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Growth performance and digestive tract development of indigenous scavenging chickens under village management

Thomas Raphulu [a,b,*], Christine Jansen van Rensburg [a]

[a] *Department of Animal and Wildlife Sciences, University of Pretoria, Pretoria 0002, South Africa*
[b] *Limpopo Department of Agriculture and Rural Development, Mara Research Station, P/bag x 2467, Makhado, 0920, South Africa*

Abstract

The study was conducted on indigenous scavenging chickens under village management firstly, to evaluate the early development of the digestive tract to 28 days of age and secondly, to determine the growth performance of these chickens up to 20 weeks of age. One hundred and seventeen chicks, 13 chicks per age class (day 1, 4, 7, 10, 14, 17, 21, 24, 28) were randomly purchased from six rural villages in the Vhembe District, Venda, South Africa. The chickens were weighed and sacrificed for measurement of the different parts of its gastrointestinal tract. The liver and pancreas were also weighed. The relative weight of the storage organs and liver peaked at day 4 while that of the small intestine and duodenum peaked at day 10. The relative lengths of the small intestine and jejunum peaked at day 7, duodenum at day 10 and ileum at day 4. Four hundred and forty four (444) chicks from 13 households were recorded at two weekly intervals starting from day old until 20 weeks of age. The mean body weight obtained for males and females were 201.7 and 171.5 g at six weeks of age and 1048.1 and 658.6 g at 20 weeks of age, respectively. The indigenous chickens under village management were characterised by slow digestive tract development, poor growth performance and high mortalities. Further research needs to be conducted to determine the effect of early feed supplementation on the development of the digestive tract and the performance of indigenous chickens under village management.

Keywords: digestive organs, relative weight, relative length, growth performance, rural communities

1 Introduction

The gastrointestinal tract (GIT) of birds undergoes rapid development during the early post-hatch period, which plays a major role in inducing early growth (Lilja, 1983; Sell *et al.*, 1991). Post-hatch development studies have been conducted in broilers (Lija, 1983, Nitsan *et al.*, 1991a,b; Katanbaf *et al.*, 1998; Noy & Sklan, 1998; Ravindran *et al.*, 2006) and in Yangzhou goslings (Liu *et al.*, 2010) and reports indicated that the digestive organs increased more rapidly in weight relative to the whole body mass. The relative weights of these organs were maximal at 6–8 days of age in turkey poults (Sell *et al.*, 1991; Noy & Sklan, 1998) and at 6–10 days of age in broiler chicks (Katanbaf *et al.*, 1998). Kadhim *et al.* (2010) reported that the rate of organ growth relative to the increase of body weight in both Malaysian fowl and broilers fed commercial diets reached a maximum at 10 days post-hatch and after that declined sharply.

Access to nutrients initiates growth about 24 hours after ingestion of exogenous feed for the first time after hatch. Early access to feed resulted in a more rapid post-hatch development of the intestine (Sklan, 2001). Feeding behaviour, rather than differences in individual body weight, accounted for gross anatomical differences in the intestine (Yamauchi & Zhou, 1998). The relative weight of the duodenum, jejunum and pancreas but not ileum was found to be higher in light breeds than heavy breeds (Dror *et al.*, 1977). Breed effect on the development of the digestive tract post-

* Corresponding author – thomas.raphulu@gmail.com
Phone (cell): 0828518296; Phone (work): 0159627200;
Fax: 0159627239

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hatch, however, was not noticeable when chickens had full access to feed.

Indigenous chickens are the most common types of poultry raised in the rural communities of Vhembe District, South Africa. Young chicks scavenge with their mothers for food around the household during the day and are provided with shelter at night. Chicks relying on scavenging for their feed might have a low and unbalanced nutrient intake, which could impair growth and the development of the digestive tract. Post-hatch development of the digestive system and growth performance of local chickens under village management have never been documented. Availability of such information might form the basis for improving the productivity of Venda Indigenous Scavenging (VIS) chickens in the rural communities. The study was carried out, firstly, to evaluate changes in the development of the digestive tract up to 28 days of age and, secondly, to determine the growth performance of VIS chickens under village management up to 20 weeks of age.

2 Materials and methods

The study was conducted at 6 adjacent villages, Tshifudi, Tshidzini, Tshamutshedzi, Tshivhilwi, Tshitereke and Makhuvha. All villages are situated between latitude 22°48′ S to 22°53′ S and longitude 30°28′ E to 30°42′ E in the Thulamela Municipality, Vhembe District in the Limpopo Province of South Africa. Vhembe District is the most northern district of the Limpopo Province and shares borders with Botswana, Zimbabwe and Mozambique. The villages are in a summer rainfall area (October to April). The wettest months and the hottest season is between October and March, when the mean maximum temperatures range from 26.7 to 29.1 °C. The coldest season is between May and August, when the minimum temperatures range from 12 to 14 °C. Winter is usually cold but rarely reach freezing point. The main crops cultivated in the area are maize, groundnuts and vegetables e.g spinach, Chinese cabbage (locally known as *mutshaina*), tomato, and beetroot.

2.1 Digestive tract measurements

A hundred and seventeen (117) VIS chicks, 13 chicks per age class (day 1, 4, 7, 10, 14, 17, 21, 24, 28) were randomly purchased from rural villages and were sacrificed in the laboratory through neck cut. The weights of the chickens were recorded before slaughtering. Directly after killing, the abdominal cavity was opened and the digestive tract from the tongue to the cloaca of each bird was removed. The GIT was separated into crop, proventriculus, gizzard, small intestine and caeca. The small intestine was divided into three regions (duodenum, jejunum and ileum) following the demarcation described by Mitchell & Smith (1990). The different segments of the digestive tract were flushed out with water and the empty weights were recorded and length measured. The accessory organs, liver and pancreas, were also removed and weighed.

2.2 Growth performance

Thirteen households participated voluntarily in the study. These households kept chickens under the traditional village management system of allowing the birds to roam free during the day to scavenge for feed, while providing shelter during the night. Shortly after hatch, 444 chicks were tagged for identification. Individual chicken live weights were recorded at two weeks intervals starting from day-old until 20 weeks of age. Prior to data collection, farmers were requested to keep the chickens in the shelter until weighing was completed in the morning.

2.3 Statistics

Data for organ weights were calculated as total or absolute weights (g) and relative weight (g/100 g body weight), absolute (cm) and relative length (cm/100 g body weight) of the digestive tract and growth performance (g). Individual birds were considered as the experimental unit. All the data (growth performance, absolute and relative weights of digestive organs, absolute and relative length of digestive organs) was subjected to General Linear Models procedure of SAS, Version 9.3 (SAS, 2016). The following model was employed on organ weights data: $Y_i = \mu + A_i + E_i$, where Y_i is an observation for a given variable; μ is the general mean common to all observations; A_i is the effect due to ith age and E_i is the random error. On body weight and growth rate data of VIS chickens, the following model was employed : $Y_j = \mu + G_j + E_j$, was employed and a 5 % significant level was used, where Y_j is an observation for a given variable; μ is the general mean common to all observations; G_j is the effect due to jth gender of chickens and E_j is the random error. Differences among means were determined by the least significant difference (LSD) procedure of SAS (2016).

3 Results

As shown in Fig. 1, an increase in mass and length of the different parts of the GIT with age was observed ($P < 0.005$). The relative weights of the storage organs (crop, proventriculus and gizzard) and liver increased rapidly and peaked at day 4 where after it remained more or less constant.

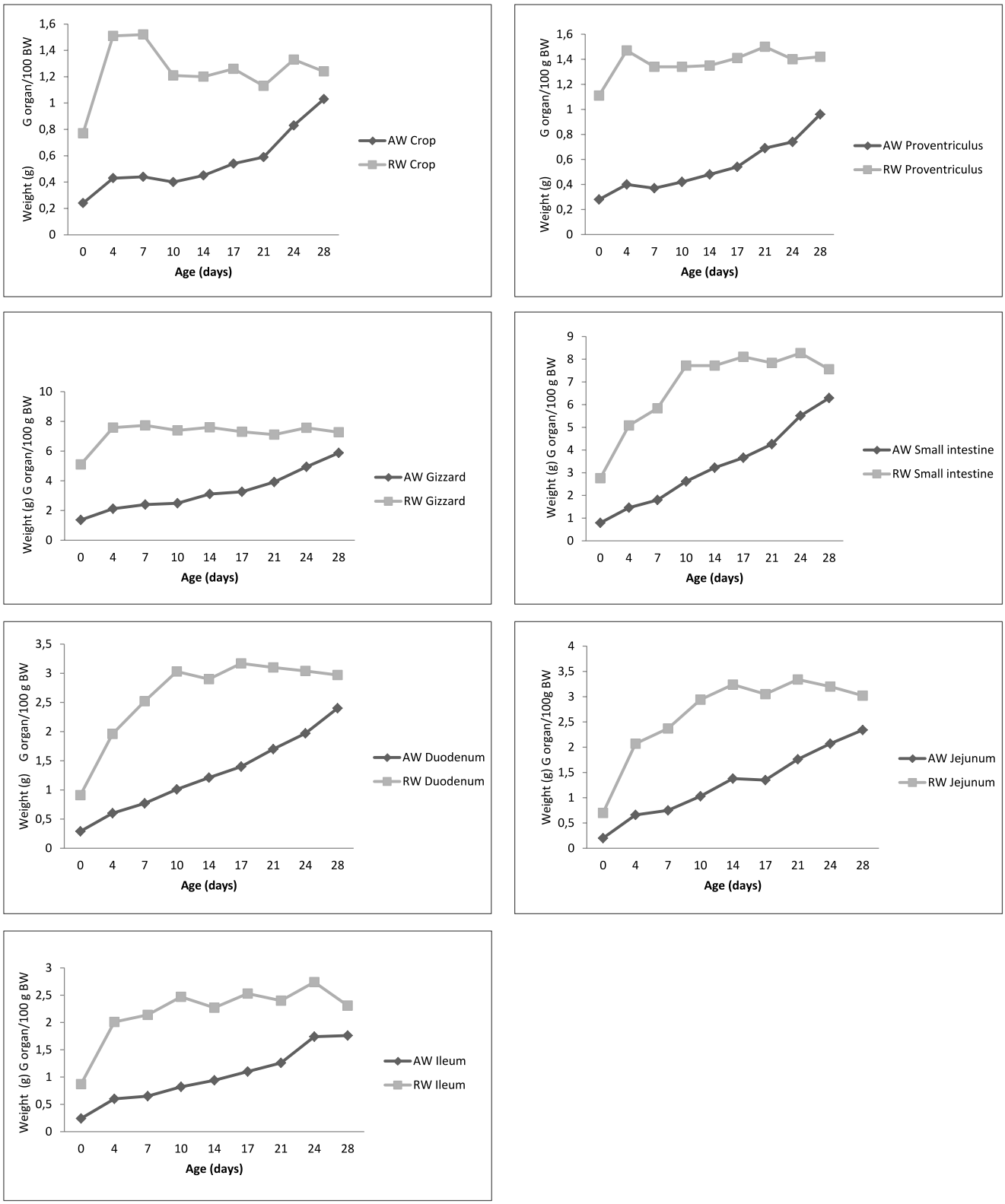

Fig. 1: *Changes in the weight of the gastro-intestinal tract segments of scavenging chicks during the first 28 days after hatch (AW – absolute weight, RW – relative weight).*

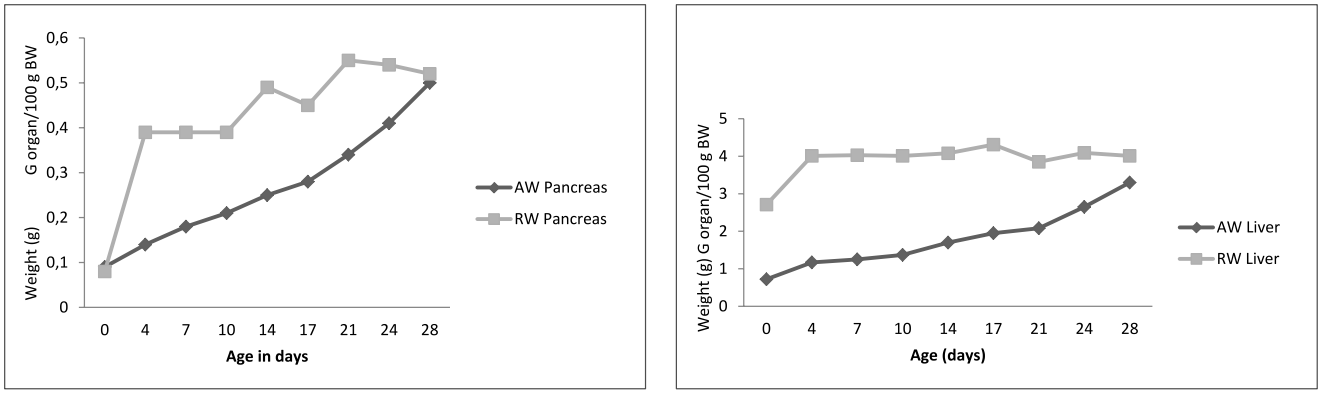

Fig. 2: *Changes in the weight of the pancreas and liver of scavenging chicks during the first 28 days after hatch (AW – absolute weight, RW – relative weight).*

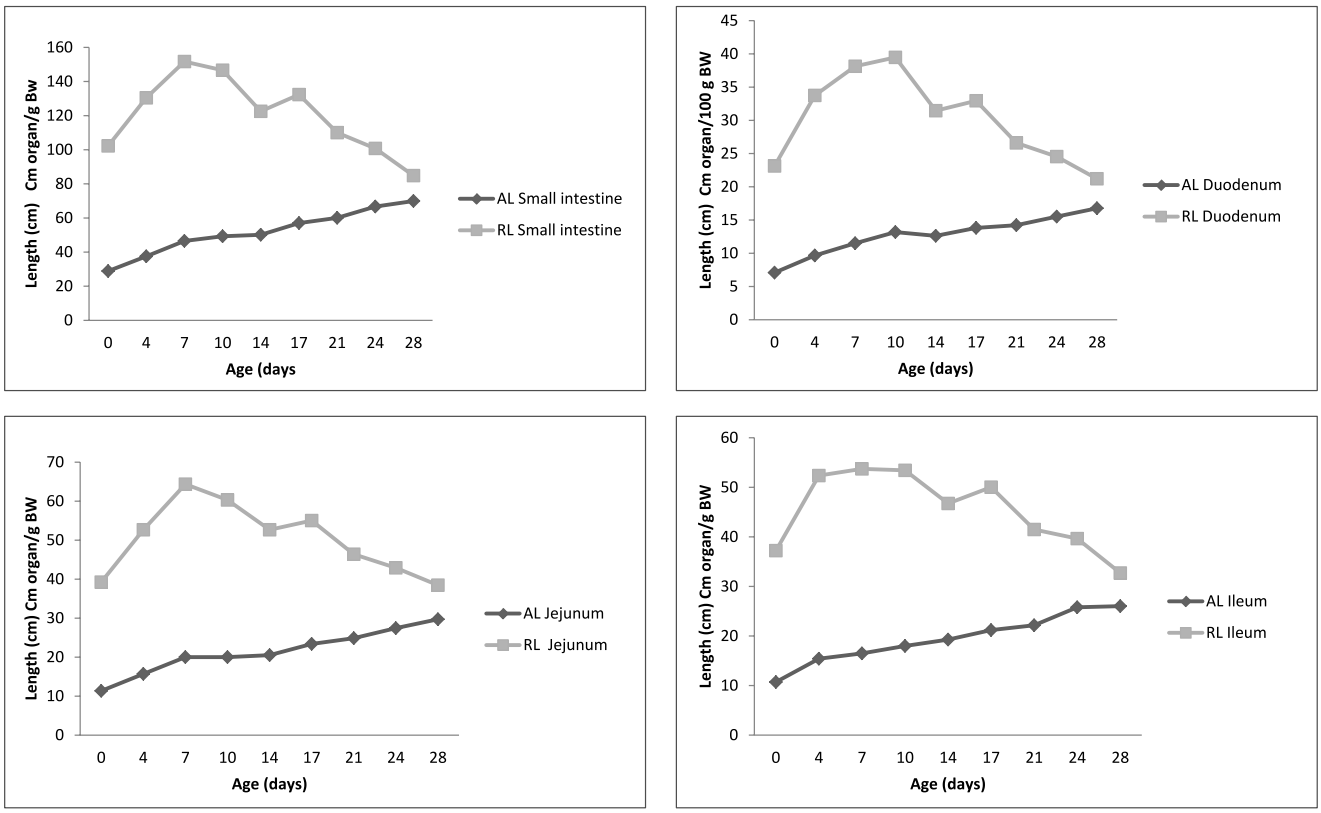

Fig. 3: *Changes in the length of small intestine segments of scavenging chicks during the first 28 days after hatch (AL – absolute length, RW – relative length).*

The relative weight of the small intestine and its separate components rapidly increased with age and peaked at about 10 days of age. The absolute mass of the small intestine increased by 127.8 % during the first 7 days. The relative weight of the pancreas increased rapidly up to day 4, and continued to increase at a slow rate up to about 21 days of age (Fig. 2). The relative length of the small intestine and jejunum peaked at day 7, duodenum at day 10 and ileum at day 4, where after it decreased (Fig. 3).

The mean body weight obtained for males and females were 201.7 and 171.5 g at six weeks of age and 1048.1 and 658.6 g at 20 weeks of age, respectively (Table 1). The cumulative mortality observed in chicks under the age of six weeks and 7–20 weeks was 57.4 and 26.3 %, respectively.

Table 1: *Performance of the VIS chickens under village management.*

Performance parameter	*Mean ± standard error*
Body weight at 6 weeks (g)	
Males	201.7 ± 5.80^{a}
Females	171.5 ± 6.74^{b}
Growth rate up to 6 weeks (g/day)	
Males	4.1 ± 0.36^{a}
Females	2.9 ± 0.42^{b}
Survival rate (%) up to six weeks	42.6
Body weight at 20 weeks (g)	
Males	1048.1 ± 28.09^{a}
Females	658.6 ± 22.94^{b}
Growth rate 7 to 20 weeks (g/day)	
Males	10.1 ± 0.51^{a}
Females	4.6 ± 0.50^{b}
Survival rate (%) 7 to 20 weeks	73.3

^{a,b} Means with different superscripts within a column and a factor differ significantly ($P < 0.05$).

4 Discussion

The development of the GIT during the post-hatch period played a major role in inducing early growth (Sell *et al.*, 1991). The digestive organs of the scavenging, indigenous chicks studied in this trial, followed a similar early growth pattern observed in other chickens (Dror *et al.*,1977; Lilja, 1983), turkeys (Sell *et al.*,1991) and ducks (King *et al.*, 2000). It has been suggested that the accelerated development of the digestive organs immediately after hatching is a prerequisite for sustained post-hatch growth in fast growing poultry (Katanbaf *et al.*, 1998).

According to Nitsan *et al.* (1991b), the pancreas of chickens first experiences a rapid growth phase from hatch to day 3 and then a slower growth phase from day 4–8. In this study, however, a rapid increase in the relative weight of the pancreas was noted until 4 days of age and a slower relative growth up to 21 days of age. The different segments of the small intestine developed at slightly different rates in relation to the increase in body weight. The observed results are in accordance with findings of Uni *et al.* (1999) who reported that the temporal increases in intestinal weight and length are not identical for different segments, with the duodenum developing at a faster rate than both the jejunum and ileum.

The absolute growth rate of the small intestine of the chicks in this study was much lower than reported by Noy *et al.* (2001), who found an increase in the mass of the small intestine by nearly 600 % within the first 7 days. Kadhim *et al.* (2010) found similar patterns of organ weights relative to body weights in both indigenous breeds (Malaysian local chickens) and broilers fed commercial diets, ruling out the possibility that genotype affects GIT development. The slower development of the small intestine in the current study could rather be attributed to the poor availability of quality feeds to the scavenging chickens in the rural communities. Growth is initiated about 24 hours after first ingestion of exogenous food and it is suggested that early access to nutrients results in the more rapid development of the intestine during the immediate post-hatch period (Sklan, 2001). The withholding of feed and water from birds resulted in reduced growth of all segments of the intestinal tract (Murakami *et al.*, 1992; Uni *et al.*, 1998). It is possible that the development of the digestive tract of the scavenging chickens in this study might have been impaired by a lack of feed and irregular access to water which inhibited the growth of the birds in general. It is known that little care is taken with regard to housing, feeding, breeding or parasite and disease control (Minga *et al.*, 1989). As a result, chicks might survive for a few days post-hatch mainly on nutrients supplied by the yolk. Sell *et al.* (1991) reported that nutrients from the yolk are depleted in broiler chicks and poults within 4–5 days. It has been reported that the yolk is used for maintenance, while exogenous energy is utilised for growth (Anthony *et al.*, 1989). The slower gut development and growth rate and high mortality of the chicks in this study could have been caused by a limited feed intake. There is no planned feeding for scavenging chickens in the rural areas. Chickens are left to scavenge around the homesteads during daytime feeding on household leftovers, waste products and environmental materials such as insects, worms, seeds and green forages (Goromela *et al.*, 2006; Raphulu *et al.*, 2015). Supplementation is rarely done since farmers assume that the chickens scavenging from the natural resource feed base get adequate nutrients to meet their maintenance, reproductive and productive needs (Nzioka *et al.*, 2017). The growth of an animal depends in part on its capacity to digest and assimilate ingested macromolecules (Liu *et al.*, 2010). Results from this study indicated that supplementary feed to chicks in the rural communities might be necessary during the first few weeks to promote the development of the GIT until chicks can scavenge successfully.

The peak of the relative length of the small intestine observed in this study was 2–3 days later than the 5–7 days post-hatch reported by Noy & Sklan (1998). However, our results are in accordance with that of Sell *et al.* (1991), that the process of rapid relative growth was maximal at 6–8 days in the poult and 6–10 days in the chick. Kadhim *et al.* (2010) found that the absolute length of the intestinal segments of the Malaysian local chicken fed a commercial diet were shorter by approximately one fold than those of

broilers. Nir *et al.* (1993) suggested that the smaller breeds have relatively lighter and shorter intestines than broilers.

There is a lack of published data on the productivity of local chickens under village management under South African conditions. However, a few studies have been conducted in other parts of Africa. Under village management conditions in Tanzania, Lwelamira *et al.* (2008) reported mean body weights of 1135 and 1240 g for 20 weeks old female and male chickens, respectively. Mwalusanya *et al.* (2002) reported growth rates of chickens up to 10 weeks to be 5.4 and 4.6 g/day for males and females, respectively, whereas chickens aged 10–14 weeks old showed rates of 10.2 and 8.4 g/day for males and females. The obtained body weight gain of the chickens at eight weeks in this study were higher than those described by Mafeni (1995) for Cameroon, Omeje & Nwosu (1984) for Nigeria, and Tadelle & Ogle (2001) for Ethiopia, but less than those obtained by Lwelamira *et al.* (2008). Differences in growth performance of local chickens could be due to genetic differences between birds, climatic condition and local management that determine the availability of feeds between countries. Aini (1990) stated that the productivity of local birds is characteristically very low, but there is large variation in production performance between birds of different localities.

Mortality was high in chicks up to ten weeks of age (73.8 %). The observed results are comparable to the results of Minga *et al.* (1989) who reported 50 % mortality in scavenging chickens during rearing. Mwalusanya *et al.* (2002) reported a mortality of 40.3 % up to 10 weeks of age. Mortality is a serious problem in local chicken production and it needs intervention. It was noted from the famers that the causes of high mortality in local chickens under six weeks of age were lack of quality feeds, theft and predators (dogs and eagles). This was confirmed by Mwalusanya *et al.* (2002) who reported predation to be an important cause of loss in chicken flocks. Chicks can be protected from predators by providing shelters and supplementary feeds can be given to chicks under six weeks of age to improve survivability. It is believed that chicks older than six weeks might be able to escape attacks from the predators and also successfully search for food. The high costs involved in provision of housing and feeds to chicks might be challenging in the poverty restricted rural communities and it might be necessary but feasible to use locally produced feed resources and building materials.

5 Conclusion

The chickens under village management were characterised by slow digestive tract development, growth performance and high mortalities. Dietary supplementation strategies using locally produced feeds, brooding and provision of shelter to newly hatched chicks for the first six weeks might be important tools in improving chicken production in general, through reduced mortality at early age and improved growth rate. Further research needs to be conducted to determine the effect of early feed supplementation on the development of the digestive tract and the performance of chickens under village management.

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