CHAPTER 1

INTRODUCTION

1.1 **Background**

The poultry industry is one of the fastest growing livestock industries in South Africa. Large scale commercial poultry farmers produce two thirds of the conventional poultry sales using modern methods of management (Moran, 1991). Poultry production in the smallholder farming sector is also increasing every year. Poultry provides food, income and employment, thus contributing to poverty alleviation in South Africa (Sonaiya, 1999).

Over the period 1957 to 2000, the age to slaughter and the amount of feed required to produce a given quantity of chicken meat has been more than halved due to genetic selection for early fast growth and efficient feed utilization (Harverstein *et al*., 1994). The main increase in growth rate is manifested primarily in the first four weeks after hatching (Marks, 1979). Growth management, therefore, is necessary to assist in achieving optimum performance in terms of mortality, diet intake, live weight, uniformity, feed conversion rate and meat yield.

1.2 **Problem**

In Limpopo province farmers receive chicks late, sometimes 36 hours after hatching or more before placement in their rearing facilities. This leaves the residual yolk sac nutrients as the only source of nutrition for the chicks. This leads to poor growth rates and high mortality rates. Thus, productivity is affected (Uni et al., 2004).

1.3 **Motivation**

The period between final stage of embryonic development and first days of life in the broiler chickens is made up of a complex and sensitive stage of digestive, physiological and immune system maturation especially for broiler chicks selected for rapid growth, where the first week of life is very important for muscle production, improved growth rate and livability (Moss et al., 1964). Immediately after hatching, most nutrients from the yolk are used for intestinal growth (Noy & Sklan, 1998a). This preferential growth occurs regardless of initiation of feeding after hatching (Maiorka & Malheiros, 2000). However, as observed by Dibner et. al. (1998) the residual yolk sac nutrient are not always sufficient to satisfy the chick's optimal metabolic nutrient requirements during the first few days post-hatch, thus limiting the hatchlings growth and livability. Therefore, in order not to jeopardize the development of the chick, the best preliminary practice would be to stimulate the initial growth so that the bird can express all its muscular growth potential, digestive and

immunizing capacities (Fanguy et al., 1980). This first stage of initial stimulation relates to, in particular, the time of initiation of feeding after hatching. It is, therefore, important to examine the effect of time of initiation of feeding after hatching on productivity and livability of broiler chicks.

After hatching, the broiler chicks are exposed to environmental, pathological and nutritional stresses. Supplementation with exogenous nutrients such as lysine or vitamin C provides benefits to growing chicks (Pardue & Thaxton, 1986; Plavnik & Hurwitz, 1989). Jones & Farrell (1992) observed higher growth rates and leaner carcasses in previously feed-restricted birds supplemented with lysine in comparison to the non-restricted birds. Similarly, vitamin C supplementation enhanced productivity, immune responses and survivability under stressful conditions (Zulkifli *et al.,* 1996). However, there are other studies indicating no significant beneficial effects of lysine or ascorbic acid supplementation in previously feed-restricted birds compared to non-restricted ones (Acar *et al.,* 1991; Puron *et al*., 1994). It is, therefore, important to ascertain such responses in broiler chickens under different times of initiation of feeding after hatching. Such data would be valuable to farmers with regards to improving productivity of the broiler chickens.

1.4 **Objectives**

The objectives of this study were:

1 To determine the effect of time of initiation of feeding after hatching on performance and mortality of Ross 308 broiler chickens.

2 To determine the effect of supplemental dietary lysine and ascorbic acid on productivity and mortality of Ross 308 broiler chickens following nutritional stress occasioned by delayed initiation of feeding after hatching.

3 To determine the effect of interaction between time of initiation of feeding after hatching and levels of dietary supplemental lysine and ascorbic acid on the productivity and mortality of Ross 308 broiler chickens.

4 To determine the relationships between times of initiation of feeding after hatching and short-term biological responses of broiler chicks.

CHAPTER 2

LITERATURE REVIEW

2.1 **Introduction**

The time from hatching to initiation of feeding in commercial poultry offers an excellent model to determine if nutritional programming occurs during this period. The concept of nutritional programming suggests that what is fed or not fed during critical or sensitive periods of development may " program " the lifelong structure or function of the animal (Lucas, 1998). A classic example of programming is found in experiments showing that a reduction of intake in suckling rats soon after birth caused a slower growth rate. This slower growth continued to diverge after the restriction period and ultimately resulted in lower body weight for the entire life-time (McCane, 1962). However, when this restriction occurred a few weeks later, the restricted rats easily caught up with the non-restricted ones. Subsequent work in this area determined that lifetime effects on bodysize were influenced by postnatal nutrition but not prenatal nutrition of the mother (Snoek *et al.,* 1990).

2.2 **Nutritional programming and timing**

Just as the classical rat pup restriction studies showed, the age at which a nutrient restriction is imposed will determine the overall impact on the neonate. In the same manner, Novus International researchers (http/www.novusint.com, 1998) conducted a trial in which hatchling poults were either fed a hydrated nutritional supplement or fasted from 1-3 days post-hatch and growth rates of the entire body and individual organ systems were measured through 28 days of age. The 3-day fast resulted in a 30 % slower growth rate for bodyweight and unlike results observed by restriction later in life starting from seven days of age or more (Plavnik & Hurwitz, 1988a) there was no indication of ‘catching up’ in the 28 days timeframe of the experiment. This is further supported by the work of Fanguy *et al.* (1980) and Wyatt.*et al.* (1985) who reported that delayed initiation of feeding after hatching retards the maturation of systems that begin developing in the hatchling only after the addition of exogenous nutrients.

In this regard, also, Friedman et al. (1994) reported that early supply of exogenous nutrient immediate post-hatch confers several advantages to the bird including better tolerance, earlier responses, immune competence, better protection and a better developed intestinal tract. This is in addition to the desired promotion of muscle growth. However, other authors have found that period or time of initiation of feeding after hatching had no effect on performance of the broiler chicken (Hogan, 1984). Thus, timing or age at which nutrient restriction is imposed and possibly severity of nutrient restriction will determine the impact on subsequent growth of hatchling broilers (Snoek *et al.,* 1990).

2.3 **Nutritional programming and compensatory growth**

The phenomenon of compensatory growth has long been recognized as having the potential to have profound effects on the rate of growth and body composition of most animals. An animal whose growth has been slowed by nutritional deprivation may exhibit an enhanced rate of growth when realimented. If this exceeds the maximal rate of gain when adequate nutrition has been provided, the animal is said to have undergone compensatory or 'catch-up' growth (McMurtry *et al*., 1998). Wilson & Osbourne (1960) referred to compensatory growth as being the period of rapid growth, relative to age, exhibited by mammals and birds after a period of nutritional restriction. It is complex because it involves genetic, physiological, nutritional, metabolic, endocrinal and behavioral relationships (Nir et al., 1986).

Food restriction consists of limiting the level of consumption of a food in time, quantity, quality or reducing the hours of illumination of feeding (Religious et al., 2001). This practice is used for a reduction in carcass fat content and improvement in food utilization (Plavnik & Hurwitz 1985), as well as reduction in pathological disorders associated with early rapid growth due to selection and genetic breeding such as ascites and osteoporosis (Acar et al., 1995; Jones 1995; Sanchez et al., 2000). Plavnik & Hurwitz (1985), Calvert et al. (1989) and Jones & Farrell (1992) reported that during the period of feed restriction, growth rate is slower than that of birds given free access to food but when access to food is again unrestricted the birds exhibit an accelerated rate of weight gain. However, when feed restriction is severe, compensatory growth is not sufficient to 'catch up' to market weight (Mosier, 1986). On the other hand, birds apparently utilize food more efficiently following the period of restricted feeding because their overall feed intake and feed conversion ratio are lower than that of full fed birds (AL-Taleb, 2003).

Various methods of undernutrition have been used to retard or even stop growth during the undernutrition period. These methods include limiting the level of consumption of feed in time (Religious et al., 2001), physical feed restriction (Plavnik & Hurwitz, 1989), diet dilution and chemical methods of feed restriction and use of low protein or low energy diets (Zubair & Lesson, 1986)..

2.4 **Theories surrounding the regulation of compensatory growth in animals**

Two current theories surrounding the regulation of compensatory growth suggest that it is regulated by the central nervous system or through peripheral control. Mosier (1986) speculated that an unknown control regulator that relates the current body size to the set-point size appropriate for that age detects the growth deficit due to nutrient restriction. This stimulates a signal to be sent to the hypothalamus to increase the production of growth hormone by the anterior pituitary gland, which in turn is modulated by the environmental photoperiod. However, this theory holds an obvious weakness in that sufficient evidence exists to dismiss the action of growth hormone alone on compensatory growth (Mosier, 1986; Hornick et al., 1998b; Yambayamba et al., 1996).

Although much of this theory still remains hypothetical in that the sensors and signals have not been identified, the underlying thought that there is some central control mechanism that defines the end body size of the animal still remains plausible. The second "peripheral control" theory suggests that the control of body size lies at the tissue level through cell number or total content of DNA (Pitts, 1986). Therefore, only upon severe restriction pre-natally or very early post-natally would one expect that total DNA might be decreased so that total mature size would be decreased. Nutritional deprivation has been shown to impact on DNA size, not number, so that theoretically upon realimentation the animal should be able to attain its appropriate size for age (Pitts, 1986).

2.5 **Types of compensatory responses**

There are four possible responses that an animal can exhibit when realimented after a period of nutritional compensation. These include complete compensation, partial compensation, no compensation or a reduction in mature size. Complete compensation occurs when the animal is able to attain the same weight for age as unrestricted counterparts. This has been reported numerous times in sheep (Plavnik & Hurwitz, 1985, 1989, 1991), pigs (Ryan et al., 1993b), and chickens (Zubair & Leeson, 1994, 1996). Partial compensation occurs when animals increase their rate of gain upon realimentation, but are unable to attain the same weight for age as unrestricted animals.

Thus, in these situations the initial period of increased rates of growth only persists for a short while and then diminishes back to the level of unrestricted animals so that the growth curves of the unrestricted and restricted animals become parallel. However, some researchers claim that certain trials ended while growth rates were still different so it might have been

possible to attain complete compensation even though it was reported that the animals had only partial compensation (Kamalzadeh et al., 1998; Ryan, 1990). A less common response to nutritional restriction followed by realimentation is for an animal to grow at the same rate as unrestricted animals, thereby showing no compensation. This has been observed in various species and is usually seen when nutrient restriction has occurred at a very young age (Morgan, 1972; Tudor & O'Rourke, 1980). In most cases when nutrient restriction has been imposed at a level that is very severe, a reduction in mature size or permanent stunting has been observed (Taylor et al., 1981).

2.6 **Factors that influence compensatory responses in the broiler chicken**

The factors that influence compensatory growth include the nature, severity and duration of undernutrition, the age at the commencement of undernutrition, strain and sex of the bird, and the degree and quality of realimentation diet (Zubair & Leeson, 1996).

2.6.1 **Age**

The most sensitive period in life during which restriction could have a detrimental affect on future growth is in the pre and immediate post-natal period (Tudor & O'Rourke, 1980). Very little research has been done in this area for most species with the exception of the broiler chickens in which a significant amount of research has focused specifically on this factor (Zubair & Leeson, 1996). Due to the short time span to marketing age in broiler chickens, a very precise schedule is required to ensure adequate time for complete compensation. In broiler chickens, it is recommended that restriction be applied no earlier than six days post-hatch (Zubair & Leeson, 1994), although full compensation by eight weeks has been seen when restriction has been applied as early as three days and as late as 11 days post-hatch (Plavnik & Hurwitz, 1989).

However, there have been a few exceptions in broiler chickens in which compensation has been observed following restriction shortly after birth (Hogan, 1984). Hopkins & Tulloh (1985) restricted lambs for five weeks after birth and noted increased gains in the lambs for 35 days followed by a return to normal growth rates for the next 300 days. There is also evidence that as animals approach or reach maturity there is little or no compensatory growth following a period of restriction (Ryan, 1990). Therefore, essentially the rate of maturation of each species dictates the span of time in which compensatory growth gains can be achieved.

2.6.2 **Strain and sex of the bird**

There have been differing compensatory responses between the sexes of various species of animals, but the findings have not always been consistent. The difference in responses between the sexes is likely the result of the higher innate rate of growth of males in comparison to females (Zubair & Leeson, 1996). Plavnik & Hurwitz (1991) found that although both sexes were capable of complete compensation under similar conditions, male broiler chickens were able to compensate more quickly than females. An interesting observation in pigs was also made by Kyriazakis et al. (1991) who noted that during the restriction period the male pigs gained at a faster rate than the females, but at the end of the restriction there was no significant difference in body composition between the sexes. Upon realimentation there was also no difference in daily weight gain or final body composition between the sexes.

Differences in compensatory responses between genotypes within a species appear to be more pronounced than differences between sexes. As well, it is not only the growth rates that are known to differ, but the final body composition can also be influenced (Carstens et al., 1991; De Greef et al. 1992; Hogberg and Zimmerman, 1978; Plavnik & Hurwitz, 1985, 1991). In broiler chickens, fast-growing strains showed much less compensatory growth than slower growing ones, suggesting that nutrient requirements after restriction might vary with genetic differences (Cherry et al., 1978).

2.6.3 **Severity and duration of restriction**

Wilson and Osbourne (1960) suggested that the more severe the restriction, the greater the initial gains would be immediately after realimentation. Carstens et al. (1991) followed this up by proposing that the severity of growth restriction is greater when the period of growth restriction is imposed at an earlier stage of maturity when the impetus for lean tissue growth is higher. They based this hypothesis on their observations that as the severity of restriction increased in steers, there was a tendency for lean tissue growth to be reduced and fat tissue growth to be increased during the realimentation period (Carstens et al., 1991). Studies have also shown that the longer the period of undernutrition, the more difficult it is for broiler chickens to compensate for the reduction in weight gain (Yu & Robinson, 1992). Feed restriction for a period of one week starting from seven days of age allowed for complete body weight recovery (Plavnik & Hurwitz, 1988a and b). However, recovery was not seen when restriction was imposed immediate post-hatch (Fanguy *et al*., 1980).

2.6.4 **Degree and quality of realimentation diet**

Numerous studies have pointed out the importance of the realimentation diet and the effect it can have on the type of response that is seen. Plavnik & Hurwitz (1989) concluded that broiler chickens require higher amounts of methionine and lysine during realimentation for improved compensatory growth. This was further supported by the work of Jones & Farrel (1992) who observed higher growth rates and leaner carcasses in previously restricted birds supplemented with lysine in comparison to the non-restricted birds. Dietary lysine has been shown to impact on the performance of broiler chickens, particularly with aspect of breast meat accretion and yield (Corzo & Kidd, 2004). According to Acar *et al.* (1991), lysine concentrations of 7.5 to 11.5 g/kg diet had no effect on performance or carcass yield of broiler chickens aged between six to eight weeks. Fontana *et al*. (1992) reported that following restriction, protein maybe a limiting nutrient in the realimentation diet. Insufficient levels of protein in the realimentation diets may also be the reason why complete compensation has not always been reported after nutritional restriction (Benschop, 2000). In the same manner, also, poultry require supplementary dietary vitamins since common feed ingredients used in poultry production do not provide adequate quantities to meet minimum requirements (Leeson & Summers, 2001). Vitamin C plays a role in the biosynthesis of corticosterone (Bains, 1996), a primary glucocorticoid hormone involved in gluconeogenesis to enhance energy supply during stress (Frandson, 1986). Poultry have the ability to synthesize ascorbic acid (vitamin C) in their bodies (McDowell, 2000); hence, no recommended requirement is established by the NRC (1994). However, environmental, nutritional and pathological stressors are known to alter vitamin C use or synthesis or both in the fowl (Pardue & Thaxton, 1986). Although synthesis in the neonatal chick is apparently limited (Horning & Frigg, 1979), it is generally assumed that the endogenous synthesis is adequate to meet biological demands in poultry.

However, during certain conditions vitamin C supplementation provides benefits to poultry (Pardue & Thaxton, 1986). Some significant improvements in growth of chicks by the addition of vitamin C under high temperature have been observed. Broiler chickens fed diets containing vitamin C were less stressed due to having reduced body temperature and respiratory rates (Pardue & Thaxton, 1984; Thaxton & Pardue, 1986; Kassim & Norziha, 1995) and showed higher feed intake (Kutlu & Forbes, 1993; Mckee & Harrison, 1995) than control birds. Studies are available showing under field conditions that feeding vitamin C enhanced productivity, immune response, disease resistance, and survivability under stressful conditions (Gross, 1998 ; Pardue *et al*., 1985; Zulkifli *et al*., 1996).

2.7 **Mechanisms responsible for compensatory growth**

Several factors have been implicated as the key mechanisms in compensatory growth responses. These include decreased maintenance costs, increased feed intake, increased efficiency of growth, the role of hormones and in most cases increased digesta load. However, there is no conclusive evidence that points to one mechanism as being the critical factor that results in the abnormally high growth rates, rather it appears to be a combination of two or more of these mechanisms.

2.7.1 **Reduced maintenance requirements**

One mechanism that has generated a lot of attention is the theory of reduced maintenance requirements as a consequence of nutrient restriction. The reduction in maintenance costs would then allow for comparatively more energy for growth upon realimentation, thus contributing to the compensatory growth response (Ryan, 1990). Zubair & Leeson (1994) observed the same occurrence of significantly decreased metabolic rates during restriction in broiler chickens.

2.7.2 **Increased feed intake**

Several researchers have implicated increased feed intake as the main mechanism that drives compensatory growth (Hornick et al., 1998a; Ryan et al., 1993b; Zubair & Leeson, 1996). However, due to inconsistencies in the literature in how feed intake is expressed, comparisons between different experiments are often not possible. Yambayamba et al. (1996) did not observe a significant increase in feed intake in restricted steers compared to the control steers at the same age. However, based on the available data from that trial, one could deduce that if feed intake had been measured as a percent of body weight, significant differences in feed intake would have been observed. In cattle, feed intake in restricted-realimented animals has been measured to be in the range of five to seven percent higher than in full-fed control animals (Ryan et al., 1993b; Santra & Pathak, 1999).

In broiler chickens, restricted-refed broiler chickens have shown higher feed intake relative to body weight when compared to controls, supporting the conclusion that compensatory growth is accompanied by a higher intake relative to body weight (Zubair & Leeson, 1994)

In contrast, Carstens et al. (1991) did not see any differences in feed intake upon realimentation when the steers were measured at similar body weights, even though the restricted steers showed higher growth rates when realimented.

2.7.3 **Increased efficiency of growth**

An alteration in energy deposition appears to be another mechanism involved in compensatory growth. Due to the increased efficiency of protein deposition because of the concomitant water deposition that results in more gain per gram protein deposited than lipid deposited, higher rates of protein deposition during realimentation would have a significant impact on the overall growth rates. The commonly observed increase in protein deposition rate following realimentation carries with it some important applications (Carstens et al. 1991 Ryan et al., 1993a; Zubair & Leeson, 1996). These findings have not only helped to explain compensatory growth more fully, but they have also falsified two previously held theories which stated that maximum protein gain capacity is a constant animal factor, and that there is a fixed relation between lipid and protein deposition (De Greef et al., 1992).

2.8 **Conclusion**

A number of studies have been conducted on the time of initiation of feeding after hatching in broiler chickens. However, results of these studies have been variable, particularly in relation to compensatory responses. It is, therefore, important to ascertain such responses in Ross 308 broiler chickens in Limpopo province where placement is often delayed as a result of distance from the hatchery to the farmers rearing facilities.

CHAPTER 3

MATERIAL AND METHODS

3.1 Study area

This study was conducted at the University of Limpopo Experimental Farm at Syferkuil. The farm is located at about 10 km northwest of the University campus. The ambient temperatures around the study area are above 32 ^{0}C during summer and around 25 ^{0}C or lower during the winter season. The mean annual rainfall is between 446.8 and 468.4 mm.

3.2 Preparation of the house

The experimental house was thoroughly cleaned with water and disinfected with Jeyes fluid from NTK Company in 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 organism that was not killed by the disinfectant. The experimental house was divided into 36 floor pens of equal sizes of approximately 1.5 m^2 for the first experiment while the second experiment was divided into 45 floor pens of 2.5 m^2 each. Fresh sawdust was spread to a thickness of 7 cm deep. All the equipment such as drinkers, feeders and wire separators were cleaned thoroughly and disinfected. The footbath was thoroughly cleaned on a daily basis and a new disinfectant added.

3.3 Acquisition of material and birds

All the required material for the experiments were purchased in advance prior to the commencement of the study. A total of 360 unsexed day old Ross 308 chicks from SA chicks Hatchery in Benoni were used in an open-sided house with curtains for the first experiment while a total of 675 unsexed day old Ross 308 chicks purchased from the same company were used for the second experiment.

3.4 Experimental procedure, dietary treatments and design

Two experiments were conducted to determine the effect of time of initiation of feeding after hatching and levels of supplemental dietary lysine or ascorbic acid on productivity and mortality of Ross 308 broiler chickens as indicated in the following paragraphs.

3.4.1. Experiment 1: Effect of time of initiation of feeding after hatching and influence of supplemental dietary lysine on productivity and mortality of Ross 308 broiler chickens

The experiment was carried out during the winter period (July-August) with maximum temperatures ranging between 8 and 25 ^{0}C and it commenced immediately on arrival of the chicks at the farm. A total of 360 unsexed day-old Ross 308 broiler chicks with an initial weight of 30 ± 2 g per bird were assigned to varying treatments as in a 3 (lysine supplemental levels) x 4 (times of initiation of feeding) factorial arrangement in a complete randomized design (SAS, 2000). Lysine supplementation started three days after hatching. The treatments were as follows for the starter phase:

ST_0L_0 : Initial ad-libitum feeding (starter feed) within 1 to 24 hours after hatching with no lysine supplementation.

ST_0L_1: Initial ad-libitum feeding (starter feed) within 1 to 24 hours after hatching plus 2.5g lysine supplementation per kg feed starting at 3 days old

ST_0L_2: Initial ad-libitum feeding (starter feed) within 1 to 24 hours after hatching plus 5 g lysine supplementation per kg feed starting at 3 days old

ST_1L_0 : Initial ad-libitum feeding (starter feed) within 24 to 36 hours after hatching with no lysine supplementation.

ST_1L_1: Initial ad-libitum feeding (starter feed) within 24 to 36 hours after hatching plus 2.5 g lysine supplementation per kg feed starting at 3 days old

ST_1L_2: Initial ad-libitum feeding (starter feed) within 24 to 36 hours after hatching plus 5 g lysine supplementation per kg feed starting at 3 days old

ST_2L_0: Initial ad-libitum feeding (starter feed) within 36 to 48 hours after hatching with no lysine supplementation.

ST_2L_1: Initial ad-libitum feeding (starter feed) within 36 to 48 hours after hatching plus 2.5 g lysine supplementation per kg feed starting at 3 days old.

ST_2L_2: Initial ad-libitum feeding (starter feed) within 36 to 48 hours after hatching plus 5 g lysine supplementation per kg feed starting at 3 days old

ST_3L_0: Initial ad-libitum feeding (starter feed) within 48 to 60 hours after hatching with no lysine supplementation.

ST_3L_1: Initial ad-libitum feeding (starter feed) within 48 to 60 hours after hatching plus 2.5 g lysine supplementation per kg feed starting at 3 days old.

ST_3L_2: Initial ad-libitum feeding (starter feed) within 48 to 60 hours after hatching plus 5 g

lysine supplementation per kg feed starting at 3 days old.

The treatments for the grower phase were as follows:

GT_0L_0 : Ad-libitum grower feeding following initial ad-libitum starter feeding within 1 to 24 hours after hatching with no lysine supplementation starting at 3 days old.

GT_0L_1: Ad-libitum grower feeding following initial ad-libitum starter feeding within 1 to 24 hours after hatching plus 2.5g lysine supplementation per kg feed starting at 3 days old.

GT_0L_2: Ad-libitum grower feeding following initial ad-libitum starter feeding within 1 to 24 hours after hatching plus 5 g lysine supplementation per kg feed starting at 3 days old.

GT_1L_0 : Ad-libitum grower feeding following initial ad-libitum starter feeding within 24 to 36 hours after hatching with no lysine supplementation starting at 3 days old.

GT_1L_1: Ad-libitum grower feeding following initial ad-libitum starter feeding within 24 to 36 hours after hatching plus 2.5 g lysine supplementation per kg feed starting at 3 days old.

GT_1L_2: Ad-libitum grower feeding following initial ad-libitum starter feeding within 24 to 36 hours after hatching plus 5 g lysine supplementation per kg feed starting at 3 days old

GT_2L_0: Ad-libitum grower feeding following initial ad-libitum starter feeding within 36 to 48 hours after hatching with no lysine supplementation starting at 3 days old.

GT_2L_1: Ad-libitum grower feeding following initial ad-libitum starter feeding within 36 to 48 hours after hatching plus 2.5 g lysine supplementation per kg feed starting at 3 days old

GT_2L_2: Ad-libitum grower feeding following initial ad-libitum starter feeding within 36 to 48 hours after hatching plus 5 g lysine supplementation per kg feed starting at 3 days old

GT_3L_0: Ad-libitum grower feeding following initial ad-libitum starter feeding within 48 to 60 hours after hatching with no lysine supplementation starting at 3 days old.

GT_3L_1: Ad-libitum grower feeding following initial ad-libitum starter feeding within 48 to 60 hours after hatching plus 2.5 g lysine supplementation per kg feed starting at 3 days old.

GT_3L_2: Ad-libitum grower feeding following ad-libitum starter feeding within 48 to 60 hours after hatching plus 5 g lysine supplementation per kg feed starting at 3 days old

Finally, diets ST_0L_0 plus GT_0L_0; ST_0L_1 plus GT_0L_1; ST_0L_2 plus GT_0L_2; ST_1L_0 plus GT_1L_0; ST_1L_1 plus GT_1L_1; ST_1L_2 plus GT_1L_2; ST_2L_0 plus GT_2L_0; ST_2L_1 plus GT_2L_1; ST_2L_2 plus GT_2L_2; ST_3L_0 plus GT_3L_0; ST_3L_1 plus GT_3L_1; ST_3L_2 plus GT_3L_2 were designated as diets A, B, C, to L as follows:

A: Initial ad-libitum feeding within 1 to 24 hours after hatching with no lysine supplementation during the starter and grower phases (ST_0L_0 plus GT_0L_0).

B: Initial ad-libitum feeding within 1 to 24 hours after hatching plus 2.5g lysine supplementation per kg feed during the starter and grower phases (ST_0L_1 plus GT_0L_1).

C: Initial ad-libitum feeding within 1 to 24 hours after hatching plus 5 g lysine supplementation per kg feed during the starter and grower phases (ST_0L_2 plus GT_0L_2).

D: Initial ad-libitum feeding within 24 to 36 hours after hatching with no lysine supplementation during the starter and grower phases (ST_1L_0 plus GT_1L_0).

E: Initial ad-libitum feeding within 24 to 36 hours after hatching plus 2.5 g lysine supplementation per kg feed during the starter and grower phases (ST_1L_1 plus GT_1L_1).

F: Initial ad-libitum feeding within 24 to 36 hours after hatching plus 5 g lysine supplementation per kg feed during the starter and grower phases (ST_1L_2 plus GT_1L_2).

G: Initial ad-libitum feeding within 36 to 48 hours after hatching with no lysine supplementation during the starter and grower phases (ST_2L_0 plus GT_2L_0).

H: Initial ad-libitum feeding within 36 to 48 hours after hatching plus 2.5 g lysine supplementation per kg feed during the starter and grower phases (ST_2L_1 plus GT_2L_1).

I: Initial ad-libitum feeding within 36 to 48 hours after hatching plus 5 g lysine supplementation per kg feed during the starter and grower phases (ST_2L_2 plus GT_2L_2).

J: Initial ad-libitum feeding within 48 to 60 hours after hatching with no lysine supplementation during the starter and grower phases (ST_3L_0 plus GT_3L_0).

K: Initial ad-libitum feeding within 48 to 60 hours after hatching plus 2.5 g lysine supplementation per kg feed during the starter and grower phases (ST_3L_1 plus GT_3L_1).

L: Initial ad-libitum feeding within 48 to 60 hours after hatching plus 5 g lysine supplementation per kg feed during the starter and grower phases (ST_3L_2 plus GT_3L_2).

3.4.2. Experiment 2. Effect of time of initiation of feeding after hatching and influence of supplemental dietary ascorbic acid on productivity and mortality of Ross 308 broiler chickens

The experiment was carried out during the summer period (December-January) with maximum temperatures ranging between 32 and 36 ^{0}C. It commenced immediately on arrival of the chicks at the farm. A total of 675 unsexed day-old Ross 308 broiler chicks with an initial weight of 32 ± 3 g per bird were assigned to varying treatments as in a 3 (times of initiation of feeding) x 5 (ascorbic acid/vitamin C supplemental levels) factorial arrangement in a complete randomized design (SAS, 2000). Ascorbic acid supplementation started three days after hatching. The treatments were as follows for the starter phase:

ST_0C_0 : Initial ad-libitum feeding (starter feed) within 1 to 24 hours after hatching with no ascorbic acid supplementation.

ST_0C_1: Initial ad-libitum feeding (starter feed) within 1 to 24 hours after hatching plus 100 ppm ascorbic acid supplementation per kg feed starting at 3 days old

ST_0C_2: Initial ad-libitum feeding (starter feed) within 1 to 24 hours after hatching plus 200 ppm ascorbic acid supplementation per kg feed starting at 3 days old

ST_0C_3 : Initial ad-libitum feeding (starter feed) within 1 to 24 hours after hatching plus 300 ppm ascorbic acid supplementation per kg feed starting at 3 days old.

ST_0C_4: Initial ad-libitum feeding (starter feed) within 1 to 24 hours after hatching plus 400 ppm ascorbic acid supplementation per kg feed starting at 3 days old

ST_1C_0 : Initial ad-libitum feeding (starter feed) within 36 to 48 hours after hatching with no ascorbic acid supplementation.

ST_1C_1: Initial ad-libitum feeding (starter feed) within 36 to 48 hours after hatching plus 100 ppm ascorbic acid supplementation per kg feed starting at 3 days old

ST_1C_2: Initial ad-libitum feeding (starter feed) within 36 to 48 hours after hatching plus 200 ppm ascorbic acid supplementation per kg feed starting at 3 days old

ST_1C_3 : Initial ad-libitum feeding (starter feed) within 36 to 48 hours after hatching plus 300 ppm ascorbic acid supplementation per kg feed starting at 3 days old.

ST_1C_4: Initial ad-libitum feeding (starter feed) within 36 to 48 hours after hatching plus 400 ppm ascorbic acid supplementation per kg feed starting at 3 days old

ST_2C_0 : Initial ad-libitum feeding (starter feed) within 48 to 60 hours after hatching with no ascorbic acid supplementation.

ST_2C_1: Initial ad-libitum feeding (starter feed) within 48 to 60 hours after hatching plus 100 ppm ascorbic acid supplementation per kg feed starting at 3 days old

ST_2C_2: Initial ad-libitum feeding (starter feed) within 48 to 60 hours after hatching plus 200 ppm ascorbic acid supplementation per kg feed starting at 3 days old

ST_2C_3 : Initial ad-libitum feeding (starter feed) within 48 to 60 hours after hatching plus 300 ppm ascorbic acid supplementation per kg feed starting at 3 days old.

ST_2C_4: Initial ad-libitum feeding (starter feed) within 48 to 60 hours after hatching plus 400 ppm ascorbic acid supplementation per kg feed starting at 3 days old.

The treatments for the grower phase were as follows:

GT_0C_0 : Ad-libitum grower feeding following initial ad-libitum starter feeding within 1 to 24 hours after hatching with no ascorbic acid supplementation.

GT_0C_1: Ad-libitum grower feeding following initial ad-libitum starter feeding within 1 to 24 hours after hatching plus 100 ppm ascorbic acid supplementation per kg feed.

GT_0C_2: Ad-libitum grower feeding following initial ad-libitum starter feeding within 1 to 24 hours after hatching plus 200 ppm ascorbic acid supplementation per kg feed.

GT_0C_3 : Ad-libitum grower feeding following initial ad-libitum starter feeding within 1 to 24 hours after hatching plus 300 ppm ascorbic acid supplementation per kg feed.

GT_0C_4: Ad-libitum grower feeding following initial ad-libitum starter feeding within 1 to 24 hours after hatching plus 400 ppm ascorbic acid supplementation per kg feed.

GT_1C_0 : Ad-libitum grower feeding following initial ad-libitum starter feeding within 36 to 48 hours after hatching with no ascorbic acid supplementation.

GT_1C_1: Ad-libitum grower feeding following initial ad-libitum starter feeding within 36 to 48 hours after hatching plus 100 ppm ascorbic acid supplementation per kg feed.

GT_1C_2: Ad-libitum grower feeding following initial ad-libitum starter feeding within 36 to 48 hours after hatching plus 200 ppm ascorbic acid supplementation per kg feed.

GT_1C_3 : Ad-libitum grower feeding following initial ad-libitum starter feeding within 36 to 48 hours after hatching plus 300 ppm ascorbic acid supplementation per kg feed.

GT_1C_4: Ad-libitum grower feeding following initial ad-libitum starter feeding within 36 to 48 hours after hatching plus 400 ppm ascorbic acid supplementation per kg feed.

GT_2C_0 : Ad-libitum grower feeding following initial ad-libitum starter feeding within 48 to 60 hours after hatching with no ascorbic acid supplementation.

GT_2C_1: Ad-libitum grower feeding following initial ad-libitum starter feeding within 48 to 60

hours after hatching plus 100 ppm ascorbic acid supplementation per kg feed.

GT_2C_2: Ad-libitum grower feeding following initial ad-libitum starter feeding within 48 to 60 hours after hatching plus 200 ppm ascorbic acid supplementation per kg feed.

GT_2C_3 : Ad-libitum grower feeding following initial ad-libitum starter feeding within 48 to 60 hours after hatching plus 300 ppm ascorbic acid supplementation per kg feed.

GT_2C_4: Ad-libitum grower feeding following initial ad-libitum starter feeding within 48 to 60 hours after hatching plus 400 ppm ascorbic acid supplementation per kg feed.

Finally, diets ST_0C_0 plus GT_0C_0; ST_0C_1 plus GT_0C_1; ST_0C_2 plus GT_0C_2; ST_0C_3 plusGT_0C_3; ST_0C_4 plus GT_0C_4; ST_1C_0 plus GT_1C_0; ST_1C_1 plus GT_1C_1; ST_1C_2 plus GT_1C_2; ST_1C_3 plus GT_1C_3; ST_1C_4 plus GT_1C_4; ST_2C_0 plus GT_2C_0; ST_2C_1 plus GT_2C_1; ST_2C_2 plus GT_2C_2; ST_2C_3 plus GT_2C_3; ST_2C_4 plus GT_2C_4; were designated as diets A, B, C, to O as follows:

A: Initial ad-libitum feeding within 1 to 24 hours after hatching with no ascorbic acid supplementation during the starter and grower phases (ST_0C_0 plus GT_0C_0).

B: Initial ad-libitum feeding within 1 to 24 hours after hatching plus 100 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_0C_1 plus GT_0C_1).

C: Initial ad-libitum feeding within 1 to 24 hours after hatching plus 200 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_0C_2 plus GT_0C_2).

D: Initial ad-libitum feeding within 1 to 24 hours after hatching plus 300 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_0C_3 plus GT_0C_3).

E: Initial ad-libitum feeding within 1 to 24 hours after hatching plus 400 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_0C_4 plus GT_0C_4).

F: Initial ad-libitum feeding within 36 to 48 hours after hatching with no ascorbic acid supplementation during the starter and grower phases (ST_1C_0 plus GT_1C_0).

G: Initial ad-libitum feeding within 36 to 48 hours after hatching plus 100 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_1C_1 plus GT_1C_1).

H: Initial ad-libitum feeding within 36 to 48 hours after hatching plus 200 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_1C_2 plus

GT_1C_2).

I: Initial ad-libitum feeding within 36 to 48 hours after hatching plus 300 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_1C_3 plus GT_1C_3).

J: Initial ad-libitum feeding within 36 to 48 hours after hatching plus 400 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_1C_4 plus GT_1C_4).

K: Initial ad-libitum feeding within 48 to 60 hours after hatching with no ascorbic acid supplementation during the starter and grower phases (ST_2C_0 plus GT_2C_0).

L: Initial ad-libitum feeding within 48 to 60 hours after hatching plus 100 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_2C_1 plus GT_2C_1).

M: Initial ad-libitum feeding within 48 to 60 hours after hatching plus 200 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_2C_2 plus GT_2C_2).

N: Initial ad-libitum feeding within 48 to 60 hours after hatching plus 300 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_2C_3 plus GT_2C_3).

O: Initial ad-libitum feeding within 48 to 60 hours after hatching plus 400 ppm ascorbic acid supplementation per kg feed during the starter and grower phases (ST_2C_4 plus GT_2C_4).

3.5 Data collection

3.5.1 Live weight

The initial live weights of the chickens were taken at 24 hr old and every 12 hrs thereafter until the 3rd day. Then daily mean live weights of the chickens were determined until the end of the experiment at 42 days of age. The initial and final live weights were used to calculate growth rate.

3.5.2 Feed intake.

The group average 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.

3.5.3 Feed conversion ratio.

Feed conversion ratio (FCR) 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).

3.5.4 Mortality rate.

Deaths were recorded daily. Mortality rate of chickens per pen was calculated as the total number of deaths divided by total number of chickens per pen then multiplied by 100.

3.5.5 Apparent digestibility.

At day 36, two chickens from each replicate were randomly selected and transferred into the metabolic cages. The cages are designed with separate watering and feeding troughs. Birds were allowed to adapt in their crates 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.* (1992) as follows:

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

3.5.6 Carcass characteristics:

At day 42, four broiler chickens per pen were randomly selected, 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, thigh, drumstick, gizzard and abdominal fat contents and intestinal lengths were measured. The length of the intestines was measured as from the duodenum to the cloaca. Fat surrounding the gizzard and

intestines extending to the bursa was considered as abdominal fat (Mendonca & Jensen, 1989). At the end of each slaughtering, meat samples from each breast part of the slaughtered chicken were taken and stored in the refrigerator until analyzed for nitrogen.

3.5.7 Chemical analysis.

3.5.7.1 Determination of dry matter (AOAC, 1984)

A clean crucible was placed in the oven, set at 100 ^{0}C, for 30 minutes. The crucible was then removed using metal tongs and allowed to cool in a desiccator. Then, the crucible was weighed to four decimal places [W0]. Two grams of the feed, feed leftovers, faeces or meat sample was weighed into the crucible [W1], and the crucible plus content was placed in the oven for 24 hours at 105 ^{0}C. The crucible plus content was removed from the oven to a desiccator and allowed to cool to room temperature (25 ^{0}C). The crucible and content [W2] was weighed as soon as possible to prevent moisture absorption. Formula for dry matter (DM) determination was as follows:

DM (%) = {(W2- W0)}/ {(W1- W0)} X 100.

3.5.7.2 Determination of nitrogen, crude protein and lysine (AOAC, 1984)

The Nitrogen contents of the diets, feed refusals, faeces and meat samples were determined using the Leco FP 2000 machine (the University of Kwazulu Natal laboratory, South Africa). Diets were analysed for lysine contents by EPOL (South Africa) according to the method described by AOAC (1984)

3.5.7.3 Determination of gross energy and fat

The gross energy (GE) of the diets and the excreta samples were determined using an adiabatic bomb calorimeter (University of Kwazulu Natal laboratory, South Africa). The apparent metabolizable energy (AME) content of the diets was calculated. AME was equal to energy in the feed consumed minus energy excreted in the faeces (AOAC, 1984). Fat contents of the diet were analysed according to the method described by AOAC (1984).

3.6 Statistical analysis.

Data on live weight, feed intake, digestibility, carcass characteristics, feed conversion ratio and mortality of broiler chickens was analyzed using the general linear model procedure of the statistical analysis of variance (SAS,2000). For Experiment 1, a 3 (dietary lysine levels) x 4 (times of initiation of feeding) factorial complete randomized design was used. For Experiment 2, a 3 (times of initiation of feeding) x 5 (dietary ascorbic acid / vitamin C levels) factorial complete randomized design was used. The Tukey test for multiple comparisions was used to test the significance of differences between treatment means ($P < 0.05$) (SAS, 2000). Regression analysis was used to determine the relationships between times of initiation of feeding after hatching and short-term biological responses of the broiler chickens.

CHAPTER 4

RESULTS

4.1.0 Experiment 1. Effect of time of initiation of feeding after hatching and dietary lysine supplementation on productivity and mortality of Ross 308 broiler chickens.

The nutrient compositions of the starter and grower diets are presented in Tables 4.1.01 and 4.1.02, respectively. The diets at each phase (i.e. starter and grower phases) were isocaloric and isonitrogenous but with different levels of lysine supplementation. Levels of other nutrients of the diets were similar and met the broiler chicken requirements as recommended by the NRC (1994).

Results of the effect of time of initiation of feeding after hatching on live weight at three days of age, feed intake at three days old and mortality of Ross 308 broiler chickens between one and three days of age are presented in Table 4.1.03. Time of initiation of feeding after hatching had effect ($P<0.05$) on live weight and feed intake at three days of age and mortality of Ross 308 broiler chickens. Broiler chickens on initial ad-libitum feeding within 1 to 24 hours and those within 24 to 36 hours after hatching weighed and ate more ($P<0.05$) than those on initial ad-libitum feeding within 36 to 48 hours and those within 48 to 60 hours after hatching. Mortality was also lower ($P<0.05$) in broiler chickens on initial ad-libitum feeding within 1 to 24 hours and those within 24 to 36 hours after hatching than those on initial ad-libitum feeding within 36 to 48 hours and those within 48 to 60 hours after hatching. However, broiler chickens on initial ad-libitum feeding within 36 to 48 hours and those within 48 to 60 hours after hatching had similar ($P>0.05$) live weight and feed intake at 3 days of age and mortality between 1 and 3 days of age. Similarly, broiler chickens on initial ad-libitum feeding within 1 to 24 hours and those within 24 to 36 hours after hatching had similar ($P>0.05$) live weight and feed intake at 3 days of age and mortality between 1 and 3 days of age.

Results of the effect of time of initiation of feeding after hatching and lysine supplementation on growth rate, feed intake, feed conversion ratio and mortality of Ross 308 broiler chickens between 3 and 21 days of age are presented in Table 4.1.04. Time of initiation of feeding after hatching and lysine supplementation had no effect ($P>0.05$) on growth rate, feed intake, feed conversion ratio and mortality of Ross 308 broiler chickens.

Table 4.1.01 Nutrient composition, initiation of feeding (hours after hatching) of the starter diet and lysine supplementation (units are in g/kg DM except energy as MJ/kg DM feed, lysine supplementation and dry matter as g/kg feed).

Diet	Nutrient						
	Dry matter	Energy	Protein	Lysine	Fat (min)	Lysine supp.	Feed initiation
ST_0L_0	880	16.6	212	11	25	0	1-24
ST_0L_1	880	16.6	212	11	25	2.5	1-24
ST_0L_2	880	16.6	212	11	25	5	1-24
ST_1L_0	880	16.6	212	11	25	0	24-36
ST_1L_1	880	16.6	212	11	25	2.5	24-36
ST_1L_2	880	16.6	212	11	25	5	24-36
ST_2L_0	880	16.6	212	11	25	0	36-48
ST_2L_1	880	16.6	212	11	25	2.5	36-48
ST_2L_2	880	16.6	212	11	25	5	36-48
ST_3L_0	880	16.6	212	11	25	0	48-60
ST_3L_1	880	16.6	212	11	25	2.5	48-60
ST_3L_2	880	16.6	212	11	25	5	48-60

Table 4.1.02 Nutrient composition, initiation of feeding (hours after hatching) of the grower diet and lysine supplementation (units are in g/kg DM except energy as MJ/kg DM feed, lysine supplementation and dry matter as g/kg feed).

	Nutrient						
Diet	Dry matter	Energy	Protein	Lysine	Fat (min)	Lysine supp.	Feed initiation
GT_0L_0	880	16.8	200	11.5	25	0	1-24
GT_0L_1	880	16.8	200	11.5	25	2.5	1-24
GT_0L_2	880	16.8	200	11.5	25	5	1-24
GT_1L_0	880	16.8	200	11.5	25	0	24-36
GT_1L_1	880	16.8	200	11.5	25	2.5	24-36
GT_1L_2	880	16.8	200	11.5	25	5	24-36
GT_2L_0	880	16.8	200	11.5	25	0	36-48
GT_2L_1	880	16.8	200	11.5	25	2.5	36-48
GT_2L_2	880	16.8	200	11.5	25	5	36-48
GT_3L_0	880	16.8	200	11.5	25	0	48-60
GT_3L_1	880	16.8	200	11.5	25	2.5	48-60
GT_3L_2	880	16.8	200	11.5	25	5	48-60

Table 4.1.03. Effect of time of initiation of feeding after hatching on live weight at three days of age (g/bird), feed intake (g/bird/day) at three days old and mortality (%) of Ross 308 broiler chickens between one and three days of age.

Diet	Live weight	intake	mortality
ST_0L_0	75^a	30^a	10^b
ST_0L_1	78^a	29^a	14^b
ST_0L_2	75^a	28^a	10^b
ST_1L_0	79^a	30^a	10^b
ST_1L_1	76^a	30^a	14^b
ST_1L_2	78^a	29^a	14^b
ST_2L_0	48^b	20^b	48^a
ST_2L_1	54^b	20^b	52^a
ST_2L_2	51^b	19^b	57^a
ST_3L_0	48^b	19^b	57^a
ST_3L_1	49^b	20^b	57^a
ST_3L_2	45^b	18^b	52^a
SE	3.40	1.31	6.29

^{a,b} :Means in the same column not sharing a common superscript are significantly different ($P<0.05$).

SE : Standard error

Results of the effect of time of initiation of feeding after hatching and lysine supplementation during "catch up" period on intake per bird, intake as % of live weight and feed conversion ratio of Ross 308 broiler chickens following realimentation are presented in Table 4.1.05. Time of initiation of feeding after hatching and lysine supplementation during 'catch-up' period had an effect ($P<0.05$) on intake per bird and intake as % of live weight of Ross 308 broiler chickens. Lysine supplementation during realimentation reduced the number of days of 'catch-up'. The overall 'catch-up' rate was faster in those birds supplemented with 5 g lysine per kg feed, 'catching-up' at two days, followed by those supplemented with 2.5 g lysine per kg feed, 'catching-up' at three days, while those without lysine supplementation had a 'catch-

up' period of five days. This trend was similar in all the birds irrespective of the time of initiation of feeding after hatching (Table 4.1.05 and Figures 1, 2 and 3).

Broiler chickens supplemented with 5 g lysine per kg feed had higher ($P<0.05$) feed intake as a % of live weight than those supplemented with 2.5 g lysine per kg feed and those fed without lysine supplementation. There were significant differences ($P<0.05$) in feed intake as a % of live weight between broiler chickens supplemented with 2.5 g lysine per kg feed and those fed without lysine supplementation. Time of initiation of feeding after hatching and lysine supplementation during 'catch-up' had no effect ($P>0.05$) on feed conversion ratio of the chickens.

Results of the effect of time of initiation of feeding after hatching and lysine supplementation on live weight and feed intake of Ross 308 broiler chickens at 21 days of age are presented in Table 4.1.06. Lysine supplementation within each period of initiation of feeding after hatching had no effect ($P>0.05$) on live weight of the chickens at 21 days of age (Table 4.1.06 and Figures 4,5,6 and 7).

Results of the effect of time of initiation of feeding after hatching and lysine supplementation on feed intake at 42 days old, growth rate, feed conversion ratio and mortality of Ross 308 broiler chickens between 22 and 42 days of age are presented in Table 4.1.07. Time of initiation of feeding after hatching and lysine supplementation had no effect ($P>0.05$) on feed intake, growth rate, feed conversion ratio and mortality of Ross 308 broiler chickens.

Results of the effect of time of initiation of feeding after hatching and lysine supplementation on diet dry matter and nitrogen digestibilities, nitrogen retention and metabolisable energy of Ross 308 broiler chickens between 40 and 42 days of age are presented in Table 4.1.08. Time of initiation of feeding after hatching and lysine supplementation had no effect ($P>0.05$) on diet dry matter and nitrogen digestibilities, nitrogen retention and metabolisable energy in Ross 308 broiler chickens. Metabolizable energy values of the different diets ranged between 15 and 16 MJ/kgDM

Results of the effect of time of initiation of feeding after hatching and lysine supplementation on live weight, dressing percentage and carcass parts of Ross 308 broiler chickens at 42 days old are presented in Table 4.1.09. Time of initiation of feeding after hatching and lysine

supplementation had no effect (P>0.05) on live weight, dressing percentage, carcass parts and intestinal length of the chickens.

Table 4.1.04. Effect of time of initiation of feeding after hatching and lysine supplementation on growth rate (g/bird/day), feed intake (g/bird/day),feed conversion ratio (FCR) and mortality(%) of Ross 308 broiler chickens between 3 and 21 days of age.

Diet	growth rate	intake	FCR	mortality
ST_0L_0	34	40	1.1	0
ST_0L_1	36	41	1.1	0
ST_0L_2	36	42	1.1	0
ST_1L_0	38	41	1.1	5
ST_1L_1	36	43	1.2	0
ST_1L_2	37	44	1.1	0
ST_2L_0	34	46	1.3	5
ST_2L_1	35	46	1.3	0
ST_2L_2	36	47	1.3	0
ST_3L_0	36	46	1.2	0
ST_3L_1	35	44	1.2	0
ST_3L_2	36	45	1.2	5
SE	1.78	1.81	0.07	2.38

Results of the effect of time of initiation of feeding after hatching and lysine supplementation on nitrogen content of Ross 308 broiler chicken breast meat samples at 42 days old are presented in Table 4.1.10. Time of initiation of feeding after hatching and lysine supplementation had no effect (P>0.05) on nitrogen content.

Table 4.1.05 Effect of time of initiation of feeding after hatching and lysine supplementation during "catch up" period on intake (g/bird/day), intake as % of live weight and feed conversion ratio (FCR) of Ross 308 broiler chickens following realimentation.

Diet	Days of "catch-up" following suppl.	intake	intake as % of live weight	FCR
ST_0L_0	_	13^b	16^c	1.1
ST_1L_0	_	13^b	16^c	1.2
ST_2L_0	5	13^b	18^c	1.4
ST_3L_0	5	13^b	19^c	1.2
ST_0L_1	_	18^b	24^b	1.2
ST_1L_1	_	18^b	25^b	1.3
ST_2L_1	3	18^b	29^b	1.4
ST_3L_1	3	19^b	28^b	1.2
ST_0L_2	_	28^a	41^a	1.4
ST_1L_2	_	31^a	43^a	1.3
ST_2L_2	2	30^a	45^a	1.3
ST_3L_2	2	29^a	46^a	1.3
SE		1.66	1.47	0.07

^{abc} :Means in the same column not sharing a common superscript are significantly different ($P<0.05$).

SE :Standard error

*ST_0L_0 / ST_1L_0 : Have similar body weights at 3 days old.

*ST_0L_1 / ST_1L_1 : Have similar body weights at 3 days old.

*ST_0L_2 / ST_1L_2 : Have similar body weights at 3 days old.

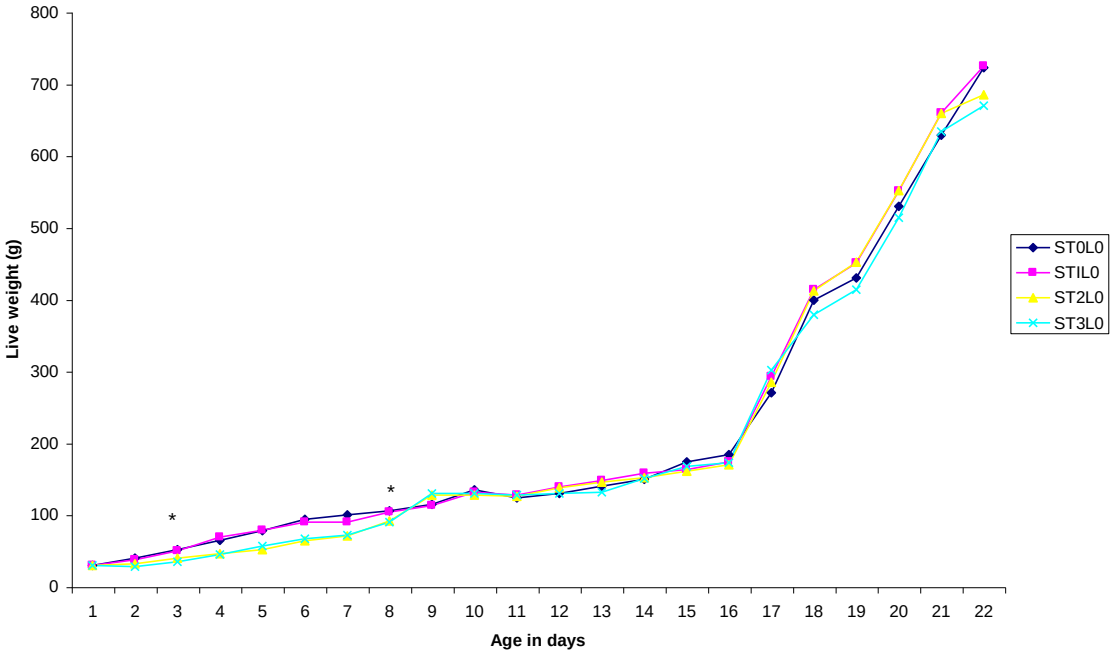
Table 4.1.06. Effect of time of initiation of feeding after hatching and lysine supplementation on live weight (g/bird), and feed intake (g/bird/day) of Ross 308 broiler chickens at 21 days of age.

Diet	Live weight	intake
ST_0L_0	682	70
ST_0L_1	723	70
ST_0L_2	730	70
ST_1L_0	765	71
ST_1L_1	725	73
ST_1L_2	744	73
ST_2L_0	660	66
ST_2L_1	685	67
ST_2L_2	690	65
ST_3L_0	702	66
ST_3L_1	670	65
ST_3L_2	687	64
SE	32.91	2.28

SE : Standard error

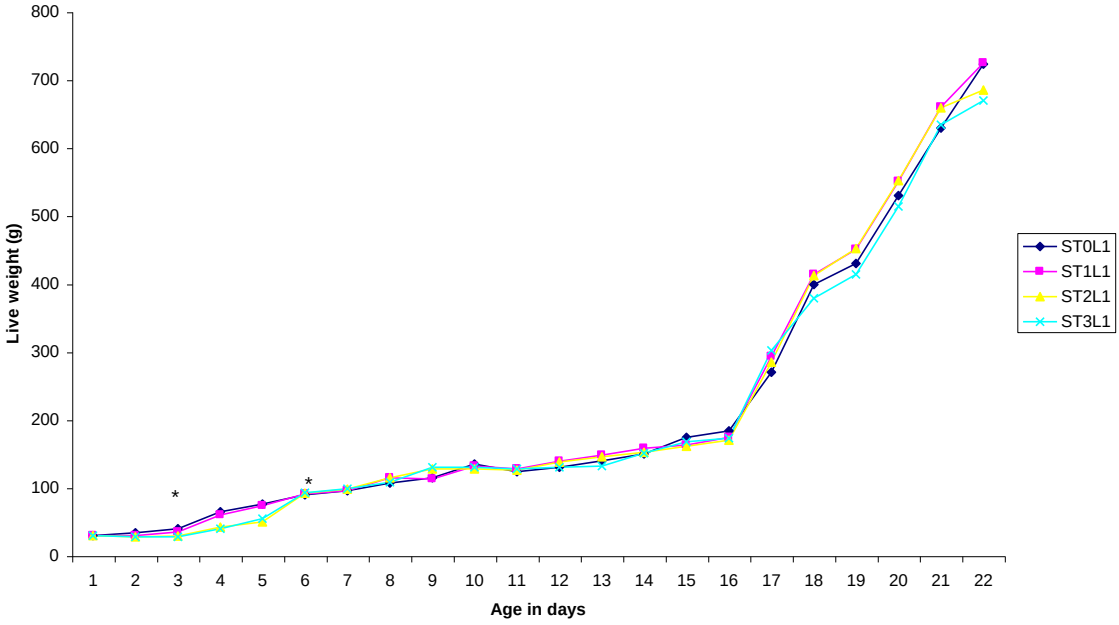
A series of linear regressions that predict mortality and live weight of Ross 308 broiler chickens at 3 days of age from time of initiation of feeding after hatching are presented in Table 4.1.11. Mortality was positively and strongly correlated (r = 0.917) with time of initiation of feeding after hatching. Live weight was negatively and strongly correlated (r = 0.906) with time of initiation of feeding after hatching.

Figure 1. Effect of time of initiation of feeding after hatching on live weight of Ross 308 broiler chickens up to 21 days of age.



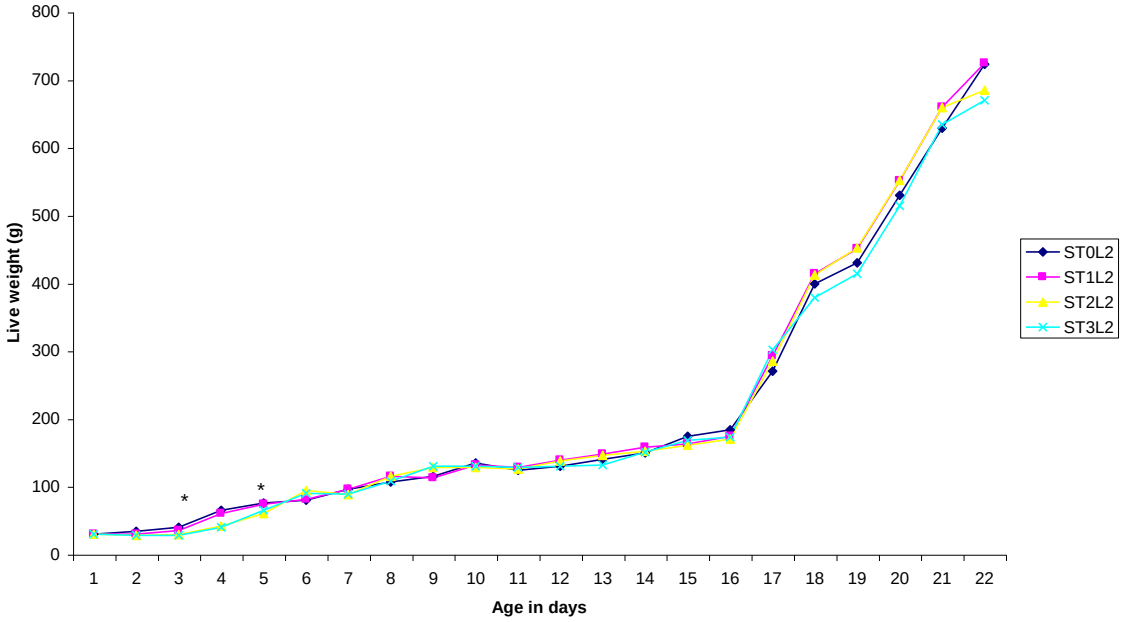
***:In-between indicates the number of days of catch-up following realimentation (5days)**

Figure 2. Effect of supplementation with 2.5 g lysine per kg feed following different times of initiation of feeding after hatching on live weight of Ross 308 broiler chickens up to 21 days of age.



***:In-between indicates the number of days of catch-up following realimentation (3days)**

Figure 3. Effect of supplementation with 5 g lysine per kg feed following different times of initiation of feeding after hatching on live weight of Ross 308 broiler chickens up to 21 days of age.



***: In-between indicates the number of days of 'catch-up' following realimentation (2 days)**

Figure 4. Effect of lysine supplementation within initiation of feeding period of 1 to 24 hours after hatching on live weight of Ross 308 broiler chickens up to 21 days of age.

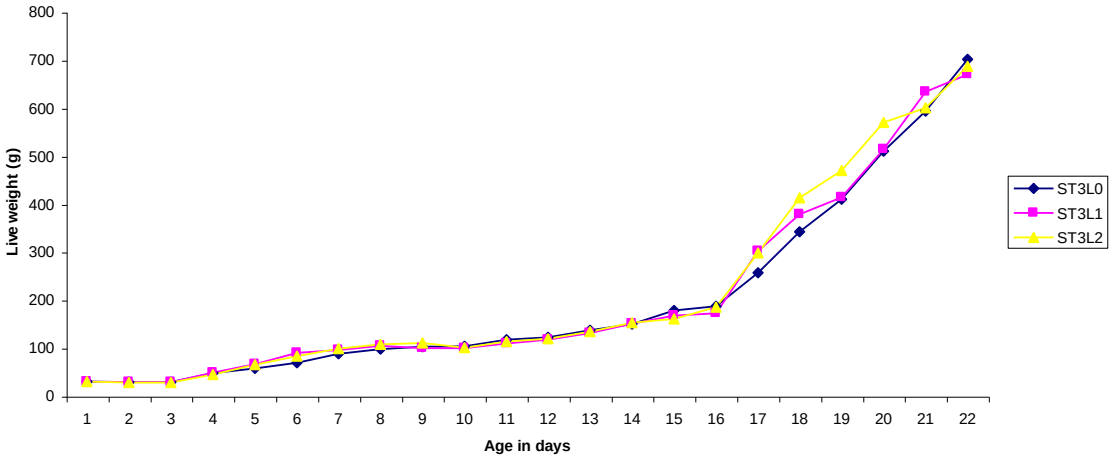


Figure 5. Effect of lysine supplementation within initiation of feeding period of 24 to 36 hour after hatching on live weight of Ross 308 broiler chickens up to 21 days of age.

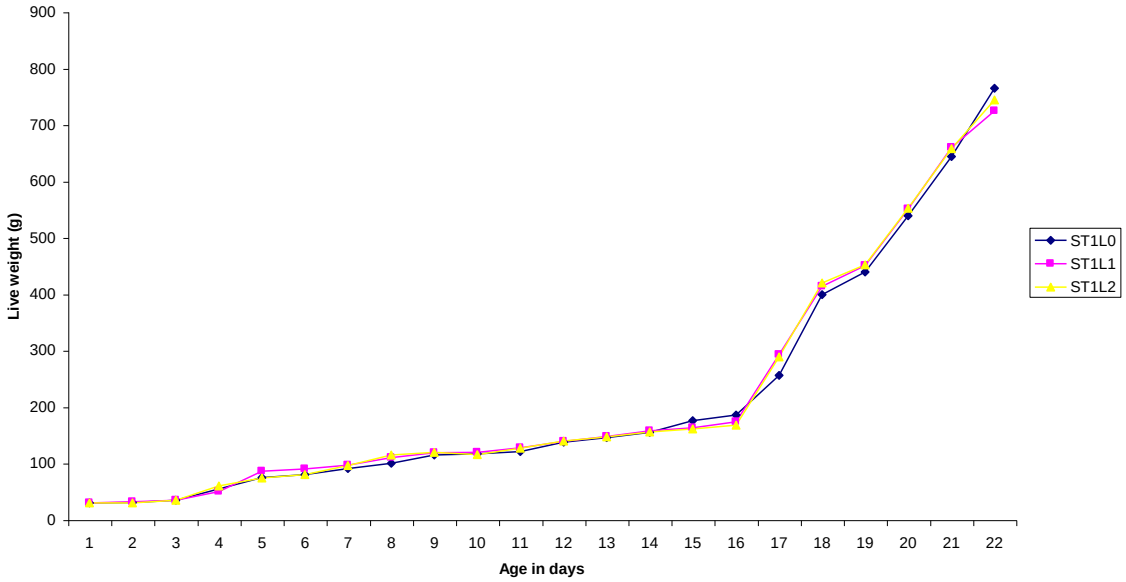


Figure 6. Effect of lysine supplementation within initiation of feeding period of 36 to 48 hours after hatching on live weight of Ross 308 broiler chickens up to 21 days of age.

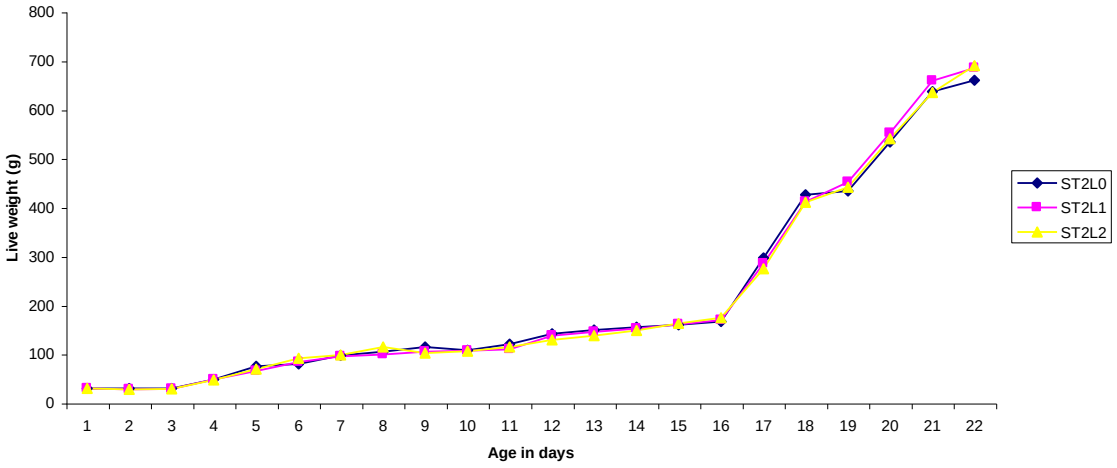


Figure 7. Effect of lysine supplementation within initiation of feeding period of 48 to 60 hours after hatching on live weight of Ross 308 broiler chickens up to 21 days of age.

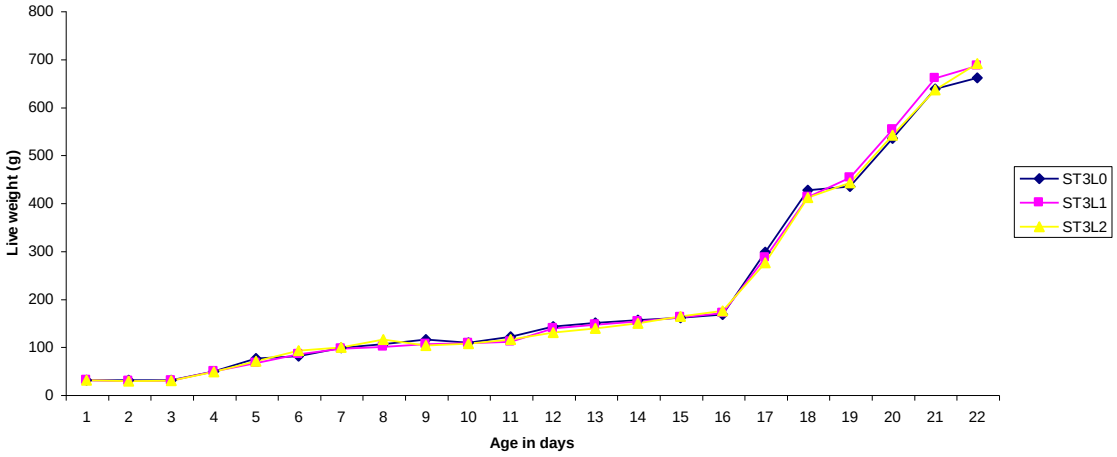


Table 41.07. Effect of time of initiation of feeding after hatching and lysine supplementation on feed intake (g/bird/day) at 42 days old, growth rate(g/bird/day), feed conversion ratio (FCR) and mortality(%) of Ross 308 broiler chickens between 22 and 42 days of age.

Diet	growth rate	intake	FCR	mortality
GT_0L_0	51	129	2.5	0
GT_0L_1	50	136	2.7	0
GT_0L_2	50	143	2.8	0
GT_1L_0	49	138	2.7	0
GT_1L_1	48	132	2.7	0
GT_1L_2	53	152	2.8	0
GT_2L_0	58	153	2.6	0
GT_2L_1	55	142	2.6	0
GT_2L_2	54	149	2.7	0
GT_3L_0	50	136	2.7	0
GT_3L_1	53	143	2.7	0
GT_3L_2	53	141	2.6	0
SE	2.61	9.09	0.18	0

SE : Standard error

Table 4.1.08. Effect of time of initiation of feeding after hatching and lysine supplementation on diet dry matter and nitrogen digestibilities (decimal), nitrogen retention (g/bird/day) and metabolisable energy (ME) (MJ/kgDM) of Ross 308 broiler chickens between 40 and 42 days of age.

Diet	Dry matter digestibility	Nitrogen digestibility	Nitrogen retention	ME
GT_0L_0	0.92	0.88	2.2	16
GT_0L_1	0.88	0.83	1.9	15
GT_0L_2	0.88	0.84	2.0	15
GT_1L_0	0.88	0.81	2.2	15
GT_1L_1	0.88	0.83	2.1	15
GT_1L_2	0.86	0.80	1.5	15
GT_2L_0	0.88	0.82	2.0	15
GT_2L_1	0.87	0.82	2.0	15
GT_2L_2	0.87	0.82	1.6	15
GT_3L_0	0.90	0.85	1.9	16
GT_3L_1	0.87	0.82	1.7	15
GT_3L_2	0.91	0.89	1.9	16
SE	0.02	0.03	0.22	0.32

SE : Standard error

Table 4.1.09. Effect of time of initiation of feeding after hatching and lysine supplementation on live weight (g), dressing percentage (%) carcass parts (g), and intestinal length (cm) of Ross 308 broiler chickens at 42 days old.

Diets	Live weight	dressing %	intestine length	wing	gizzard	abdominal fat	breast	thigh	drum stick
A	1751	87	171	113	45	18	355	199	170
B	1772	88	181	116	50	15	341	196	172
C	1779	89	185	135	46	13	343	189	175
D	1810	90	168	127	51	11	352	191	185
E	1730	90	182	132	45	12	326	194	175
F	1857	87	188	135	47	16	358	197	177
G	1878	88	185	141	40	12	360	208	185
H	1836	88	196	146	46	14	342	212	168
I	1816	89	194	133	45	18	378	232	196
J	1752	90	160	114	46	13	354	202	180
K	1774	90	197	128	42	15	377	193	178
L	1795	89	183	123	43	11	376	209	186
SE	67.14	0.64	9.84	10.02	3.34	2.31	14.81	12.72	9.82

SE : Standard error

Table 4.1.10. Effect of time of initiation of feeding after hatching and lysine supplementation on nitrogen content (g/kgDM) of Ross 308 broiler chicken breast meat samples at 42 days old.

Diet	Nitrogen content
A	130
B	127
C	131
D	129
E	125
F	127
G	133
H	127
I	127
J	133
K	131
L	128
SE	14.60

SE: Standard error

Table 4.1.11. Prediction of mortality and live weight at three days old from time of initiation of feeding after hatching(T) in Ross 308 broiler chickens.

Factor	Y-variable	Formula	r	Probability
T	Mortality	Y= 17.16T – 10	0.917	0.083
T	live weight	Y = -11.28T + 91.2	- 0.906	0.094

r : Correlation coefficient.

4.2.0 Experiment 2. Effect of time of initiation of feeding after hatching and dietary ascorbic acid supplementation on productivity and mortality of Ross 308 broiler chickens.

The nutrient compositions of the starter and grower diets are presented in Tables 4.2.01 and 4.2.02, respectively. The diets at each phase (i.e. starter and grower phases) were isocaloric and isonitrogenous but with different levels of ascorbic acid supplementation. Levels of other nutrients of the diets were similar and met the broiler chicken requirements as recommended by the NRC (1994).

Results of the effect of time of initiation of feeding after hatching on live weight and feed intake at three days of age and mortality of Ross 308 broiler chickens between 1 and 3 days of age are presented in Table 4.2.03. Time of initiation of feeding after hatching had an effect ($P<0.05$) on live weight and feed intake of Ross 308 broiler chickens. Broiler chickens on initiation time of feeding of within 1 to 24 hours after hatching weighed and ate more ($P<0.05$) than those on initiation time of feeding of within 36 to 48 and 48 to 60 hours after hatching. However, broiler chickens on initiation time of feeding of 36 to 48 hours and 48 to 60 hours after hatching had similar ($P>0.05$) live weights and feed intakes. Time of initiation of feeding after hatching had no effect ($P>0.05$) on mortality of Ross 308 broiler chickens between one and three days old. Mortality rates ranged between 18 and 31 %.

Results of the effect of time of initiation of feeding after hatching and ascorbic acid supplementation during "catch up" period on intake per bird, intake as % of live weight and feed conversion ratio of Ross 308 broiler chickens following realimentation are presented in Table 4.2.04. Time of initiation of feeding after hatching and ascorbic acid supplementation during 'catch-up' period had no effect ($P>0.05$) on intake per bird , intake as % of live weight and feed conversion ratio of Ross 308 broiler chickens. The 'catch-up' for all the treatments was seven days irrespective of time of initiation of feeding after hatching

Results of the effect of time of initiation of feeding after hatching and ascorbic acid supplementation on feed intake, growth rate, feed conversion ratio and mortality of Ross 308 broiler chickens between 3 and 21 days of age are presented in Table 4.2.05. Time of initiation of feeding after hatching and ascorbic acid supplementation had no effect ($P>0.05$)

on feed intake within each period of feeding of Ross 308 broiler chickens. Similarly, time of initiation of feeding after hatching had no effect (P> 0.05) on growth rate, feed conversion ratio and mortality of Ross 308 broiler chickens. However, ascorbic acid supplementation had an effect (P<0.05) on growth rate, feed conversion ratio and mortality of Ross 308 broiler chickens between 3 and 21 days of age. Within each period of initiation of feeding after hatching, increasing ascorbic acid supplementation increased growth rates and improved (P<0.05) feed conversion ratio of Ross 308 broiler chickens. Within each period of initiation of feeding after hatching, ascorbic acid supplementation reduced (P<0.05) mortality rates of Ross 308 broiler chickens.

Results of the effect of time of initiation of feeding after hatching and ascorbic acid supplementation on live weight and feed intake of Ross 308 broiler chickens at 21 days of age are presented in Table 4.2.06. Time of initiation of feeding after hatching and ascorbic acid supplementation had no effect (P>0.05) on feed intake of Ross 308 broiler chickens. Similarly, time of initiation of feeding after hatching had no effect (P>0.05) on live weight of Ross 308 broiler chickens. However, ascorbic acid supplementation had an effect (P<0.05) on live weight of Ross 308 broiler chickens at 21 days of age. Within each period of initiation of feeding after hatching, increasing ascorbic acid supplementation increased (P<0.05) live weight of Ross 308 broiler chickens.

Results of the effect of time of initiation of feeding after hatching and ascorbic acid supplementation on live weight and feed intake at 42 days old, growth rate, feed conversion ratio and mortality of Ross 308 broiler chickens between 22 and 42 days of age are presented in Table 4.2.07. Time of initiation of feeding after hatching and ascorbic acid supplementation had no effect (P>0.05) on live weight, feed intake and mortality of Ross 308 broiler chickens. Similarly, time of initiation of feeding after hatching had no effect (P>0.05) on growth rate and feed conversion ratio of Ross 308 broiler chickens. However, ascorbic acid supplementation had an effect (P<0.05) on live weight of Ross 308 broiler chickens at 42 days old as well as growth rate and feed conversion ratio between 22 and 42 days of age. Within each period of initiation of feeding after hatching, increasing ascorbic acid supplementation increased (P<0.05) growth rates, and improved (P<0.05) feed conversion ratio of the chickens

Table 4.2.01 Nutrient composition, time of initiation of feeding (hours after hatching) of the starter diets and ascorbic acid supplementation (units are in g/kg DM except energy as MJ/kg DM feed, ascorbic acid supplementation as ppm/kg feed and dry matter as g/kg feed).

	Nutrient						
Diet	Dry matter	Energy	Protein	Lysine	Fat (min)	Ascorbic acid supp.	Feed initiation
ST_0C_0	880	16.6	212	11	25	0	1-24
ST_0C_1	880	16.6	212	11	25	100	1-24
ST_0C_2	880	16.6	212	11	25	200	1-24
ST_0C_3	880	16.6	212	11	25	300	1-24
ST_0C_4	880	16.6	212	11	25	400	1-24
ST_1C_0	880	16.6	212	11	25	0	36-48
ST_1C_1	880	16.6	212	11	25	100	36-48
ST_1C_2	880	16.6	212	11	25	200	36-48
ST_1C_3	880	16.6	212	11	25	300	36-48
ST_1C_4	880	16.6	212	11	25	400	36-48
ST_2C_0	880	16.6	212	11	25	0	48-60
ST_2C_1	880	16.6	212	11	25	100	48-60
ST_2C_2	880	16.6	212	11	25	200	48-60
ST_2C_3	880	16.6	212	11	25	300	48-6
ST_2C_4	880	16.6	212	11	25	400	48-60

Table 4.2.02 Nutrient composition, time of initiation of feeding (hours after hatching) of the grower diets and ascorbic acid supplementation (units are in g/kg DM except energy as MJ/kg DM feed, ascorbic acid supplementation as ppm/kg feed and dry matter as g/kg feed).

	Nutrient						
Diet	Dry matter	Energy	Protein	Lysine	Fat (min)	Ascorbic acid supp.	Feed initiation
GT_0C_0	880	16.8	200	11.5	25	0	1-24
GT_0C_1	880	16.8	200	11.5	25	100	1-24
GT_0C_2	880	16.8	200	11.5	25	200	1-24
GT_0C_3	880	16.8	200	11.5	25	300	1-24
GT_0C_4	880	16.8	200	11.5	25	400	1-24
GT_1C_0	880	16.8	200	11.5	25	0	36-48
GT_1C_1	880	16.8	200	11.5	25	100	36-48
GT_1C_2	880	16.8	200	11.5	25	200	36-48
GT_1C_3	880	16.8	200	11.5	25	300	36-48
GT_1C_4	880	16.8	200	11.5	25	400	36-48
GT_2C_0	880	16.8	200	11.5	25	0	48-60
GT_2C_1	880	16.8	200	11.5	25	100	48-60
GT_2C_2	880	16.8	200	11.5	25	200	48-60
GT_2C_3	880	16.8	200	11.5	25	300	48-60
GT_2C_4	880	16.8	200	11.5	25	400	48-60

Table 4.2.03. Effect of time of initiation of feeding after hatching on live weight at 3 days old (g/bird), feed intake (g/bird/day) at 3 days old and mortality (%) of Ross 308 broiler chickens between 1 and 3 days of age.

Diet	Live weight	intake	mortality
ST_0C_0	71^a	39^a	25
ST_0C_1	74^a	38^a	20
ST_0C_2	70^a	37^a	18
ST_0C_3	75^a	39^a	20
ST_0C_4	71^a	36^a	20
ST_1C_0	53^b	16^b	31
ST_1C_1	52^b	15^b	20
ST_1C_2	51^b	14^b	22
ST_1C_3	50^b	15^b	20
ST_1C_4	52^b	15^b	18
ST_2C_0	40^b	10^b	22
ST_2C_1	39^b	9^b	27
ST_2C_2	40^b	9^b	29
ST_2C_3	37^b	11^b	27
ST_2C_4	38^b	10^b	29
SE	3.25	3.58	7.99

^{ab} :Means in the same column not sharing a common superscript are significantly different ($P<0.05$).

SE : Standard error

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Table 4.2.04 Effect of time of initiation of feeding after hatching and ascorbic acid supplementation during "catch up" period on intake (g/bird/day), intake as % of live weight and feed conversion ratio (FCR) of Ross 308 broiler chickens following realimentation.

Diet	Days of "catch-up" following suppl.	intake	intake as % of live weight	FCR
ST_0C_0	_	27	25	2.1
ST_1C_0	7	28	25	2.0
ST_2C_0	7	28	25	2.3
ST_0C_1	_	26	23	2.1
ST_1C_1	7	26	23	2.0
ST_2C_1	7	27	25	2.2
ST_0C_2	_	28	25	2.3
ST_1C_2	7	24	22	2.1
ST_2C_2	7	28	25	2.3
ST_0C_3	_	26	23	2.2
ST_1C_3	7	24	22	2.2
ST_2C_3	7	29	26	2.2
ST_OC_4	_	28	24	2.2
ST_1C_4	7	24	22	2.0
ST_2C_4	7	28	26	2.1
SE		1.31	0.86	0.10

SE :Standard error

Table 4.2.05. Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on growth rate(g/bird/day), feed intake (g/bird/day), feed conversion ratio (FCR) and mortality (%) of Ross 308 broiler chickens between 3 and 21 days of age.

Diet	growth rate	intake	FCR	mortality
ST_0C_0	16^{e}	54	3.3^{a}	33^{a}
ST_0C_1	20^{d}	48	2.4^{b}	0^{b}
ST_0C_2	29^{c}	52	1.7^{c}	0^{b}
ST_0C_3	37^{b}	49	1.2^{d}	0^{b}
ST_0C_4	57^{a}	48	0.8^{e}	0^{b}
ST_1C_0	16^{e}	54	3.4^{a}	31^{a}
ST_1C_1	21^{d}	49	2.3^{b}	0^{b}
ST_1C_2	29^{c}	52	1.7^{c}	0^{b}
ST_1C_3	39^{b}	49	1.2^{d}	0^{b}
ST_1C_4	59^{a}	49	0.8^{e}	0^{b}
ST_2C_0	15^{e}	54	3.4^{a}	40^{a}
ST_2C_1	20^{d}	49	2.3^{b}	0^{b}
ST_2C_2	29^{c}	52	1.7^{c}	0^{b}
ST_2C_3	39^{b}	49	1.2^{d}	0^{b}
ST_2C_4	59^{a}	49	0.8^{e}	0^{b}
SE	0.77	1.89	0.65	4.32

^{abcde} :Means in the same column not sharing a common superscript are significantly different ($P<0.05$).

SE : Standard error

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Results of the effect of time of initiation of feeding after hatching and ascorbic acid supplementation on dry matter and nitrogen digestibilities, nitrogen retention and metabolisable energy of Ross 308 broiler chickens between 40 and 42 days of age are presented in Table 4.2.08. Time of initiation of feeding after hatching and ascorbic acid supplementation had no effect ($P>0.05$) on dry matter and nitrogen digestibilities, nitrogen retention and metabolisable energy of the chickens.

Results of the effect of time of initiation of feeding after hatching and ascorbic acid supplementation on live weight, carcass characteristics and dressing percentage of Ross 308 broiler chickens at 42 days old are presented in Table 4.2.09. Time of initiation of feeding after hatching had no effect ($P>0.05$) on live weight, carcass characteristics and dressing percentage of the chickens. Ascorbic acid supplementation had an effect ($P<0.05$) on live weight, carcass characteristics and dressing percentage of Ross 308 broiler chickens. Within each period of initiation of feeding after hatching, increasing ascorbic acid supplementation improved ($P<0.05$) live weight, dressing percentage, breast meat yield, wing meat, thigh meat and drum stick weight of the chickens. Time of initiation of feeding after hatching and ascorbic acid supplementation had no effect ($P>0.05$) on intestine length, gizzard meat and abdominal fat yield of Ross 308 broiler chickens at 42 days old.

Results of the effect of time of initiation of feeding after hatching and ascorbic acid supplementation on nitrogen content of Ross 308 broiler chicken breast meat samples at 42 days old are presented in Table 4.2.10. Time of initiation of feeding after hatching and ascorbic acid supplementation had no effect ($P>0.05$) on nitrogen content of Ross 308 broiler chicken breast meat samples.

A series of linear regressions that predict mortality and live weight of Ross 308 broiler chickens at three days of age from time of initiation of feeding after hatching are presented in Table 4.2.11. Mortality was positively and strongly correlated ($r = 0.963$) with time of initiation of feeding after hatching. Live weight was negatively and strongly correlated ($r = 0.991$) with time of initiation of feeding after hatching.

Table 4.2.06. Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on live weight (g/bird) and feed intake (g/bird/day) of Ross 308 broiler chickens at 21 days of age.

Diet	Live weight	Feed intake
ST_0C_0	338[e]	67
ST_0C_1	415[d]	66
ST_0C_2	580[c]	72
ST_0C_3	752[b]	67
ST_0C_4	1093[a]	63
ST_1C_0	333[e]	67
ST_1C_1	421[d]	66
ST_1C_2	578[c]	70
ST_1C_3	755[b]	66
ST_1C_4	1110[a]	63
ST_2C_0	336[e]	69
ST_2C_1	422[d]	66
ST_2C_2	580[c]	69
ST_2C_3	757[b]	66
ST_2C_4	1113[a]	63
SE	11.97	3.2

[abcde] :Means in the same column not sharing a common superscript are significantly different ($P<0.05$).

SE : Standard error

Table 4.2.07 Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on feed intake (g/bird/day) at 42 days old, growth rate(g/bird/day), feed conversion ratio (FCR) and mortality (%) of Ross 308 broiler chickens between 22 and 42 days of age.

Diet	growth rate	feed intake	FCR	mortality
GT_0C_0	33^{e}	171	5.1^{a}	0
GT_0C_1	38^{d}	158	4.1^{b}	0
GT_0C_2	48^{c}	164	3.5^{c}	0
GT_0C_3	54^{b}	152	2.7^{d}	0
GT_0C_4	75^{a}	148	1.9^{e}	0
GT_1C_0	34^{e}	172	5.1^{a}	0
GT_1C_1	38^{d}	158	4.1^{b}	0
GT_1C_2	46^{c}	164	3.5^{c}	0
GT_1C_3	54^{b}	152	2.7^{d}	0
GT_1C_4	74^{a}	147	1.9^{e}	0
GT_2C_0	34^{e}	172	5.1^{a}	0
GT_2C_1	38^{d}	158	4.1^{b}	0
GT_2C_2	46^{c}	164	3.5^{c}	0
GT_2C_3	54^{b}	152	2.7^{d}	0
GT_2C_4	74^{a}	147	1.9^{e}	0
SE	0.67	6.45	0.09	0

^{abcde} :Means in the same column not sharing a common superscript are significantly different ($P<0.05$).

SE : Standard error

Table 4.2.08. Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on dry matter and nitrogen digestibilities (decimal), nitrogen retention (g/bird/day) and metabolisable energy (ME) (MJ/kgDM) of Ross 308 broiler chickens between 40 and 42 days of age.

Diet	Dry matter digestibility	Nitrogen digestibility	Nitrogen retention	ME
GT_0C_0	0.83	0.82	2.9	14
GT_0C_1	0.83	0.83	2.7	14
GT_0C_2	0.86	0.84	2.6	14
GT_0C_3	0.77	0.76	2.4	13
GT_0C_4	0.70	0.69	1.7	13
GT_1C_0	0.78	0.74	1.6	14
GT_1C_1	0.75	0.73	2.0	13
GT_1C_2	0.80	0.78	2.0	14
GT_1C_3	0.82	0.79	3.0	14
GT_1C_4	0.71	0.66	2.0	13
GT_2C_0	0.69	0.64	1.5	13
GT_2C_1	0.82	0.78	2.2	14
GT_2C_2	0.82	0.83	2.6	14
GT_2C_3	0.85	0.82	2.5	14
GT_2C_4	0.77	0.69	2.7	14
SE	0.05	0.04	0.59	0.69

SE : Standard error

Table 4.2.09. Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on live weight (g), carcass characteristics (g) and dressing percentage of Ross 308 broiler chickens at 42 days old.

Diet	liveweight	dressing %	wing	intestine length	gizzard	abdominal fat	breast yield	thigh	drum stick
A	1042^{e}	51^{e}	44^{e}	195	36	19	142^{e}	81^{e}	58^{e}
B	1217^{d}	62^{d}	60^{d}	182	30	17	198^{d}	104^{d}	82^{d}
C	1548^{c}	71^{c}	75^{c}	194	38	13	235^{c}	123^{c}	105^{c}
D	1892^{b}	81^{b}	89^{b}	184	37	16	300^{b}	138^{b}	122^{b}
E	2642^{a}	91^{a}	115^{a}	191	37	16	450^{a}	153^{a}	137^{a}
F	1055^{e}	50^{e}	43^{e}	185	38	19	141^{e}	80^{e}	57^{e}
G	1229^{d}	61^{d}	60^{d}	182	32	15	198^{d}	104^{d}	81^{d}
H	1547^{c}	72^{c}	75^{c}	184	37	17	235^{c}	124^{c}	105^{c}
I	1899^{b}	80^{b}	88^{b}	178	34	14	300^{b}	138^{b}	121^{b}
J	2642^{a}	91^{a}	115^{a}	160	33	12	450^{a}	153^{a}	137^{a}
K	1054^{e}	51^{e}	44^{e}	174	35	12	142^{e}	80^{e}	58^{e}
L	229^{d}	61^{d}	60^{d}	175	36	15	197^{d}	104^{d}	81^{d}
M	1547^{c}	72^{c}	75^{c}	182	38	17	235^{c}	125^{c}	105^{c}
N	1897^{b}	81^{b}	89^{b}	193	39	21	300^{b}	139^{b}	122^{b}
O	2641^{a}	91^{a}	115^{a}	185	35	16	450^{a}	153^{a}	137^{a}
SE	18.03	1.01	2.54	8.93	1.64	3.05	6.66	2.48	2.49

^{abcde} :Means in the same column not sharing a common superscript are significantly different ($P<0.05$).

SE : Standard error

Table 4.2.10. Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on nitrogen content (g/kgDM) of Ross 308 broiler chicken breast meat samples at 42 days old.

Diet	Nitrogen content
A	135
B	130
C	133
D	131
E	129
F	130
G	133
H	130
I	134
J	132
K	128
L	129
M	129
N	136
O	130
SE	2.1

SE: Standard error

Table 4.2.11. Prediction of mortality and live weight at three days old from time of initiation of feeding after hatching(T) in Ross 308 broiler chickens.

Factor	Y-variable	Formula	r	Probability
T	Mortality	Y= 3.10T +17	0.963	0.173
T	live weight	Y = -16.70T + 87.6	- 0.991	0.085

r : Correlation coefficient.

CHAPTER 5

DISCUSSION

5.1 Effect of time of initiation of feeding after hatching and dietary lysine supplementation on productivity and mortality of Ross 308 broiler chickens.

This study examined the effect of three planes of dietary lysine supplementation on broiler chicken productivity and mortality following different times of initiation of feeding after hatching between July and August 2006. Results showed that different times of initiation of feeding after hatching affected live weight at three days of age, feed intake and mortality of Ross 308 broiler chickens between 1 and 3 days of age. It was observed that initiation of feeding within 1 to 36 hours after hatching promoted good growth and feed intake in broiler chickens. Increasing time of initiation of feeding above 36 hours after hatching retarded live weight and reduced feed intake by the age of three days. These results are similar to the findings of Noy & Sklan (1998a). However, these results are different from the findings of Dibner et al. (1998a) and Maiorka et al. (2000) which indicated that initiation of feeding within 24 hours after hatching enhanced growth and feed intake, while increasing initiation of feeding above 24 hours after hatching retarded growth and reduced feed intake in broiler chickens. Explaining the reason for enhanced growth and improved feed intake following initiation of feeding within 36 hours after hatching, Noy & Sklan (1999) reported that immediately after hatching, most nutrients are used for maintenance activities and growth, specifically for intestinal growth. This preferential growth occurs regardless of initiation of feeding after hatching. When the nutrients are not supplied by exogenous feed, newly hatched chicks use the nutrients from the yolk sac for intestinal growth (Maiorka & Malheiros, 2000). However, as observed by Dibner et al. (1998), the maximum amount of nutrients produced by the york sac is less than the optimal maintenance requirements of the chick during the first day of life. Therefore, in order to achieve its optimal maintenance nutrient requirements during this period, intake of nutrients from exogenous feed is necessary. Besides, Nitsan et al. (1991) and Shehata et al. (1984) observed that intestinal growth immediate post-hatch is accompanied by increase in the production and activity of digestive enzymes such as amylase, trypsin and pancreatic lipase from intestinal membranes. However, Sell et al. (1991) reported that these digestive enzymes are already in the gastrointestinal tract during embryo phase but the presence of nutrients from oral intake of exogenous feed improves their activity (Traber & Turro, 1991). Therefore, birds fed immediately after hatching have a constant secretion of these enzymes resulting in higher trypsin, amylase and lipase activities in intestinal mucosa, which results in higher intestinal weight and body weight growth (Sklan & Noy, 2000).

Feeding first after hatching, therefore, seems to improve the activities of the digestive enzymes in the intestinal mucosa, increase digestion, and consequently enhance body weight growth and feed intake of broiler chickens. Feed restriction after 36 hours immediate post-hatch might have led to low enzymatic activity in the intestinal mucosa and hence a decrease in digestion. This might have led to lower growth rates. Therefore, the present results support the finding of Dibner et al. (1998a) which indicates that residual york sac nutrients are optimally utilized for enhancing growth and intake where initiation of feeding after hatching is within 36 hours. Growth of chickens is negatively affected when initiation of feeding after hatching is beyond 36 hours.

Different times of initiation of feeding after hatching affected mortality rates in broiler chickens. More than 50% of the chicks died by the age of 60 hours when initiation of feeding was delayed to above 36 hours of hatching. This observation is similar to that of Dibner et al. (1998b). These authors explained that when initiation of feeding after hatching is longer than 24 hours, the chick degrades maternal immunoglobulins present in the vitelline residue to produce its own proteins necessary for survival. During this time of fasting, exogenous food and non-food particles, which constitute an important antigen battery, are not introduced to the chick. Thus, the diversity of the immunoglobulin pool produced is negatively affected and this tends to weaken the immune system of the bird. Furthermore, Lowenthal & Trout (1994) observed that lymphocytes of one day-old chicks, although apparently mature, are functionally immature at hatch and gradually acquire immune activity with the intake of exogenous nutrients. Similarly, Rose & Rogaush (1974) and Klasing (1998) indicated that lack of oral intake of exogenous nutrients during the first days of life may lead to the absence of a specific and well developed humoral response in the chick and this condition leads the chick to be very dependent of maternal antibodies, which might not satisfy the required immune needs of the bird within this period. Thus, intake of nutrients from exogenous feed are essential for the adequate development of the bird's immune system after hatching. As a result, delayed initiation of feeding after hatching leads to high mortality rates. A critical time of initiation of feeding after hatching was found to be 36 hours in the present study.

Following lysine supplementation at three days of age, mortality rates stabilized irrespective of time of initiation of feeding after hatching and lysine supplementation. It is possible that the improvement in immune response was as a result of intake of exogenous nutrients (Dibner

et al.1998b). Exogenous feed increases availability of nutrients which are required for total development of lymphoid organs, helps to improve the activities of these organs and consequently leads to complete differentiation and maturation of the immune system, particularly the B-lymphocytes which are the secondary immune organs of the bird, thus enhancing immunity (Dibner et al.,1998b).

Lysine supplementation during realimentation tended to reduce the number of days of 'catch-up' irrespective of time of initiation of feeding after hatching. The overall 'catch-up' period was shorter in those birds supplemented with 5 g lysine per kg feed, 'catching-up' at two days, followed by those supplemented with 2.5 g lysine per kg feed, 'catching-up' at three days, while those without lysine supplementation had a 'catch-up' period of five days. Hays et al. (1995) also observed that restricted steers realimented on diets of increasing protein levels (9, 12 or 15 % CP) showed a differential growth response to dietary protein in the first two weeks of realimentation. These authors suggested that the responsiveness to dietary protein in the realimentation diet was directly related to the severity of the restriction period. Thus, the more severe the restriction (as measured by the depletion of protein stores), the greater the initial growth rates were on the higher protein diet. Although the present results showed existence of a differential growth response to dietary lysine supplementation, they do not support the idea that the more severe the restriction (as measured by the delayed time of initiation of feeding after hatching), the greater the initial growth rates. However, based on the shorter 'catch-up' period of broiler chickens on a diet supplemented with 5 g lysine per kg feed, it may be concluded that lysine may have been limiting in the realimentation diet. Plavnik & Hurwitz (1989) also concluded that broilers require higher amounts of lysine and methionine during realimentation. However, the results obtained in this study are contrary to the findings of Jones and Farrell (1992) who observed little or no response to lysine and methionine supplementation when fed from 4 to 7 weeks of age. In the present study, higher feed intake relative to the body weight seemed to have been the main reason for shorter 'catch-up' period. Zubair & Leeson (1994) also observed the same occurrence of significantly increased feed intake relative to body weight in restricted-refed broilers. However, Carstens et al. (1991) did not observe any differences in feed intake upon realimentation when steers were measured at similar body weight, even though the restricted steers showed higher growth rates when realimented. Yambayamba et al. (1996) did not observe a significant increase in feed intake in restricted steers compared to the control steers at the same age. However, based on the available data from that trial, one could deduce that if feed intake had been measured as a

percent of body weight, significant differences in feed intake would have been observed. It was not possible to estimate the optimum level because of the short range of lysine supplementation levels used. Thus, compensatory growth resulted in a minimization of the differences in growth rates between the birds fed within 1 to 24 hours or 24 to 36 hours and those fed within 36 to 48 hours or 48 to 60 hours after hatching and enabled full recovery of body weight at the latest by the age of eight days. Thereafter, lysine supplementation had no effect on live weight, feed intake, growth rate, feed conversion ratio and carcass characteristics of the broiler chickens.

The results of the present study indicate that different times of initiation of feeding after hatching and dietary lysine supplementation had no significant effect on dry matter and nitrogen digestibilities, nitrogen retention, metabolisable energy, dressing percentage, carcass parts, intestinal length, and nitrogen content of Ross 308 broiler chickens during the grower phase. According to Acar *et al.* (1991), lysine concentrations of 7.5 g to 11.5 g / kg diet has no effect on performance or carcass yield of broilers aged between six and eight weeks. However, in other studies, dietary lysine has been shown to impact on the performance of broilers, particularly with respect to breast meat accretion and yield (Corzo and Kidd, 2004).

The current study indicated that mortality was positively and strongly correlated with time of initiation of feeding after hatching while live weight was negatively and strongly correlated with time of initiation of feeding after hatching at three days of age. This is in agreement with the findings of (Fanguy et al., 1980; Wyatt et al., 1985) which indicated that delayed initiation of feeding post-hatch induces high mortality rate and lowers live weight in broiler chickens due to its negative effect on maturation of the supply and immune organs which play a key role in supplying nutrients for growth and enhanced immune competence. Perhaps, this could explain some of the impact of delayed time of initiation of feeding after hatching on growth and mortality.

5.2 Effect of time of initiation of feeding after hatching and dietary ascorbic acid supplementation on productivity and mortality of Ross 308 broiler chickens.

Food restriction consists of limiting the level of consumption of a food in time, quantity, quality or reducing the hours of illumination of feeding (Religious et al., 2001). This practice is used for a reduction in carcass fat content and improvement in food utilization (Plavnik & Hurwitz, 1985), as well as for a reduction in pathological disorders associated with early rapid growth due to selection and genetic breeding such as ascites and ostoprosis (Acar et al., 1995; Jones 1995; Sanchez et al., 2000). However, the period between final stage of embryonic development and first days of life in the broiler chickens is made up of a complex and sensitive stage of digestive, physiological and immune system maturation. Feed restriction during this period may significantly affect the bird's growth and livability (Dibner et al., 1998b). In order not to jeopardize the development of the chick, the best preliminary practice would be to stimulate the initial growth so that the bird can express all its muscular growth potential, digestive and immunizing capacities (Fanguy et. al., 1980). This first stage of initial stimulation relates to, in particular, the time of initiation of feeding after hatching.

The present study examined the effect of time of initiation of feeding after hatching and dietary ascorbic acid supplementation on productivity and mortality of Ross 308 broiler chickens during the summer period (November-December). Results showed that different times of initiation of feeding after hatching affected live weight and feed intakes at three days of age. It was observed that birds fed within 1 to 24 hours after hatching ate and weighed more than those fed within 36 to 48 hours or 48 to 60 hours after hatching. A reduction in body weight has been previously observed in birds fed after 36 hours post-hatch (Pinchasov & Noy, 1993; Noy & Sklan, 1998c). Novus International researchers (http://www.novusint) also observed that delaying initiation of feeding after hatching for more than 24 hours can retard growth mainly due to starvation during the early phase of life. However, these results are contrary to the findings of Hogan (1984), which indicated that residual york sac nutrients fulfil the hatchling's nutritional requirements for the first 72 hours after hatching. Thus, the results from the present study may indicate that the use of residual york sac nutrients during this critical period of development (36 to 60 hours) was, therefore, not enough to enhance growth (Dibner et al., 1998a).

Unlike the effect on live weight, time of initiation of feeding after hatching had no significant effect on mortality of the chicks between one to three days of age. However, high mortality rates of between 18 and 31 % were observed among the treatments.

In the present study, ascorbic acid supplementation but not time of initiation of feeding after hatching affected mortality rates of the broiler chickens between 3 and 21 days of age. Lower mortalities were observed in birds supplemented with ascorbic acid irrespective of time of initiation of feeding after hatching. This was similar to the results of Giang & Doan (1998), Doan (2000), Pardue et al. (1985) and Null (2001). These authors have indicated that ascorbic acid takes part in the synthesis of leukocytes, especially phagocytes and neutrophiles, which enhance immunity in the broiler chickens and by so doing lowering mortality.

In the current study, time of initiation of feeding after hatching and ascorbic acid supplementation had no effect on feed intake, intake as percentage of live weight and feed conversion ratio of Ross 308 broiler chickens during the 'catch-up' period. Thus, compensatory growth in this study cannot be explained in terms of increased feed intake and feed efficiency. However, it is possible that the birds delayed for a longer period of initiation of feeding of 36 to 60 hours after hatching had a reduced maintenance requirement due to their small body size which allowed for comparatively more energy for growth upon realimentation hence contributing to the compensatory response (Ryan, 1990). It is, also possible, that the compensatory growth response was as a result of increased efficiency of growth (Carstens et al., 1991; Ryan et al., 1993a). These authors observed that increased efficiency of protein deposition results in more gain per gram protein deposited than lipid deposited. Thus, higher rates of protein deposition during realimentation would have a significant impact on the overall growth rate hence contributing to compensatory growth response

Following the 'catch-up' period, it was observed that time of initiation of feeding after hatching and ascorbic acid supplementation had no effect on feed intake of the broiler chickens till 42 days of age. These results are in agreement with Blaha & Kreosna (1997) and Jaffer & Blaha (1996) who reported that feed intakes of broiler chickens were not affected by the supplementation of ascorbic acid.

However, ascorbic acid supplementation but not time of initiation of feeding after hatching affected growth rates and feed conversion ratio of the birds between 3 and 21 days of age. Growth rate increased incrementally with increasing levels of ascorbic acid supplementation within each time of initiation of feeding after hatching. Improved growth rate in the ascorbic acid supplemented birds resulted in improved live weight in comparison with those without ascorbic acid supplementation at 21 days of age and continued until 42 days of age. Live weight increased incrementally with increasing levels of ascorbic acid supplementation within each time of initiation of feeding after hatching. However, the optimum level of ascorbic acid supplementation was not calculated because of the short range of values used. These results are similar to those of Jaffar & Blaha (1996) who observed a 10.9 % increase in body weight of chickens supplemented with ascorbic acid at 20 mg/bird/day in drinking water during acute heat stress (29-43 ^{0}C).

Blaha & Kreosna (1997) observed an even higher increase of 18% among chickens placed on ascorbic acid supplementation. Njoku (1984) and Njoku (1986) also observed that ascorbic acid supplementation improved growth rates of broiler chickens. However, during the winter period with temperatures ranging between 10.1 and 26 ^{0}C, Puron et al. (1994) found that 200 ppm dietary ascorbic acid supplementation had no effect on performance and survivability of broiler chickens. Sykes (1977) pointed out that only a slight effect of ascorbic acid supplementation on the performance of broiler chickens would be expected under winter conditions. Apparently, beneficial effects of ascorbic acid supplementation are most expressed under high ambient temperatures (Njoku, 1984).

Increasing the level of ascorbic acid supplementation improved feed conversion ratio between 3 and 21 days of age and continued until 42 days of age. This is similar to the results of Blaha & Kreosna (1997), Mckee & Harrison (1995). These authors detected an improvement in feed conversion ratio of broiler chickens as a result of ascorbic acid supplementation during heat stress. Ascorbic acid is associated with the conversion of body proteins and fat into energy for production and survival through increased corticosterone secretion (Marshall & Hughes, 1980; Bain, 1996). Similarly, ascorbic acid supplementation has been shown to enhance productivity, immune resistance and survivability under stressful conditions (Zulkifli et al., 1996).

Time of initiation of feeding after hatching and dietary ascorbic acid supplementation had no effect on nutrient digestibility at 42 days of age. However, dietary ascorbic acid supplementation had a significant effect on dressing percentage and breast meat yield at 42 days old. Increasing ascorbic acid supplementation within each time of initiation of feeding after hatching increased dressing percentage and breast meat yield. Quarks & Adrian (1988) observed similar results when they supplemented broiler chickens with ascorbic acid before slaughter. The current study indicated that time of initiation of feeding after hatching and ascorbic acid supplementation had no effect on breast meat nitrogen content. However, no previous study on this issue has been reported. This was expected since the diets were isocaloric and isonitrogenous (Labadan et al., 2001).

The current study indicated that mortality was positively and strongly correlated with time of initiation of feeding after hatching while live weight was negatively and strongly correlated with time of initiation of feeding after hatching at three days of age. This is in agreement with the findings of (Fanguy et al., 1980; Wyatt et al., 1985) which indicated that delayed initiation of feeding post-hatch induces high mortality rate and lowers live weight in broiler chickens.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The time from hatching to initiation of feeding is a critical period in the development of the broiler chicken. Time of initiation of feeding after 36 hours from hatching resulted in growth retardation. However, the birds 'caught-up' at the latest within eight days of realimentation in winter and 10 days in summer. This compensatory growth could be explained in terms of higher intakes during the winter period and possibly, in terms of reduced maintenance requirement or increased efficiency of growth during the summer period. Also, time of initiation of feeding after 36 hours from hatching resulted in a high mortality rate. This is a big loss as overall productivity is adversely affected. Lysine supplementation during realimentation reduced the number of days of 'catch-up' irrespective of time of initiation of feeding after hatching. Generally, the higher the level of lysine supplementation, the lower was the number of days of 'catch-up' upon ralimentation.

It is concluded that time of initiation of feeding after 36 hours from hatching is not desirable, mainly because of its effect on mortality. However, lysine supplementation in the diet of broiler chickens subjected to delayed initiation of feeding after hatching might play a key role in accelerating the rate of 'catch-up' growth response.

Time of initiation of feeding after hatching and dietary lysine supplementation had no significant effect on dry matter and nitrogen digestibilities, nitrogen retention, metabolisable energy, dressing percentage, carcass parts, intestinal length, and nitrogen content of Ross 308 broiler chickens during the grower phase. This, possible, may indicate that the level of dietary lysine used in the present study were equal or above the requirements for optimum dry matter and nitrogen digestibilities, nitrogen retention, metabolisable energy, dressing percentage, carcass parts, intestinal length, and nitrogen content of Ross 308 broiler chickens during the grower phase.

Conversely, ascorbic acid supplementation during realimentation reduced mortality rate and improved growth rates irrespective of time of initiation of feeding after hatching. Growth rate increased incrementally with increasing levels of ascorbic acid supplementation within each time of initiation of feeding after hatching. Improved growth rate in the ascorbic acid supplemented birds resulted in improved live weight in comparison with those without ascorbic acid supplementation at 21 day of age and continued until 42 days of age. Live weight increased incrementally with increasing levels of ascorbic acid supplementation within

each time of initiation of feeding after hatching. Similarly, increasing ascorbic acid supplementation within each time of initiation of feeding after hatching increased dressing percentage and breast meat yield. It is concluded that the beneficial effect of ascorbic acid supplementation could be exploited in reducing mortality rate and improving growth rates in broiler chickens subjected to stressful conditions.

Time of initiation of feeding after hatching and dietary ascorbic acid supplementation had no significant effect on feed intake, dry matter and nitrogen digestibilities, nitrogen retention, metabolisable energy, intestinal length, and nitrogen content of breast meat of Ross 308 broiler chickens during the grower phase. This, possibly, may indicate that the level of dietary ascorbic acid used in the present study were equal or above the requirements for optimum dry matter and nitrogen digestibilities, nitrogen retention, metabolisable energy, and breast meat nitrogen content of Ross 308 broiler chickens.

6.2 RECOMENDATIONS

The impact of early feeding is more than simply giving birds a head start over those where feeding is delayed for a day or more. What is consumed in the first days following hatching can play a definitive role in enhancing immune competence of the broiler chickens. Thus, broiler chicken feeding within 36 hours after hatching can allow for improved feed efficiency, uniformity, improved productivity and an enhanced immune competence. While dietary lysine supplementation in the diet of broiler chickens subjected to delayed initiation of feeding after hatching might play a key role in accelerating the rate of 'catch-up' growth response, supplementation with dietary ascorbic acid on the other hand, could be beneficial in reducing mortality rate and improving growth rates in broiler chickens subjected to stressful conditions. Finally, more research is needed to fully understand the effect of time of initiation of feeding after hatching, the influence of nutrients supplementation during realimentation and the mechanism of compensatory growth following delayed initiation of feeding after hatching. Experiments to determine the optimum levels of dietary lysine and ascorbic acid supplementation for maximum productivity following delayed initiation of feeding after hatching are also recommended.

CHAPTER 7

REFERENCES

Acar, N., Moran, E.T., Jr & Bilgili, S.F., 1991. Live performance and carcas yield of male broilers from two commercial strain crosses receiving rations containing lysine below and above the established requirement between six and eight weeks of age.Poultry Science 70: 2315-2321.

Acar, N.R., Sizemore, F. G., Leach, G. R., Wideman, R. F. Jr, Owen, R. L., & Barbato G. F., 1995. Growth of broiler in response to feed restriction to reduce ascites. Poultry. Sci., 74, 833-843.

AOAC., 1984. Official Methods of Analysis, 14th edition. A.O.A.C. Washington, DC.

AI-TaIeb, S.S., 2003. Effect of an early feed restriction productive performance and carcass quality. On Line Journal of Biological Sciences 3(6): 607-611.

Bains, B. S., 1996. The role of Vitamin C in stress management. World Poultry, 12 (4): 38-41.

Benschop, D., 2000. Compensatory growth in ruminants- an overview.In: CANT, J,(Ed) Proceedings of the 2000 course in Ruminants Digestion and Metabolism ANSC 6260. University of Guelp, 1-16

Blaha, J., & Kroesna, K., 1997. Effect of Vitamin and electrolytes supplements on broilers performance, slaughter value and chemical composition of meat during heat stress. Universitas Agriculture Praga Press, 30: 103-113.

Carstens, G.E., Johnson, D.E., Ellenberger, M.A., & Tatum, J.D., 1991. Physical and chemical components of the empty body during compensatory growth in beef steers. Journal. Anim. Sci. 69: 3251-3264.

Calvert, C.C., MucMurtey, D. Brocht & Miller, D.E., 1989. Effect of 6 and 12 day early feed restriction on rate and composition of gain in broilers. Poultry Science 68: 23-28.

Cherry, J. A., Siegel, P.B., & Beane, W.L., 1978. Genetic-Nutritional relationships in growth and carcass characteristics of broiler chickens. Poult. Sci. 57: 1482-1487.

Corzo, A. & Kidd, M.T., 2004. Starter dietary lysine level and strain cross effects on performance and carcass traits of broiler females. Revista Brasileira Ciencia Avicola. Vol.6, no.2, p.93-97. ISSN 1516-635X

Chort, M. & Annison, G., 1992. The inhibition of nutrition digestion by wheat pentosan. British Journal of Nutrition 67: 123-132.

De Greef, K. H., Kemp, B., & Verstegen M.W.A., 1992. Performance and body composition of fattening pigs of two strains during protein deficiency and subsequent realimentation. Livestock. Prod. Sci. 30: 141-153.

Dibner, J.J., Knight, C.D., Kitchwell, Mr L., Atwell, C.A., Downs A.C., & Ivey, F.J., 1998a. Early feeding and development of the immune system in neonatal poultry. Journal.Appl. Res. Poultry.7:425-436.

Dibner, J.J., Knight, C.D. & Ivey, F.J., 1998b. Nutritional programming in hatchling poultry: Why a good start., Poultry Digest. Vol 57, no.4, Pg 2-5.

Doan, B. H., 2000. Effect of different level of dietary calcium and supplemental vitamin C on growth, survivability, leg abnormalities, total ash in tibia, serum calcium and phosphorus in 0-4 weeks-old chicks under tropical conditions, Livestock research for Rural Development, CIPAV Publication, Colombia, 12(1).

Fanguy, R.C., Misera, L.K. Vo, K.C. Blohowiak, C.C. & Kreuger W.F., 1980. Effect of delayed placement on mortality and growth performance of commercial broilers. Poultry Science 59: 1215-1220.

FAO., 1999. Human Nutrition in the developing world. Latham M. C., FAO Food and Nutrition Series no. 29.

Frandson, R.D., 1986. Anatomy and physiology of farm animals, Chapter 32: Endocrinology, Page 481-507, Lea and Febiger Publisher, Philadelphia, USA.

Friedman A, aI-Sabbagh A, Santos L.M., Fishman-Lobell J, Polanski M. Das M.P. Khoury, S. & Weiner H.L., 1994. Oral tolerance: A biological relevant pathway to generate peripheral tolerance against external and self antigens. Chemical Immunology, 58: 259-90.

Fontana, E. A., Weaver, W.D. Watkins, Jr., B.A. & Denbow, D.M., 1992. Effect of early feed restriction on growth, feed conversion and mortality in broiler chickens. Poultry Science 71: 1296-1305.

Giang, V. D., & Doan, B. H., 1998. Effect of Vitamin C supplementation on the absorption of a diet for 0-4 week old chicks on the absorption of calcium and phosphorus, in Livestock research for Rural Development, CIPAV Publication, Colombia, 10(2).

Gross, W.B., 1998. Effect of environmental stress on the responses of ascorbic acid- treated chickens to Escherichra Coli Challenge infection. Avian Digestion 32: 432-436.

Hays, C.L., Davenpot, G.M., Osborn, T.G., & Mulvaney, D.R., 1995. Effect of dietary protein and estradiol-17B on growth and insulin-like growth factor I in cattle during realimentation. Journal. Anim. Science.73: 589-597.

Harverstein, G.B., Ferket, P.R., Scheider,S.E., & Larson, B.T., 1994. Growth, Livability and feed conversion of 1957 vs 1991 broilers when fed "typical" 1957 and 1991 diets. Poultry Science 73: 1785-1794.

Hogan, J.A., 1984. Pecking and Feeding in chicks. Learn Motiv 15: 360-376.

Hogberg, M. G., & Zimmerman, D.R., 1978. Compensatory responses to dietary protein, length of starter period and strain of pig. Journal. Anim. Sci. 47: 893-899.

Hopkins, D. L., & Tulloh., N.M., 1985. Effects of a severe nutritional check in early post-natal life on the subsequent growth of sheep to the age of 12 -14 months. Journal. Agric. Sci. (Camb). 105: 551-562.

Horning, M.P., & Frigg, M., 1979. Effects of age on biosynthesis of ascorbale in chicks. Archiv fuer Gefluegelkunde 43: 108-112.

Hornick, J.L., Eenaeme C. Van., Clinquart, A., Diex, M., & Istasse, L., 1998a. Different periods of feed restriction before compensatory growth in Belgian Blue Bulls: 1. Animal performance, nitrogen balance, meat characteristics and fat composition. Journal Animal Science. 76: 249-259.

Hornick, J.L., Eenaeme C. Van., Clinquart, A., Diex, M.,& Istasse, L., 1998b. Different periods of feed restriction before compensatory growth in Belgian Blue Bulls: 11. Plasma metabolites and hormones. Journal Animal Science. 76: 260-271

Jaffar, G.H., & Blaha, J., 1996. Effect of ascorbic acid supplementation in drinking water on growth rate, feed consumption and feed efficiency of broiler chickens maintained under acute heat stress conditions. Universitas Agriculrae Praga Press. 41 (1) 485-490.

Jones, G.P.D., & Farrell, D.J., 1992. Early life food restriction of the chicken.1. Methods of Application, amino acid supplementation and the age at which restriction should commence. British Poultry Science 33: 579-587.

Jones, G.P.D., 1995. Manipulation of organ growth by early-life food restriction: Its influence on the development of ascites in broiler chickens.British Poultry Science 36: 135-142.

Kamalzadeh, A., Koops, W.J., Bruchem Van. J., & Bangma, G.a., 1998. Effect of duration of Feed quality restriction on body dimensions in lambs. Journal Animal. Science. 76: 735-742.

Kassim, H., & Norziha, I., 1995. Effect of ascorbic acid (vitamin C) supplementation in layer and broiler diets in the tropics. Asian-australas Journal. Animal Science 8: 607-610.

Klasing, K.C., 1998. Nutritional modulation of resistance to infectious diseases. Poultry Science. Vol 77. page. 1119-1125

Knight, C.D., & Dibber, J.J., 1998. The Feeding of Neonatal Poultry. World Poultry, vol. 14 no.5, Pgs 1-5.

Kutlu, H.R., & Forbes J.M., 1993. Effect of changes in environmental temperature on self-selection of ascorbic acid in colored feeds by broiler chicks. Proceedings Nutrition Society 52: 29A.

Kyriazakis, I., Stamataris, C., Emmans, G.C., & Whittemore, C.T. 1991. The effects of food protein content on the performance of pigs previously given foods with low or moderate protein contents. Anim. Prod. 52: 165-173

Labadan, M.C (Jr)., Hsu, K.N., & Austic, R. E., 2001. Lysine and Arginine requirements of broiler chickens at two to three week intervals to eighteen weeks of age. Poultry Science 80: 599-606.

Lehmann, D., Pack, M., & Jeroch, H., 1996. Response of growing and finishing turkey toms to dietary lysine. Poultry Science 75: 711-718.

Leeson. S., & Summers J.D., 2001. Nutrition of the Chicken. 4th ed. Univ. Books, Guetph, ON. Canada.

Lowenthal, J.W., & Trout, J.M., Development of T cell immune responsiveness in the chicken. Immunology and Cell Biology. Vol. 72: page. 115-122

Lucas, A., 1998. Programming by early Nutrition: An experimental approach Journal of Nutrition.128: 4015-4065.

Maiorka. A., & Malheiros. R.D., 2000. Desenvolvimento do trato gastrointestinal de embrioes oriundos de matrizes pesadas de 30 e 60 semanas de idade. Revista Brasileira de Ciencia Avicola, v.2, p.141-148.

Marks, H.L., 1979. Growth rate and feed intake of selected and nonselected Broilers. Growth 43: 80-90.

Marshall, P.T., & Hughes, G.M., 1980. Physiology of mammals and other vertebrates. Chapter11: The endocrine system, page 277-300, Cambridge University Press. USA.

McCane, R.A., 1962. Food growth and time. Lancet Li :271-272

McDonald, P., Edwards, R. A., & Greenhalgh, J.F.D., 1992. Evaluation of foods (A) Digestibility. In: Animal Nutrition, 4th edition. Pages 200-216.

McDowell, L.R., 2000. Vitamins in Animal and Human Nutrition, 2nd ed. Iowa state University Press, Ames. Iowa.

McKee, J. S., & Harrison, P.C., 1995. Effect of supplemental ascorbic acid on the performance of broiler chickens exposed to multiple concurrent stressors. Poultry Science. 74 : 1772-1785.

McMurtry,J.P., Rosebrough, R.W. Plavnik,I. & Cartwright, A.I., 1998. Influence of early plane of nutrition on enzyme systems and subsequent tissue deposition. pp. 329-341 In: Biomechanisms Regulating Growth and Development (G. L. Steffens and T.S. Rumsey, ed). Betsville Symposia on Agricultural Research [12] Klumer Academic Publishers, Dordrecht, the Netherlands.

Mendonca, C. X., & Jensen, L.S., 1989. Influence of protein concentration on the sulphur containing amino acid requirement of broiler chickens. British Poultry Science 30 : 889-898

Moran, F.T., 1991. Success in Poultry keeping.Longman, Zimbabwe.

Morgan, J.H.L., 1972. Effect of plane of nutrition in early life on subsequent live weight gain, carcass and muscle characteristics and eating quality of meat in cattle. J. Agric. Sci. (Camb). 78: 417-423.

Mosier, H.D., Jr., 1986. The control of catch-up growth. Endocrinology, 113:1-7.

Moss, F.P., Sommonds, R.A., & McNary, H.W., 1964. The growth and composition of skeletal muscle in the chicken.Poultry Science. 43: 283-290

Nir, I., 1986. The uncertainties of broiler growth. PP 19-20. Proceedings world's Poultry Science, 10th European Symposium on Poultry Nutritiomn, Analysis Turkey.

Nitsan, Z., Ben-Avraham, G., Zoref Z., & Nir, I., 1991. Growth and development of the digestive organs and some enzyme in broiler chicks after hatching. British Poultry Science.32: 515-523.

Njoku, P,C., 1984. The effect of ascorbic acid supplementation on broiler performance in a tropical environment, in Poultry Science. 63: 156 (Abstract).

Njoku, P,C., 1986. The effect of dietary ascorbic acid supplementation on broiler performance in a tropical environment, in Animal Feed Science and Technology. 16: 17-24

Novus International Researchers., 1998. Early Nutrition helps achieve optimal performance. http://www.novusint.com.

Noy , Y., & Sklan, D., 1997. Posthatch development in poultry. Journal Applied Poultry Research 6: 344-354.

Noy , Y., & Sklan, D., 1998a. Metabolic responses to early nutrition. Journal Applied Poultry Research 7: 437-451.

Noy , Y., & Sklan, D., 1998b. Metabolic responses to early nutrition. Journal Applied Poultry Research 7: 437-451.

Noy , Y., & Sklan, D., 1999. Energy utilization in newly chicks. Poultry. Science. 78: 1750-1756

Null, G., 2001. The antioxidant Vitamin-Vitamin C in www. Vitaminfoundation.org.

NRC., 1994. National Research Council. Nutrient requirements of Poultry. 9th revised. ed. National Academy Science.,Washington. DC.

Pardue, S. L., & Thaxton, J.P., 1984. Ascorbic acid and physiological stress. Pages 25-31 in Proc. Ascorbic Acid in Domestic Animals. Royal Danish Agricultural Society, Copenhagen.

Pardue, S.L., Thaxton, J.P. & Brake. J., 1985. Role of ascorbic acid in chicks exposed to high environmental temperature. Journal Applied Physiology 58: 1511-1516.

Pardue, S. L., & Thaxton, J.P., 1986. Ascorbic acid in poultry: A review. World Poultry Science Journal 42: 107-123.

Pedersen, C. V., 1998. Fare driven research on the village chicken production in Zimbabwe. http://www.iaea.org.

Peters, T., 1997. Weight at five weeks determines future laying performance. In: World Poultry Misset, vol. 13, no.6 p.43.

Pitts, G.C., 1986. Cellular aspects of growth and catch-up growth in rats: A re-evaluation. Growth 50: 419-436.

Pinchasov, Y., & Noy, Y., 1993. Comparision of post-hatch holding time and subsequent early performance of broiler chicks and turkey poults British.Poultry Science. 69: 1718-1723.

Plavnik, I., & Hurwitz, S., 1985. The performance of broiler chicks during and following a severe feed restriction at an early age. Poultry Science 64: 348-355.

Plavnik, I., & Hurwitz,S., 1988a. Early feed restriction in chicks: Effects of age, duration and Sex. Poultry Sc. 67: 1407-1413.

Plavnik, I., & Hurwitz, S., 1988b. Early feed restriction in male turkeys: Growth pattern, feed efficiency and body composition. Poultry Sci.67: 1407-1413.

Plavnik, I., & Hurwitz, S., 1989. Effect of dietary protein, energy and feed pelleting on the response of chicks to early feed restriction. Poultry Science 68: 1118-1125.

Plavnik, I., & Hurwitz,S., 1991. Response of broiler chickens and turkey poults to feed restriction of varied severity during early life. British Poultry Science 32:343-352

Puron, D., Santamaria, P. & Segura, J. C., 1994. Effect of Sodium Bicarbonate, Acetylsalicylic and Ascorbic acid on broiler performance in a tropical Environment. Journal of Applied Poultry Research, 3: 141-145

Quarks, C. R., & Adrian, W. J., 1988. The role of vitamin C in poultry. Page 37 in stress management. RCD 7839. Hoffman-LaRoche Inc. Nutlcy. NJ.

Religious, K.B., Tesseraud. S., & Piccady, O. A., 2001. Food neonatale and early development of table fowl. 2001, INRA. Production. Animal., 14, 219-230.

Rose, M.E., & Rogaush ,H., 1974. Immunoglobulin classes in the hen's egg: Their segregation in yolk and white. European Journal Immunology. 4. 521-523.

Ryan, W. J., Williams, I. H., & Moir, R.J., 1993b. Compensatory growth in sheep and cattle.11. Changes in body composition and tissue weights Aust. J. Agric Res. 44: 1623-1633.

Ryan, W. J., Williams, I. H., & Moir, R.J., 1993a. Compensatory growth in sheep and cattle.1. Growth pattern and feed intake. Aust. J. Agric Res. 44: 1623-1633.

Ryan, W.J., 1990. Compensatory growth in cattle and sheep. Nutrition Abstract Revision (B) 60: 653-664.

Santra, A., & Pathak, N.N., 1999. Nutrient utilization and compensatory growth in crossbred (Bos indicus X Bos taurus) calves. Journal. Anim. Sci. 12: 1285-1291.

Sanchez, A., Plouzeau, M., Rault, P., & Picard M., 2000. Croissance musculaire et function cardio-respiratoire chez le poulet de chair. INRA Prod. Animal., 13, 37-45.

SAS, 2000. SAS User's Guide: statistics 6th edition. SAS Institute, Inc.Raleigh, North Carolina, USA.

Sell, J .L., Angel, C. R., Piquer F.J., Mallarino, E.G., & AL-Batshan, H.A., 1991. Development patterns of selected characteristics of the gastrointestinal tract of young turkeys. Poultry Science. 70: 1200-1205.

Shehata, A. T., & Skalan. D., 1984. Development of nutrient transport system in chicks jejunum. America Journal of physiology. Vol. 246, page G101-G107.

Sklan, D., & Noy, Y., 2000. Hydrolysis and absorption in the small intestines of post-hatch chicks. Poultry. Science. 79: 1306-1310.

Sonaiya, E.A., 1999. National Interventions. The evidence. Proceeding of Nutrition Society. 59: 417-418.

Snoek, A. C., Remacle, B. Reusens, & Hoet, J.J., 1990. Effect of a low protein diet during pregnancy on the fetal rat endocrine pancreas. Biological Neonate 57: 107-118.

Smith, R., 1998. Turkey growers urged to achieve maximum potential, optimal results. In: Feedstuffs vol 70, no. 18 p.14.

Sykes, A.H., 1977. Nutrition-environment interaction in poultry, in nutrition and the climate Environment. Page 17-31, Butterworth Group, Nottinham, UK.

Taylor, St. C. S., Turner, H.G., & Young, G. B., 1981. Genetic control of equilibrium maintenance efficiency in cattle. Anim. Prod. 33: 170-194.

Thaxton, J. P., & Pardue, S. L., 1984. Ascorbic acid and physiological stress. Pages 25-31 in Proc. Ascorbic Acid in Domestic Animals. Royal Danish Agricultural Society, Copenhagen.

Traber, P.G., & Turro, I., 1991. Isolation of intestinal epithelial cells for the study of differential gene expression along the crypt-villus axis. American Journal of physiology. 260: G895-G903.

Tudor, G.D., & O'Rourke., 1980. The effect of pre and post-natal nutrition on the growth of beef cattle. 11. The effect of severe restriction in early post-natal life on growth and feed efficiency during recovery. Aust. J. Agric. Res. 31: 179-189.

Uni, Z., & Ferket, R.P., 2004. Methods for early nutrition and their potential. World's Poultry Science Journal, Volume 60, Number 1, March 2004, pp. 101-111(11)

Wyatt, C. L., Weaver,W.D.Jr., & Beane, W.L., 1985. Influence of egg size, eggshell quality, and post-hatch holding time on broiler performance. Poultry Science 64: 2049-2055.

Wilson, P.N., & Osbourne, D.F., 1960. Compensatory growth after undernutrition in mammals and birds. Biological Review 89: 300-306.

Yambayamba, E.S.K., Price M.A. & Foxcroft, G.R., 1996. Hormonal status, metabolic changes, And resting metabolic rate in beef heifers undergoing compensatory growth. Journal Animal Science. 74: 57-69.

Yu, M.E., & Robinson, F.E., 1992. The application of short term feed restriction to broiler Chicken production: A review. Journal of Applied Poultry Research.Volume: 147-153.

Zubair, A.K., & Leeson, S., 1986. Compensatory growth in broiler chicken: World Poultry Science Journal. Vol. 52 July. Pages189-201.

Zubair, A.K., & Leeson, S., 1994. Effect of varying period of early nutrient restriction on growth composition and carcass characteristics of male broilers. Poult. Sci. 73: 129-136

Zubair, A.K., & Leeson, S., 1996. Compensatory growth in broiler chicken: A review. World Poultry Science 52: 189-201.

Zulkifli, I., Rambah, A.K., Vidadaran, M.K., & Rasedee, A., 1996. Dietary Ascorbic acid: Self-selection and response to high temp. and humidity in broilers. Malayasia Applied Biology 25: 93-101.

CHAPTER 8

APPENDICES

APPENDIX 8. 1: VACCINATION PROGRAM

The vaccination program of the experiment was as indicated below.

WEEK ONE:

Day one on arrival:

1. Chicks were vaccinated against Newcastle disease from the hatchery using Clone 30. Secondly, Vita stress was added in the drinking water immediately on arrival for the first two days to calm down the chicks due to stress they mighty have experienced through transportation and handling.

Day three:

1. Tylo Tad was added in the drinking water for prevention of *Escheria coli* bacteria and other disease causing microorganisms

Day seven:

1. Chicks was vaccinated against Infectious Bronchitis using "IBH 120".

WEEK TWO:

Day twelve:

1. Chicks was vaccinated against Gumbora using D78 through drinking water.

WEEK THREE:

Day eighteen:

1. Vaccinate against Gumbora using D78.

Day twenty one:

1. Tylotad was added in the drinking water. The withdrawal period was 15 days.

WEEK FOUR:

Day twenty three:

1. Vaccinate against New Castle disease using Clone 30.