Effects of L-carnitine supplementation in drinking water on layer-type chick juvenile performance

Einfluss einer L-Carnitin-Zulage zum Trinkwasser auf die Entwicklung von Legehennenküken in der Starterphase

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Introduction

Improvement of chicken performance can be realized with 1-d-old chicks of high quality, which may be determined a posteriori by their survivability and growth potential (Christensen, 2001). Several factors in newly hatched chicks can influence post-hatch growth, and these include chick holding and nutritional conditions during juvenile stage (Uni and Ferket, 2004). According to Romanoff (1960), yolk sac is an important source of energy in developing embryo. This author reported that almost 20% of the body weight of newly hatched chicks is yolk, which provides immediate post-hatch energy. Indeed, Anthony et al. (1989) and Noy and Sklan (1998) reported that during the first days of life, yolk sac content is used for maintenance. Energy of chick during the first days of life is provided by oxidation of fatty acids of yolk sac content (Puvadolphro et al., 1997). During the first 5 d after hatching, chicks acquire yolk derived lipids via lipoproteins. It is also assumed that yolk sac is involved in initiation of the growth process for chicks (Bigot et al., 2001) and carries immunoglobulins which are transferred from hen to chick. With regard to its importance during early stage of chick life, quick utilization of yolk sac content can improve chick juvenile performance parameters such as growth rate, feed efficiency and mortality. Fast utilization of yolk sac content can be enhanced by administration of substances that can be involved in fatty acid metabolism. L-carnitine is well known for its metabolic activity of fatty acid (Rebouche, 1992; Hsu et al., 2001) and in addition to its anti-oxidant activity. L-carnitine enhances long chain fatty acids' metabolism through mitochondrial membrane. It can be produced by the animal organism from lysine and methionine. Arslan (2006) reported that endogenous production together with feed supplementation of L-carnitine should be sufficient to cover the needs of adult birds. However, in young chick biosynthesis of L-carnitine is less well developed and therefore, L-carnitine supplementation of chicks during the starter stage may lead to faster utilization of yolk sac content. This fast utilization of yolk may result in improvement of performance parameters and immunity functions. The aim of this study was to investigate the effects of supplementation of L-carnitine in drinking water during the first 7 d of life on juvenile growth rate, feed efficiency, yolk sac content utilization, morbidity and serum levels of triglyceride and total proteins.

Material and Methods

Experimental design

A total of 684 Hisex Brown female layer chicks provided by VLIR project hatchery (Laboratory of Poultry Sciences, University of Lome) were studied. The chicks were randomized and divided into three different groups of 228 chicks each. These groups were 1) control group (Cont), 2) chicks with supplementation of 30 mg of L-carnitine per liter of drinking water (LC30) and 3) chicks with supplementation of 60 mg of L-carnitine per liter of drinking water (LC 60). L-carnitine doses were based on studies of Xu et al. (2003) and Buyse et al. (2001). L-carnitine supplementation took place during the first 7 d of rearing. Within each group, chicks were weighed individually and divided into two replications of 114 each. They were fed with standard starter diet2 (2,800 Kcal ME/kg and 20% CP). Feed and water were provided ad libitum. Within each replication, all chicks were weighed individually at 7 and 14 d of age. Sample of 36 chicks were used to collect blood and to weigh residual yolk sac at 1, 7 and 14 d of age. Blood samples were used to determine serum levels of triglyceride and total proteins. Feed consumptions were measured and numbers of chicks showing morbidity signs during the first week of life were recorded.

Morbidity definition

Morbidity was defined as chick showing sign of diarrhea in cloacal area. During the first week of life, all the chicks were checked individually within each replication. For each group, numbers of chicks that showed sign of diarrhea were recorded. These numbers were used to calculate the proportions of chicks showing morbidity signs as:

\[
\text{Morbidity} = \frac{NI}{N} \times 100
\]

where \(N\) = number of chicks showing sign of diarrhea in the cloacal area, \(N\) = total chick of chicks and \(i\) = replication i.

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Triglyceride, Glucose and total proteins levels determination

For Triglyceride and total proteins measurements, blood samples were collected from chicks at 1, 7 and 14 d of age. Within each replication, blood samples were collected from 18 chicks at each stage. Triglyceride and total proteins were measured in serum samples by Elisa. Total protein liquicolor, glucose liquicolor, and triglycerides liquicolor provided by Human GmbH (65205 Wiesbaden – Germany) were used for, respectively, total protein and triglyceride concentration determination. All samples were run in the same assay in order to avoid inter-assay variability.

Statistical analysis

The data were processed with a statistical software package of SYSTAT 11. The general linear models procedure was used to analyze chick weights; serum triglyceride and total proteins concentrations in relation to treatment. The model was as follows:

$$Y_i = \mu + \alpha_i + \varepsilon_i,$$

Where, $Y_i$ = chick weights, triglyceride or total proteins concentrations of chick from treatment i, $\mu$ = overall mean, $\alpha_i$ = main effect of treatment i, and $\varepsilon_i$ = random error term from treatment.

Logistic regression was used to analyze the effect of treatment on morbidity and feed intake.

Results

Effect of L-carnitine on chick weights

Day-old chick weights were similar between the three treatment groups. Overall, chick weight increased from 71.8 g at 7 d of age to 116.4 g at 14 d of age. Figure 1 shows average chick weights according to age and treatments. At 7 d of age, chicks of control group were lighter ($P < 0.05$) than those of LC30 and LC60 which were comparable. At d 14 of age, chick weights of control group were slightly higher than those of LC30 and LC60 but the difference was not significant.

Effect of L-carnitine on yolk sac utilization and morbidity

Yolk sac weights of d-old chicks were similar between groups. Figure 2 indicates that, at 7 d of age, remaining yolk sac weights decreased with increasing dose of L-carnitine ($P < 0.05$). At the same stage proportion of chicks showing morbidity signs was higher in control group compared to LC30 and LC60 groups (Figure 3; $P < 0.05$). Proportions of chicks with morbidity signs were not different between LC30 and LC60 groups.

Effect of L-carnitine on feed intake

Daily feed intake per chick varied between 14.1 g and 15.7 g or 16.4 and 18.07 g, respectively, during the first or the second week of age. Figure 4 shows feed consumption according to treatments and age of chicks. Feed intake increased as age of chicks increased ($P < 0.01$). During the first week of life, amount of feed consumed decreased with increasing dose of L-carnitine ($P < 0.05$). For the second week, feed intake of chicks of control group was higher ($P < 0.05$) than that of chicks of LC30 and LC60 groups which were comparable.

Effect of L-carnitine on triglyceride and total proteins concentrations

Serum triglyceride, glucose and total protein concentrations of d-old chicks were similar between groups. Average concentrations were 300.97 mg/dL, 86.05 mg/dL and 4.15 mg/dL, respectively for triglycerides, glucose and total protein. Glucose levels were not affected by L-carnitine supplementation and age of chicks (data not shown). Figure 5 indicates that overall levels of triglyceride decreased from d 7 to d 14 ($P < 0.01$). At 7 d and 14 d of age,
triglyceride levels decreased significantly with increasing dose of L-carnitine ($P < 0.01$).

Figure 6 shows concentrations of total proteins in serum according to treatment and chick age. Total proteins levels decreased with increasing age of chicks ($P < 0.01$). At d 7 of age, proteins concentrations were higher in serum of chicks of control group ($P < 0.01$) than those of LC30 and LC60 which were similar. But, at 14 d of age proteins concentrations were comparable between all treatment groups.

Discussion

The results from this study clearly demonstrate L-carnitine supplementation in drinking water leads to more efficient utilization of yolk sac content and therefore, improves chick juvenile growth, morbidity and feed efficiency. L-carnitine supplementation also affected serum levels of biochemical parameters such as triglycerides and total protein concentrations.
At hatching, the weight of the yolk residue is approximately 10 to 20% of the body weight (Romanoﬀ, 1960 and Nitsan et al., 1991). Yolk comprises 16–20% lipids and 20–25% proteins at hatch. Yolk lipids are mainly composed of triglycerides (72,5%) and phospholipids (25%) with small amounts of cholesterol esters (4%) and no free fatty acids (Noble and Ogunyemi, 1989 and Nov and Sklan, 1998). Although the decrease in protein during the first day is slight, thereafter it was rapid reaching only 10% of the original protein content on day 6 (Nitsan et al., 1991). The current study shows that L-carnitine supplementation in drinking water during the ﬁrst week of chick life leads to fast utilization of yolk sac content. This result is in the line with report of Zhai et al. (2008) who pointed out that high concentration of L-carnitine in the yolk of hatching eggs encourages the utilization of fat. According to Bigot et al. (2001), the rate of yolk sac content absorption is mainly related to intensive peristaltic activity. It can be hypothesized that L-carnitine increases peristaltic activity that is involved in yolk sac content absorption. Moreover, it is well known that L-carnitine is involved in fat metabolism (Rabies and Ul for facilitating project activities implementation.

L-carnitine administration decreased serum triglyceride levels during the ﬁrst two weeks of age. Moreover, the decrease was more pronounced in LC60 group conﬁrming that L-carnitine is greatly involved in fat metabolism. This result is in the line with reports of Sayed et al. (2001), Lieng and Horng (2001) and Buyse et al. (2001) who pointed out that incorporation of L-carnitine in broiler diet decreased serum concentration of triglycerides.

The negative effect of L-carnitine on serum total protein levels during the ﬁrst week of age may be partly explained by increased mobilization of proteins for growth during this stage. Surprisingly, L-carnitine administration leads to high body weight at the end of 7 d of rearing and coincides with period of administration of L-carnitine. Also, changes in body weight followed exactly the same trend as serum total protein levels suggesting that the low protein levels in the L-carnitine supplemented chicks may be a consequence of utilization of proteins for growth. Indeed, high body weight at the end of 7 d can be due to positive effect of L-carnitine of yolk lipoproteins utilization. With regard to feed intake, this study pointed out that supplementation of L-carnitine in drinking water improves feed efficiency up to 14 d. This improvement in feed efﬁciency may be linked to better utilization of yolk sac content for maintenance and for juvenile growth.

It is concluded that L-carnitine supplementation in drinking water leads to quick utilization of yolk sac content improved in a dose dependent way, and may hence be considered for improving early post-hatch performance.

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Summary

In young chicks, L-carnitine supplementation during the starter stage may lead to faster utilization of yolk sac content and hence improvement of juvenile performance. To evaluate possible dose effects of L-carnitine supplementation in drinking water on juvenile layer-type chick performance, a total of 684 Hisex Brown layer chicks were studied. The chicks were divided into three groups of 228 chicks each, namely 1) control group (Cont), 2) chicks with supplementation of 30 mg of L-carnitine per liter of drinking water (LC30) and 3) chicks with supplementation of 60 mg of L-carnitine per liter of drinking water (LC60). Within each group, chicks were divided into two replications of 114 each and were reared up to 14 d of age. Sample of chicks used to collect blood and to weigh yolk sac at 1, 7 and 14 d of age.

Results indicate that, yolk sac utilization, morbidity and serum concentration of triglyceride decreased signiﬁcantly with increasing dose of L-carnitine (P < 0.05). The decrease in triglyceride concentration lasted up to 14 d of age not understanding the fact that L-carnitine supplementation covered only the ﬁrst 7 d. Serum total protein levels or chick body weights, respectively, were lower or higher in L-carnitine supplemented chicks compared to control group (P < 0.05) only during the period of administration. It is concluded that L-carnitine supplementation in drinking water inﬂuences chick juvenile performance parameters and this is in relationship to yolk sac consumption and blood biochemical parameters.

Key words

Layer chick, L-carnitine supplementation, yolk utilization, production parameters.

Zusammenfassung

Einﬂuss einer L-Carnitin-Zulage zum Trinkwasser auf die Entwicklung von Legehennenküken in der Starterphase


Mit der Höhe des Zusatzes an L-Carnitin zum Trinkwasser nahm die Verwertung des Dottersacks signiﬁkant zu und die Morbidität sowie die Serum-Triglyzerid-Konzentration signiﬁkant ab (P < 0.05). Der Rückgang der Serum-Triglyzerid-Konzentration hielt bis zum 14. Lebenstag an, obwohl die L-Carnitin-Zulage nur bis zum 7. LT erfolgte. Die Serum-Gesamtweiß-Konzentration war bei den L-Carnitin-Behandlungen nur während der Zulageperiode geringer und das Körpergewicht höher als bei der Kontrollgruppe (P < 0.05). Es kann daher der Schluss gezogen wer-

**Stichworte**

Legehennenküken, L-Carnitin-Zulage, Dotterverbrauch, Entwicklung

**Abbreviation keys**

LC30: Chicks with supplementation of 30 mg of L-carniti­ne per liter of drinking water;  
LC60: chicks with supplementation of 60 mg of L-carnitine per liter of drinking water.

**References**


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