CHAPTER 1

INTRODUCTION

1.1 Background

Indigenous chickens are found in all developing countries and they play a vital role in many poor rural households of Limpopo province (Alders *et al*., 2001). They are economically, nutritionally and socially important (Sonaiya *et al.,* 1999). However, productivity of these chickens is low, thus they produce few eggs which have low hatchability (Ebangi and Ibe, 1994; Safalaoh, 2001). Chicks have high mortality values (Gueye, 1998). Poor nutrition plays an important role in all these problems (Rose, 1997) and thus, the production potential of these breeds can't be realized without supplying them with required nutrients. All this contributes to low income and poor nutrition for rural communities. Furthermore, it has been shown that indigenous chickens tend to have lower feed efficiency (King'ori *et al.,* 2003; Tadelle *et al.,* 2003b). Surai *et al.* (1999) indicated that vitamin E supplementation of maternal diet can substantially increase vitamin E concentration in the developing tissues of the chick and significantly decrease their susceptibility to lipid peroxidation. Saly *et al.* (2000) studied the effect of vitamin E on egg production in laying hens and reported that supplementation of vitamin E increases egg weight, but decreases egg shell quality. Improved indigenous poultry production in Limpopo province offers a viable approach to improving nutritional and economic status of the rural communities.

1.2 Motivation

This study will generate information on the effects of supplementing Venda hens with vitamin E on egg production, hatchability and chick productivity. Such information may help in improving productivity of Venda chickens. Improvement in productivity may result in increased income and nutrition of the rural communities.

1.3 Aim and objectives

The aim of this study was to determine the effects of supplementing Venda hens with vitamin E on egg production, egg hatchability, chick hatch-weight and productivity of the chicks.

The objectives of the study were as follows:

i. To determine the effects of supplementing Venda hens with vitamin E on egg production, egg hatchability and chick hatch-weight.

ii. To determine the effects of supplementing Venda hens with Vitamin E on feed intake, digestibility, growth, mortality and carcass characteristics of the progenies.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Halliwell and Gutheridge (1989) and Yu (1994) reported that vitamin E was an excellent biological chain-breaking antioxidant that protects cells and tissues from lipoperoxidative damage induced by free radicals. In addition, it is important as an antioxidant in chicks (Arslan *et al.,* 2000; Leonel e*t al.,* 2007). Supplementing vitamin E to growing chicks results in low mortality, high growth rate and improved carcass characteristics (Bollengier-Lee *et al.,* 1998). Chickens, however, cannot synthesize vitamin E. Requirements must be met from dietary sources (Chan and Decker, 1994). However, not much information is available on the effects of vitamin E supplementation to indigenous hens on egg production, egg hatchability chick hatch-weight and productivity of the chicks.

2.2 Biochemical functions of vitamin E

There are two main groups of vitamin E compounds: tocopherol and the tocotrienols, each containing four isomers (MacDonald *et al*., 2008). Both structures are similar except that the tocotrienol structure has double bonds on the isoprenoid units. There are many derivatives of these structures due to the different possible substituents on the aromatic ring at positions 5, 6 and 7. The tocotrienols have the same ring structure, but have an unsaturated tail (Figure 2.01) (MacDonald *et al*., 2008). Vitamin E (alpha tocopherol) is a biological antioxidant, soluble in fat, and it inhibits the oxidation of long chain unsaturated fatty acids of the cell membrane. Unsaturated fatty acids react with oxygen and form superperoxides and hydroperoxides which damage cell walls (Arslan *et al.,* 2000). There are at least eight different tocopherols with vitamin E activity; of these alpha-tecopherol is the most significant as a dietary supplement, being converted to tecopherol during digestion and absorption (Jordan, 1993). Vitamin E is deposited in subcellullar membranes in positions adjacent to the phospholipids chain and is a highly efficient scavenger of neighbouring fatty acyl radicals (Buettner, 1993). Among the various forms of vitamin E, alpha-tocopherol is up to 15 times more powerful as an antioxidant (Burton *et al*., 1983).

Vitamin E is stored mainly in the adipose tissues, liver and in the muscles. It is equipped to perform unique functions such as in fertility and reproduction (McDonald *et al*., 2008). Vitamin E, unlike antibiotics and other chemicals, is a nutrient and not known to cause any unacceptable side effects of welfare concern. It is reported to enhance immune competence of chickens (Gore and Qureshi, 1997; Erf *et al.,* 1998).

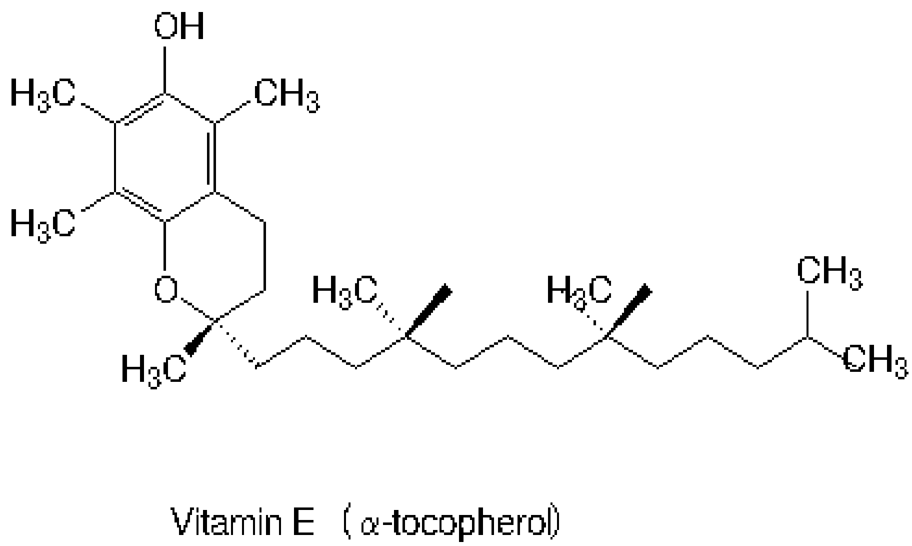

Figure 2.01 Chemical structure of alpha- tecopherol (Macdonald *et al*., 2008)

2.3 Requirements of vitamin E in chickens

The nutrients required for chicken embryo development are derived from the nutrients stored in the eggs and vitamin E can be increased by raising the level of vitamin E in the diets of hens (Cherian *et al.,* 1997; Grobas *et al.,* 2001). The requirement for prevention of encephalomalacia may be higher than that for growth in chickens (Jordan, 1993). Watt (1992) reported that broiler breeders require an average of 24.17 IU per kg DM feed and broiler chickens require 35. 6, 36.5 and 45.8 IU of vitamin E for different growth phases. However, NRC (1994) reported that optimum level for breeding hens is 10 mg per kg DM feed. The recommended dietary vitamin E levels are the same (10 IU per kg DM feed) for starter, grower and finisher phases for optimal growth and maximum productivity in broiler chickens (NRC, 1994). Laying hens and broiler chickens have different requirements of vitamin E according to age and stage of production, as indicated in Table 2.01 and 2.02. However, knowledge about effects of vitamin E in indigenous chickens such as Venda chickens is limited and variable.

Table 2.01 Vitamin E requirements of laying chickens (milligram per kilogram DM)

Author	0 to 6 weeks	6 to 12 weeks	12 to 18 weeks	Laying period
NRC (1994)	9.4	4.7	4.7	4.7
Jeffre (1993)	5	5	10	10
Ketelaar (2000)	-	7.5	10	10
AWT (2002)	30	20	20	20
DSM (2006)	30	15	15	15
Lin *et. al* (2005)	15.5	15.6	17.3	16.0

Table 2.02 Vitamin E requirements of broiler chickens (milligram per kilogram DM)

Author	0 to 3 Weeks	3 to 6 Weeks	6 to 8 Weeks
Kennedy *et al.* (1992)	16.29	14.30	12.4
Watt (1992)	35.6	36.5	45.8
NRC (1994)	10	10	10
Ketelaars (2000)	10	10	10

2.4 Effect of vitamin E on egg production, egg characteristics and hatchability

Bolukbasi *et al.* (2007) reported that vitamin E caused a very significant increase in egg yield. Egg production was significantly greater with 85 IU of vitamin E feed as compared to control hens. Benefits of vitamin E supplementation have been reported in laying hens during heat stress (Scheildeler and Froning., 1996, Whitehead *et al.,* 1998; Bollengier-Lee *et al*., 1998; 1999; Sahin *et al*., 2001, and Ciftci *et al*., 2005) aging (Bartov *et al.,* 1991). These benefits were reported in terms of higher egg production. Puthponsiriporn e*t al.* (2001) reported a positive response in egg production, egg mass and egg yolk of laying hens with the level of 65 IU of vitamin E per kg DM feed during heat stress. Sahin *et al*. (2001; 2002) found that Japanese quails fed diets supplemented with 250 and 500 mg of vitamin E per kg DM feed increased egg production, egg weight, egg specific gravity, and egg shell thickness. In addition, vitamin E supplementation reduced negative effects of heat stress in Japanese quails. Vitamin E supplementation of diets containing high amount of polyunsaturated fatty acids may prevent feed oxidation and may contribute to egg formation (Ciftci *et al.,* 2005). The supplementation of 14% vitamin E- free sunflower oil caused a significant decrease of the laying performance by 15% (Richter *et al*. 1985). Jaing *et al*. (1994), Surai *et al*. (1999); Meluzzi *et al.* (2000) and Shahria *et al*. (2008) reported that vitamin E supplementation increased the content of vitamin E in the egg yolk. However, supplementation of vitamin E and lycopene combination reduced serum and yolk cholesterol concentration and improved antioxidant status of Japanese quails (Sahin *et al.,* 2002).

Vitamin E supplementation increased egg hatchability in laying hens (Olso *et al.,* 1962; Atkinson *et al*., 1963; Kling and Soares, 1986) and native kadaknath hen (Shahria *et. al*. 2008). Chang *et al.* (2004) reported that fertility and egg hatchability of all eggs supplemented with 80 mg of vitamin E per kg DM feed increased by 7.7 and 13.4 %, respectively, and an additional of 80 mg of vitamin E per kg DM feed obtained the best performance in egg production, egg mass, feed efficiency, hatchability and fertility for breeder pullets and Taiwan native chickens (Lin *et al*., 2002). In addition, vitamin E supplementation showed beneficial effects for the reproduction of Taiwan native chickens (Lin *et al.,* 2004; 2005) and native kadaknath hen (Shahria *et. al*., 2008) The development of embryo and hatched chick are completely dependent on nutrients deposited in the egg (Kenny and Kemp, 2005). Vitamin E supplementation increased progeny's red blood cells at hatch (Boa-Amponsem *et al.*, 2001). Embryos from hens fed rations low in vitamin E may die as early as the fourth day of incubation (Scot *et al*., 1976). However, other studies have not found vitamin E supplementation to improve egg hatchability (Arnold *et al*., 1974). However, Muduuli et al. (1982) observed that different levels of dietary supplemented vitamin E improved the hatchability rate of chickens.

2.5 Effect of vitamin E on growth and mortality of chickens

Effects of vitamin E appear to be influenced by several factors including age and dietary level (Gore and Qureshi, 1997; Erf *et al.,* 1998). Oxidative stress plays a crucial role in the laying stage which is a critical period for chick survival (Chang *et al*., 2004). Heat stress in laying hens reduces live weight gain, feed intake, feed efficiency, production and quality of eggs and increases mortality (Demir *et al*., 1995; Bollengier-Lee *et al*., 1999). Supplementation of vitamin E increased body weight and feed conversion ratio of broiler chickens (Swain *et al*., 2000; Arvinda *et al*., 2001; Vall-arpatino *et al.,* 2002; Guo *et al.,* 2003, Bodade, 2009; Rajput *et al*., 2009). Whitehead *et al.* (1998) found that dietary vitamin E levels of 315 IU per kg DM feed resulted in a higher rate of lay and better feed conversion efficiency during hot periods. A study conducted by Hussain *et al.* (2004) on influence of dietary vitamin E on egg production of broiler breeders and the growth and immune response of progeny from eggs injected with vitamin E showed higher body weight at 42 days, higher feed conversion efficiency and reduced mortality of the chicks. Furthermore, vitamin E and selenium showed better growth improvement in the performance of broiler chicks reared under heat stress (EI-sheikh and Ahmad, 2006). In addition, dietary vitamin E supplementation has been observed to increase feed intake of hens (Bollengier-Lee *et al.,* 1998) and Japanese quails (Sahin *et al.,* 2002) exposed to heat stress. However, Shaikh *et al.* (2005), Bodade (2009) and Bolukbasi *et al*. (2007) found that supplementation of vitamin E decreased feed intake of hens. However, Vitamin E and Selenium supplements did not influence, feed intake, laying, performance, feed efficiency per 100 g egg development of body weight and mortality (Richter *et al.,* 1985). Similarly, Biswas *et al.* (2007) and Niu *et al* (2009) indicated that supplementation of vitamin E to the diets of Japanese quail did not affect feed intake, mortality and feed conversion ratio of hens. Vitamin E may be required for early post-hatch growth of chickens (Bhanja *et al*., 2006).

Lin *et al.* (2002) indicated that maternal supplementation with high levels of vitamin E (120–160 mg/kg DM feed) enhances antioxidant capability and depresses oxidative stress in chicks. The antioxidant system of the brain is of great importance because of the development of nutritional encephalomalacia, which occurs in young chicks as a result of vitamin E deficiency (Dror *et al*., 1982; Jordan, 1993; Ketelaars, 2000). Surai e*t al.* (1995) indicated that an increased vitamin E supplementation of the maternal diet can substantially increase vitamin E concentration in the developing tissues of the chick and significantly decrease their susceptibility to lipid peroxidation. This has been attributed to the antioxidant property of vitamin E. In addition, an increased vitamin E in chicks, yolk sac membrane, liver, brain and lung reduces susceptibility to peroxidation (Surai *et al.,* 1999). Dietary supplementation of vitamin E enhances immunity of birds to *Escherichia coli* infection, coccidiosis, infectious bursal diseases and Newcastle diseases (Haq *et al.*, 1996; Hussain *et al*., 2004; Zhu, 2004; Abdel-Raheen and Ghaffar, 2004). In addition, Zhu *et al*. (2004) and Choct and Nylor (2004) indicated that chickens and turkeys that receive additional vitamin E develop more infection-fighting lymphocytes. Vitamin E levels of 150 and 450 mg/kg increased passively transferred antibody levels in chicks to Brucella abortus up to seven days of age (Jackson *et al*. 1978). Low levels of vitamin E may affect both the maturation of specific lymphocyte subpopulations and the functional and proliferative capabilities of the peripheral lymphocytes (Chang *et al.,* 1994). Bollengier-Lee *et al.* (1998) speculated that vitamin E protects the liver from lipid peroxidation and damaged cell membranes. In other studies the combination of selenium and vitamin E to broiler breeders has shown to increase liver glutathione activity of progeny (Haq *et al.,* 1996).

2.6 Effect of vitamin E on carcass characteristics of chickens

Extra amount of vitamin E in the diet of broiler chickens improved the meat quality stability substantially against oxidative deterioration (Guo et al., 2003; Zhu *et al.,* 2004). Rubison *et al.* (2000) reported that dietary vitamin E was capable of inhibiting the development of the Pale Soft Executive (PSE) syndrome, hence improving meat functional properties. In addition, supplementation of vitamin E improved carcass characteristics of Japanese quails (Sahin and Kucuk, 2001). A study conducted by

Leonel *et. al*. (2007) indicated that vitamin E supplementation positively improved vitamin E retention levels in breast and leg muscles, however, the supplementation of diets with vitamin E at 300 mg/kg feed for different periods did not improve performance, yields of carcass and cuts, fatty acid profile, total lipid percentage, color, or pH of breast and leg muscles. Bhat *et al.* (2006) noted that broiler chickens supplemented with 20 mg/kg vitamin E had no effect on meat: bone and skin ratios in breast, drumsticks, neck, thighs, back and wings. Vitamin E reduced sensory meat rancidity, whilst vitamin E, beta carotene and their combination modified meat texture (Carreras *et al*., 2004). In addition, hens supplemented with dietary vitamin E had significant reduction in thiobarbituric acid reactive substance (TBARS) values, as an indicator of lipid peroxidation (Coetzee and Hoffman, 2001) in eggs and liver tissues (Cherian and Sim, 1997).

2.7 Conclusion

Some available information indicates that vitamin E supplementation improves productivity of hens and their progenies. However, there are some studies which found no effect of vitamin E supplementation on productivity of hens and their progenies. Not much information is available on vitamin E requirements of Venda chickens. In fact, no information was found regarding supplementation of vitamin E on indigenous chickens. The availability of such information is important for optimizing egg production, hatchability chick hatch-weight and carcass characteristics of these chickens. It is, therefore, important to determine the effect of vitamin E supplementation level to the diets of Venda hens on egg production, egg hatchability, chick hatch-weight and productivity of the chicks.

CHAPTER 3

MATERIALS AND METHODS

3.1 Study site

This experiment was conducted at the University of Limpopo Experimental farm, South Africa. The ambient temperatures range between 17 and 32 ^{0}C in summer and between 5 and 25 ^{0}C in winter. The mean annual rainfall ranges between 446.8 and 468.4 mm.

3.2 Chicken house and incubator

The experimental house was thoroughly cleaned with water, disinfected with formalin (NTK, Polokwane) and then left to dry for seven days. The house was left open for one week after cleaning so as to break the life cycle of any disease causing organisms that are not killed by the disinfectant. The experimental house was divided into 30 pens of equal sizes of approximately 1.5 m^2 for laying pens. Fresh saw dust was spread to a thickness of 7 cm high. All the equipment such as drinkers, feeders, nests and wire separators were thoroughly cleaned and disinfected. The foot bath was thoroughly cleaned and a new disinfectant was added daily. The Incubator was thoroughly cleaned and disinfected.

3.3 Experimental design, treatments and procedures

One hundred and twenty Venda hens were allocated to 5 treatments in a completely randomized design. The hens were 30 weeks old at the start of the experiment. Each treatment had five replicates with two hens in each replicate. Semen was artificially collected from one cock and used for inseminating all the hens. The treatments were as follows:

V_0 : Layers mash without vitamin E supplementation

V_{200} : Layers mash supplemented with 200 mg of vitamin E/kg DM feed

V_{400} : Layers mash supplemented with 400 mg of vitamin E/kg DM feed

V_{800} : Layers mash supplemented with 800 mg of vitamin E/kg DM feed

V_{1000} : Layers mash supplemented with1000 mg of vitamin E/kg DM feed

The feed and nutrient composition of the diets for Venda hens are presented in Tables 3.01 and 3.02, respectively. The diets, based on a commercial layers mash, contained 930 g DM per kg and 150 g protein per kg DM, but was supplemented with different levels of vitamin E, ranging from 13.33 to 1013.33 mg of vitamin E per kg DM. (Table 3.02). The diets were mainly based on maize and soyabean meal (Table 3.01).

Table 3.01. Diet composition of laying mash for Venda hens

Feed	Level (%)
Maize	45.69
Wheat	15
Lucern meal	5.8
Soyabean meal	16.84
Fish meal (2- 8% fat)	5
Maize gluten meal	1.47
Full fat	3.19
Soya oil	4
DI sodium phosphate	0.11
Calcium carbonate	0.86
Salt	0.18
DI Calcium phosphate	1.47
DL –Methionine	0.20
L- Lysine	0.20

Water and feeds were provided *ad libitum* throughout the experimental period. There were 25 days for the preliminary period and 14 days for the collection of eggs. Eggs were collected and weighed every day. One egg from each replicate was used for determination of egg contents and egg weight. The remaining eggs were weighed and artificially incubated for hatching. Hatchability of eggs and chick hatch-weight were determined. Hatched chicks were reared on a similar commercial grower diet but kept separately according to the initial treatment of the hens. The commercial grower diet contained 880 g DM/kg, 200 g protein/kg DM, 16.9 g MJ energy/kg DM, 11.5 lysine/kg DM, 25 g fat/kg dm, 10 g calcium/kg DM, 5.5 g phosphorus/kg DM feed and 14 mg of vitamin E/kg DM. The grower diet was based on maize and soyabean meal (Table 3.03). A completely randomized design was used to determine the effect of vitamin E supplementation on feed intake, growth, mortality and carcass characteristics of the chickens. The chickens were reared until they were 13 weeks old.

Table 3.02 Nutrient composition of the diets of Venda hens (units are in g/kg DM except metabolisable energy as MJ/kg DM feed, vitamin E as mg/kg DM and dry matter as g/kg feed)

	Nutrient				
Diet	Dry matter	Energy	Protein	Vitamin E	Vitamin E supp.
V_0	930	14.06	150	13.33	0
V_{200}	930	14.06	150	13.33	200
V_{400}	930	14.06	150	13.33	400
V_{800}	930	14.06	150	13.33	800
V_{1000}	930	14.06	150	13.33	1000

3.4 Data collection

Live weights of the hens were taken weekly. The initial live weights of the chicks were taken at 24 hours old. Weekly live weights of the chicks were determined until the end of the experiment at 13 weeks of age. These weights were used to calculate growth rate. Voluntary feed intake per bird was measured daily by subtracting the weight of feed leftovers from that of the feed offered per day, and the difference was divided by the total number of birds in the pen. Feed conversion ratio per pen 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 (Lehmann *et al.,* 1996).

Table 3.03. Diet composition of grower mash for Venda chickens

Feed	Level (%)
Maize	40.69
Wheat	15
Lucern meal	5.8
Soyabean meal	21.84
Fish meal (2- 8% fat)	5
Maize gluten meal	3.47
Full fat	2.19
Soya oil	4
DI sodium phosphate	0.11
Calcium carbonate	0.86
Salt	0.18
DI Calcium phosphate	1.47
DL –Methionine	0.20
L- Lysine	0.20

Deaths were recorded daily. Mortality rate of chickens per pen was calculated as the total number of deaths divided by the total number of chickens per pen then multiplied by 100. Digestibility was done when the chicks were seven and 13 weeks old. Digestibility was done in metabolic cages. The cages are designed with separate watering and feeding troughs. Birds were allowed to adapt in their cages for a period of three days after which excreta was collected from each replicate, dried and kept for chemical analysis. Feed and water were provided *ad libitum* as per each treatment. Meanwhile, feed offered and refusals during this collection period were weighed. Apparent digestibility (AD) of nutrients was calculated according to McDonald *et al.* (2008) as follows:

$$\text{AD (decimal)} = \frac{\text{Amount of nutrient ingested} - \text{Amount of nutrient excreted}}{\text{Amount of nutrient ingested}}$$

At 13 weeks all remaining Venda chickens per pen were weighed on an electronic weighing scale to obtain the live weight and then slaughtered. After slaughtering, the carcass weight of an individual chicken was measured. Dressing percentage was calculated as carcass weight divided by the live weight and then multiplied by a hundred. Breast, wing, thigh, drumstick, gizzard, liver and heart were weighed. At the end of each slaughtering, meat samples from each breast part of the slaughtered chicken were taken and stored in the refrigerator at -20 ^{0}C until analyzed for nitrogen.

3.5 Chemical analysis

Dry matter content of feeds, feed refusals, faeces and meat samples were determined by drying the samples for 24 hours at 105 ^{0}C. The bomb calorimeter was used to measure energy values for feeds, meat and faeces, and semi-micro Kjeldahl method (AOAC, 2000; MacDonald et al., 2008) was used to analyze nitrogen contents of eggs, faeces and meat. High liquid chromatography (HPLC) was used to determine the quantity of vitamin E in the experimental chickens feeds (LATS, University of Limpopo, Polokwane) according to the method described by Swan-Choo and Siong (1996).

3.6 Statistical analysis

Effect of vitamin E supplementation on feed intake, number of eggs, egg weight, egg hatchability, chick hatch-weight, live weight, digestibility, feed conversion ratio, growth rate, carcass characteristics and mortality of Venda chickens were analyzed using the General Linear Model (GLM) procedure of the statistical analysis of variance (SAS, 2008). The Least Significant Difference test for multiple comparisons was used to test the significance of differences between treatment means (P<0.05) (SAS, 2008). The responses in optimum intake, number of eggs, egg weight, chick hatch-weight, hatchability, weight gain, feed conversion ratio, growth rate, carcass characteristics and mortality of Venda chickens were modeled using the following quadratic equation:

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

Where Y = optimum feed intake, number of eggs, egg weight, chick hatch-weight, hatchability, weight gain, feed conversion ratio, growth rate, carcass characteristics and mortality; a = interception; b_1 and b_2 = coefficients of the quadratic equation; x = level of vitamin E 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, 2008). The quadratic model was used because it gave the best fit (SPSS, 2008).

CHAPTER 4

RESULTS

Results of the effect of vitamin E supplementation level to the diets of Venda hens on feed intake, number of eggs over 14 days, egg weight, egg yolk nitrogen, egg white nitrogen, egg hatchability and chick hatch-weight are presented in Table 4.01. Dietary vitamin E supplementation level to the diets of Venda hens had no effect (P>0.05) on feed intake. Venda hens fed on a diet not supplemented with vitamin E produced more (P<0.05) eggs than those on diets supplemented with 800 and 1000 mg of vitamin E per kg DM feed. However, hens on a diet not supplemented with vitamin E and those on diets supplemented with 200 and 400 mg of vitamin E per kg DM feed produced similar (P>0.05) number of eggs. Similarly, hens on diets supplemented with 200, 400 and 800 mg of vitamin E per kg DM feed produced similar (P>0.05) number of eggs.

Venda hens fed on a diet supplemented with 1000 mg of vitamin E per kg DM feed produced heavier (P<0.05) eggs than hens on a diet not supplemented with vitamin E and those on diets supplemented with 200, 400 and 800 mg of vitamin E per kg DM feed. However, hens on a diet supplemented with 400 mg of vitamin E per kg DM feed produced heavier (P<0.05) eggs than hens on a diet not supplemented with vitamin E and hens on diets supplemented with 200 and 800 mg of vitamin E per kg DM feed. Hens on a diet supplemented with 800 mg of vitamin E per kg DM feed produced heavier (P<0.05) eggs than those on a diet not supplemented with vitamin E and those on a diet supplemented with 200 mg of vitamin E per kg DM feed. Venda hens fed a diet not supplemented with vitamin E produced heavier (P<0.05) eggs than those on a diet supplemented with 200 mg of vitamin E per kg DM feed.

Egg yolk weight from hens fed a diet supplemented with 400 mg of vitamin E per kg DM feed were heavier (P<0.05) than those from hens fed on a diet not supplemented with vitamin E and from hens on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed. However, hens fed on a diet supplemented with 1000 mg of vitamin E per kg DM feed produced eggs with heavier (P<0.05) egg yolks than those produced by hens on a diet not supplemented with vitamin E and from those hens on diets supplemented with 200 and 800 mg of vitamin E per kg DM feed. Hens fed on a diet supplemented with 200 and 800 mg of vitamin E per kg DM feed produced lighter

(P<0.05) egg yolks than those produced by hens on a diet not supplemented with vitamin E per kg DM feed.

Egg white weight from hens fed on a diet supplemented with 400 mg of vitamin E per kg DM feed were heavier (P<0.05) than those from hens on a diet not supplemented with vitamin E and those from hens on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed. Hens fed on a diet supplemented with 800 mg of vitamin E per kg DM feed had heavier (P<0.05) egg whites than those from hens on a diet not supplemented with vitamin E and those from hens on diets supplemented with 200 and 1000 mg of vitamin E per kg DM feed. However, hens fed on a diet supplemented with 200 mg of vitamin E produced heavier (P<0.05) egg white weight than those produced by hens on a diet not supplemented with vitamin E and those from hens supplemented with 1000 mg of vitamin E per kg DM feed. Hens fed on a diet not supplemented with vitamin E produced heavier (P<0.05) egg whites than those produced by hens on a diet supplemented with 1000 mg of vitamin E per kg DM feed.

Nitrogen content of egg yolk was higher (P<0.05) in eggs from hens fed on a diet supplemented with 200 mg of vitamin E per kg DM feed than those produced by hens fed on a diet not supplemented with vitamin E and those from hens on diets supplemented with 400, 800 and 1000 mg of vitamin E per kg DM feed. However, hens fed on diets supplemented with 200 and 400 mg of vitamin E per kg DM feed attained similar (P>0.05) egg yolk nitrogen contents. Hens fed on diets supplemented with 400, 800 and 1000 mg of vitamin E per kg DM feed attained similar (P>0.05) egg yolk nitrogen contents. Hens fed on a diet not supplemented with vitamin E produced lower (P<0.05) egg yolk nitrogen contents than hens supplemented with vitamin E. Hens fed on a diet supplemented with 200 mg of vitamin E per kg DM feed produced egg white with higher (P<0.05) nitrogen contents than those from hens on a diet not supplemented with vitamin E and those produced by hens fed on diets supplemented with 400, 800 and 1000 mg of vitamin E per kg DM feed. Hens fed on a diet supplemented with 800 mg of vitamin E produced egg white with higher (P<0.05) nitrogen contents than those from hens fed on a diet not supplemented with vitamin E and those produced by hens fed on diets supplemented with 400 and 1000 mg of vitamin E per kg DM feed.

However, hens fed on a diet not supplemented with vitamin E produced egg white with higher ($P<0.05$) nitrogen contents than those produced by hens on diets supplemented with 400 and 1000 mg of vitamin E per kg DM feed. Hens fed on diets supplemented with 400 and 1000 mg of vitamin E attained similar ($P>0.05$) egg white nitrogen contents.

Eggs from hens fed on a diet supplemented with 400 mg of vitamin E per kg DM feed had higher ($P<0.05$) egg hatchability values than those from hens on a diet not supplemented with vitamin E and those from hens on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed. Hens supplemented with 200 mg of vitamin E per kg DM feed produced eggs with lower ($P<0.05$) hatchability values than those from hens not supplemented with vitamin E. Eggs from hens fed on a diet not supplemented with vitamin E and those from hens supplemented with 800 mg of vitamin E per kg DM feed attained similar ($P>0.05$) egg hatchability values. However, eggs from hens fed on a diet supplemented with 200 mg of vitamin E per kg DM feed had higher ($P<0.05$) egg hatchability values than those from hens on a diet supplemented with 1000 mg of vitamin E per kg DM feed.

Vitamin E supplementation to the diets of Venda hens had an effect ($P<0.05$) on chick hatch-weights. Chicks hatched from hens fed on a diet supplemented with 1000 mg of vitamin E had higher ($P<0.05$) hatch-weights than those hatched from eggs produced by hens on a diet not supplemented with vitamin E, and those hatched from eggs produced by hens on diets supplemented with 200, 400 and 800 mg of vitamin E per kg DM feed. However, chicks hatched from eggs produced by hens fed on diets supplemented with 200, 400 and 800 mg of vitamin E had higher ($P<0.05$) hatch-weights than those chicks hatched from eggs produced by hens on a diet not supplemented with vitamin E per kg DM feed. Similarly, chicks hatched from eggs produced by hens fed on a diet supplemented with 200 mg of vitamin E per kg DM feed and those from eggs produced by hens on a diet not supplemented with vitamin E attained similar ($P>0.05$) chick hatch-weights. Number of eggs produced, egg white weight, egg yolk nitrogen, egg white nitrogen and egg hatchability were optimized at different vitamin E supplementation levels to the diets of Venda hens of 113, 750, 476, 750, and 445 mg per kg DM feed, respectively (Figures 4.01, 4.04, 4.05, 4.06 and 4.07, respectively and Table 4.02).

Generally increasing vitamin E supplementation level to the diets of hens increased egg weights and chick hatch-weight (Figures 4.02 and 4.08, respectively). However, feed intake, egg weight and chick hatch-weight were not optimized within the range of values of vitamin E supplementation used in this experiment.

Table 4.01 Effect of vitamin E supplementation level to the diets of Venda hens on feed intake (g/bird/day), number of eggs over 14 days (eggs/hen/14 days), egg weight (g), egg yolk weight (g), egg white weight (g), egg yolk nitrogen content (%), egg white nitrogen content (%), egg hatchability (%) and chick hatch-weight (g/chick)

Variable	Treatment					SE
	V_0	V_{200}	V_{400}	V_{800}	V_{1000}	
Feed intake	100	102	104	103	111	5.192
Number of eggs	13^a	12.6^{ab}	13^{ab}	11^b	9^c	0.555
Egg weight	53.1^d	50.7^e	61.4^b	59.1^c	64.3^a	0.221
Egg yolk weight	4.0^c	2.6^e	4.6^a	3.2^d	4.1^b	0.015
Egg white weight	7.3^d	7.8^c	10.3^a	8.0^b	6.8^e	0.185
Egg yolk N content	12.2^c	13.8^a	13.5^{ab}	13.3^b	13.3^b	0.105
Egg white N content	5.6^c	6.2^a	5.4^d	5.7^b	5.5^d	0.022
Egg hatchability	46^b	42^c	67^a	47^b	31^d	0.540
Hatch- weight	31^c	34.4^{bc}	38^b	37.8^b	45.6^a	1.747

SE : Standard error

^{abcde}: Means with different superscripts in the same row are significantly different ($P < 0.05$)

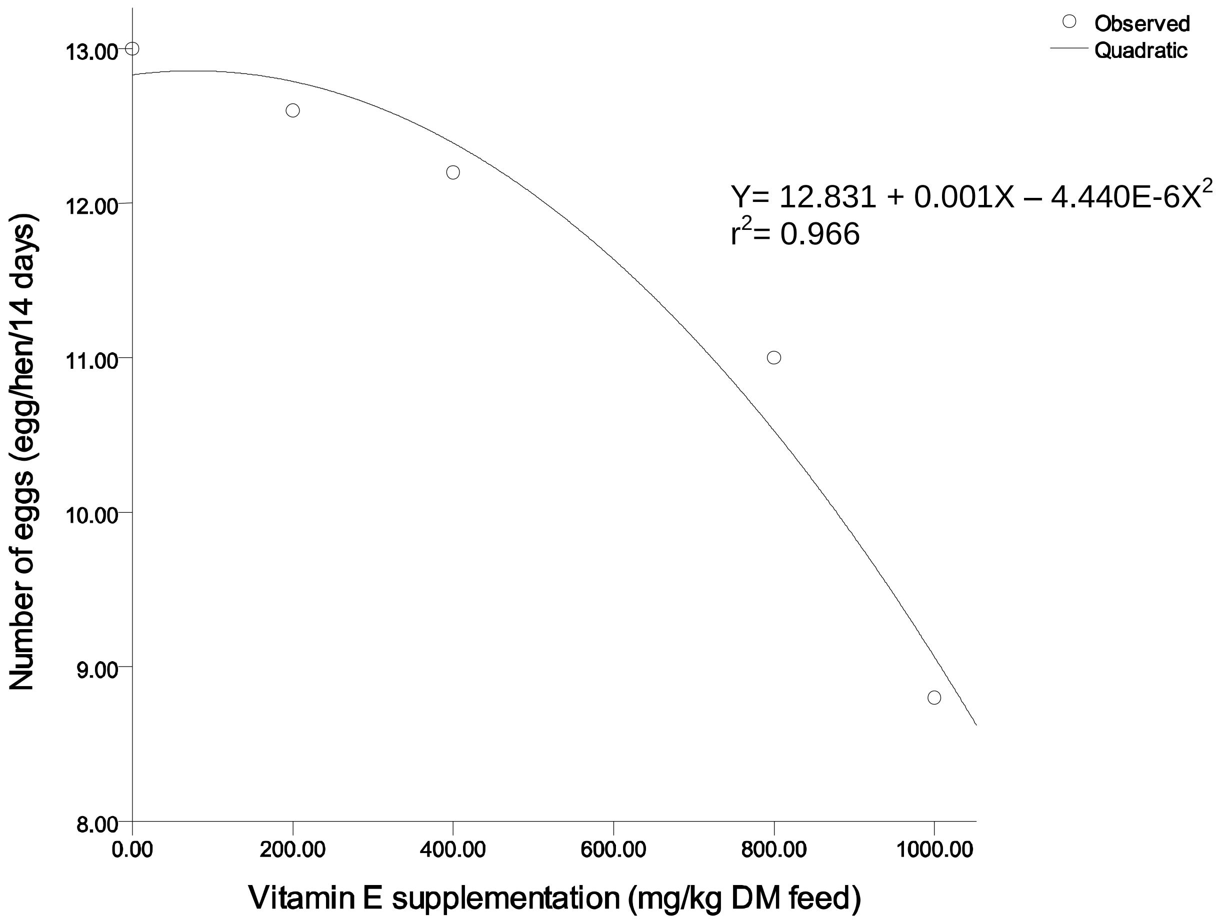

Figure 4.01 Effect of vitamin E supplementation level to the diets of Venda hens on the number of eggs per hen over 14 days

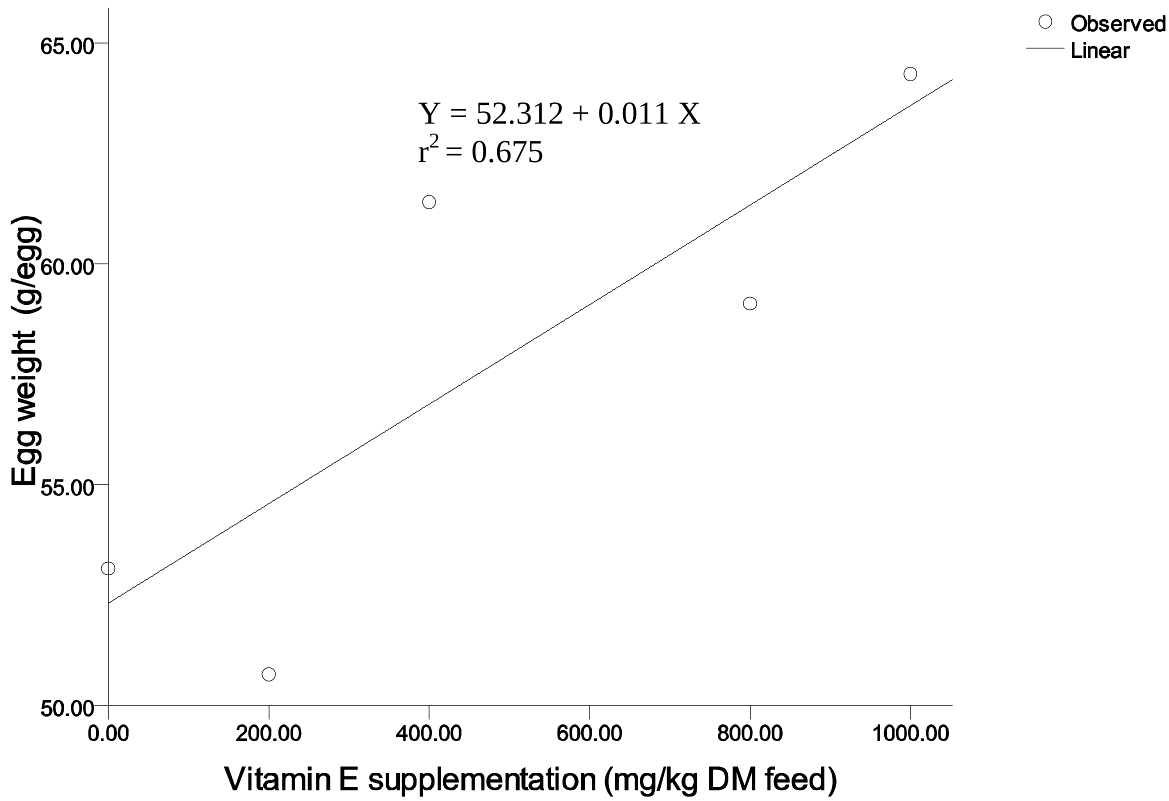

Figure 4.02 Relationship between vitamin E supplementation level to the diets of Venda hens and egg weight

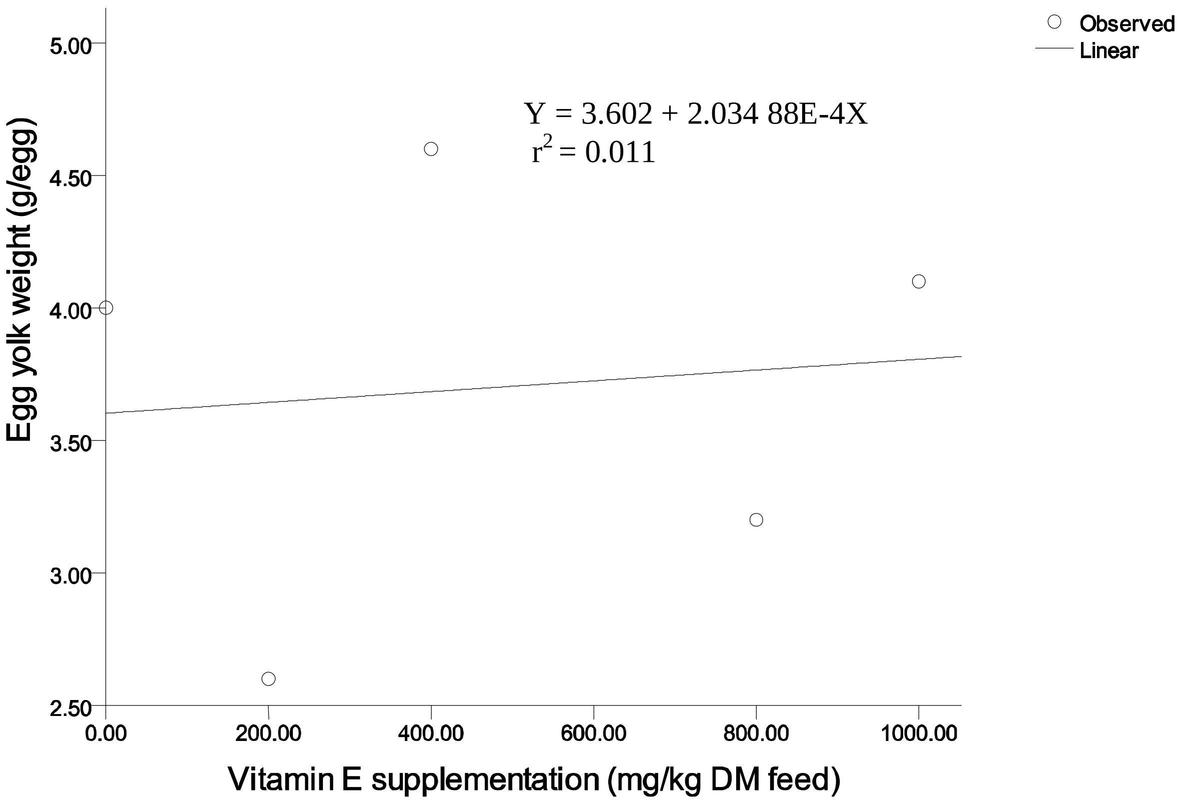

Figure 4.03 Relationship between vitamin E supplementation level to the diets of Venda hens and egg yolk weight

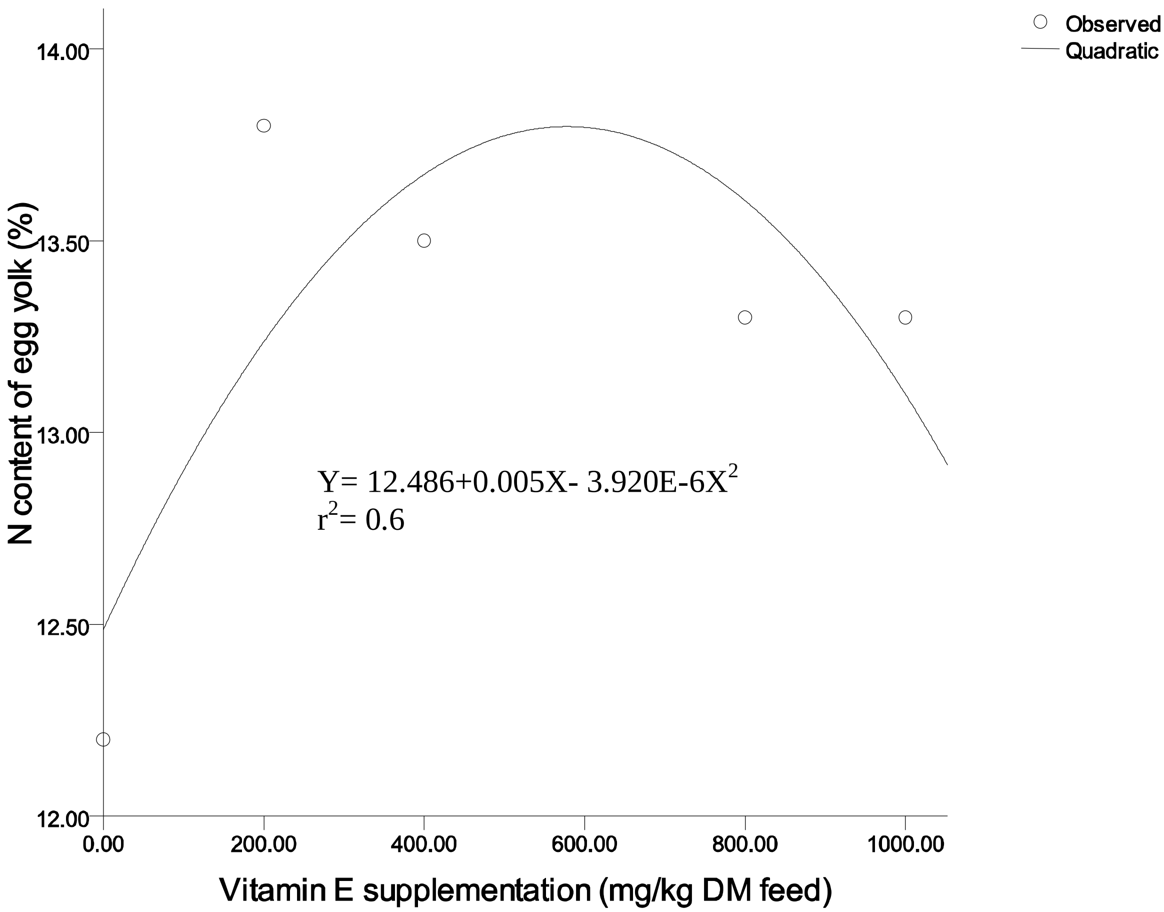

Figure 4.04 Effect of vitamin E supplementation level to the diets of Venda hens on egg yolk nitrogen content

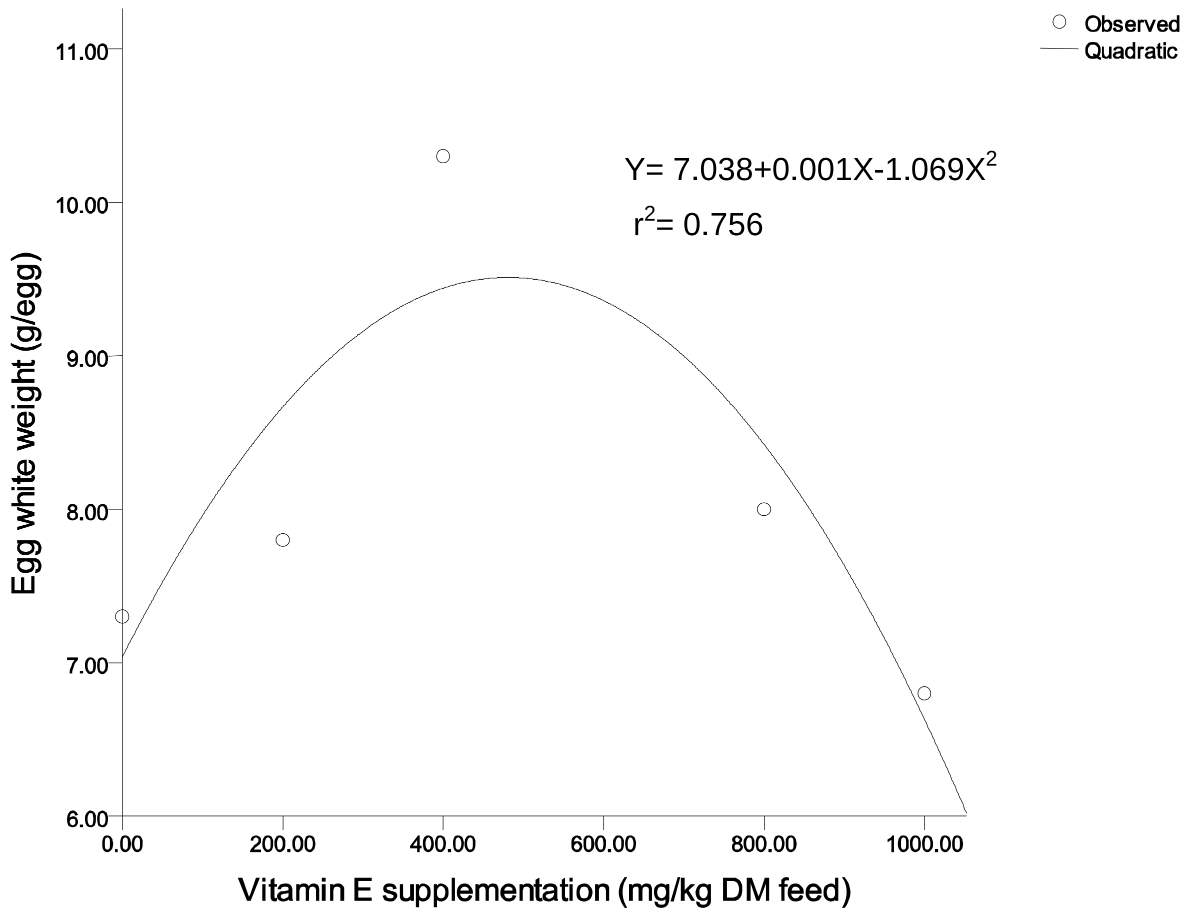

Figure 4.05 Effect of vitamin E supplementation level to the diets of Venda hens on egg white weight

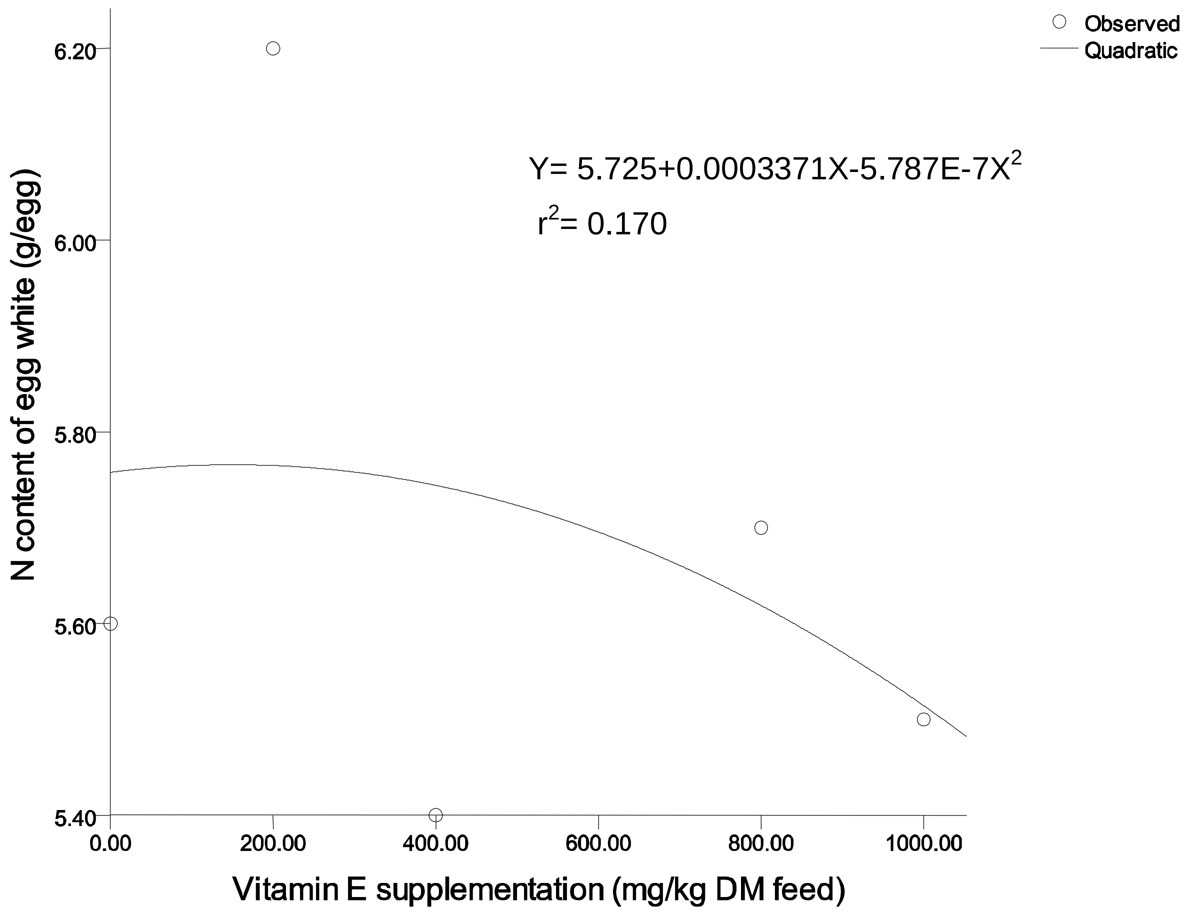

Figure 4.06 Effect of vitamin E supplementation level to the diets of Venda hens on egg white nitrogen content

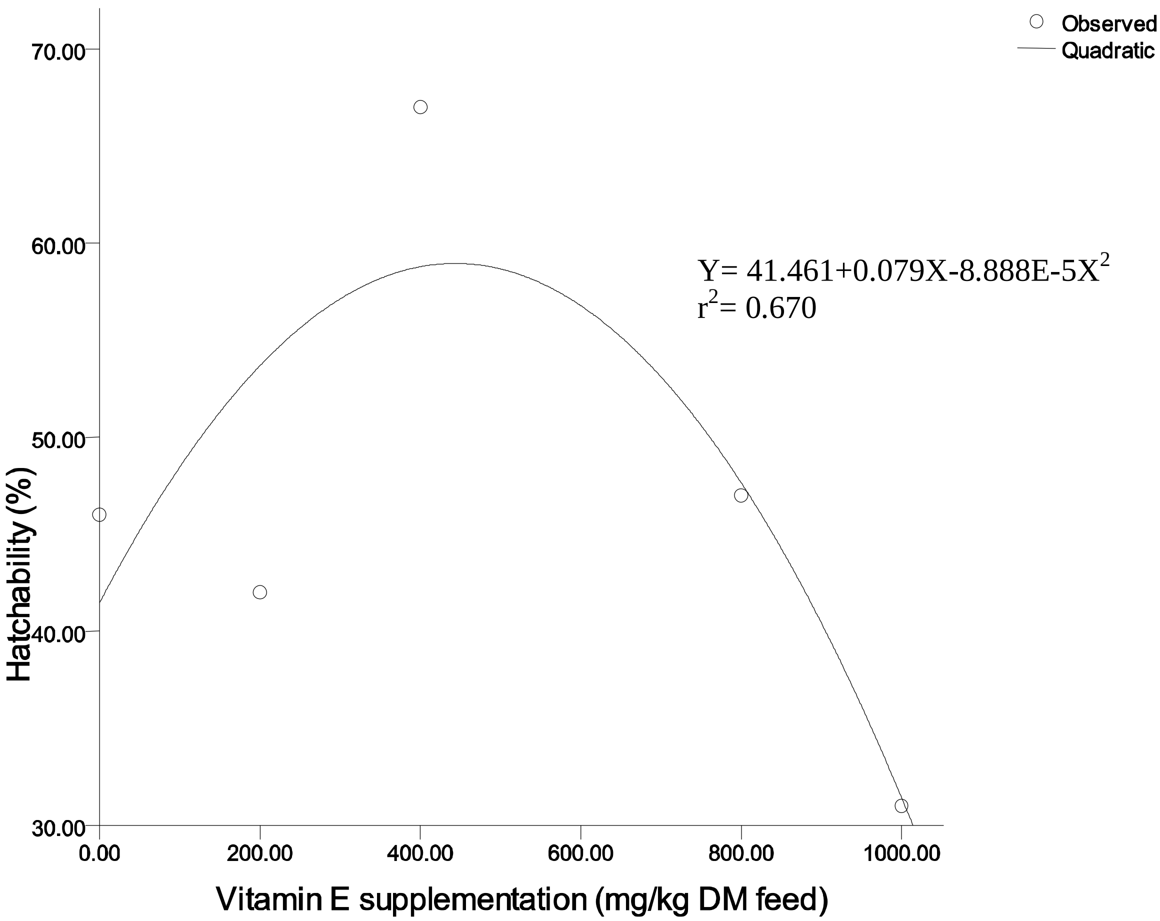

Figure 4.07 Effect of vitamin E supplementation level to the diets of Venda hens on egg hatchability

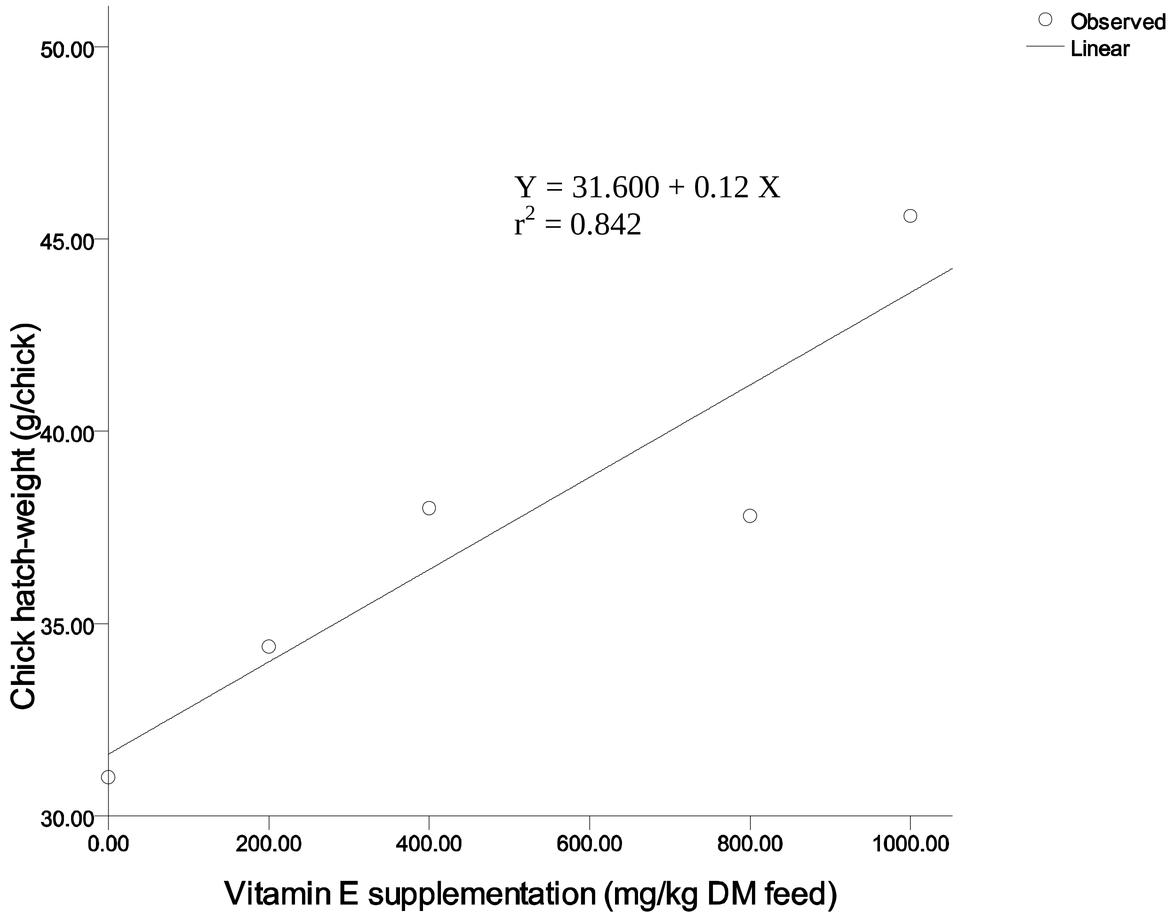

Figure 4.08 Relationship between vitamin E supplementation level to the diets of Venda hens and chick hatch-weight

Table 4.02 Vitamin E supplementation levels (g/kg DM feed) to the diets of Venda hens for optimal number of eggs (egg/hen/14 days), egg white weight (g/egg), egg yolk nitrogen content (%), egg white nitrogen content (%) and egg hatchability (%)

Trait	Formula	r^2	Vitamin E level *	Optimum Y level	P
No. of eggs	$Y=13.263+0.001X-4.478E-6X^2$	0.966	113	12.9	0.342
Egg white wt	$Y=7.038+0.010X-1.069E-5X^2$	0.756	476	9.4	0.940
Egg yolk N content	$Y=12.486+0.005X-3.920E-6X^2$	0.617	637	14.08	0.383
Egg white N content	$Y=5.725+0.0003371X-5.787E-7X^2$	0.182	750	5.7	0.875
Egg hatchability	$Y=41.461+0.079X-8.888E-5X^2$	0.670	445	59	0.330

r^2 : Regression coefficient

* : Level of vitamin E supplementation for optimal variable

P: Probability level

Results of the effect of vitamin E supplementation level on the diets of Venda hens on feed intake, growth rate, feed conversion ratio, mortality and live weight of their progenies between one and seven weeks old are presented in Table 4.03. Vitamin E supplementation to the diets of Venda hens had no effect (P>0.05) on growth rate and mortality of their progenies. However, vitamin E supplementation to the diets of Venda hens had effect (P<0.05) on feed intake, feed conversion ratio and live weight of their progenies. Chickens hatched from hens fed on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed had higher (P<0.05) feed intake than those from hens on a diet supplemented with 400 mg of vitamin E per kg DM feed and those from hens on a diet not supplemented with vitamin E. However, chickens from hens fed on a diet supplemented with 400 mg of vitamin E per kg DM feed had higher (P<0.05) feed intake than those from hens on a diet not supplemented with vitamin E.

Table 4.03 Effect of vitamin E supplementation level to the diets of Venda hens on feed intake (g/bird/day), growth rate (g/bird/day), feed conversion ratio (FCR) (g DM feed/g live weight gain) mortality (%) of their progenies between one and seven weeks of age

	Treatment					
Variable	V_0	V_{200}	V_{400}	V_{800}	V_{1000}	SE
Intake	28.3^c	61.6^a	37.1^b	55.8^a	61.8^a	2.209
Growth	7.4	8.1	7.5	9.3	7.9	0.595
FCR	3.8^c	7.7^a	5.0^{bc}	6.2^b	7.9^a	0.430
Mortality	4.67	16	0.0	15	0.0	5.469
Live weight	573.0^{ab}	646.7^a	498.3^b	625.7^a	610.0^a	34.242

SE : Standard error

^{abcde} : Means with different superscripts in the same row are significantly different (P < 0.05)

Chickens from hens fed on a diet not supplemented with vitamin E had better (P<0.05) feed conversion ratio than those from hens supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed. Chickens from hens supplemented with 200 and 1000 mg of vitamin E per kg DM feed had poorer (P<0.05) feed conversion ratios than those from hens not supplemented with vitamin E and those from hens supplemented with 400 and 800 mg of vitamin E per kg DM feed. Chickens from hens fed on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed had higher (P<0.05) live weights than those from hens on a diet supplemented with 400 mg of vitamin E per kg DM feed. Chickens from hens fed on a diet not supplemented with vitamin E and those from hens on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed had similar (P>0.05) live weights. Similarly, chickens from hens fed on a diet not supplemented with vitamin E and those from hens on a diet supplemented with 400 mg of vitamin E per kg DM feed had similar (P>0.05) live weights. Dietary vitamin E supplementation to the diets of Venda hens had no effect (P>0.05) on dietary intake, dry matter digestibility, metabolisable energy and nitrogen retention of their progenies at seven weeks of age (Table 4.04).

Table 4.04 Effect of dietary vitamin E supplementation level to the diets of Venda hens on dry matter intake (DMI) (g/bird/day), dry matter digestibility (DMD) (decimal), metabolisable energy (ME) (MJ/kg DM) and nitrogen retention (g/bird/day) of their female progenies at seven weeks of age

	Treatment					
Variable	V_0	V_{200}	V_{400}	V_{800}	V_{1000}	SE
DMI	84.7	86.8	78.6	76.3	80.9	3.591
DMD	69.0	69.5	63.5	58.6	64.7	3.475
N- retention	1.8	1.5	1.4	1.4	1.6	0.165
ME	14.1	14.2	13.9	13.8	14.0	0.299

SE : Standard error

abcde : Means with different superscripts in the same row are significantly different (P < 0.05)

Vitamin E supplementation level to the diets of Venda hens had no effect (P>0.05) on feed intake, growth rate, feed conversion ratio, live weight and mortality of their male progenies aged between eight and 13 weeks (Table 4.05). The results of the effect of vitamin E supplementation level to the diets of Venda hens on dry matter intake, dry matter digestibility, nitrogen retention and metabolisable energy of their male progenies at 13 weeks of age are presented in Table 4.06. Chickens from hens supplemented with 400 mg of vitamin E per kg DM feed had higher (P<0.05) dry matter intake than those from hens on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed. However, chickens from hens on a diet not supplemented with vitamin E and those from hens on a diet supplemented with 400 mg of vitamin E per kg DM feed had similar (P>0.05) dry matter intakes. Chickens from hens on a diet not supplemented with vitamin E and those from hens on a diet supplemented with 1000 mg of vitamin E per kg DM feed attained similar (P>0.05) dry matter intakes. Chickens from hens fed on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed attained similar (P>0.05) dry matter intakes.

Chickens from hens fed on a diet supplemented with 400 mg of vitamin E had higher (P<0.05) dry matter digestibility values than those from hens fed on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed. However, chicken from hens fed on a diet not supplemented with vitamin E and those from hens fed on 400 mg of vitamin E per kg DM feed attained similar (P>0.05) dry matter digestibility values. Chickens from hens fed on a diet not supplemented with vitamin E and those from hens fed on diets supplemented with 200 and 1000 mg of vitamin E per kg DM feed attained similar (P>0.05) dry matter digestibility values. Similarly, chickens from hens fed on diets supplemented with 800 and 1000 mg of vitamin E attained similar (P>0.05) dry matter digestibility values. Chickens from hens fed on a diet not supplemented with vitamin E and those from hens on diets supplemented with 400 and 1000 mg of vitamin E per kg DM feed had higher (P<0.05) nitrogen retention values than those from hens on diets supplemented with 200 and 800 mg of vitamin E per kg DM feed. Chickens from hens fed on a diet supplemented with 400 mg of vitamin E per kg DM feed had higher (P<0.05) metabolisable energy values than those from hens on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed. However, chickens from hens fed on a diet not supplemented with vitamin E and those from hens on a diet supplemented with 400 mg of vitamin E per kg DM feed had similar (P>0.05) metabolisable energy values. Chickens from hens on a diet not supplemented with vitamin E and those from hens on a diet supplemented with 1000 mg of vitamin E per kg DM feed had similar (P>0.05) metabolisable energy values. Chickens from hens fed on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed had similar

(P>0.05) metabolisable energy values. Chickens from hens fed on a diet not supplemented with vitamin E had higher (P<0.05) breast meat nitrogen contents than those from hens on diets supplemented with 200, 400, 800 and 1000 mg of vitamin E per kg DM feed. Chickens from hens on a diet supplemented with 400 mg of vitamin E per kg DM feed had higher (P<0.05) breast meat nitrogen contents than those from hens on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed. However, chickens from hens fed on diets supplemented with 200, 800 and 1000 mg of vitamin E per kg DM feed had similar (P>0.05) breast meat nitrogen contents.

Results of the effects of vitamin E supplementation level on the diets of Venda hens on carcass weight and carcass parts of their male progenies at 13 weeks of age are presented in Table 4.07. Vitamin E supplementation to the diets of hens had no effect (P>0.05) on carcass, breast yield, drumstick, thigh and wing weights. However, chickens from hens fed on diets supplemented with vitamin E had effect (P<0.05) on gizzard, liver and heart weights. Chickens from hens fed on diets supplemented with 400 and 1000 mg of vitamin E per kg DM feed had higher (P<0.05) gizzard weights than those from hens on a diet not supplemented with vitamin E and those from hens on a diet supplemented with 200 mg of vitamin E per kg DM feed. However, chickens from hens fed on diets supplemented with 400, 800 and 1000 mg of vitamin E per kg DM feed had similar (P>0.05) gizzard weights. Chickens from hens fed on a diet not supplemented with vitamin E and those from hens on a diet supplemented with 800 mg of vitamin E per kg DM feed had similar (P>0.05) gizzard weights. Similarly, chickens from hens fed on a diet not supplemented with vitamin E and those from hens on a diet supplemented with 200 mg of vitamin E per kg DM feed attained similar (P>0.05) gizzard weights.

Chickens fed on a diet supplemented with 1000 mg of vitamin E per kg DM feed had higher (P<0.05) liver weights than those from hens on a diet supplemented with 200 mg of vitamin E per kg DM feed. However, chickens from hens fed on a diet not supplemented with vitamin E and those from hens on diets supplemented with 400, 800 and 1000 mg of vitamin E per kg DM feed attained similar (P>0.05) liver weights.

Similarly, chickens from hens fed on a diet not supplemented with vitamin E and those from hens on diets supplemented with 200, 400 and 800 mg of vitamin E per kg DM feed attained similar (P>0.05) liver weights. Heart weights of chickens from hens fed on diets supplemented with 400 and 800 mg of vitamin E per kg DM feed were higher (P<0.05) than those from hens on a diet not supplemented with vitamin E However, chickens from hens fed on diets supplemented with 200, 400, 800 and 1000 mg of vitamin E per kg DM feed had similar (P>0.05) heart weights. Similarly, chickens from hens fed on a diet not supplemented with vitamin E and those from hens on diets supplemented with 200 and 1000 mg of vitamin E per kg DM feed attained similar (P>0.05) heart weights.

Table 4.05 Effect of vitamin E supplementation level (mg/kg DM) to the diets of Venda hens on feed intake (g/bird/day), growth rate (g/bird/day), feed conversion ratio (g DM feed/g live weight gain) and mortality (%) of their male progenies between eight and 13 weeks old and live weight at 13 weeks old

	Treatment					
Variable	V_0	V_{200}	V_{400}	V_{800}	V_{1000}	SE
Feed intake	111.4	135.7	136.1	195.9	187.4	28.190
Growth	17.0	14.7	13.7	16.0	16.7	1.238
FCR	6.7	9.6	9.7	11.9	11.3	1.746
Live weight	1437	1575	1471	1778	1491	379.8
Mortality	75	72	80	79.	69	6.99

SE : Standard error

Table 4.06 Effect of dietary vitamin E supplementation level (mg/kg DM) to the diets of Venda hens on dry matter intake (DMI) (g/bird/day), dry matter digestibility (DMD) (decimal), metabolisable energy (ME) (MJ/kg DM), nitrogen retention (g/bird/day) and breast meat nitrogen content (%) of their male progenies at 13 weeks of age

	Treatment					
Variable	V_0	V_{200}	V_{400}	V_{800}	V_{1000}	SE
DMI	89.2^{ab}	80.3^{c}	91.1^{a}	80.9^{c}	81.5^{bc}	2.592
DMD	66.8^{ab}	55.9^{b}	69.3^{a}	57.1^{c}	58.5^{bc}	2.694
N- retention	1.3^{a}	0.63^{b}	1.4^{a}	0.8^{b}	1.6^{a}	0.105
ME	13.3^{ab}	12.8^{c}	13.8^{a}	12.8^{c}	13.1^{bc}	0.143
Breast meat N content	14.4^{a}	13.6^{c}	14.2^{b}	13.5^{c}	13.6^{c}	0.054

SE : Standard error

^{abcde} : Means with different superscripts in the same row are significantly different ($P < 0.05$)

Table 4.07 Effect of vitamin E supplementation level to the diets of Venda hens on carcass weight (g/bird), and carcass parts (g) of their male progenies at 13 weeks of age

Variable	Treatment					SE
	V_0	V_{200}	V_{400}	V_{800}	V_{1000}	
Carcass	1055.3	1074.1	1184.9	1148.7	1084.1	65.942
Breast meat	230.0	198.3	228.3	248.7	238.7	24.542
Drumstick	150.6	171.7	179.0	169.2	162.3	10.224
Thigh	163.0	187.7	186.3	188.0	172.7	11.77
Wing	136.1	142.9	153.0	159.5	141.6	9.99
Gizzard	33.7^{bc}	29.7^{c}	48.7^{a}	41.0^{ab}	45.3^{a}	2.637
Liver	28.2^{ab}	27.1^{b}	33.6^{ab}	31.0^{ab}	34.8^{a}	2.33
Heart	7.5^{b}	8.0^{ab}	8.1^{a}	8.7^{a}	7.9^{ab}	0.305

SE : Standard error

^{abcde} : Means with different superscripts in the same row are significantly different ($P < 0.05$)

CHAPTER 5

DISCUSSION

This study showed that vitamin E supplementation to the diets of Venda hens had no effect on feed intake. These results are similar to the findings of Coetzee and Hoffman (2001) in broiler breeder hens, and Richter *et al. (*1986), Bolukbasi *et al.* (2007) and Bollengier-Lee *et al.* (1999) in commercial laying hens. Similarly, Biswas *et al.* (2007) and Niu *et al* (2009) observed same results in Japanese quail. Contrary to these results, Kirunda *et al.* (2001), Sahin *et al.* (2002), Lin *et al.* (2004) and Aljamal *et al.* (2005) indicated that supplementation of vitamin E to the diets of commercial laying hens increased their feed intake.

Vitamin E supplementation to the diets of Venda hens did not improved the number of eggs produced. However, dietary vitamin E supplementation level for optimal number of eggs produced was calculated to be 113 mg per kg DM feed (r^2 = 0.966). Similar results were reported by Richter *et al.* (1986), Bartov *et al.* (1991) and Shahria *et al*. (2008) in commercial laying hens. These results are contrary to the findings of Scheldeler *et al.* (1996), Bollengier-Lee *et al.* (1998, 1999), Kirunda *et al*. (2001), Lin *et al.* (2002), Sahin *et al.* (2002) and Lin *et al.* (2004) who observed that supplementation of vitamin E to the diets of laying hens during heat stress improved the number of eggs produced

Increasing levels of vitamin E supplementation to the diets of Venda hens improved egg weights. Similar results were reported by Muduuli *et al.* (1982), Puthpongsiriporn *et al.* (2001), Sahin *et al* (2002), Lin *et al.* (2004), Ciftci, (2005), Aljamal *et al*. (2005), Saly *et al*. (2000) and Bhanja *et al*. (2006). These authors reported that supplementation of vitamin E to the diets of commercial laying hens improved the weight of eggs produced. However, Bollengier-Lee *et al.* (1998, 1999), Kirunda *et al.* (2001) and Shahria *et al.* (2008) indicated that vitamin E supplementation to the diets of hens had no effect on egg weight.

The present study showed that vitamin E supplementation to the diets of Venda hens improved egg yolk and egg white weights. This is in agreement with the findings of Puthpongsiriporn *et al.* (2001) and Tsai *et al.* (2008) who indicated that vitamin E supplementation to the diets of commercial laying hens improved egg yolk and egg white weights. Similarly, Kirunda *et al.* (2001) and Lin *et al.* (2004) observed improved egg yolk and egg white weights due to vitamin E supplementation to the diets of commercial laying hens. Aljamal *et al.* (2005) also showed an improvement in egg yolk and egg white weights due to vitamin E supplementation to the diets of commercial laying hens. In the present study dietary vitamin E supplementation value for optimal egg white and egg yolk weights were calculated to be 476 (r^2 = 0.756) and 637 (r^2 = 0.617) mg per kg DM feed, respectively.

The present study showed that vitamin E supplementation to the diets of Venda hens improved egg yolk and egg white nitrogen. However, dietary vitamin E supplementation values for optimal egg yolk nitrogen and egg white nitrogen were calculated to be 750 (r^2 = 0.170) and 750 (r^2 = 0.182) mg per kg DM feed. No information was found regarding this issue on vitamin E supplementation to the diet of indigenous Venda hens.

Vitamin E supplementation to the diets of Venda hens improved egg hatchability. Dietary vitamin E supplementation value for optimal egg hatchability was calculated to be 445 mg per kg DM feed (r^2 = 0.670). Increases in egg hatchability due to vitamin E supplementation to the diets of hens were also observed by Jensen and McGinnis (1960), Muduuli *et al.* (1982), Lin *et al.* (2002, 2004) and Tsai *et al.* (2008). Contrary to these results, Bhanja *et al.* (2006) observed that chickens injected with vitamin E produced eggs with lower hatchability values. Hooda *et al.* (2007) also indicated that vitamin E supplementation to the diets of hens had no effect on egg hatchability.

Vitamin E supplementation to the diets of Venda hens improved chick hatch-weight. No information was found on the effect of vitamin E supplementation on chick hatch-weight of indigenous Venda chickens. However, Bhanja *et al.* (2006), Lopez and Leeson (1995) reported that supplementation of crude protein to the diets of breeder hens improved chick hatch-weight. Antencio (2005b) indicated that vitamin D supplementation improved hatch body weight of the chicks. These results are contrary to the findings of Triyuwanta *et al*. (1992) who reported that breeder hens supplemented with 2, 6 and 10 g of phosphorus per kg DM feed produced chicks with similar hatch-weights. Kidd (2003) observed that low maternal dietary protein resulted in low chick hatch-weight. However, Pond *et al.* (1968, 1987, 1991); Atinmo *et al.* (1990) reported that restriction of the protein component of the maternal diet to 5 g per kg in pigs resulted in a reduction of piglet birth-weight.

Increasing levels of vitamin E supplementation to the diets of Venda hens improved feed intake of their progenies aged between one and seven weeks. No information was found on feed intake of progenies when hens were fed diets with different levels of vitamin E. However, Peeble *et al.* (1998) indicated that progenies of breeder hens fed diets having different levels of corn oil had similar feed intakes.

Vitamin E supplementation to the diets of Venda hens did not improve growth rate of their progenies between one and seven weeks old. No information was found on the growth rate of progenies of hens fed diets having different levels of vitamin E. However, Leeson *et al.* (1979a, 1979b) found that vitamin B_{12} deficient diets of broiler breeder hens had no effect on growth rate of their progenies. Furthermore, Harms and Wilson (1984) reported that breeder hens fed diets having different levels of crude protein, phosphorus, calcium and lysine had no effect on growth rate of their progenies at 41 days old. Merkley and Sexton (1982) and Van Toled and Combs (1984) also observed that supplementation of sodium fluoride to the diets of breeder hens had no effect on growth rate of their progenies. Kidd *et al.* (1992; 1993), Stahl *et al.* (1986; 1990) and Virden *et al.* (2003) observed that organic zinc and manganese supplementations to the diets of breeder hens had no effect on growth rates of their progenies. These results are contrary to the findings of Beer *et al.* (1963) who observed that patothenic acid supplementation to the diets of breeder hens improved growth rate of their progenies. Atencio *et al.* (2006) and Kemp *et al.* (2001) also observed improved growth rates of progenies when hens were fed on diets supplemented with vitamin $D_{3.}$ However, Cantor and Scott (1974) and Poley *et al*. (1941) showed that supplementation of selenium to the diets of Leghorn breeder hens improved growth rates of their progenies.
Increasing levels of vitamin E supplementation to the diets of Venda hens resulted in progenies with higher feed conversion ratio. Similar results were reported by Haq *et al.*

(1996) and Hossain *et al.* (1998) when they supplemented commercial laying hens with vitamin E. Not much information was found on feed conversion ratio of progenies when hens were fed diets with different levels of vitamin E.

This study indicated that vitamin E supplementation to the diets of hens did not reduce mortality of their progenies between one and seven weeks of age. However, Jensen and McGinnis (1960) and Hossain *et al.* (1998) observed that high levels of vitamin E supplementation to the diets of broiler breeder hens reduced mortality of their progenies. Similarly, Ciftci *et al.* (2005) observed lower mortalities in progenies when laying hens had been supplemented with vitamin E and C. Kemp *et al.* (2001), Poley *et al.* (1941) and Cantor and Scott (1974) also observed lower mortalities of progenies when laying hens had been supplemented with selenium.

Increasing levels of vitamin E supplementation to the diets of Venda hens improved live weight of their progenies at seven weeks old. No information was found regarding the effects of vitamin E supplementation to the diets of hens on live weight of the progenies. However, Peric *et al.* (2005) reported that increasing Sel-Plex to the diets of hens improved their progenies's body weight. Brake *et al.* (2003) indicated that increasing levels of crude protein and energy to the diets of hens improved body weight of their male progenies. Similarly, Attia *et al.* (1995) found that supplementing energy to the diets of breeder hens resulted in their male progenies attaining higher live weight. Antencio *et al.* (2005a; b; c) showed that progenies hatched from hens supplemented with high doses of vitamin D_3 or 25-OHD had higher body weight gain. This is contrary to the findings of Peeble *et al.* (1998) who observed that supplementing corn oil to the diets of broiler breeder hens had no effect on body weight of the progenies. Halle (1999) also showed that palm butter and safflower oil supplementations to the diets of breeder hens did not improve body weight of their progenies.

Vitamin E supplementation to the diets of Venda hens had no effect on dry matter intake, dry matter digestibility, nitrogen retention and metabolisable energy of their progenies at seven weeks old. No information was found regarding this issue on progenies.

This study indicated that vitamin E supplementation to the diets of Venda hens had no effect on feed intake, growth rate, feed conversion ratio and mortality of their male progenies between eight and 13 weeks old. No studies were found on this issue. However, Pearson and Herron (1981), Proudfoot and Hulan (1986) observed that supplementation of crude protein and energy to the diets of breeder hens had no effect on mortality, growth rate and feed conversion ratio of their progenies. Sibbald and Davidson (1998) and Daniel *et al.* (2007) also observed that maternal dietary restriction to the diets of ewes had no effect on feed intake, growth rate and feed conversion efficiency of their progenies. These results are contrary to the findings of Brake *et al.* (2003), Attia *et al.* (1995) and Spratt and Lesson (1987) who found that increasing crude protein and energy levels to the diets of hens improved body weight of their male chicks. Hill *et al.* (1961) observed that increasing levels of vitamin A to the diets of hens improved growth rate of their progenies.

The present study indicated that vitamin E supplementation to the diets of Venda hens improved dry matter intake, dry matter digestibility, nitrogen retention, metabolisable energy and breast meat nitrogen of their male progenies at 13 weeks old. No information was found on these factors. However, Mckee *et al.* (1997) reported that supplementation of ascorbic acid to the diets of broiler breeder chickens had no effect on dry matter digestibility, metabolisable energy and nitrogen retention of their progenies. However, Spratt and Lesson (1987) observed that increasing crude protein and energy levels to the diets of hens increased carcass protein of their progenies.

The present study showed that vitamin E supplementation to the diets of Venda hens had no effect on carcass, breast meat, drumstick, thigh and wing weights of their male progenies at 13 weeks old. No previous information was found regarding performance of progenies when hens had been fed diets supplemented with vitamin E. However, Lopez and Leeson (1995) found that supplementing diets of broiler hens with protein did not affect carcass trait of their progenies. Contrary to these results, Peebles *et al.* (1999b; 2002) reported that increased coconut oil or poultry oil to the diets of breeder hens improved carcass weight of their progenies at 43 days old. Kidd *et al*. (2005) indicated that breeder hens supplemented with L-carnitine improved breast meat of their progenies.

The present study showed that vitamin E supplementation to the diets of Venda hens improved gizzard weight, liver weight and heart weight of their progenies at 13 weeks old. However, Bautista-Ortega *et al*. (2002) observed that feeding broiler breeder hens with diets low in n-3 fatty acids resulted in their progenies having lower heart weights and lower body weights. Atti *et al.* (1995) found that increasing levels of energy to the diets of broiler breeder hens improved liver weight of their progenies at a day old. These results are contrary to the findings of Peeble *et al.* (1998) who indicated that supplementation of corn oil to the diet of breeder hens had no effect on liver weight of their progenies.

There was some indication in the present study that production variables were optimized at different levels of vitamin E supplementation to the diets of Venda hens. This has implications on ration formulation for these chickens.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

It is concluded that vitamin E supplementation to the diets of Venda hens improved egg weight, egg contents, hatchability and chick hatch-weight. Dietary levels of vitamin E supplementation of 750 (r^2 = 0.170), 476 (r^2 = 0.756), 750 (r^2 = 0.182) and 445 (r^2 = 0.670) mg per kg DM feed optimized egg white weight, egg yolk nitrogen, egg white nitrogen and egg hatchability, respectively. Thus, vitamin E supplementation level for optimal productivity of Venda hens depended on the parameter in question. This has implications when formulating diets for Venda hens.

High levels of vitamin E supplementation to the diets of Venda hens improved feed intake, feed conversion ratio and live weight of their progenies between one and seven weeks of age. Vitamin E supplementation to the diets of Venda hens did not improve growth rate and mortality of their progenies between one and seven weeks of age. Similarly, vitamin E supplementation to the diets of Venda hens did not improve dry matter intake, digestibility, nitrogen retention and metabolisable energy of their progenies at seven weeks old.

Dietary vitamin E supplementation to the diets of Venda hens improved dry matter intake, digestibility, nitrogen retention, metabolisable energy, breast meat nitrogen content, gizzard weight, liver weight and heart weight of their progenies at 13 weeks old.

6.2 Recommendations

More studies are required to investigate biochemical reasons for improved feed intake, feed conversion ratio, live weight, carcass parts, digestibility and breast meat nitrogen content of chicks hatched from Venda hens supplemented with vitamin E.

CHAPTER 7

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