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EFFECT OF L-CARNITINE DIETARY SUPPLEMENTATION ON QUALITY CRITERIA OF BROILER CARCASSES DURING CHILLING STORAGE

(With 4 Tables)

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تأثير إضافة الكارنيتين لعلائق بدارى التسمين على جودة ذبائحها أثناء حفظها بالتبريد

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تهدف هذه الدراسة إلى معرفة تأثير إضافة الكارنيتين فى علائق بدارى التسمين على ذبائحها من حيث التركيب الكيميائى (الرطوبة، البروتين، الدهن، الرماد)، كمية دهن البطن والكوليستيرول فى اللحم بالإضافة إلى تأثيره على الجودة الحسية والكيميائية والبكتريولوجية وذلك أثناء حفظ هذه الذبائح بالتبريد. وفى هذا الصدد تم تربية ١٠٠ كتكوت من نوع (هابرد) عمر ٧ أيام وتقسيمهم إلى أربعة مجاميع (٢٥ كتكوت للمجموعة) وتغذية كل مجموعة على عليقة مختلفة فالمجموعة الضابطة تم تغذيتها على عليقة أساسية مكونة من ذرة وفول الصويا وتحتوى على ٣% زيت نباتى بينما المجموعة الأولى تم تغذيتها على العليقة الأساسية ولكن مع إضافة الكارنيتين بنسبة ١٠٠ مجم/ كجم من العليقة. أما المجموعة الثانية فقد تم تغذيتها على العليقة الأساسية ولكن مع وجود نقص فى الليسين بنسبة ٢٠% كذلك المجموعة الثالثة تم تغذيتها على نفس عليقة المجموعة الثانية مع إضافة الكارنيتين بنسبة ١٠٠ مجم/ كجم من العليقة. ولقد أظهرت النتائج وجود زيادة معنوية فى نسبة البروتين ونقص معنوى فى كمية دهن البطن وذلك فى المجاميع التى تم تغذيتها على علائق محتوية على الكارنيتين سواء كان هناك نقص فى الليسين أم لا. وبالنسبة للحفظ بالتبريد فقد أظهرت الذبائح جودة حسية عالية فى الأربعة أيام الأولى من التخزين وكان ذلك متوافقاً مع قيمة حامض الثيوباربيتيوريك وكمية المواد النيتروجينية الطيارة. وظلت هذه الذبائح مقبولة من الناحية الحسية حتى اليوم السابع مع وجود زيادة فى كمية المواد النيتروجينية الطيارة. أما عند اليوم العاشر فأظهرت الذبائح فساداً واضحاً من الناحية الحسية مصحوباً بارتفاعاً فى كمية المواد النيتروجينية الطيارة. وجاءت نتائج الفحص البكتريولوجى مرتفعة منذ بداية الحفظ مما قد يعكس حدوث تلوث أثناء عمليات الذبح والتجهيز. وأوضحت التحاليل الإحصائية عدم وجود فروق معنوية فى جودة الذبائح بين

المجموعات المختلفة. ومما سبق يتضح أن استخدام الكارنيتين فى علائق بدارى التسمين من الممكن أن يزيد من نسبة البروتين وأن يقلل من كمية دهن البطن ولكنه لا يؤثر على جودة ذبائح بدارى التسمين خلال فترة حفظها بالتبريد.

SUMMARY

Effects of L- carnitine dietary supplementation on proximate analysis, abdominal fat and cholesterol content in broiler carcasses were examined. In addition, sensory, chemical and bacteriological quality parameters of refrigerated storage broiler carcasses were conducted. Hubbard broiler chicks of 7 days old were used in this study. Four diet combinations were formulated. Maize-soybean containing 3% vegetable oil basal diet as control group, and group I was basal diet containing 100mg L-carnitine (Lonza, Biotec, S.r.o., CZ)/ kg diet. While group II was basal diet with 20% deficient lysine, and group III was basal diet containing 100mg L-carnitine / kg diet, and 20% lysine deficiency. Generally the obtained results revealed a significant increase in protein content and reduction of abdominal fat as absolute weights in groups fed on 100mg/kg L- carnitine containing diet irrespective to lysine content. The control and treated broilers carcasses were of high sensory quality for the first four days of storage and the TBA-value was correlated well with sensory results. Also TVB-N content was within the permissible limit. At the 7^{th} day of storage the examined carcasses were marginally accepted while all carcasses were obviously decomposed at the 10^{th} day of storage. It is worthily mentioning that L-carnitine has no influence on any of quality deteriorative criteria among groups.

Key works: *L-carnitine, broiler carcasses, bacteriology, total volatile basic nitrogen, thiobarbituric acid*

INTRODUCTION

Chicken meat is considered healthy meat as it is high in protein, low in calories and comparatively low in fat. Unprocessed poultry products contain a high percentage of unsaturated fat which helps to reduce blood cholesterol levels and so help maintain a healthy heart (Ronald and Ronald, 1991 and BPC, 2001).

Excessive fatness is one of the undesirable consequences of selection for increased growth of modern broiler. Generally, fat accumulation in abdomen and viscera of broiler carcasses represents a

waste product to consumers who are increasingly concerned about nutritional and health aspect of their foods. Moreover, high dietary fat consumption, particularly saturated fat, has been associated with the incidence of cardiovascular diseases, diabetes, colon and breast cancers hence consumer demand for lean tissue is increasing (Jensen, 1982).

Carnitine is a quaternary amine (β-hydroxy γ-trimethylaminobutyrate), which is easily soluble in water and found in two stereo isomeric forms, D- and L-carnitine (McDowell, 1989). The most important and well known function of carnitine is the transport of long-chain fatty acids into the mitochondrial matrix for β-oxidation by the fatty acid oxidation complex (Borum, 1983). It is synthesized in the animals from two essential amino acids, lysine and methionine (Borum, 1983; Feller and Rudman, 1988). It is of importance to emphasize that its concentration in animals widely varies in different species (Szilagyi *et al.* 1992), among tissues (Bremer, 1983 and Rinaudo *et al.*, 1991), and nutritional status of the animals. In addition, little percentage of L-carintine is contained in corn and soybean, which are the main constituent in broiler's feeds and this may predispose to L-carintine deficiency in broiler carcasses (Baumgartner and Blum, 1997). The key role of L-carintine in energy metabolism is to reduce the availability of lipid for peroxidation by transporting fatty acids into mitochondria for β-oxidation to generate adenosine triphosphate (Borum, 1983). So that incorporation of L-carintine in the broiler's diet may contribute to a reduction in the degree of adiposity in the broiler carcasses through enhancement of utilization of dietary fat, and other dietary components would be metabolized in favour of protein deposition (Rabie and Szilagyi, 1998 and Miah, *et al.*, 2004).

So, the current study was conducted to investigate the influence of supplemental dietary L-carintine on the proximate analysis, abdominal fat reduction and cholesterol content. Quality criteria of broiler carcasses (sensory attributes, TBA-value, TVB-N, mesophilic and psychrotrophic count) during chilling storage of broiler carcasses were also studied.

MATERIALS and METHODS

Hundred Hubbard broiler chicks of 7 days old were individually weighed and randomly classified into four groups (25 each) housed in separate pens. All birds were reared under standard hygienic conditions.

The chicks were fed on a starter diet up to 3weeks, then on grower finisher diet for the last 3 weeks and provided with fresh and clean water. Nutrient levels of diet were based on the National Research Council (1994).

Four dietary treatments were conducted. Maize-soybean containing 3% vegetable oil basal diet as control group, and basal diet in addition to 100mg L-carnitine (Lonza, Biotec, S.r.o., CZ)/ kg diet as group I. while group II was 20% deficient lysine basal diet, and group III was 20% deficient lysine basal diet containing 100mg L-carnitine / kg.

After 45 days, ten birds from each group were randomly selected and each bird was slaughtered and manually processed. The abdominal fat pad (fat extending within the ischium, surrounding the cloaca and adjoining the abdominal muscle) was dissected according to the method described by Fancher and Jensen (1989), weighed and the abdominal fat content was calculated as absolute weight.

The carcasses were stored on refrigerator shelf at 4-6˚C and examined periodically every three days for deterioration criteria. Samples of breast and thigh were collected for the determination of carcass quality as follows:

Proximate Analysis: was calculated according to the methods recommended by AOAC (2000). For water content, 2 gm of the prepared samples were dried in hot air oven (100°C) to constant weight. Total fat content (Soxhlet method) was extracted with petroleum ether (BP 40–60ºC). While protein content was estimated by using Kjeldahl procedure and the nitrogen content was multiplied by 6.25 the ash content was determined by heating in a muffle furnace at 550°C to constant weight.

Cholesterol content: was determined according to the method of Searcy and Bergquist (1960) as described by Rhee *et al.* (1983). Muscle fat was extracted as described by Folch *et al.* (1957). The extracted lipid was saponified with alcoholic KOH and the unsaponifiable material was extracted with hexane and dried, where, cholesterol concentration was determined calorimetrically. A cholesterol standard curve was constructed.

Sensory evaluation: Breast and thigh samples were cooked to internal temperature of 80˚C. The cooked samples were examined for flavour, juiciness, tenderness and overall acceptability using 8-point rating

hedonic scales according to Williams and Damron (1998). The scale range from 0 (no flavour, very dry, very tough and unacceptable) to 8 (very flavour, very juicy, very tender and highly acceptable) was used.

Chemical deterioration criteria: determination of thiobarbituric acid (TBA) - value and total volatile basic nitrogen (TVB-N) by distillation method was performed according to techniques described by Tarladgis *et al.* (1960) with additional modification of Pikul *et al.* (1983) for TBA-value and FAO (1986) for TVB-N.

Bacteriological examination: ten grams of breast and thigh muscles were blended with 90 ml ringer solution to form a dilution of 10^{-1}, from which serial decimal dilution up to10^{-8} was preformed. Mesophilic and psychrotrophic counts were determined on standard plate count agar at 32˚C for 72 hours and 7˚C for 7-10 days respectively according to the technique recommended by APHA (1992).

Statistical analysis: The results are presented as the mean of three samples with standard deviation error, collected and calculated data were analyzed for analysis of variance (ANOVA) using principles of completely randomized design (CRD) in MSTAT computer package, according to Snedecor and Cochran (1980). Least significant difference (LSD) was calculated to compare between treatments, where ANOVA showed significant difference.

RESULTS

Table 1: Mean values of proximate analysis of the examined samples.

Groups	Moisture	Fat	Protein	Ash
Control	76.40± 3.41 [a]	3.60± 0.17 [a]	17.90± 1.05 [b]	1.80± 0.11 [a]
I	73.10± 4.52 [a]	3.30± 0.27 [a]	21.70± 1.54 [a]	1.90± 0.21 [a]
II	76.00± 3.76 [a]	3.50± 0.25[a]	17.50± 0.97 [b]	2.10± 0.19 [a]
III	74.00± 2.99 [a]	3.40± 0.19 [a]	20.00± 1.21 [a]	2.00± 0.09 [a]

Means in the same column with the same letter are not significantly different at $P \leq 0.05$

Table 2: Mean values of cholesterol content and abdominal fat of broiler carcasses.

Groups	Abdominal fat (g)	Cholesterol content (mg/100g)
Control	35.90± 2.41 [a]	66.00± 4.56 [a]
I	28.00± 1.64 [b]	65.90± 3.64 [a]
II	33.30± 1.97 [a]	65.00± 5.14 [a]
III	30.00± 2.12 [b]	65.00± 4.97 [a]

Means in the same column with the same letter are not significantly different at $P \leq 0.05$

Table 3: Mean values of TBA-value mg mal/kg and TVB-N mg/100g in broiler carcasses during chilling storage.

Groups	1st day		4th day		7th day		10th day	
	TVB-n	TBA	TVB-n	TBA	TVB-n	TBA	TVB-n	TBA
Control	10.80 ±0.71 [a]	0.12 ±0.01[a]	15.00 ±1.12 [a]	0.25 ±0.01 [a]	18.60 ±1.05 [a]	0.34 ±0.01 [a]	24.00 ±1.64 [a]	0.52 ±0.04[a]
Group I	11.20 ±0.88 [a]	0.15 ±0.02 [a]	15.60 ±0.97 [a]	0.22 ±0.02 [a]	19.00 ±1.68 [a]	0.29 ±0.02 [a]	26.20 ±2.45 [a]	0.48 ±0.03 [a]
Group II	9.80 ±0.56 [a]	0.15 ±0.01 [a]	13.80 ±0.07 [a]	0.23 ±0.02[a]	18.80 ±1.34 [a]	0.33 ±0.03 [a]	23.80 ±2.01 [a]	0.51 ±0.04 [a]
Group III	11.10 ±0.98 [a]	0.14 ±0.01 [a]	16.20 ±1.35 [a]	0.23 ±0.01 [a]	19.10 ±0.99 [a]	0.33 ±0.02 [a]	25.40 ±1.97 [a]	0.46 ±0.02 [a]

Means in the same column with the same letter are not significantly different at $P \leq 0.05$

Table 4: Mean values of mesophilic and psychrotrophic count of broiler carcasses during chilling storage.

Groups	1st day		4th day		7th day		10th day	
	Meso.	Psych.	Meso.	Psych.	Meso.	Psych.	Meso.	Psych.
Control	5.53± 0.41 [a]	3.28± 0.18 [a]	4.80± 0.21 [a]	3.79± 0.29 [a]	5.80± 0.41 [a]	4.11± 0.39 [a]	7.61± 0.39 [a]	7.79± 0.61 [a]
Group I	5.20 ± 0.32 [a]	3.32± 0.14 [a]	3.95± 0.37 [a]	3.66± 0.21 [a]	5.66± 0.25 [a]	4.38± 0.45 [a]	7.75± 0.64 [a]	7.34± 0.54 [a]
Group II	4.92 ± 0.24 [a]	3.52± 0.24 [a]	4.15± 0.51 [a]	3.58± 0.34 [a]	5.86± 0.36 [a]	4.41± 0.21 [a]	7.26± 0.42 [a]	7.51± 0.51 [a]
Group III	4.99 ± 0.19 [a]	3.43 ±0.31 [a]	4.32± 0.42 [a]	3.71± 0.32 [a]	5.43± 0.51 [a]	4.87± 0.37 [a]	7.20± 0.64 [a]	7.65± 0.72 [a]

Means in the same column with the same letter are not significantly different at $P \leq 0.05$

DISCUSSION

Chemical composition:

Proximate composition (moisture, fat, protein and ash content) of broiler carcasses given diets with various dietary fat and L-carnitine are shown in table (1). Protein content in group I and III was significantly ($P \leq 0.05$) higher than that of control group in response to added dietary L-carnitine irrespective to lysine content. These results may be referred to an improved utilization of dietary nitrogen achieved through more efficient fat oxidation by L-carnitine (Leibettseder, 1995). The obtained results were in harmony with that recorded by Rabie *et al.* (1997), Rabie and Szilagyi (1998) and Sayed *et al.* (2001). In this regard McDowell (1989) stated that the increased fatty acids oxidation induced by L-carnitine may result in decrease availability of long chain fatty acids for estrification to triglycerides, and at the same time can elevate the mitochondrial level of acetyl co-A. Such situation can affect the activation of pyruvate carboxylase which is an acetyl co-A dependent enzyme that can supply c- chain for amino acid biosynthesis. No significant ($P \geq 0.05$) differences could be recognized in fat, moisture and ash content among, groups as a result of L-carnitine supplementation. Nearly similar results were obtained by Barker and sell (1994) and Daskiran and Teeter (2001).

Abdominal fat and cholesterol content:

Incorporation of L- Carnitine in broiler's diet resulted in significant ($P \leq 0.05$) reduction in abdominal fat content as absolute weight in groups I (28.00± 1.64) and III (30.00± 2.12) irrespective to lysine content in the diet (table 2). These results were in agreement with that obtained by Rabie *et al.* (1997), Rabie and Szilagyi (1998) and Xu *et al.* (2003) who recorded that supplementation with 50 mg/kg L-carnitine to broiler diet induce abdominal fat reduction. On contrary Leibetseder (1995) and Celik *et al.* (2003) found no effect on abdominal fat content by adding L- carnitine to the broiler diet. From the same table, it is noticed that no significant ($P \geq 0.05$) differences could be established in cholesterol content among groups of L- carnitine or deficiency of lysine on. This result emphasized the opinion of Leibetseder (1995) who stated that L- Carnitine dietary supplementation had no advantage to minimizing the cholesterol content in the yolk.

Quality parameters of broiler carcasses during chilling storage:

The control and treated broiler carcasses were of high sensory quality for the first four days of storage and the TBA-value was well

correlated with sensory results. Also TVB-N content was within the permissible limit stated by EES (1996) as presented in table (3**).** At the 7^{th} day of storage the examined carcasses were marginally accepted with higher TBA-value and TVB-N. While at the 10^{th} day of storage all carcasses were obviously decomposed, TVB-N exceed the permissible limit and TBA-value was within the permissible limit.

The mean mesophilic and psychrotrophic counts of broiler carcasses for different treated groups are presented in table (4). A high initial mesophilic counts were recorded. This high count may be referred to improper handling and contamination during manual defeathering, evisceration and other processing steps. Decline in mesophilic counts were observed in all groups after three days of refrigeration storage, followed by continuous increase till the end of the storage period. While psychrotrophic counts showed steadily increase all over the storage time. These results were supported by Davies and Board (1998) observation who stated that when broiler carcasses are held at low temperature, conditions for growth of most bacteria species are not longer optimal, whereas total number of bacteria on poultry stored at 0ºC decreased during the first few days of storage. It is of importance to mention that an increase in mesophilic and psychrotrophic counts during storage period was observed. It is of importance to emphasize that none of the quality parameters (sensory attributes, TBA-value, TVB-N, mesophilic, and psychrotrophic counts) were influenced by L-carnitine dietary supplementation.

Under the conditions of this study, it could be concluded that L-carnitine dietary supplementation achieved significant increase in protein content and reduction in abdominal fat, irrespective to lysine content. Moreover, none of quality parameters (sensory attributes, TBA-value, TVB-N, mesophilic, and psychrotrophic counts) were influenced by L-carnitine dietary supplementation. The storage life of broiler carcasses extended for 10 days in both control and treated carcasses. So it's recommended to use L-carnitine (100 mg/kg) as a safe broilers feed additive.

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