

BLOOD PROFILES AND HISTO-MORPHOMETRIC ANALYSIS OF THE GASTROINTESTINAL TRACTS OF ROSS 308 BROILER AND INDIGENOUS VENDA CHICKENS FED THE SAME DIET

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Abstract. The aim of this study was to assess the blood parameters and gut histology of broiler and indigenous chickens at different ages. A total of 120 Ross 308 broiler and Venda chickens were assigned in a complete randomized design to assess blood profiles and gut histomorphology in order to determine the immunity and digestive ability of the two breeds. Blood profiles and gut histology of two breeds at ages 42 and 90 days were determined. A measuring tape and RADWAG digital scale (Model PS 750/C/2) were used to measure the lengths and weights, respectively. At 42 days, platelets and serum creatinine were higher ($P<0.05$) for Ross 308 broiler than Venda chickens. Total protein was higher ($P<0.05$) in Venda than Ross 308 broiler chickens. The blood parameters measured at 90 days were higher ($P<0.05$) in Ross 308 broiler. Platelets were higher ($P<0.05$) in Venda than in Ross 308 broiler chickens. Weights and lengths of the gut were higher ($P<0.05$) in Ross 308 broiler than Venda chickens at both 42 and 90 days. Jejunum villus height was higher ($P<0.05$) in Ross 308 broiler than in Venda chickens aged 42 days. Crypt depth was higher ($P<0.05$) in the duodenum and ileum of Ross 308 broiler than in Venda chickens. The villus height/crypt depth ratios were higher ($P<0.05$) in Venda than Ross 308 broiler chickens at both 42 days. Age and breed affects blood profiles of broiler and indigenous chickens. The histomorphology of Ross 308 broiler was superior which reflects better absorption capabilities compared to Venda chickens.

Keywords: *haematology, weights, lengths, villi height, crypt depth*

Introduction

Chickens contribute a lot to social and economic well-being of most rural households of South Africa. The feed intake, digestibility, growth rate and overall productivity of broiler and indigenous chickens vary (Pauwels et al., 2015; Rondelli et al., 2003). Haematological and blood parameters of chickens are reliable indicators of their health status and productivity (Abdi-Hachesoo et al., 2011). Indigenous chickens which are mainly abundant in rural areas are known to be tolerant and resistant to diseases than their counterpart Ross 308 broiler chickens (Abdi-Hachesoo et al., 2013). It is, therefore, important to understand and determine the haematological indices of indigenous chickens in order to better interpret their health status and immune system capability to tolerate poultry

diseases. The gastrointestinal tract (GIT) of the chicken and its gut state and condition are accountable for nutrient digestion, metabolism and absorption (Mabelebele et al., 2014). The GIT of fast growing Ross 308 broiler chickens develop and mature faster than those of the slow growing indigenous chickens (Jamroz, 2005). Ross 308 broiler chickens have been selected for high feed conversion ratio and growth rate. This has resulted in changes in the anatomy and function of the digestive system (Krás et al., 2013). The length and weight of the small intestines vary between the different species of birds (Hassouna et al., 2001).

Histologically, villus height and mucosa thickness are normally used as a good index for understanding the intestinal status which is directly linked to the absorptive functions (Incharoen, 2013). Morphology and histology of the gastrointestinal tract of Ross 308 broiler chickens were described and studied previously by Aitken (1958), Calhoun (1954) and Hassouna (2001). However, in more recent studies by Mabelebele et al. (2014), the digestive organ weights and lengths of Ross 308 broiler and indigenous Venda chickens at 90 days of age were compared. These authors observed that although broiler chickens at 90 days of age had heavier and longer digestive organs however, Venda chickens had lower gizzard pH, which might be related with better fibre digestion. As such, not much information on the blood profiles, morphology and histological differences between Ross 308 broiler and indigenous Venda chickens is available. Therefore, the objective of this study was to determine the differences between the blood profiles, morphometric and histological analyses of Ross 308 broiler and indigenous Venda chickens raised under the same conditions and fed a similar diet.

Materials and methods

Study site and experimental design

This study was conducted at the University of Limpopo Animal Unit. The study commenced with 60 Ross 308 broiler and 60 Venda chickens aged 1 day. Ross 308 broilers chickens were acquired from Lufafa hatchery, Tzaneen, South Africa while indigenous Venda chickens were obtained from the University of Limpopo hatchery. The chickens were kept for a period of 90 days on a commercial diet (Table 1). Feed and water were provided *ad libitum* and except for the first day when 24 hours of light was provided, 18 hours of lighting and 6 hours of darkness in every 24-hour period was maintained throughout the trial period. Chickens were housed in pens, assigned to a complete randomized design with each breed replicated five times with twelve birds per replicate. All managements of the birds were carried out with the strict accordance of the rules and regulations of the University of Limpopo Animal Ethics Committee with the following ethics approval number (TREC/12/2014:IR).

Table 1. *Ingredients and nutrient contents of diets fed at 0-42 and 43-90 days.*

Ingredients (g/kg)	0-42 days	43-90 days
Yellow maize	672.53	738.43
SBM	156.21	140.97
Canola (solvent-extracted)	50.00	10.00
Meat meal	87.31	79.39
Canola Oil	12.75	15.43

Limestone	2.36	2.46
Dical Phos 18P/21Ca	0.01	0.01
Salt	0.597	0.72
Na bicarb	1.82	1.89
Vitamin/mineral premix [†]	2.00	2.00
Choline Cl 70%	1.28	1.16
L-lysine HCl 78.4	4.04	3.81
DL-methionine	1.81	1.68
L-threonine	1.98	1.68
Chemical composition (g/kg)		
Metabolisable energy (MJ/kg)	12.97	13.39
Crude protein	215.0	195.0
Crude fiber	24.47	22.2
Crude fat	45.5	47.9
Digestible arginine	11.1	9.84
Digestible lysine	11.5	10.2
Digestible methionine	4.7	4.3
Digestible methionine + cysteine	7.0	6.3
Digestible leucine	9.0	7.4
Digestible tryptophan	1.7	1.5
Calcium	8.7	7.8
Available phosphorus	4.35	3.9
Potassium	2.3	6.6
Chloride	1.6	2.3
Sodium	1.6	1.6
Choline (mg/kg)	1600	1500

[†]The active ingredients contained in the vitamin–mineral premix were as follows (per kg of diet): vitamin A – 12000 IU, vitamin D3 – 3500 IU, vitamin E – 30.0 mg, vitamin K3 – 2.0 mg, thiamine – 2 mg, riboflavin – 6 mg, pyridoxine – 5 mg, vitamin B12 – 0.02 mg, niacin – 50 mg, pantothenate – 12 mg, biotin 0.01 mg, folic acid – 2 mg, Fe – 60 mg, Zn – 60 mg, Mn – 80 mg, Cu – 8 mg, Se – 0.01 mg, Mo – 1 mg, Co – 0.03 mg, I – 1

Haematological values

Two chickens per replicate were selected for slaughter at 42 and 90 days of age. Before slaughter, 3 ml of blood samples from both Ross 308 broiler and Venda chickens were collected from a jugular vein into two test tubes per bird, one with ethylenediaminetetraacetic acid (EDTA) as an anticoagulant and the other without EDTA. The blood collection tubes were kept in ice to avoid denaturing of protein, and plasma was stored at -20°C until further analysis. Blood samples were analysed within 2 hours of collection for haematocrit (HCT), red blood cell (RBC), white blood cell (WBC) and haemoglobin (HBG) according to the methods of Dein (1984). Haemoglobin amount was measured using the Beckman Coulter ACT diff Haematology Analyzer (Beckman-Coulter, USA). Platelet counts were also measured. The HCT was measured as micro haematocrit with 75 × 16 mm capillary tubes and centrifuged at 2500 rpm for 5 minutes. Mean corpuscular volume (MCV), Mean corpuscular haemoglobin (MCH) and Mean corpuscular haemoglobin concentration (MCHC) were calculated according to Ritchie et al. (1994). Serum parameters analysed included total protein, albumen, glucose, cholesterol, triglycerides, calcium, phosphorus, sodium and potassium (Aravind et al., 2003).

Morphology of the gastrointestinal tracts

In order to evaluate organ weights and intestinal morphometrics of the chickens at 42 and 90 days of age, the gizzard, proventriculus, small intestines and the large intestines, including the caeca, were collected and weighed immediately at both 42 and 90 days. A measuring tape and RADWAG digital scale (Model PS 750/C/2) were used to measure the lengths and weights, respectively. The gizzard was weighed after the contents were removed and cleaned. After removal of the contents, the small and large intestines were cut in segments, cleaned, weighed and measured. The small intestines were measured from the site where the duodenum emerges from the gizzard and the beginning of the caeca, and the large intestine length included the length of the colon and the rectum. Chickens were weighed before slaughter.

Digestibility and Histological analysis

Nutrient digestibility at 42 days of age was determined according to the methods of McDonalds et al (1992). At the ages 42 and 90 days, 2 birds per pen were sacrificed by cervical dislocation. The whole small intestine was removed immediately and immersed in 10% buffered formalin. Three small intestine segments measuring approximately 3.0 cm of the duodenum (from the gizzard to pancreatic and bile duct), jejunum (from the bile duct to Meckel's diverticulum) and ileum (from the Meckel's diverticulum to ileo-caecalcolonic junction) were cut according to Samanya and Yamauchi (2002) for each chicken at ages 42 and 90 days. The samples were washed in phosphate buffer solution at 0.1 M (pH 7.4) and fixed in Bouin solution for three days. The samples were then trimmed to eliminate the torn edges, and remained for further 24 hours in the fixing solution. The samples were washed in ethanol at 70% to remove the fixing solutions, dehydrated in graded series of alcohol and cleaned in xylol. Four semi-serial sections with 7-cm thickness were placed in each slide. The slides were dyed using the method of the periodic acid of Schiff (PAS). Using an image capture and analysis system (Image J, 1.47r), villi height and crypt depths were measured in duodenum, jejunum and ileum sections were measured. Villus height was measured from the basal region, which starts at the higher portion of the crypt, until villus tip, whereas crypt depth was measure from the base up to the crypt-villi transition region (Carrijo et al., 2005).

Statistical analysis

Data on haematology, morphology and histology of the GIT of both Ross 308 broiler and Venda chickens were analysed using the General Linear Model (GML) procedure of the statistical analysis of variance (SAS, 2008). Differences were considered significant at $P < 0.05$.

Results

Haematological and biochemical parameters of Ross 308 broiler and Venda chickens aged 42 and 90 days

The results of the blood profiles of Ross 308 broiler and Venda chickens aged 42 days are presented in *Table 2*. No significant ($P > 0.05$) differences were observed on the complete blood count and biochemical parameters between the chicken breeds except for platelets and serum creatinine. The platelets were higher ($P < 0.05$) in Ross 308 broiler than in Venda chickens. Serum creatinine at 42 days of age was higher ($P < 0.05$)

for Ross 308 broiler than Venda chickens. However, the total protein of Venda chickens at 42 days of age were higher ($P<0.05$) than those of Ross 308 broiler chickens. The results of the blood profiles of Ross 308 broiler and Venda chickens aged 90 days are presented in *Table 3*. The WBC, RBC, HGB, HCT and MCV were lower ($P<0.05$) in Venda than Ross 308 broiler chickens. However, the platelets were lower ($P<0.05$) in Ross 308 broiler than Venda chickens. No significant differences ($P>0.05$) in MCH, MCHC, RDW were observed between Ross 308 broiler and Venda chickens aged 90 days. Serum calcium, creatinine, cholesterol and albumen were higher ($P<0.05$) in broiler than indigenous chickens. However, sodium, potassium, phosphorus, glucose and total protein were similar in Ross 308 broiler and Venda chickens. Venda chickens had higher ($P<0.05$) serum triglycerides than those in Ross 308 broiler chickens.

Table 2. The haemato-biochemical profiles of Ross 308 broiler and Venda chickens aged 42 days

Parameters	Ross 308 broiler	Venda chickens	SEM
WBC ($\times 10^3$ cell/ μ L)	90	88	3.32
RBC ($\times 10^6$ cell/ μ L)	2	2	0.27
Haemoglobin (g/dL)	10	13	1.26
Haematocrit (L/L)	32	39	3.95
MCV (fL)	134	137	4.98
MCH (pg)	45	45.	0.56
MCHC (g/dL)	33	32.	0.34
RDW %	7	7.	0.10
Platelets	59 ^a	24 ^b	10.13
Sodium (mmol/L)	162	156	5.21
Potassium (mmol/L)	10	10	0.64
Calcium (mmol/L)	2	2	0.07
Magnesium (mmol/L)	1	0.9	0.24
Glucose (mmol/L)	17	14	2.15
Creatinine(μ mol/L)	17 ^a	9 ^b	5.05
Cholesterol (mmol/L)	3	4	0.66
Triglyceride (mmol/L)	0.3	0.3	0.16
Phosphorus (mmol/L)	6	7	0.64
Albumen (g/L)	3	2	3.20
Total protein (g/L)	20 ^b	25 ^a	0.15

SEM: Standard error of the mean

^{a,b} Means within the same row with different letters are significantly different ($P<0.05$)

Table 3. The haemato-biochemical profiles of Ross 308 broiler and Venda chickens aged 90 days

Parameters	Ross 308 broiler	Venda chickens	SEM
WBC ($\times 10^3$ cell/ μ L)	734 ^a	662.6 ^b	18.97
RBC ($\times 10^6$ cell/ μ L)	2 ^a	1.8 ^b	0.15
Haemoglobin (g/dL)	10 ^b	12.6 ^a	0.66
Haematocrit (L/L)	0.2 ^a	0.2 ^b	0.01
MCV (fL)	112. ^a	101.3 ^b	4.10
MCH (pg)	53	52.9	2.75
MCHC (g/dL)	47	46.8	3.11
RDW %	18	19.2	1.05
Platelets	12 ^b	14.4 ^a	3.29

Sodium (mmol/L)	157	150.0	2.66
Potassium (mmol/L)	11	10.3	0.65
Calcium (mmol/L)	2 ^a	2.5 ^b	0.02
Glucose (mmol/L)	15	15.6	0.20
Creatinine(μmol/L)	10 ^a	8.4 ^b	0.76
Cholesterol (mmol/L)	4 ^a	3.3 ^b	0.12
Triglyceride (mmol/L)	0.1 ^b	0.3 ^a	0.03
Phosphorus (mmol/L)	2	2	0.05
K8Albumen (g/L)	10 ^a	8 ^b	0.23
Total protein (g/L)	42	38	1.81

SEM: Standard error of the mean

^{a,b} Means within the same row with different letters are significantly different (P<0.05)

Tables 4 and 5 show the live and carcass weights and gastrointestinal weights of Ross 308 broiler and Venda chickens aged 42 and 90 days. The live and carcass weights were heavier (P<0.05) for Ross 308 broiler than Venda chickens at both ages. The GIT weights of Ross 308 broiler were heavier (P<0.05) than those of the Venda chickens at both ages. The crop, proventriculus and gizzards were heavier (P<0.05) in Ross 308 broiler than in Venda chickens at both ages. Heavier weights (P<0.05) for small intestines, duodenum, jejunum, ileum, large intestines and the caeca were obtained in Ross 308 broiler than Venda chickens at both ages.

Table 4. The gastrointestinal tract weights (g) of Ross 308 broiler and Venda chickens aged 42 days

Parameters	Ross 308 broiler	Venda chickens	SEM
Live-weight	1443 ^a	520 ^b	489.91
Carcass weight	1004 ^a	309 ^b	369.55
GIT	198 ^a	89 ^b	60.39
Crop	12 ^a	4 ^b	5.39
Proventriculus	7 ^a	3 ^b	2.17
Gizzard	38 ^a	15 ^b	12.29
Small intestine	50 ^a	20 ^b	16.38
Duodenum	30 ^a	12 ^b	9.78
Jejunum	9 ^a	4 ^b	3.07
Ileum	7 ^a	3 ^b	3.73
Large intestine	8 ^a	4 ^b	2.28
Caeca*	4 ^a	2 ^b	2.19

* An average value of each caeca pair

SEM: Standard error of the mean

^{a,b} Means within the same row with different letters are significantly different (P<0.05)

Table 5. The gastrointestinal tract weights (g) of Ross 308 broiler and Venda chickens aged 90 days

Parameters	Ross 308 broiler	Venda chickens	SEM
Live-weight	2861 ^a	1339 ^b	102.47
Carcass weight	2105 ^a	830 ^b	82.54
GIT	200 ^a	120 ^b	9.41
Crop	16 ^a	8 ^b	1.13
Proventriculus	11 ^a	7 ^b	0.45
Gizzard	53 ^a	36 ^b	2.65
Small intestine	78 ^a	47 ^b	7.27

Duodenum	23 ^a	10 ^b	4.66
Jejunum	25 ^a	14 ^b	1.71
Ileum	26 ^a	21 ^b	2.18
Large intestine	32 ^a	12 ^b	0.56
Caeca*	7 ^b	10 ^a	2.41

* An average value of each caeca pair

SEM: Standard error of the mean

^{k8a,b} Means within the same row with different letters are significantly different (P<0.05)

The lengths of the gastrointestinal tract are presented in *Tables 6 and 7*. A similar trend observed for GIT weights was also observed for lengths with the entire tract being longer (P<0.05) for Ross 308 broiler than Venda chickens at 42 days of age. The small intestines, duodenum, ileum, large intestines and the caeca were shorter (P<0.05) for Venda than Ross 308 broiler chickens. At 90 days of age, the gastrointestinal lengths of the Venda chickens followed a similar tendency as their weights. The entire GIT length, small intestines and its segments, the large intestines and caeca were longer (P<0.05) for Ross 308 broiler than Venda chickens.

Table 6. The gastrointestinal tract lengths (cm) of Ross 308 broiler and Venda chickens aged 42 days

Parameters	Ross 308 broiler	Venda chickens	SEM
GIT	202 ^a	124 ^b	42.42
Small intestine	147 ^a	98 ^b	29.49
Duodenum	95 ^a	53 ^b	22.80
Jejunum	39 ^a	23 ^b	7.82
Ileum	27 ^a	19 ^b	10.39
Large intestine	13 ^a	11 ^b	3.55
Caeca*	17 ^a	9 ^b	2.84

* An average value of each caeca pair

SEM: Standard error of the mean

^{a,b} Means within the same row with different letters are significantly different (P<0.05)

Table 7. The gastrointestinal tract lengths (cm) of Ross 308 broiler and Venda chickens aged 90 days

Parameters	Ross 308 broiler	Venda chickens	SEM
GIT	208 ^a	138 ^b	8.96
Small intestine	179 ^a	114 ^b	8.86
Duodenum	34 ^a	22 ^b	1.92
Jejunum	64 ^a	39 ^b	2.27
Ileum	89 ^a	57 ^b	2.67
Large intestine	39 ^a	17 ^b	0.53
Caeca*	22 ^a	11 ^b	4.08

* An average value of each caeca pair

SEM: Standard error of the mean

^{a,b} Means within the same row with different letters are significantly different (P<0.05)

The results of the villus height, crypt depth and villus/crypt depth ratio of small intestine segments between Ross 308 broiler and indigenous Venda chickens are presented in *Tables 8 and 9*. Similar villus heights (P>0.05) were observed on

duodenum and ileum of Ross 308 broiler and Venda chickens aged 42 days. However, the jejunal villus height of Ross 308 broiler were higher ($P<0.05$) than those of Venda chickens aged 42 days. Duodenum and ileum crypt depths of Ross 308 broiler were higher ($P<0.05$) than those of Venda chickens aged 42 days. Similar ($P>0.05$) jejunum crypt depths were observed between Ross 308 broiler and Venda chickens. Venda chickens exhibited higher ($P<0.05$) villus/crypt depth ratios in all segments of the small intestines than Ross 308 broiler chickens at 42 days of age. Villus heights of the duodenum, jejunum and ileum were similar ($P>0.05$) between Ross 308 broiler and Venda chickens at 90 days. Crypt depths of the duodenum and ileum were higher in Ross 308 broiler chickens than in Venda chickens. However, no differences ($P>0.05$) in jejunal crypt depths were observed between the two breeds. Venda chickens had higher ($P<0.05$) ileum villus/crypt depth ratio than Ross 308 broiler chickens at ages 90days. No differences ($P>0.05$) were recorded on duodenum and jejunum villus/crypt depth ratios of Ross 308 broiler and Venda chickens aged 90 days. The results of nutrient digestibility of a grower diet fed to Ross 308 broiler and Venda chickens are presented in Table 10. Ross 308 broiler chickens showed higher ($P<0.05$) dry matter and crude protein digestibility, metabolisable energy and N retention than in Venda chickens.

Table 8. Histological measurements of duodenal, jejunal and ileal wall of Ross 308 broilers and Venda chickens aged 42 days

Parameters	Duodenum			Jejunum			Ileum		
	Ross 308 broiler	Venda chickens	SEM	Ross 308 broiler	Venda chickens	SEM	Ross 308 broiler	Venda chickens	SEM
Villus height (mm)	758	783	21.4	720 ^a	624 ^b	22.43	617	665	21.07
Crypt depth (mm)	187 ^a	130 ^b	9.80	173	166	38.17	145 ^a	104 ^b	4.64
Villus/Crypt ratio	4 ^b	6 ^a	0.269	3 ^b	6 ^a	0.42	4 ^b	6 ^a	0.31

SEM: Standard error of the mean

^{a,b} Means within the same column with different letters are significantly different ($P<0.05$)

Table 9. Histological measurements of duodenal, jejunal and ileal wall of Ross 308 broilers and Venda chickens aged 90 days

Parameters	Duodenum			Jejunum			Ileum		
	Ross 308 broiler	Venda chickens	SEM	Ross 308 broiler	Venda chickens	SEM	Ross 308 broiler	Venda chickens	SEM
Villus height (mm)	1266	1259.	47.13	1146	1153	50.40	809	846	41.58
Crypt depth (mm)	339 ^a	275 ^b	11.54	302	253	24.19	319 ^a	219 ^b	35.19
Villus/Crypt ratio	3	4.1	0.28	4	4	0.35	2 ^a	4. ^b	0.30

SEM: Standard error of the mean

^{a,b} Means within the same column with different letters are significantly different ($P<0.05$)

Table 10. Nutrient digestibility of a grower diet fed to Ross 308 broiler and Venda chickens aged 42 days

Parameters	Ross 308 broiler	Venda chickens	SEM
Digestibility (Decimal)			
DM	0.83 ^a	0.56 ^b	0.030
CP	0.92 ^a	0.76 ^b	0.071
ME*	15 ^a	10 ^b	0.263
N retention (g/bird/day)	6 ^a	1 ^b	0.041

DM: Dry matter

CP: Crude protein

ME: Metabolisable energy (MJ/kg DM)

SEM: Standard error of the mean

^{a,b} Means within the same row with different letters are significantly different (P<0.05)

Discussion

The blood parameters of chickens are regarded as dependable and good indicators of the bird's health status. Haematological indices are reported not to be consistent in chickens because of a number of reasons including diseases (Fudge, 2000b), stress (Bedonova et al., 2007), season (Hauptmanova et al., 2006) and genotype (Gayathri and Hegde et al., 2006). In the current study Ross 308 broiler and indigenous Venda chickens aged 42 days had similar haematological parameters. The values reported in the present study are within the normal ranges reported for Ross 308 broiler chickens aged 42 days by Tehrani et al. (2012) and Talebi et al. (2005). However, several studies conducted on indigenous chickens in other countries have reported contradicting haematological indices. Higher values of WBC ($2.27 - 2.43 \times 10^3$ cell/ μ L) and MCH (66-70 pg) were observed in Nigerian local chickens (Peters et al., 2011) than the indigenous chickens in the current study. In the study by Pampori and Iqbal (2007), values of for HCT and Hb were higher in Kashmir native chickens than the values obtained in indigenous chickens in the present study. The platelets in the current study were higher in Ross 308 broiler than indigenous Venda chickens. The results were contrary to those reported by Maxwell et al. (1991) who showed lower thrombocyte (platelets) of Ross 308 broiler chickens at the age of 7 weeks. These cells help in the blood clotting process by promoting homeostasis (Paul et al., 2012) which, therefore, indicates that at 42 days of age in the current study the functioning of these cells were poor in Venda chickens as compared to Ross 308 broiler chickens.

At 90 days of age the WBC, RBC, HCT and MCV were higher for Ross 308 broiler than indigenous Venda chickens. Values in the current study were contrary described by Pampori and Iqbal (2007), Peters et al. (2011) and Albokhadiam et al. (2012) who found that indigenous chickens had higher haematological values or indices than broiler chickens. However, supporting the current findings is a report by El-Safty et al. (2006) which indicated that WBC and MCH were higher in broiler than indigenous chickens. The haemoglobin blood concentrations and platelets were higher for indigenous Venda chickens in the current study than Ross 308 broiler chickens. The higher haemoglobin values of indigenous Venda chickens in the present study are similar to those reported by Orawen and Aengwanich (2007) for indigenous chickens. However, MCH, MCHC and RDW were not influenced by breed in the present study.

The serum parameters at the ages of 42 days were similar between the chicken breeds. However, the serum total protein was higher in indigenous Venda than in Ross 308 broiler chickens, the levels reported in the current study were still lower (20 g/L for Ross 308 and 25g/L for indigenous Venda chickens) than those reported (33-47g/L in Ross 308 broiler aged 42 days) in a study by Piotrowska et al. (2011). Total serum protein can extremely vary in chickens and its variation depends on internal and external factors and results from physiological roles in blood proteins. This parameter is important to measure the chickens' body condition. Other differences identified where serum creatinine was higher for Ross 308 broiler than indigenous Venda chickens at 42 and 90 days of age. Serum creatinine is an important indicator of protein metabolism, a by-product of phosphocreatine breakdown in skeletal muscles (Piotrowska et al., 2011). Its concentration is directly related to muscle mass and is associated with age and physical activity (Szabo et al., 2005; Rajman et al., 2006). The serum creatinine values for Naked neck and Kashmir indigenous chickens reported in the studies conducted by Peters et al. (2011) and Pampori and Iqbal (2007) were higher (13 and 14 $\mu\text{mol/L}$, respectively) than values of indigenous Venda chickens in the current study at 42 days of age. Lipid metabolites are associated with energy metabolism and reflect fluctuations occurring during the growth period of chickens. At 42 days of age there were differences observed in the triglycerides concentration between the breeds. However, high triglycerides concentrations levels in indigenous Venda chickens were observed at 90 days of age.

Higher serum triglycerides concentrations, most often, represent intensive lipid metabolism and transport. These results are supported by Piotrowska et al. (2011) who indicated that the serum triglycerides of Ross 308 broiler chicken decrease as they grow in age. However, on the contrary Abdi-Hachesoo et al. (2011) indicated that no serum triglycerides difference was observed between Iranian indigenous and Ross 308 broiler chickens. Higher serum cholesterol levels were observed for Ross 308 broiler in the current study. These findings are similar to those reported by Abdi-Hachesoo et al. (2011) and Simaraks et al. (2004) who showed that serum cholesterol of indigenous chickens is lower than other breeds. The authors went further to hypothesize that this might be because of the high body activity and high energy need in the indigenous chickens.

Minerals are essential for chickens' growth and are involved in many biosynthetic processes in the body. Calcium is mainly needed for ossification of bones, regulation of muscle activity and catalyzation of enzyme and hormonal synthesis (Underwood and Suttle, 1999). On the 90th day serum calcium was higher for Ross 308 broiler than indigenous Venda chickens. Abdi-Hachesoo et al. (2011) reported similar serum calcium values between Ross 308 broiler and Iranian indigenous chickens.

Differences in GIT weights and lengths between the two breeds used in the current study were observed. GIT were heavier and longer in Ross 308 broiler than indigenous Venda chickens. It was clearly evident in the present study that the slow growing indigenous Venda chickens abundant in rural South Africa and with lighter live and carcass weights, had inferior GIT weights and lengths. A study conducted by Borin et al. (2006) indicated that the GIT weights and lengths of indigenous chickens were heavier and longer compared to broiler chickens aged 120 days. The authors explained this by stating that due to the extensive traditional system these chickens are kept under the availability of bulky and fibrous feeds which will contribute to superior GIT weights and lengths than those of the fast growing broiler chickens. These findings are contrary

to the current study. The current study is supported by Khempaka et al. (2009), De Verdal et al. (2010) and Mossammi et al. (2011) who indicated that GIT lengths and weights of broiler chickens are superior. A recent study by Mabelebele et al. (2014) conducted on indigenous Venda and broiler chickens noted that broiler chickens with their heavier body weight tended to have heavier and longer GIT and digestive organs, with the exception of the gizzard under an intensive system which supports the current findings.

The intestinal villus and crypt morphology are associated with intestine function and growth in chickens. According to Tivey and Smith (1989), changes in enterocytes development and villi structure determine the digestive and absorptive capacity of the small intestine. The small intestine histomorphology including villus height, crypt depth and their ratio are important pointers of gut health in chickens. Increased villus height and villus height to crypt depth ratio are directly correlated with an increased epithelial turnover and longer villi are associated with activated cell mitosis (Montangne et al., 2003). On the other hand, a decrease in villus to crypt ratio or lower crypt to villus ratio is indicative of a higher rate of enterocyte-cell migration from the crypt to the villus (Adibmoradi et al., 2006; Silva et al., 2009). This can lead to poor nutrient absorption, increased secretion in gastrointestinal tract and reduced performance. In the current study the villus height and crypt depth in the duodenum and ileum were higher for Ross 308 broiler than indigenous Venda chickens. The smallest depth of the crypts was observed from indigenous Venda chickens. Decreasing crypt depth in indigenous chickens might be explained by the fact that the crypt can be regarded as the villus factory and a large crypt indicates rapid tissue turnover and a high demand for new tissues (Choct, 2009). The increased villus height in the small intestines could be associated with higher absorptive intestinal surface (Loddi et al., 2004) which facilitates the nutrient absorption and hence, has a direct impact on growth performance. This indicates that Ross 308 broiler chickens with longer and heavier GIT had better absorptive functions and, therefore, growth as compared to indigenous Venda chickens. At 90 days of age, chickens had similar intestinal villus height. This, however, does not imply that the breeds had similar nutrient absorption potential as the crypt depths are different. Ross 308 broiler chickens had higher crypt depth which is indicative of a higher epithelial cell turn over to permit renewal of the villus as needed (Langhout et al., 1999; Sobayo et al., 2012). Thus, a better absorption potential is evidenced by Ross 308 broiler chickens compared to indigenous Venda chickens. The better intestinal and absorptive functions in Ross 308 broiler chickens, perhaps, can be best interpreted by higher nutrient digestibility and N retention as observed in the current study.

Conclusion and Recommendations

Age affects the blood profiles of both broiler and indigenous chickens. It was observed that at age 42 days, most haematological and biochemical parameters were similar between broiler and indigenous Venda chickens. However, platelets and serum creatinine were higher for Ross 308 broiler chickens at 42 days of age. At 90 days of age, WBC, RBC, Haematocrit, MCV, platelets, serum calcium, creatinine, cholesterol and albumen were higher for Ross 308 broiler chickens. Total protein at 42 days of age, platelets, haemoglobin, serum triglycerides at 90 days of age were higher for Venda chickens. It was expected that indigenous Venda chickens would have superior immunological abilities than broiler chickens in the current study. However, this was

not the case, debunking the perception that indigenous chickens are hardier and more resistant to diseases than the broiler chickens. Perhaps the immunological abilities of indigenous chickens are superior when kept under extensive conditions, which was not the case in this study. A comparative study should be conducted on the blood profiles of indigenous chickens under intensive and extensive rearing systems.

Breed and age had an influence on the gastrointestinal tract lengths and weights. This was expected as broiler chickens have superior body weights with faster growth rate compared to indigenous chickens. The histology of the small intestine segments varied between breed and age. Higher villus height and deeper crypt depth were observed in Ross 308 broiler than indigenous chickens. This shows the better absorptive functions of the broiler chicken breed which in turn results to faster growth rate.

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