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Effect of Hoodia gordonii meal supplementation at finisher stage on productivity and carcass characteristics of Ross 308 broiler chickens

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Abstract Two experiments were conducted to evaluate the effect of *Hoodia gordonii* meal supplementation at finisher stage on productivity and carcass characteristics of Ross 308 broiler chickens. The first experiment examined the effect of level of *Hoodia gordonii* meal supplementation at finisher stage (30 to 42 days of age) on productivity and carcass characteristics of chickens. Level of *Hoodia gordonii* meal supplementation had no effect (P>0.05) on diet intake, growth rate, feed conversion ratio and live weight of chickens. Daily supplementation with 300 mg of *Hoodia gordonii* meal reduced (P<0.05) fat pad weights by 40 % in broiler chickens The second experiment examined the effect of *Hoodia gordonii* meal supplementation interval on the productivity and carcass characteristics of broiler chickens. *Hoodia gordonii* meal supplementation interval had no effect (P>0.05) on feed intake, growth rate, live weight, feed conversion ratio and all carcass characteristics except fat pad of broiler chickens. Daily supplementation with 300 mg of *Hoodia gordonii* meal/bird reduced fat pad weights of the chickens by 18 %. This could not be explained in terms of differences in feed intake, digestibility, or growth rate.

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Introduction

Chicken production is an important source of income and employment and it contributes substantially to food security among people of Africa (Yami 1995). Broiler chickens are selected for high food intakes and growth rates (Richards 2003). However, excessive fat in chickens may become one of the problems to be faced by the broiler industry since it reduces carcass quality and feed efficiency (Oyedeji and Atteh 2005). Coronary heart diseases and arteriosclerosis are strongly related to the dietary intake of cholesterol and saturated fatty acids and are among the most important causes of human mortalities (Sacks 2002). Appetite control in poultry could be of importance in reducing fat deposition. *Hoodia gordonii* (a shrub found in the Kalahari desert) has been used by San people to suppress appetite during hunting expeditions in the Kalahari desert (Holt 2005). The chemical P57AS3 in *Hoodia gordonii* mimics adenosine triphosphate in the hypothalamus to cause satiety in rats, thus, reducing appetite (Maclean and Luo, 2004; Wynberg 2004). However, the effects of *Hoodia gordonii* meal on food intake, digestibility, growth and fat deposition in broiler chickens are not known. Even though *Hoodia gordonii* is considered an endangered species (CITES 2004), there are a number of studies exploring the possibilities of domestication and commercialization of the plant (Tibe et al 2008).

The objective of this study was to determine the effect *Hoodia gordonii* meal supplementation at finisher stage on productivity and carcass characteristics of broiler chickens.

Materials and methods

Study site

This study was conducted in an open-sided broiler chicken house with curtains at the University of Limpopo Experimental farm. The farm is situated 10 km north-west of the Turfloop campus of the University of Limpopo. The ambient temperatures around this area are above 32°C during summer and around 25°C or below during winter seasons.

Experimental procedure, dietary treatments and design

The first experiment determined the effect of level of *Hoodia gordonii* supplementation at finisher stage on productivity and carcass characteristics of Ross 308 broiler chickens. A total of 360 male and female chickens were used in this experiment. The chickens were raised up to 29 days old before the experiment commenced. The experiment was terminated when the chickens were 42 days old. Feed and water were offered *ad libitum* throughout the experiment. *Hoodia gordonii* was given as a feed supplement each morning at 8.00 hours. The design of the experiment was a 2 (male or female chickens) x 6 (*Hoodia gordonii* levels) factorial arrangement in a completely randomised design. The chickens were fed a grower diet supplemented with 0 mg (H_0), 100 mg (H_{100}), 200 mg (H_{200}), 300 mg (H_{300}), 400 mg (H_{400}) or 500 mg (H_{500}) of *Hoodia gordonii* meal/bird/day. Therefore, the experiment had 12 treatments replicated 3 times, resulting in a total of 36 floor pens with 10 birds in each. At 30 days of age, chickens were randomly allocated to the 12 treatments. The second experiment was done after the first one and it determined the effect of *Hoodia gordonii* meal supplementation interval at finisher stage on productivity and carcass characteristics of Ross 308 broiler chickens. A total of 360 chickens were used in a 2 (male or female chickens)×3 (dose intervals) factorial arrangement in a completely randomized design. Chickens were fed either a grower diet without *Hoodia gordonii* meal supplementation (H_0D_0); grower diet with 300 mg of *Hoodia gordonii* meal/bird supplemented daily for 12 days ($H_{300}D_{12}$); or grower diet with 300 mg of *Hoodia gordonii* meal/bird supplemented twice, on 30th and 36th days of age ($H_{300}D_6$). Therefore, the experiment had 6 treatments replicated 6 times, resulting in a total of 36 floor pens of 10 birds each. At 30 days of age, chickens were randomly allocated to the 6 treatments.

The initial live weights of the birds were taken at the start of each experiment. Average live weight per bird was measured daily by weighing the chickens in each pen, and the total weight was divided by the total number of birds in the pen to get the average live weight of the chickens. These live weights were used to calculate growth rate. Feed conversion ratio per pen was calculated as total feed consumed divided by the weight of the birds minus weight of all the birds in the pen at the start of the experiment. Digestibility was done between 36 and 42 days of age. Digestibility was conducted in specially designed metabolic cages having separated watering and feeding troughs. Two birds were randomly selected from each replicate and transferred to metabolic cages for the measurement of apparent digestibility. A three-day acclimatization period was allowed prior to a three-day collection period. Droppings voided by each bird were collected on a daily basis at 9.00 hours. Care was taken to avoid contamination from feathers, scales, debris and feeds. Apparent nutrient digestibility was calculated as follows:

$$\text{Apparent Digestibility} = \frac{(\text{Amount of nutrient ingested} - \text{Amount of nutrient excreted})}{(\text{Amount of nutrient ingested})}$$

The apparent metabolisable energy contents of the diets and nitrogen retention were also calculated (AOAC 1990). Feed conversion ratio was calculated as the total amount of feed consumed divided by the weight gain of live birds plus the weight gain of dead or culled birds in the pen. At 42 days of age all remaining broiler chickens per pen were slaughtered by cervical dislocation to determine the carcass characteristics. Carcass parts and abdominal fat were weighed. Fat surrounding the gizzard and intestines extending to the bursa were considered as abdominal fat (Mendonca and Jensen 1989).

The grower diet was bought from a milling company, NTK in Polokwane, South Africa. The nutrient contents were determined as explained below. Thus, the feed contained 880 g DM/kg, 16.9 MJ energy/kg DM, 200 g protein/kg DM, 11.5 g lysine/kg DM, 25 g fat/kg DM, 10 g calcium/kg DM and 5.5 g phosphorus/kg DM. *Hoodia gordonii* meal contained 59 g crude protein per kg DM and 13.95 mg of P57AS3/kg DM sample, an oxyprgane steroidal glycoside thought to be the active ingredient (determined by the supplier, Hoodiabushman, Pretoria, South Africa).

Chemical analyses

Dry matter (DM) contents of feeds, feed refusals, excreta and meat were determined using the method described by AOAC (1990). Feeds, feed refusals and excreta samples were also analyzed for ash, calcium, phosphorus, fat and fibre by the methods of AOAC (1990). The nitrogen content was determined using LECO FP 2000® Protein Analyzer (University of Limpopo laboratory, Polokwane). Lysine content of the diet was analyzed by ion-exchange chromatography (HPLC, University of Pretoria). The bomb calorimeter was used to measure gross energy values for feeds and feaces (University of Kwazulu-Natal laboratory, Durban).

Statistical analysis

The effects of *Hoodia gordonii* meal supplementation at finisher stage on productivity and carcass characteristics of Ross 308 broiler chickens were analyzed using GLM procedures of SAS (2003).The statistical model used for the first and second experiments was:

$$Y_{ijk} = \mu + P_i + Aj + (PA)_{ij} + e_{ijk}$$

Where Y_{ijk} is the observation on voluntary feed intake, digestibility, live weight, carcass characteristics, feed conversion ratio and mortality due to level of *Hoodia gordonii* meal supplementation, sex of the chickens and their interaction; μ is the overall mean; P*i* is the *i*th effect of level or interval of *Hoodia gordonii* meal supplementation; A_j is the *j*th effect of sex of the chickens; PA_{ij} is the interaction of level and sex of the chickens and e_{ijk} is the residual effect. Tukey test was used to test the significance of differences between treatment means at 5% significance level ($P<0.05$).The effects of gender interactions were not significant and hence only combined means are reported here. The responses in fat pad to level of supplementation were also modeled using the following quadratic equation (SAS 2003):

$$Y = a + b_1x + b_2x^2$$

Where Y = optimum fat pad; a = intercept; b = coefficients of the quadratic equation; x = *Hoodia gordonii* meal level of supplementation and $b_1/2b_2$ = x value for optimum response. The quadratic model was fitted to the experimental data by means of the NLIN procedure of SAS (SAS 2003).

Results

Level of *Hoodia gordonii* meal supplementation had no effect ($P>0.05$) on intake, feed conversion ratio, growth rate, live weight, intake as percentage of live weight and breast meat nitrogen content of Ross 308 broiler chickens (Table 1**)**. Level of *Hoodia gordonii* meal supplementation had no effect ($P>0.05$) on carcass weight, dressing percentage and carcass parts of Ross 308 broiler chickens except fat pads (Table 2). Daily supplementation with 300 mg of *Hoodia gordonii* meal reduced ($P<0.05$) fat pad weights by 40 % in broiler chickens. A quadratic model was fitted to the data where $Y=1.521+-0.003x+0.00000607x^2$, $r^2=0.742$. Minimum fat pad weight was achieved at an optimum supplementation of 247 mg/bird/day.

Hoodia gordonii meal supplementation interval had no effect ($P<0.05$) on intake, feed conversion ratio, growth rate, apparent diet dry matter and nitrogen digestibilities, nitrogen retention, metabolizable

Table 1 Effect of level of *Hoodia gordonii* supplementation at finisher stage on dry matter intake, feed conversion ratio, growth rate, live weight, intake as % of live weight, and breast meat nitrogen content of Ross 308 broiler chickens

Variables	Supplementation level						
	H_0	H_{100}	H_{200}	H_{300}	H_{400}	H_{500}	SE
DM Intake (g/bird/day)	140.7	141.0	142.8	142.7	140.2	142.4	4.20
FCR	2.1	2.5	2.3	2.2	2.3	2.5	0.20
Growth rate (g/bird/day)	70	59	64	67	65	62	5.65
Live weight(g/bird at 42 days old)	2028	1990	2018	1988	1960	1982	6305
Intake as % of Live Weight	11.0	11.4	10.7	11.0	10.7	10.2	0.45
Breast meat nitrogen content (%)	44.7	44.3	44.5	44.6	44.8	44.3	0.74

SE : Standard error

energy, live weight, carcass weight, intake as percentage of live weight, breast meat nitrogen content, dressing percentage and carcass parts of Ross 308 broiler chickens at 42 days of age except fat pads (Table 3). Daily supplementation with 300 mg of *Hoodia gordonii* meal reduced ($P<0.05$) fat pad weights by 18 %.

Discussion

This study showed that *Hoodia gordonii* meal supplementation had no effect on feed intake. This is contrary to the findings of FAQ (2001), Maclean and Luo (2004) showed that the active chemical P57AS3 in *Hoodia gordonii* mimics adenosine triphosphate (ATP) in the hypothalamus to cause satiety in rats, thus, reducing intake. In the present study, *Hoodia gordonii* supplementation had no effect on growth rate, live weight, feed conversion ratio and breast meat yield of broiler chickens. These results may be explained in terms of similar feed intake and digestibility in the chickens, irrespective of the treatment. Contrary to the present findings, Heerden et al (2007) showed that supplementation with *Hoodia gordonii* meal reduced growth rate and live weight of rats.

Daily supplementation with 300 mg of *Hoodia gordonii* meal in the first and second experiments reduced fat pad weights in broiler chickens by 40 and 18 %, respectively. However, regression analysis indicated that the lowest amount of fat pad would be achieved at a *Hoodia gordonii* supplementation level of 247 mg/bird/day. The reduction in fat pad was achieved without any significant reduction in feed intake and digestibility. The physiological explanation for this effect is not clear and merits further investigation. However, it is known that *Hoodia gordonii* meal

Table 2 Effect of level of *Hoodia gordonii* supplementation at finisher stage on carcass weight, dressing percentage and parts expressed as percentage of carcass weight of Ross 308 broiler chickens at 42 days of age

Variables	Supplementation level						
	H_0	H_{100}	H_{200}	H_{300}	H_{400}	H_{500}	SE
Carcass (g/bird)	1570	1567	1582	1581	1540	1523	79.4
Dressing %	75	73	74	73	73	71	2.1
Drum sticks (%)	12.7	12.6	12.9	12.7	13.0	12.6	0.20
Breast (%)	32	32	31	31	31	31	0.6
Fat pad (%)	1.5^{a}	1.3^{ab}	1.1^{ab}	0.9^{b}	1.3^{ab}	1.3^{ab}	0.12
Gizzard (%)	2.5	2.5	2.5	2.6	2.3	2.4	0.17
Liver	2.8	2.8	2.9	2.8	3.1	3.3	0.26

^{a,b} : Means in the same row not sharing a common superscript are significantly different ($P<0.05$).

SE : Standard error

Table 3 Effect of *Hoodia gordonii* supplementation interval at finisher stage on dry matter intake, feed conversion ratio, growth rate, live weight, intake as % of live weight, breast meat nitrogen content, diet dry matter and nitrogen digestibilities, nitrogen retention, apparent metabolisable energy (AME), carcass weight, dressing percentage and carcass parts expressed as percentage of carcass weight of Ross 308 broiler chickens between 30 and 42 days of age

Variables	Supplementation interval			
	$H_{300}D_{12}$	$H_{300}D_6$	H_0D_0	SE
DM Intake (g/bird/day)	144.0	149.3	146.0	2.41
FCR	2.16	2.05	2.16	0.06
Growth rate (g/bird/day)	67.1	73.0	68.3	2.40
Live weight (g/bird)	1974	2065	2004	41.2
Intake as % of live weight	10.8	10.8	11.0	0.32
Breast meat N content (%)	44.9	44.5	44.5	0.44
Dry matter digestibility (decimal)	0.41	0.49	0.41	0.03
Nitrogen digestibility (decimal)	0.78	0.79	0.77	0.01
Nitrogen retention (g/bird/day)	2.91	2.93	2.83	0.08
AME (MJ /kg DM)	14.23	14.42	14.44	0.14
Carcass weight (g/bird)	1558	1584	1595	37.6
Dressing %	76.4	77.7	78.2	1.84
Drum stick (%)	12.9	13.6	13.1	0.37
Breast (%)	32.1	32.6	33.3	1.02
Fat pad (%)	0.9^a	1.1^b	1.1^b	0.09
Gizzard (%)	2.5	2.6	2.6	0.09
Liver (%)	2.8	2.7	2.8	0.07

^{a,b} Means in the same row not sharing a common superscript are significantly different ($P<0.05$).

SE Standard error

$H_{300}D_{12}$ Broiler chickens fed a grower diet supplemented with 300 mg *Hoodia gordonii*/ bird everyday for 12 days.

$H_{300}D_6$ Broiler chickens fed a grower diet supplemented with 300 mg *Hoodia gordonii*/ bird/ day on days 30 and 36.

H_0D_0 Broiler chickens fed a grower diet without supplementation of *Hoodia gordonii*.

supplementation reduces caloric intake of the diet (FAQ 2001) and increases ATP content in the hypothalamus, thus reducing blood glucose (Maclean and Luo 2004). Pocai (2005) and Richards (2003) suggested that when blood glucose drops, the body releases the fat destroying hormones (growth hormones, glucagon and cholecystokinin) and suppresses energy storing insulin. Such transient changes in plasma glucose level do not appear to alter feed intake in chickens (Simon et al 2000). As such, fat pad depositions in the present study may have been reduced irrespective of feed intake. Similar results in rats were reported by Tulp et al (2001). They found that Hoodia gordonii meal supplementation reduced body fat by 50 % in both obese and lean rats. No similar studies in chickens were found.

Conclusions

Hoodia gordonii meal supplementation at the finisher stage had no effect on feed intake, digestibility and growth of Ross 308 broiler chickens. However, chickens given a daily supplement of 300 mg of *Hoodia gordonii* meal had lower fat pad weights than un-supplemented ones. This could not be explained in terms of differences in feed intake, digestibilities or growth rates. More research is required to explore the biochemical reasons for a reduction in chicken fat pad weights following *Hoodia gordonii* meal supplementation.

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