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## **Effect of Dietary Vitamin D<sub>3</sub> Supplementation on Meat Tenderness, Juiciness and Flavour of Indigenous Venda Cocks**

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### **ABSTRACT**

An experiment was conducted to determine the effect of dietary Vitamin D<sub>3</sub> supplementation on sensory attributes (meat tenderness, juiciness and flavour) of indigenous Venda cock meat. Different supplementation levels (0, 2000, 4000, 6000 and 8000 IU) of dietary Vitamin D<sub>3</sub> per kg DM (880 g kg<sup>-1</sup> feed) feed were used. In this experiment, thirteen weeks old Venda cocks with a mean live weight of 1200±3 g were supplemented with the above different levels of Vitamin D<sub>3</sub> for a period of seven days before slaughter. A 2 (postmortem aging of 0 or 24 h) × 5 (dietary Vitamin D<sub>3</sub> levels) factorial arrangement in a complete randomized design was used for sensory evaluation of the meat. A quadratic equation was also used to determine Vitamin D<sub>3</sub> supplementation levels for optimum meat tenderness, juiciness and flavour. Vitamin D<sub>3</sub> supplementation had no effect on unaged meat tenderness, juiciness and flavour. However, Vitamin D<sub>3</sub> supplementation improved ( $p < 0.05$ ) aged meat tenderness and flavour. Tenderness, juiciness and flavour of aged Venda cock meat were optimized at supplementation levels of 6830, 6894 and 9795 IU of Vitamin D<sub>3</sub> per kg DM feed, respectively. It is concluded that Vitamin D<sub>3</sub> supplementation improved tenderness and flavour of aged Venda cock meat.

**Key words:** Venda chickens, Vitamin D<sub>3</sub>, tenderness, juiciness, flavour, postmortem aging, connective tissue

### **INTRODUCTION**

The indigenous chicken breeds are abundant in Southern Africa and the world as a whole. They are widely distributed in the rural areas where they are kept by a majority of the rural households. These chickens are economically, nutritionally and culturally important to the rural households (Food and Agriculture Organisation of the United Nations, 2010). The meat from these chickens is very much liked by many people because of its good taste and appreciated flavour (Fanatico *et al.*, 2005; Moula *et al.*, 2009; Kingori *et al.*, 2010). However, the meat is hard to cook and chew (Wattanachant *et al.*, 2004). Most of these chickens mature and reach the market weight at around 13 weeks of age, at this age the meat is already tough and hard. Venda chickens are multicoloured with white, black and red as predominant colours (Mbajjorgu *et al.*, 2011). The males are fairly large and have high meat yield. However, as they grow older their meat becomes tough. Tenderness has been identified as the single most important factor affecting consumers' satisfaction and perception of taste (Morgan *et al.*, 1991; Savell *et al.*, 1991). The increase in connective tissues

and the decrease in protein breaking system as the birds get older are the main reasons the meat becomes tough (Wattanachant *et al.*, 2004). Vitamin D<sub>3</sub> is responsible for increasing the muscle calcium which in return increases the activity of calpains, the intracellular proteases responsible for postmortem meat tenderness in cattle, sheep and pigs (Montgomery *et al.*, 2002; Boleman *et al.*, 2000; Enright *et al.*, 1998). Vitamin D<sub>3</sub> supplementation has been found to improve beef tenderness ratings (Karges *et al.*, 2001; Montgomery *et al.*, 2002; Swanek *et al.*, 1999b). Navid *et al.* (2011) reported that Vitamin D<sub>3</sub> supplementation had no effect on aged meat tenderness of old laying hens. Vitamin D<sub>3</sub> had no effect on the muscle tenderness but had synergistic effect with calcium content in chickens (Ma *et al.*, 2009). Chen *et al.* (2010) reported that the interaction between calcium and Vitamin D<sub>3</sub> supplementation improved meat tenderness of broiler chickens. However, there is limited and inconclusive information on the effect of Vitamin D<sub>3</sub> supplementation on the carcass quality of chickens. The objective of this study was, therefore, to determine the effect of dietary Vitamin D<sub>3</sub> supplementation level on meat tenderness, juiciness and flavour of indigenous Venda cock meat.

## MATERIALS AND METHODS

**Study location:** A study was conducted at the University of Limpopo Experimental farm at Syferkuil. The experiment was conducted during winter period with the temperatures ranging between 16 and 25°C. All materials were purchased from NTK Company in Polokwane before the start of the experiment.

**Experimental procedure, dietary treatments and design:** The experiment commenced with twenty Venda cocks aged 13 weeks raised in a close confinement, with a mean live weight of 1200±3 g. The cocks were randomly assigned to five treatments with four replicates, thus, 20 floor pens (1.5 m<sup>2</sup>) were used. The experimental feeds were isocaloric but with different dietary vitamin D<sub>3</sub> levels and a commercial grower diet was used (Table 1). Vitamin D<sub>3</sub> was orally supplemented in a form of gelatin capsules to chickens. After a seven-day period of supplementation the cocks were slaughtered and meat samples were exposed to 0 (unaged) and 24 h (aged) postmortem aging's. A 2 (postmortem aging's) × 5 (dietary Vitamin D<sub>3</sub> supplementation levels) factorial arrangement in a complete randomized design was used for sensory evaluation.

**Sensory evaluation:** Meat samples which had been frozen at -20°C were thawed for 24 h in a cooler room for sensory evaluation. An oven rack set at 160°C and allowed to pre-heat for

Table 1: Nutrient composition of diets for Venda cocks

Nutrients	Diets				
	V <sub>0</sub>	V <sub>2000</sub>	V <sub>4000</sub>	V <sub>6000</sub>	V <sub>8000</sub>
Dry matter (g kg <sup>-1</sup> feed)	880	880	880	880	880
Energy (MJ ME kg <sup>-1</sup> feed)	16.8	16.8	16.8	16.8	16.8
Crude protein (g kg <sup>-1</sup> DM)	220	220	220	220	220
Lysine (g kg <sup>-1</sup> DM)	11.5	11.5	11.5	11.5	11.5
Calcium (g kg <sup>-1</sup> DM)	12	12	12	12	12
Phosphorus (g kg <sup>-1</sup> DM)	7	7	7	7	7
Vitamin D <sub>3</sub> (IU kg <sup>-1</sup> DM feed)	2000	4000	6000	8000	10000

Table 2: Evaluation scores used by the sensory panel

Meat			
Score	Tenderness	Juiciness	Flavour
1	Too tough	Much too dry	Very bad flavour
2	Tough	Dry	Poor flavour
3	Neither tough nor tender	Neither dry nor juicy	Neither bad nor good flavour
4	Tender	Juicy	Good flavour
5	Too tender	Too juicy	Very good flavour

20 min was used to cook the meat (American Meat Science Association, 1995). The meat samples of 1.5 cm thickness were boiled for approximately 50 min and turned over every 25 min. Tongs were used for turning to avoid piercing that could lead to moisture escape. A taste panel of assessors evaluated the meat for tenderness, juiciness and flavour using a 5-point scale (Table 2).

**Chemical analysis:** Meat calcium content was done by atomic absorption spectrophotometry following the modified wet-ashing procedure of Du *et al.* (1996).

**Statistical analysis:** Data on meat tenderness, juiciness and flavor were analyzed using analysis of variance (SAS, 2008). Where there was a significant F-test ( $p < 0.05$ ), the Duncan test for multiple comparisons was used to test the significance of differences between the treatment means (SAS, 2008). The responses in optimum meat tenderness, juiciness and flavour changes to Vitamin D<sub>3</sub> supplementation were modeled using the following quadratic equation:

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

where, y is meat tenderness, juiciness or flavour, a is intercept; b<sub>1</sub> and b<sub>2</sub> are coefficients of the quadratic equation, x is the Vitamin D<sub>3</sub> level 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 (2008) and used because it gave the best fit.

## RESULTS

Vitamin D<sub>3</sub> supplementation had no effect on tenderness, juiciness and flavour of unaged Venda cock meat (Table 3). Results of the effect of Vitamin D<sub>3</sub> supplementation on tenderness, juiciness and flavor of aged Venda cock meat are presented in Table 3. Venda cocks supplemented with 4000 and 8000 IU of Vitamin D<sub>3</sub> per kg DM of feed produced meat with improved ( $p < 0.05$ ) tenderness compared to that produced by unsupplemented cocks. However, Venda cocks supplemented with 2000, 4000, 6000 and 8000 IU of Vitamin D<sub>3</sub> per kg DM of feed produced meat of similar tenderness. Similarly, Venda cocks not supplemented with Vitamin D<sub>3</sub> produced meat with similar tenderness to those produced by chickens supplemented with 2000 and 6000 IU of Vitamin D<sub>3</sub> per kg DM of feed. Venda cocks supplemented with 2000, 6000 and 8000 IU of Vitamin D<sub>3</sub> per kg DM of feed produced meat with improved ( $p < 0.05$ ) flavor compared to that produced by meat from chickens not supplemented with dietary Vitamin D<sub>3</sub>. Meat produced by chickens supplemented with 2000, 4000 and 6000, IU of Vitamin D<sub>3</sub> per kg DM of feed had similar ( $p > 0.05$ ) flavor. Vitamin D<sub>3</sub> supplementation had no effect on juiciness of aged Venda cock meat.

Table 3: Effect of vitamin D<sub>3</sub> supplementation level on tenderness, juiciness and flavour of unaged (0 h postmortem aging) and aged (24 h postmortem aging) Venda cock meat

Treatment	Sensory attributes		
	Tenderness	Flavour	Juiciness
<b>Unaged</b>			
A <sub>0</sub> V <sub>0</sub>	3.1	2.7	3.1
A <sub>0</sub> V <sub>2000</sub>	3.3	2.9	3.2
A <sub>0</sub> V <sub>4000</sub>	3.2	3.0	3.5
A <sub>0</sub> V <sub>6000</sub>	3.2	3.3	3.7
A <sub>0</sub> V <sub>8000</sub>	3.1	3.6	3.7
SE	0.040	0.032	0.081
<b>Aged</b>			
A <sub>1</sub> V <sub>0</sub>	2.8 <sup>b</sup>	2.8 <sup>c</sup>	2.4
A <sub>1</sub> V <sub>2000</sub>	3.2 <sup>ab</sup>	3.4 <sup>ab</sup>	3.4
A <sub>1</sub> V <sub>4000</sub>	3.6 <sup>a</sup>	3.1 <sup>bc</sup>	3.1
A <sub>1</sub> V <sub>6000</sub>	3.4 <sup>ab</sup>	3.4 <sup>ab</sup>	3.3
A <sub>1</sub> V <sub>8000</sub>	3.6 <sup>a</sup>	3.6 <sup>a</sup>	3.5
SE	0.170	0.371	0.356

Means in the same column not sharing a common superscript are significantly different (p<0.05). SE: Standard error

Table 4: Vitamin D<sub>3</sub> supplementation levels (IU kg<sup>-1</sup> DM feed) for optimal tenderness, juiciness and flavour of aged (24 h postmortem aging)

Trait	Formula	r <sup>2</sup>	Vitamin D <sub>3</sub> level	Optimal Y-level
Tenderness	Y = 2.811+0.00021857X-0.000000016 X <sup>2</sup>	0.839	6830	3.557
Juiciness	Y = 2.563+ 0.000262 X+ 0.000000019 X <sup>2</sup>	0.683	6894	3.466
Flavour	Y = 2.863+ 0.000137 X- 0.000000007 X <sup>2</sup>	0.657	9795	3.534

r<sup>2</sup>: Regression coefficient. Vitamin D<sub>3</sub> level: Level of dietary vitamin D<sub>3</sub> supplementation for optimal Y- level

Tenderness, juiciness and flavour of aged Venda cock meat were optimized at Vitamin D<sub>3</sub> supplementation levels of 6830 (r<sup>2</sup> = 0.839), 6894 (r<sup>2</sup> = 0.683) and 9795 (r<sup>2</sup> = 0.657) IU per kg DM of feed, respectively (Table 4). Unaged Venda cock meat (10.23 mg kg<sup>-1</sup>) contained higher (p<0.05) calcium content than aged (8.91 mg kg<sup>-1</sup>) meat.

## DISCUSSION

Vitamin D<sub>3</sub> supplementation had no effect on tenderness, juiciness and flavour of unaged Venda cock meat. These results are similar to the observation made by Navid *et al.* (2011) and Ma *et al.* (2009) that Vitamin D<sub>3</sub> supplementation had no effect on meat tenderness of unaged chicken meat. Not much information on the subject was found in relation to chickens. However, contrary to the present study, Pedreira *et al.* (2003) observed that Vitamin D<sub>3</sub> supplementation improved tenderness, juiciness and flavour unaged beef steaks. Similarly, Swanek *et al.* (1999a, b) observed that Vitamin D<sub>3</sub> supplementation improved tenderness and flavor of unaged beef steaks. In the present study, Vitamin D<sub>3</sub> supplementation had no effect on juiciness of aged Venda cock meat. This is similar to the results of Pedreira *et al.* (2003) who observed that Vitamin D<sub>3</sub> did not improve meat juiciness of aged beef steers. However, contrary to the current findings Swanek *et al.* (1999a, b) explained that juiciness of aged beef steers was improved by Vitamin D<sub>3</sub> supplementation. However, in the present study, Vitamin D<sub>3</sub> supplementation level improved tenderness and flavour of aged Venda cock meat. Vitamin D<sub>3</sub>

supplementation increases calcium content in meat. High calcium content in meat increases the activities of calpains, the intracellular proteases which are responsible for meat tenderization (Rider *et al.*, 2000). The present observation is similar to the findings of Pedreira *et al.* (2003) who observed that vitamin D<sub>3</sub> supplementation improved tenderness and flavour of aged beef steaks. However, Montgomery *et al.* (2000, 2002) observed no improvement of tenderness and flavour in meat from steers supplemented with Vitamin D<sub>3</sub>. Inconsistencies are there regarding supplementation of Vitamin D<sub>3</sub> and its role in improving meat tenderness. Vitamin D<sub>3</sub> supplementation has been indicated as one of the nutritional means of improving meat tenderness and if the mechanism by which it improves tenderness is through increase muscle calcium and enhanced calcium-activated proteolysis, then Vitamin D<sub>3</sub> must be converted to its metabolites before it is biologically active and able to enhance calcium absorption from the small intestine and resorption from the kidneys to the muscles (Wertz *et al.*, 2004). Aged Venda cock meat tenderness and flavour were optimized at vitamin D<sub>3</sub> supplementation levels of 6830 ( $r^2 = 0.839$ ) and 9795 ( $r^2 = 0.657$ ) IU per kg DM feed, respectively. It is interesting to note that meat flavour was optimized at a higher vitamin D<sub>3</sub> supplementation level. This will have implications on ration formulation for indigenous chickens. No similar studies on chickens were found.

## CONCLUSION

Vitamin D<sub>3</sub> supplementation improved tenderness and flavour of aged Venda cock meat. This offers a solution to the problem of hardness of indigenous chickens. However, Vitamin D<sub>3</sub> did not improve tenderness and flavour of unaged Venda cock meat.

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