Effect of L-carnitine on performance and dressing percentage of broiler chickens

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Abstract: Effect of L-carnitine on performance and dressing percentage of broiler chickens. The study was conducted on 640 chickens randomly divided into two groups, each having four replications (4 control and 4 experimental – L-carnitine) with 80 chickens per pen. Chickens in the control (C) and experimental groups (E) received a feed of the same nutritional value, and chickens from the experimental group were supplemented with Aminocarnifarm (43.68% of L-carnitine) in drinking water (62.5 g per 100 l) during three periods: from 1 to 7, 21 to 28, and 36 to 42 days of age. The study evaluated the effect of L-carnitine supplemented to chickens on production results and results of slaughter analysis. It was found that Aminocarnifarm supplemented to drinking water improved feed conversion during the whole rearing period, reduced mortality, and contributed to increases in average body weight, dressing percentage and proportion of leg muscles (males), reduced the proportion of breast muscles (males and females), and decreased carcass fatness (males).

Key words: broiler chickens, L-carnitine, production results, slaughter analysis.

INTRODUCTION

In recent years, broiler chickens have been intensively selected for increased weight gain. This strategy improved the rate of growth and feed conversion but had undesirable effects in the form of increased deposition of abdominal fat and greater incidence of metabolic diseases, such as ascites. Excess carcass fat is un-attractive to healthy-eating consumers who reach for poultry meat because of its nutritional properties. At the same time, increased carcass fatness reduces the profits of poultry producers. The problem can be addressed through proper selection, but this is a long-term process and breeders look for quick solutions. One solution is to provide broilers with dietary supplements such as L-carnitine (Buyse et al. 2001).

L-carnitine is synthesized in vivo from lysine and methionine, and it is formed with contributions from vitamins B3 (niacin), B6 (pyridoxine), B12 (cyanocobalamin), C (ascorbic acid) and folic acid, as well as iron (Fe²⁺) (Golzar Adabi et al. 2011). This substance is needed to transport long-chain fatty acids into mitochondria, these acids taking part in β-oxidation that leads to production of energy (Carter et al. 1995, Brooks 1998). L-carnitine was discovered in the early 20th century by Gulewitsch and Krimberg, who isolated it from muscle tissue (Arslan 2006). L-carnitine prevents fatty tissue buildup, thus reducing obesity and atherosclerosis. It decreases the calorie requirement and increases the tolerance to effort (Pietrzak and Opala 1998). Many experiments and clinical observations showed that L-carnitine takes part in regulating the body’s lipid levels. It
also has the ability to reduce the level of triacylglycerols and cholesterol (Calvani et al. 2000).

L-carnitine is known to increase antioxidant status during aging. It is accepted that L-carnitine represents the second line of cell defence against reactive oxygen species and their derivatives as it breaks free-radical chain reactions (termination of peroxidation) and prevents undesirable oxidation reactions (Arenas et al. 1998). By reducing the amount of oxidative damage that occurs as a result of peroxidation of polyunsaturated fatty acids found in membrane phospholipids, L-carnitine plays a major role in stabilizing cell membranes and in regulating the function of ion channels (role in calcium transport) (Kalaiselvi and Panneerselvam 1998).

Over the last twenty years, many experiments were performed to test the use of L-carnitine in broiler nutrition. Researchers studied its effect on production parameters such as body weight, rate of growth, feed consumption and conversion, content of abdominal fat, proportion of breast and leg muscles, and giblets percentage. It was also investigated if L-carnitine has an effect on chicken health. The results obtained were inconsistent. Some authors provided conclusive evidence that L-carnitine has a beneficial effect on these parameters, while others held that L-carnitine has no effect on, or even adversely affects production results and mortality (Golzar Adabi et al. 2011).

One of the many commercially available L-carnitine supplements is Aminocarnifarm, which also contains taurine, vitamins and amino acids. It is a complex preparation that stimulates growth, resistance and body condition and can be used in all farm animals. According to the manufacturer, Aminocarnifarm performs multiple functions in broiler nutrition: it shortens the growth period and makes chickens more resistant while reducing flock mortality.

The objective of the study was to investigate the effect of Aminocarnifarm preparation on performance of broiler chickens and results of slaughter analysis.

MATERIAL AND METHODS

The experiment was conducted at the farm of the Warsaw University of Life Sciences in Obory (Poland) using Cobb 500 broiler chickens, which were reared to 42 days of age in accordance with flock management guidelines. A total of 640 chickens were randomly divided into two groups, each having four replications (4 control and 4 experimental – L-carnitine) with 80 chickens per pen. Chickens in the control (C) and experimental groups (E) received a feed of the same nutritional value, and chickens from the experimental group were supplemented with Aminocarnifarm in water (62.5 g per 100 l) during three periods: from 1 to 7, 21 to 28, and 36 to 42 days of age. Aminocarnifarm contains vitamins (B6, B7, B12), calcium, amino acids and L-carnitine (43.68% of the preparation).

Chickens were fed starter (days 1 to 21), grower (days 22 to 35) and finisher diets (days 36 to 42). The nutritive value of the diets, provided by the manufacturer, and the results of analysis are presented in Table 1.
During the experiment, birds were monitored for individual body weight at 1, 21, 35 and 42 days of age, feed consumption each time the feed changed, and health status (mortality and culling).

At the end of the rearing period on day 42, 6 males and 6 females with body weight similar to the mean body weight of a given sex in the group were chosen from each group for slaughter, weighed and subjected to a 12-hours feed withdrawal. After slaughter, carcasses were chilled, weighed and subjected to simplified dissection. Abdominal fat, edible giblets, and breast and leg muscles were collected and weighed. The results obtained were used to calculate dressing percentage and the percentage of carcass components.

The results were analysed statistically by analysis of one-way variance using SPSS 14.0 PL for Windows (SPSS 2006).

### RESULTS

Tables 2 and 3 present the average body weight of broiler chickens at 1, 21, 35 and 42 days of rearing. The experimental group, in which chickens were supplemented with L-carnitine in Aminocarni-farm achieved higher body weights compared to the control group. Significant differences were noted in males at 35 and 42 days of rearing. The preparation also had an effect on the body weight of females, but the differences were not significant. It was found that L-carnitine preparation slightly reduced mortality and improved feed conversion (kg·kg⁻¹) in chickens (Table 4). Mortality to 14 days of age was due to omphalitis, yolk sac inflammation and gout. Between 15 and 42 days of age, pulmonary congestion, exudative diathesis and crop impact were found in necropsied birds.

### TABLE 1. Nutritive value of basal diet in broiler feeding

<table>
<thead>
<tr>
<th>Specification</th>
<th>Type of a diet/Age of chicken (days)</th>
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<tr>
<td></td>
<td>Starter (1–21)</td>
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<tr>
<td></td>
<td>Grower (22–35)</td>
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<td></td>
<td>Finisher (36–42)</td>
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<tr>
<td>EMₙ (MJ·kg⁻¹)</td>
<td>12.00</td>
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<tr>
<td>Total protein (%)**</td>
<td>19.96</td>
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<tr>
<td>Lysine (%)</td>
<td>1.39</td>
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<tr>
<td>Met. + Cys. (%)</td>
<td>0.97</td>
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<tr>
<td>Threonine (%)</td>
<td>0.82</td>
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<tr>
<td>Tryptophan (%)</td>
<td>0.23</td>
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<tr>
<td>Crude fibre (%)**</td>
<td>2.20</td>
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<tr>
<td>Crude fat (%)**</td>
<td>4.10</td>
</tr>
<tr>
<td>Crude ash (%)**</td>
<td>5.50</td>
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<tr>
<td>Nitrogen – free extract (%)**</td>
<td>55.84</td>
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**analysis of nutritive value of fodders applied in the nutrition of the broiler chickens.
Dressing percentage, the proportion of breast muscles, leg muscles and giblets, and abdominal fat content are being constantly improved by broiler breeders. The breast and leg muscles of today’s broilers are much better developed than in old-type broilers, with an approximately 90% increase in dressing percentage compared to the 1950s. However, the increased rate of growth had a negative impact on broilers. The weight of digestive tract decreased, which impaired digestion, and chickens became fatter. Fat is predominantly deposited in the abdominal cavity, in the vicinity of the cloaca, and under the skin, and because it is a waste product efforts are made to reduce its content through the use of dietary supplements.

Dressing percentage of males was higher in the experimental group that received L-carnitine compared to the control group (Table 5), but the difference was not significant. A similar relationship was observed in females, in which the difference was significant at $P < 0.01$ (Table 6).

Feeding L-carnitine to the experimental group of males caused a non-significant decrease in the proportion of breast muscles and a significant increase in the proportion of leg muscles compared to the control group (Table 5). The proportion of breast muscles also decreased in the experimental group of females (Table 6). The proportion of leg muscles was similar in both groups.

L-carnitine supplementation decreased carcass abdominal fat in males (Table 5),
but increased it in females (Table 6). The inclusion of L-carnitine to the diets of chickens from the experimental group had little effect on the proportion of gizzard, liver and heart. In males, the proportion of gizzard remained almost unchanged and the proportion of liver and heart slightly decreased in the L-carnitine-supplemented group compared to the control group. In females from the experimental group, the proportion of gizzard decreased, the proportion of liver increased significantly, and the proportion of heart remained almost unchanged (Table 7).

**DISCUSSION**

The experimental group in which chickens were supplemented with L-carnitine had higher body weights compared to the control group. It was shown that the increased body weight of chickens may result from the contribution of L-carnitine to the metabolism of long-chain fatty acids in cell mitochondria. L-carnitine transports fatty acid molecules, present in the form of acetyl-CoA, from cytosol to the mitochondrial matrix where they are oxidized, resulting in the production

<table>
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<th>TABLE 5. Results of slaughter analysis – male (%)</th>
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</tr>
<tr>
<td>Control group</td>
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<tr>
<td>Experimental group</td>
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a, b – means with different superscripts differ significantly at $P \leq 0.05$ (in column).

<table>
<thead>
<tr>
<th>TABLE 6. Results of slaughter analysis – female (%)</th>
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<tr>
<td>Item</td>
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</tr>
<tr>
<td>Control group</td>
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<td></td>
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<tr>
<td>Experimental group</td>
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<td>SE</td>
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a, b – means with different superscripts differ significantly at $P \leq 0.05$ (in column); A, B – means with different superscripts differ significantly at $P \leq 0.01$ (in column).

<table>
<thead>
<tr>
<th>TABLE 7. Results of slaughter analysis of male and female – giblets (%)</th>
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<td>Item</td>
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a, b – means with different superscripts differ significantly at $P \leq 0.05$ (in column).
of energy in the form of ATP in body cells (Hoppel 2003).

Rodehutscord et al. (2002) reported a significant effect of L-carnitine supplementation on energy and protein utilization by Ross broilers given different levels of dietary energy. They fed L-carnitine from 1 to 21 days of age and noted an increase in body weight in the experimental group compared to the control group of chickens, when 4 and 8% of fat was added to the diet. In their study on the effect of L-carnitine, Buyse et al. (2001) showed a non-significant increase in average body weight of chickens receiving L-carnitine at 14, 21, 28 and 42 days of rearing. In males, the average body weight to 28 days was non-significantly lower in the experimental compared to the control group, but at the end of rearing (day 42) the results were the same in both groups.

Nouboukpo et al. (2009), who investigated the effect of L-carnitine supplemented in drinking water on the growth of broiler chickens, observed at 7 days of rearing that chickens from the control group had significantly lower body weight compared to the experimental groups receiving 30 and 60 mg of L-carnitine in 1 l of drinking water.

In a study investigating the effect of L-carnitine supplementation of diets differing in energy levels on performance, Rabie and Szilagyi (1998) found that L-carnitine had a positive effect on the body weight of chickens at 53 days, but the differences were not significant.

Other authors who studied the effect of L-carnitine on broiler performance found that it had no effect on body weight. None of the levels of L-carnitine: 0 and 200 mg per 1 kg of feed (Leibetseder 1995); 0 and 160 mg per 1 kg of feed (Lien and Horng 2001); 0, 25, 50, 75 and 100 mg per 1 kg of feed (Xu et al. 2003); 0, 50, 100 and 150 mg per 1 kg of feed (Cevik and Ceylan 2005) increased the body weight of chickens.

L-carnitine was found to slightly reduce mortality and improve feed conversion (1 kg of feed per 1 kg gain). The decreased mortality could be due to the fact that L-carnitine increases the production of antibodies, thus enhancing body immunity (De Simone et al. 1982). Furthermore, L-carnitine has antioxidant effects as it prevents oxidative stress and regulates nitric oxide (NO) (Brown 1999) and influences the activity of enzymes that play a role in defence against oxidative agents (Kremser et al. 1995). The improvement in feed conversion could be due to the fact that L-carnitine enhances fatty acid burning, thus decreasing calorie requirements (Czeczot and Šcibor 2005).

Geng et al. (2004, 2007), who studied the effects of L-carnitine (added daily to feed from 1 to 42 days of age) and coenzyme Q10 on productivity of males, found that the supplements improved feed conversion ratio (FCR). In the experiment from 2004, the authors showed FCR to decrease non-significantly, and in the experiment from 2007, FCR decreased significantly in the group of males supplemented with 100 mg of L-carnitine per 1 kg of feed compared to the other groups.

Similar results were obtained by Rabie and Szilagyi (1998) who fed L-carnitine from 18 to 53 days of age and feed conversion improved regardless of the amount of dietary energy. The effect of L-carnitine was statistically significant.
The results obtained are not supported by the studies of Rezaei et al. (2007) and Buyse et al. (2001), in which L-carnitine supplemented to chickens had no effect on feed conversion.

In our experiment, mortality decreased in the L-carnitine-supplemented group compared to the control group. Similar findings were reported by Daskirian and Teeter (2001), who observed a significant decrease in mortality in broilers receiving dietary L-carnitine.

In two studies by Geng et al. (2004, 2007), L-carnitine had an effect on mortality due to ascites (pulmonary hypertension). This disease is assessed using the ascites heart index (AHI), which is the ratio of right ventricular weight to total ventricular weight (Burton et al. 1968). Broilers with AHI ≥ 0.30 are considered to suffer from pulmonary hypertension (Cawthon et al. 2001). The results of these two experiments were similar and showed that the L-carnitine supplement caused a significant decrease in ascites mortality.

Dressing percentage of males was higher in the experimental group supplemented with L-carnitine compared to the control group. Similar results were obtained by Daskirian and Teeter (2001) for Cobb broilers, the dressing percentage of which increased as a result of L-carnitine supplementation, but the differences were not significant.

Improved dressing percentage was also reported by Zhang et al. (2010), who studied the effect of acetyl-L-carnitine on meat quality and lipid metabolism in broilers. Dressing percentage increased with the increasing acetyl-L-carnitine supplementation, but the differences were not significant.

Different results were obtained by Celik and Ozturkcan (2003), who investigated the effect of supplemental L-carnitine and ascorbic acid on carcass composition, carcass yield, and plasma L-carnitine concentration of broiler chickens reared under different temperature; by Celik et al. (2003) in an experiment studying the effects of L-carnitine and niacin supplied by drinking water on rearing performance, carcass composition and plasma L-carnitine concentration of broiler chickens; and by Kidd et al. (2009), who determined the effect of L-carnitine on thigh yield in broilers. The three studies showed that L-carnitine supplementation had no effect on dressing percentage.

Xu et al. (2003) revealed that supplemental L-carnitine increases the proportion of breast and thigh muscles in the carcass. Best results for breast muscles were obtained when L-carnitine was added at 50 and 75 mg per 1 kg of feed. These results were significantly different compared to the other groups of broilers. The increase in leg muscles was not statistically significant.

The addition of acetyl-L-carnitine caused a non-significant increase in the proportion of breast and leg muscles (Zhang et al. 2010).

Different results were reported by Daskirian and Teeter (2001) for broilers, in which dietary L-carnitine exerted no effect on the proportion of breast muscles.

L-carnitine should decrease body fatness. Bremer (1983) proves that increased oxidation of fatty acids by L-carnitine makes them less available during esterification to triacylglycerols, which are deposited in adipose tissue. Xu et
al. (2003) also found a decrease in the abdominal fat of carcasses from males. In the group supplemented with L-carnitine, the abdominal fat content decreased significantly in relation to the control group.

Similar results were obtained by Wang et al. (2003), who found fat content to decrease in the experimental groups supplemented with L-carnitine, with statistically significant differences. Opposite results to those in the L-carnitine study were obtained by Buyse et al. (2001), who observed the proportion of abdominal fat to increase in the experimental group of males and to decrease in females. Different results were reported by Corduk et al. (2007) in an experiment investigating the effects of dietary energy density and L-carnitine supplementation on growth performance. Control broilers and those supplemented with L-carnitine in the experimental group (100 mg per 1 kg of feed) had the same abdominal fat content of 15 g per 1 kg of body weight. Kamińska (2003), who studied the effect of sex on fat content and other production parameters obtained similar results, which provided conclusive evidence that fat content was higher in pullets (2.9%) than in males (2.05% of their weight).

The dietary supplementation of chickens from the experimental group with Aminocarnifarm had little effect on the proportion of gizzard, liver and heart in the carcass. A study by Arslan et al. (2004), who added L-carnitine to goose diets, showed a significant ($P \leq 0.05$) increase in liver percentage in this group. Buyse et al. (2001) observed average liver and heart weight to increase in both males and females, but the differences were not significant. Decreased gizzard weight was found by Rabie and Szilagyi (1998), who reported that gizzard weight averaged 28.28 g in the control group of broilers and 27.39 g in the experimental group supplemented with 50 mg of L-carnitine per 1 kg of feed. These differences were not significant.

An increase in average liver weight was also reported by Celik et al. (2003), but it was not significant. Different results were obtained by Rezaei et al. (2007) in an experiment with broiler males, in which liver weight decreased and heart percentage remained unchanged in the experimental group receiving L-carnitine.

CONCLUSIONS

In summary, Aminocarnifarm (43.68% of L-carnitine) had a beneficial effect on weight gains, mortality and feed conversion, and increased dressing percentage and the proportion of leg muscles.

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Streszczenie: Wpływ L-karnityny na wyniki produkcyjne i wydajność reżmową kurcząt brojlerów. Badania przeprowadzono na 640 kurczątach po- dzielonych losowo na dwie grupy, każda w cztery-ech powtorzeniach (4 kontrolne i 4 doświadczalne – L-karnityna), liczące po 80 ptaków. Kurcząta z grupy kontrolnej (K) i z grupy doświadczalnej (E) otrzymywały mieszankę o tej samej wartości odżywczej, natomiast kurczątoma z grupy
doświadczalnej podano dodatek Aminocarnifarmu (43,68% L-karnityny) do wody – 62,5 g na 100 l w 3 okresach: od 1 do 7, od 21 do 28 oraz od 36 do 42 dnia życia. Oceniano wpływ preparatu z L-karnityną dla kurcząt brojlerów na wyniki produkcyjne i wyniki analizy rzeźnej. Stwierdzono, że dodatek do wody Aminocarnifarmu spowodował w całym okresie odchowu poprawę wykorzystania paszy, obniżenie śmiertelności oraz wpłynął na wzrost średniej masy ciała (35. 42 dzień, \( P \leq 0,05 \)), wydajności rzeźnej (\( P \leq 0,01 \)), udziału mięśni nóg (\( P \leq 0,05 \)), udziału wątroby (\( P \leq 0,05 \)).

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