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Full Length Research Paper

Effect of *Hoodia gordonii* leaf meal supplementation at finisher stage on productivity, carcass characteristics and meat sensory attributes of male Ross 308 broiler chickens

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A nutritional experiment was conducted to determine the effect of *Hoodia gordonii* leaf meal supplementation at finisher stage (30 to 42 days old) on productivity, carcass characteristics and meat sensory attributes of Ross 308 broiler chickens. The chickens were fed a finisher diet supplemented with 0 (H_0), 200 (H_{200}), 300 (H_{300}), 400 (H_{400}), 500 (H_{500}) or 600 (H_{600}) mg of *H. gordonii* leaf meal/bird/day in a completely randomized design. *H. gordonii* leaf meal supplementation at finisher stage had no effect (P>0.05) on feed intake, growth rate, feed conversion ratio, live weight, blood glucose and blood urea of Ross 308 broiler chickens. However, daily supplementation with 300 mg of *H. gordonii* leaf meal per chicken reduced (P<0.05) fat pad weights of the chickens by 20%, and improved (P<0.05) meat tenderness and flavour. These results could not be explained in terms of differences in feed intake, digestibility, growth rate or blood glucose of the chickens. More research is required to explore the biochemical reasons for a reduction in chicken fat pad weights and improvement in meat tenderness and flavour following *H. gordonii* leaf meal supplementation

Key words: *Hoodia gordonii* meal, broiler chickens, intake, growth, fat pad weights, meat sensory attributes.

INTRODUCTION

Broiler chicken production is nutritionally, economically and culturally very important in the world. The success of broiler chicken meat production has been strongly related to improvements in growth and carcass yield, mainly through genetic manipulations (Gous, 2007). However, challenges still remain especially with regards to excessive fat deposition in these chickens. Excessive fat deposition reduces feed efficiency and carcass quality of chickens (Fontana et al., 1992). Thus, reducing fat deposition in broiler chicken production is very important. There is evidence indicating that *Hoodia gordonii* leaf meal supplementation to the diets of broiler chickens reduces fat deposition (Mohlapo et al., 2009). *H. gordonii* is a cactus like plant that grows primarily in the semi-deserts of South Africa, Botswana, Namibia and Angola. San people in the Kalahari Desert of Africa used *H. gordonii* to suppress appetite during hunting for thousands of years (Holt, 2005). MacLean and Luo (2004) isolated P57AS3 molecule from *H. gordonii*, which is a steroidal glycoside with anorectic activity in animals. Intracerebroventricular injections of the purified P57AS3 in rats increased the content of adenosine triphosphate (ATP) by 50 to 150% in the hypothalamus neurons, thus acting as an appetite suppressor. However, Mohlapo et al. (2009) observed that *H. gordonii* leaf meal supplementation at finisher stage had no effect on intake but there was a 30% reduction in carcass fat of Ross 308 broiler chickens. Information on the effect of *H. gordonii* leaf meal supplementation on tenderness, juiciness and flavour of Ross 308 broiler chicken meat is lacking.

The objective of the study was, therefore, to determine the effect of *H. gordonii* leaf meal supplementation at

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finisher stage on productivity and carcass quality of Ross 308 broiler chickens.

MATERIALS AND METHODS

Study site

This study was conducted in an open-sided broiler chicken house at the University of Limpopo Experimental Farm at Syferkuil in 2010. The farm is located about 10 km north-west of the Turfloop campus of the University of Limpopo. The ambient temperatures around this area ranged between 20 and 37°C during the experimental period.

Experimental procedure, dietary treatments and design

A total of 30 male Ross 308 broiler chickens, weighing 975 ± 6 g per bird were used in the experiment. The birds were raised on litter floor pens in a conventional broiler chicken house. The chickens were been raised on a commercial grower mash for 29 days before commencement of the experiment. *Hoodia gordonii* leaf meal was given as a feed supplement each morning at 8.00 h. The design of the experiment was a completely randomised design. The experiment had six treatments replicated five times, resulting in a total of 30 floor pens with one bird in each. Each bird had a floor space of 1 m^2. At 29 days of age, the chickens were randomly allocated to the six treatments. The chickens were fed a finisher diet supplemented with 0 mg (H_0), 200 mg (H_{200}), 300 mg (H_{300}), 400 mg ($_{H400}$), or 600 mg (H_{600}) of *Hoodia gordonii* leaf meal/bird/day. The birds had 24 h of light per day. Feed and water were offered *ad libitum* throughout the experiment. The experiment was terminated when the chickens were 42 days old.

Data collection

Daily feed intake was measured between 30 and 42 days of age by subtracting the weight of the feed leftover from that of the feed offered per day. The initial live weight of the birds was measured at 30 days of age before the commencement of the experiment. Thereafter, live weight was measured daily. These live weights were used to calculate growth rates. Feed conversion ratio was calculated as the total amount of feed consumed divided by the weight gain of the bird.

Apparent digestibility of the diets was carried out when the birds were between 39 and 42 days old. This was done in specially built metabolic cages. The excreta was collected from each replicate and stored at -15°C during the collection period until analysed for nitrogen and energy. Apparent digestibility of the nutrients was calculated according to the method of McDonald et al. (2010). Apparent metabolisable energy of the diets and nitrogen retention were calculated (AOAC, 2000). Feed conversion ratio was calculated as the total amount of feed consumed divided by the weight gain of the bird. At 42 days of age all the chickens 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 pad (Mendonca and Jensen, 1989)

The finisher diet was bought from NTK Milling Company, Polokwane, South Africa. The nutrient contents were determined as explained below. Thus, the feed contained 880 g dry matter (DM)/kg, 16.9 MJ energy/kg DM, 200 g crude 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* leaf meal contained 59 g crude protein per kg DM and 13.95 mg of P57AS3/kg DM sample, a steroidal glycoside thought to be the active ingredient (determined by the supplier, Hoodiabushman, Pretoria, South Africa).

Sensory evaluation

Individual breast meat was selected for sensory evaluation. The meat was cut into 5 cm pieces. These pieces were baked for 30 m in a stove oven set at 105°C. The meat was then evaluated for its tenderness, flavour and juiciness preferences using 32 panellists to rank each part on a 5-point ranking scale. Meat tenderness was divided into: 1, too tough; 2, tough; 3, neither tough nor tender; 4, tender and 5, too tender. The flavour was divided into: 1, very bad flavour; 2, poor flavour; 3, neither bad nor good flavour; 4, good flavour and 5, very good flavour. Juiciness was divided into: 1, extremely dry; 2, dry; 3, neither dry nor juicy; 4, juicy and 5, too juicy.

Chemical analysis

Dry matter (DM) contents of feeds, feed refusals, excreta and meat were determined by drying the samples at 105°C for 24 h. Feeds, feed refusals and excreta samples were also analysed for ash, calcium, phosphorus and fat by the methods of AOAC (2000). The nitrogen content was determined by a micro Kjeldahl method (AOAC, 2000). The apparent metabolisable energy content of the diets was calculated according to AOAC (2000). Glucose and urea contents of the blood were also determined (AOAC, 2000). Lysine content of the diet was analysed by ion-exchange chromatography (HPLC, University of Limpopo). The bomb calorimeter was used to measure gross energy values of feeds and faeces (University of Limpopo laboratory, South Africa).

Statistical analysis

Data on feed intake, digestibility, growth rate, feed conversion ratio, fat pads and other carcass characteristics of male broiler chickens were analysed using the General Linear Model (GLM) procedure of the statistical analysis of variance (SAS, 2011). Duncan's test for multiple comparisons was used to test the significance of difference between treatment means ($P<0.05$) (SAS, 2011). The responses in feed intake, feed conversion ratio, live weight, growth rate, carcass weight and other carcass characteristics to level of *H. gordonii* leaf meal supplementation were modelled using the following quadratic equation:

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

Where, Yis the optimum feed intake, feed conversion ratio, live weight, growth rate, carcass weight, breast meat, heart, liver or abdominal fat; a is the intercept; b_1 and b_2 are the coefficients of the quadratic equation; x is the *H. gordonii* leaf meal level of supplementation and $-b_1/2b_2$ is the x value for optimum response. The quadratic model was fitted to the experimental data by means of the NLIN procedure of SAS (SAS, 2011). The quadratic model was used because it gave the best fit.

RESULTS

H. gordonii leaf meal supplementation at finisher stage had no effect ($P>0.05$) on feed intake, growth rate, apparent metabolisable energy, DM digestibility, nitrogen retention, feed conversion ratio, live weight, dressing percentage, breast meat weight, heart weight, liver weight, breast meat protein content, blood glucose and blood urea of male Ross 308 broiler chickens (Table 1). However, *H. gordonii* leaf meal supplementation reduced

Table 1. Effect of *Hoodia gordonii* leaf meal supplementation level (mg/bird/day) at finisher stage on intake (g/bird/day), DM digestibility, apparent metabolisable energy (MJ/kg DM), nitrogen retention (g/bird/day), growth rate (g/bird/day), feed conversion ratio (g DM feed/g live weight gain), live weight (g/bird at 42 days old) carcass parts (g), abdominal fat (g), breast meat nitrogen (%) , blood glucose (mmol/l) and urea (mmol/l) of male Ross 308 broiler chickens between 30 and 42 days of age.

Variable	Treatment						
	H_0	H_{200}	H_{300}	H_{400}	H_{500}	H_{600}	SE
Intake	131	126	117	113	124	124	15.8
DM digestibility (decimal)	0.69	0.68	0.68	0.69	0.68	0.68	0.041
AME	15.0	14.5	14.3	14.3	14.2	14.1	0.4
N-retention	1.83	1.37	1.25	1.63	1.19	1.12	0.11
Growth rate	83.8	89.0	83.2	85.2	88.9	91.6	2.4
FCR	1.6	1.2	1.4	1.3	1.4	1.4	0.2
Live weight (g/bird)	1466	1406	1272	1299	1338	1468	58.6
Dressing %	69	71	67	70	70	65	1.9
Breast	432	398	338	385	393	405	58.3
Heart	14	12	8	12	9	11	2.1
Liver	39	43	34	37	35	40	3.5
Abdominal fat	35^{ab}	34^{ab}	28^{c}	32^{b}	31^{bc}	36^{a}	5.1
Breast meat protein	30	30	29	31	30	30	0.2
Blood glucose	11.1	11.3	10.0	10.9	11.7	10.9	0.41
Blood urea	0.32	0.36	0.19	0.32	0.23	0.53	0.080

$^{a, b, c}$Means within rows with no common superscripts differ significantly (P<0.05). SE, Standard error; AME, apparent metabolisable energy; FCR, feed conversion ratio.

(P<0.05) abdominal fat pad weights of male Ross 308 broiler chickens. Daily supplementation with 300 mg of *H. gordonii* leaf meal per bird reduced (P<0.05) fat pad weights by 20 % in male broiler chickens. However, minimum fat pad weights were achieved at a *H. gordonii* supplementation level of 315 mg/bird/day when a quadratic model was fitted to the data; where, $Y = 35.957 – 0.034x + 0.000054x^2$ (r^2=0.552) (Figure 1). No mortality was observed in all treatments during the course of the experiment.

Results of the effect of *H. gordonii* leaf meal supplementation at finisher stage on tenderness, juiciness and flavour of broiler chicken meat are presented in Table 2. *H. gordonii* leaf meal supplementation at finisher stage had no effect (P>0.05) on juiciness of broiler chicken meat. However, *H. gordonii* leaf meal supplementation improved (P<0.05) broiler chicken meat tenderness and flavour. When a quadratic model was fitted to the data, broiler chicken meat tenderness, juiciness and flavour were optimized at different *H. gordonii* leaf meal supplementation levels of 442 (r^2=0.659), 432 (r^2=0.947) and 400 (r^2=0.957) mg/bird/day, respectively (Table 3).

DISCUSSION

H. gordonii leaf meal supplementation at finisher stage had no effect on feed intake of Ross 308 broiler chickens. This is in agreement with the findings of Mohlapo et al. (2009). However, this is contrary to the findings of MacLean and Luo (2004) and FAQ (2001) who noted that *H. gordonii* leaf meal supplementation caused satiety in rats and human beings, thus, suppressing appetite. MacLean and Luo (2004) showed that the active chemical P57AS3 in *H. gordonii* mimics adenosine triphosphate (ATP) in the hypothalamus to cause satiety in rats, thus, reducing intake. In the present study, *H. gordonii* leaf meal supplementation did not have any significant effect on growth rate, live weight and carcass weight of male Ross 308 broiler chickens. These results may be explained in terms of similar feed intakes and digestibility in the chickens, irrespective of the treatment. However, Heerden et al. (2007) found that supplementation with *H. gordonii* meal reduced growth rate and live weight of rats.

In the present study, supplementation with 300 mg of *H. gordonii* leaf meal per bird per day reduced fat pad weights in broiler chickens by 20%. However, quadratic analysis of the data indicated that the lowest amount of fat pad would be achieved at a *H. gordonii* leaf meal supplementation level of 314 mg/bird/day. The reduction in fat pad was achieved without any significant reduction in feed intake and digestibility, or blood glucose. Tulp et al. (2001) found that *H. gordonii* supplementation reduced body fat by 50% in both obese and lean rats. It is known that *H. gordonii* leaf meal supplementation reduces energy intake of the diet (FAQ, 2001) and increases ATP content in the hypothalamus, thus reducing blood glucose (Maclean and Luo, 2004). Pocai

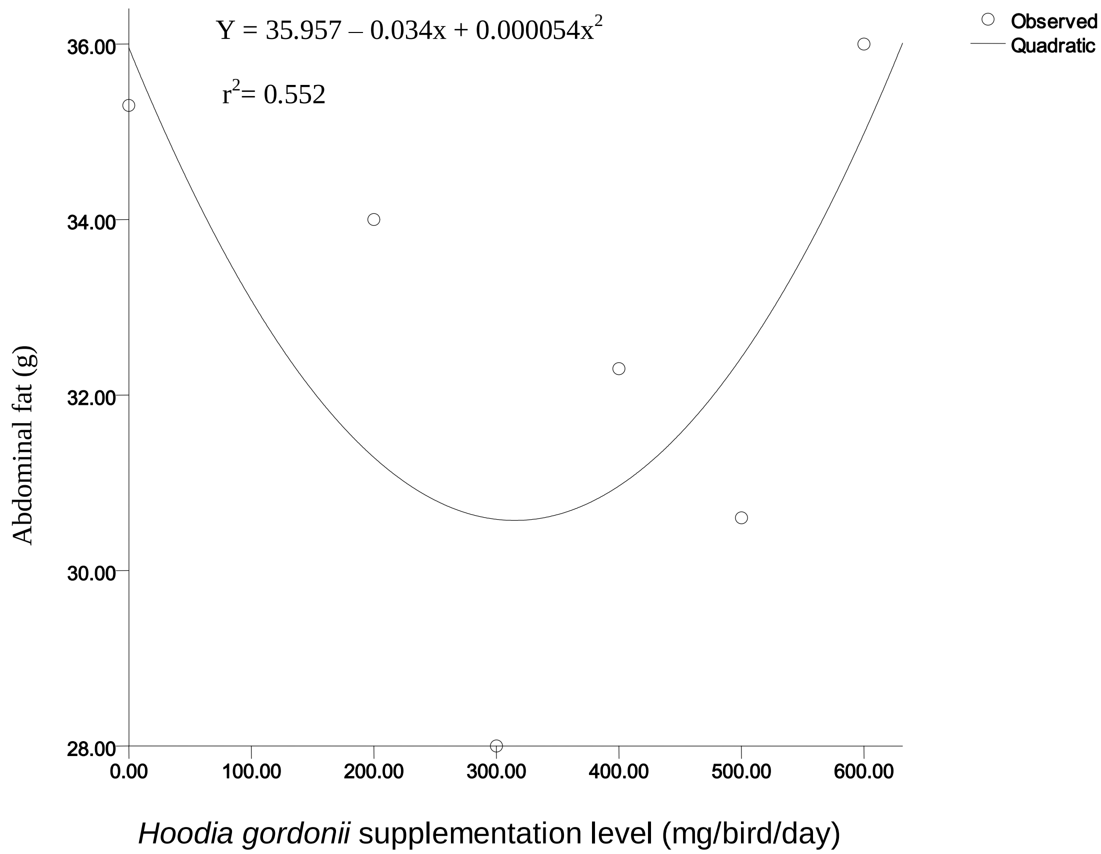

Figure 1. Effect of *Hoodia gordonii* supplementation level at finisher stage on abdominal fat pad weight of male Ross 308 broiler chickens.

Table 2. Effect of Hoodia gordonii leaf meal supplementation level (mg/bird/day) at finisher stage on Ross 308 broiler chicken meat tenderness, juiciness and favour*.

Sensory attribute	Treatment						
	H_0	H_{200}	H_{300}	H_{400}	H_{500}	H_{600}	SE
Tenderness	3.0^b	3.3^{ab}	3.7^a	3.4^{ab}	3.4^{ab}	3.6^a	0.180
Juiciness	2.3	3.4	3.4	3.5	3.4	3.4	0.366
Flavour	2.7^c	3.4^{ab}	3.6^a	3.7^a	3.5^a	3.6^a	0.371

[a, b, c]Means in the same row not sharing a common superscript are significantly different (P<0.05). SE, Standard error; *Meat graded on a 5-point scale.

et al. (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. However, in the present study, the effects of *H. gordonii* supplementation on the release of fat destroying hormones and hence reduction of fat pads seemed to have been more pronounced than the effects on feed intake and blood glucose. Simon et al. (2000) observed that changes in plasma glucose level do not appear to alter feed intake in chickens. Indeed, in the present study, *H. gordonii* supplementation did not reduce blood glucose or intake in broiler chickens. It is, also, possible that in the present study the experimental period was a bit short to have significant effects on feed intake and blood glucose (Maclean and Luo, 2004) while it was long enough to have effect on fat pad amounts.

The present study shows that *H. gordonii* leaf meal supplementation for 7 days prior to slaughter had no effect on juiciness of broiler chicken meat. However, panel sensory evaluation indicated that *H. gordonii* leaf meal supplementation improved broiler chicken meat tenderness and flavour. This has a potential for improving the demand for broiler chicken meat. No similar studies on chickens were found. It is, therefore, suggested that more research is done to ascertain the findings and also

Table 3 Effect of *Hoodia gordonii* supplementation level (mg/bird/day) on optimal broiler chicken meat tenderness, juiciness and flavour[#].

Variable	Formula	r^2	Optimal level*	Y-level
Tenderness	$Y = 3.015 + 0.002X – 0.000002262X^2$	0.659	442	3.457
Juiciness	$Y = 2.355 + 0.006X – 0.000006905X^2$	0.947	434	3.658
Flavour	$Y = 2.714 + 0.004X – 0.000005X^2$	0.957	400	3.514

r^2, Regression coefficient; *****: level of *Hoodia gordonii* supplementation (mg/bird/day) for optimal variable; [#]Meat graded on a 5-point scale.

explore the biochemical reasons for improved broiler meat tenderness and flavour following *H. gordonii* leaf meal supplementation at finisher stage. Quadratic regression analysis indicated that broiler chicken meat tenderness, juiciness and flavour were optimized at different *H.gordonii* leaf meal supplementation levels of 442, 432 and 400 mg/bird/day, respectively. These results indicate that different production variables would be optimized at different *H. gordonii* leaf meal supplementation levels. This has implication on ration formulation. Thus, optimal level of *H. gordonii* leaf meal supplementation in the diet will depend on the production variable in question.

Conclusions

H. gordonii leaf meal supplementation at finisher stage had no effect on feed intake, digestibility and growth rate of male Ross 308 broiler chickens. However, daily supplementation with 300 mg of *H. gordonii* meal per chicken reduced fat pad weight by 20%, and improved meat tenderness and flavour. More research is required to explore the biochemical reasons for a reduction in chicken fat pad weights and improvement in meat tenderness and flavour following *H. gordonii* leaf meal supplementation.

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