30
FE_1T_9	21.50
FE_1T_{12}	20.50
FE_2T_0	22.30
FE_2T_9	21.30
FE_2T_{12}	21.40
SE	0.52

SE: Standard Error

were fed a high energy diet. Similarly, poor correlations were observed between *A. karroo* leaf meal level of supplementation and crude protein retention in broiler chickens.

DISCUSSION

This experiment was designed to have high and low energy diets. The analyzed experimental grower diets had ME levels of 10.5 and 11.0 MJ/kg DM for Low and High diets, respectively. The *Acacia karroo* used in this study contained 120 g of crude protein per kg DM. This is quite high and ideal for supplementation in animal feeds (Makkar, 2003). Similar, results have been reported elsewhere (Dube 1993; Kahiya *et al.*, 2004). However, *Acacia karroo* contained high concentrations of tannins, particularly condensed tannins. Dube (1993) reported similar concentrations. Condensed tannins bind with diet protein and other nutrients, hence they tend to lower diet intake and digestibility in animals (Dube, 1993; Makkar, 2003). Thus, the performance of animals on high tanniniferous feeds is usually low (Makkar, 2003).

The present results showed that dietary energy levels had no effect on feed intake, growth rate, FCR, digestibility, nitrogen retention, carcass weight, fat pad, carcass parts and dressing percentage of broiler chickens. Metabolisable energy levels of the grower

Table 8: Prediction of diet dry matter digestibility (decimal), fat pad content (g/bird) and CP retention (g/bird/day) in male and female Ross 308 broiler chickens from tanniniferous *Acacia karroo* leaf meal level of supplementation

Factor	Y-variable	Formulae	r^2	P
10.5 MJ/kg DM feed				
A. karroo	Male fat pad	y = -1.80x + 38.3	0.329	0.120
A. karroo	Male CP retention	y = -0.24x + 22.5	0.024	0.237
A. karroo	DM digestibility (males)	y = 1.8x – 2	0.689	0.027
A. karroo	Female fat pad	y = -7. 55x + 40.7	0.071	0.493
A. karroo	Female CP retention	y = -0.61x + 23.3	0.332	0.003
A. karroo	DM digestibility (females)	y = 1.8x – 2	0.689	0.007
11.0 MJ/kg DM feed				
A. karroo	Male fat pad	y =-1.26x + 42.4	0.097	0.493
A. karroo	Male CP retention	y = -0.32x + 20.5	0.062	0.062
A. karroo	DM digestibility (males)	y = 1.8x – 2	0.689	0.037
A. karroo	Female fat pad	y = -1.40x + 47	0.456	0.018
A. karroo	Female CP retention	y = -0.53x + 23	0.222	0.770
A. karroo	DM digestibility (females)	y = 1.8x – 2	0.689	0.044

r^2: Correlation co-efficient, x: *A. karroo*

diets were not very different. Thus, lack of differences in intakes may have been expected. This is because broiler chickens eat primarily to satisfy their energy requirements (Scott *et al.*, 1982) and hence, feeds of similar energy levels will give similar intakes.

Acacia karroo leaf meal level of supplementation had no effect on growth rate, feed conversion ratio, carcass parts, dressing percentage and crude protein contents of breast meat of broiler chickens at 42 days of age. These results could be explained in terms of similar intakes, digestibilities and nitrogen retention, irrespective of the treatment. Similar results were obtained by Al-Mamary *et al.* (2001) who found that addition of sorghum grains low in tannins to diets of rabbits did not change growth rate, feed intake and feed conversion ratio. Similar, results were also reported by Diao *et al.* (1990). These findings are contrary to the findings of Laurena *et al.* (1984), Makkar (2003) and Hassan *et al.* (2003) who found adverse effects of tannins on feed efficiency, growth rate and protein digestibility.

Male broiler chickens ate more feeds than female chickens. These results are similar to those of Dozier *et al.* (2008) who found that male broiler chickens had higher feed intake than female chickens when both sexes were fed *ad libitum*. The differences were explained in terms of female chickens requiring on average 13% less feed for maintenance per kg metabolic body weight than males. However, Gous *et al.* (1999) suggested that genetic potential influences broiler chicken growth responses because it affects their nutritional requirements. Thus, male broiler chickens have pronounced genetic advantage on feed intake compared to female broiler chickens. However, there were no differences between sexes in growth rate, carcass weights, carcass parts and breast meat nitrogen content. These results may be explained in terms of similarities in digestibility values. These results are similar to the findings of Leeson and Summers (1991) who found no differences between male and female growth rates and carcass weights. Similarly, Acar *et al.* (1993) reported that sex had similar effects on carcass weight and nitrogen content of breast meat of broiler chickens at 42 days of age. However, Lippens *et al.* (2000) reported that female broiler chickens yielded smaller carcass weights than male chickens. Han and Baker (1994), also, reported that sex had an effect on carcass weight and nitrogen content of breast meat of broiler chickens. The differences were explained in terms of higher feed intake in male than female chickens. It was, additionally, suggested that the differences between sexes probably arise from metabolic differences and also from the differences in the onset of fattening of broiler chickens.

Acacia karroo leaf meal supplementation had an effect on fat pad weights of broiler chickens. Supplementation with 9 and 12 g of *Acacia karroo* leaf meal per kg DM of feed reduced fat pad weights in male broiler chickens by 26 and 29% points, respectively. Similarly, supplementation with 9 and 12 g of *Acacia karroo* leaf meal per kg DM feed reduced fat pad weights in female chickens by 26% points. These reductions were achieved without any significant reduction in feed intake and or digestibility. The physiological explanation for this effect is not clear and it, thus, merits further investigation. However, it is known that *A. karroo* leaves contain high contents of condensed tannins which tend to bind with feed and endogenous proteins and other nutrients, thus lowering diet intake and digestibility (Makkar, 2003). The presence of condensed tannins has been associated with reduced carcass fat in ruminant animals (Purchase and Keogh, 1984; Terril *et al.*, 1992). However, no physiological explanations were given in their studies. No similar studies in chickens were found.

Low but positive correlations were found between *Acacia karroo* leaf meal level of supplementation and diet DM digestibility, fat pad weights and crude protein retention in broiler chickens. Mashamaite (2004) observed similar results in rabbits. No similar studies in chickens were found.

Conclusion and recommendations: *Acacia karroo* contained high amounts of condensed tannins. Supplementation with *Acacia karroo* leaf meal had no effect on diet intake, digestibility and live weight of broiler chickens. However, supplementation with 9 and 12 g of *Acacia karroo* leaf meal per kg DM feed reduced fat pad weights in male broiler chickens by 26 and 29 % points, respectively. Similarly, supplementation with 9 and 12 g of *Acacia karroo* leaf meal per kg DM feed reduced fat pad weights in female chickens by 26 percentage points. These reductions were achieved without any significant reduction in feed intake and digestibility. The physiological explanation for this effect is not clear and it, thus, merits further investigation.

REFERENCES

Acar, N., E.T. Moran and D.R. Mulvaney, 1993. Breast muscle development of commercial broilers from hatching to twelve weeks of age. Poult. Sci., 73: 317-325.

Ahn, D.U., H.H. Sunwoo, F.H. Wolfe and J.S. Sim, 1995. Effects of dietary alphalinolenic acid and starin of hen on the fatty acid composition, storage stability and flavor characteristics chicken egg. Poult. Sci., 74: 1540-1547.

Al-Mamary, M., A. Molham, A. Abdulwali and A, Al-Obeide, 2001. *In vivo* effect of dietary sorghum tannins on rabbits digestive enzyme and mineral absorption. Nutr. Res., 21: 1393-1401.

AOAC, 2000. Association of Official Analytical Chemists. Official Methods of Analysis. 15th Edn. Arlington. Washington DC.

Boer, I.J.M., P.L. Van Der Togt, M. Grossman and R.P. Kwakkel, 2001. Nutrient flows for poultry production. Poult. Sci., 79: 172 – 179.

Cherian, G. and F.W, Wolfe. 1996. Dietary oils with added tocopherols: Effect on eggs or tissue tocopherols, fatty acids and oxidative stability. Poult. Sci., pp: 423-431.

Dawra, R.K., H.P.S. Makkar and B. Singh, 1988. Protein binding capacity of micro quantities of tannins, Analytical Biochem., 170: 50-53.

Diao, Q.Y., Y.Z. Yang and H.J. Chun, 1990. The effects of sorghum tannin ondigestion of nutrients in leghorn cocks. Chinese Anim. Magazine, 26 (2): 30-32.

Dozier, W.A., III, A. Corzo, M.T. Kidd and M.W. Schilling, 2008. Dietary digestible Lysine Requirements of Male and Female Broilers from 49-63 Days of Age. Poult. Sci., 87: 1385-1391.

Duncan, D.B., 1955. Multiple range and multiple F tests. Biometrics, 11: 1-42.

Dube, J.S., 1993. Nutritive value of four species of browse preferred by indigenous goats in a redsoil thornveld in Southern Zimbabwe. (Mphil thesis).

Evans, M., A. Roberts and A. Rees, 2002. The future direction of cholesterol Lowering therapy. Curr. Opin. Lipodol, 13: 663–669.

Friedman-einat, M.T., G. Boswell, G. Horev, I.C. Girishvarma, R.T. Dunn Talbot and P.J. Sharp, 1999. The chicken leptin gene: Has it been cloned? General and Comparative Endocrinol., 115: 354-363.

Fisher, R. and J.M. McNab, 1997. Techniques form determining the ME content of poultry feeds. In: Recent Advances in Animal Nutrition. Haresign and Cole Publication, Butterworth.

Gous, R.M., E.T. Moran, H.R. Stilborn, G.D. Bradford and G.C.Emmans, 1999. Evaluation of the parameters needed to describe the overall growth, the chemical growth and the growth of feathers and breast muscles of broilers. Poult. Sci., 78: 812-21.

Hargis, S.P. and E.M. Van Elswyk, 1993. Manipulating the fatty acids composition of poultry meat and eggs for health conscious consumer. World's Poult. Sci. J., 49: 252.

Hagerman, A.E., 1987. Radial diffusion method for determining tannins in plant extracts. J. Chem. Ecol., 13: 437-449.

Han, Y and D.H. Baker, 1994. Digestible lysine requirement of male and female broiler chicks during the period three to six weeks post hatching. Poult. Sci., 73: 1739-1745.

Hassan, I.A., E.A. Elzuber and H.A. Tinay, 2003. Growth and apparent absorption ofminerals in broiler chicks fed diets with low or high tannin contents. Trop. Anim. Health Prod., 35: 189-196.

Kahiya, C., S. Mukaratiwa and S.M. Thamsborg, 2004. Effects of *Acacia karroo* and *Acacia nilotica* diets on Haemonchus contortus infection in goats. Vet. Physiol., 115: 265-274.

Laurena, A.C., T. Van Den and M.E. Mendoza, 1984. Effect of tannins on the in vitro digestibility of cowpea (*Vigna unguiculata*). J. Agric. Food Chem., 32: 1045-1048.

Leeson, S. and J.D. Summers, 1991. Commercial Poultry Nutrition. University Books, Quelph, Ontario Canada.

Lichtenstein, A.H., 1999. Nutrition Revision, 57: 11-14.

Lippens, M., G. Room, G. De Groote and E. Decuypere, 2000. Early and Temporary quantitative food restriction of broiler chickens 1. Effects on performance characteristics, mortality and meat quality. Br. Poult. Sci., 41: 343-354.

Mahmoud, H. and S. Mihaly , 1998. Effects of L-carnitine supplementation of diets differing in energy levels on performance, abdominal fat content, yield and composition of edible meat broilers. Br. J. Nutr., 80: 391-400.

Makkar, H.P.S., 2003. Effects and fate of tannins in ruminant animals, adaptation to tannins and strategies to overcome detrimental effects of feeding tannin rich feeds. Small Ruminant Res., 49: 241-256.

Mashamaite, L.V., 2004. Relation between tannin contents using different tannin assays and short-term biological responses in rabbits supplemented with leaves of different Acacia species, M Sc Thesis, University of Limpopo, Department of Animal production, South Africa.

Mendonca, C.X. and L.S. Jensen, 1989. Influence of protein concentration on the sulphur containing amino acid requirement of broiler chickens. Br. Poult. Sci., 30: 889-898.

NRC, 1994. Nutritional Requirements of Poultry. 9th revised Edn. National Academy of Science Press, Washington D.C.

Porter, L.J., L.W. Hristich and B.G. Chan, 1986. The conversion of proanthocyanidin and prodelphinidins to cyanidin and delphinidin. Phytochem., 25: 223-230.

Purchase, R. and R, Keogh, 1984. Fatness of lambs on grassland Maku'lotus and grassland Huia' white clover. Proc. New Zealand Soc. Anim. Prod., 44: 219-221.

Sacks, F.M., 2002. The role of High-Density Lipoprotein (HDL) cholesterol in the prevention and treatment of coronary heart disease. Am. J. Cardiol., 15: 139-143.

SAS Institute. Statistical Analysis System, 2000. User's Guide. SAS Institute Inc. Cary, NC.

Scott, M.L., M.C. Nesheim and R.J. Young, 1982. Nutrition of the chicken. 3rd Edn. M.L. Scott and Associates, publishers Ithaca, New York, pp: 1- 406.

Silanikove, N., Z. Niteau and A. Perevoloty, 1994. Effect of polyethylene glycol supplementation on intake digestion of tannins containing in leaves (*ceratonia siliqua*) by sheep. J. Agric. Food Chem., 42: 2844-2847.

Terril, T.H., G.B. Douglas, A.G. Foote, R.W. Purchas, G.F. Wilson and T.N. Barry, 1992. Effect of condensed tannins upon body growth, wool growth and rumen metabolism in sheep grazing Sulla (*Hedysarum coronarium*) and perennial pasture. J. Agric. Sci., Cambridge, 119: 265-273.

Waterman, P.G. and S, Mole, 1994. Analysis of phenolic plant metabolites. Blackwell Scientific Publications, Oxford. UK.