

CHOLESTEROL AND PHOSPHOLIPID LEVELS IN GOAT MEAT AS AFFECTED BY DIETARY CALCIUM¹

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ABSTRACT - The objective of this study was to determine the contents of cholesterol and phospholipid in the meat from goats fed on calcium supplemented diets. Nine castrated male undefined breed goats with 17 to 23 months of age and 22.5 kg average weight were used. Animals were reared during 28 weeks in native pasture and offered mineral supplements consisting of: A = NaCl 93.2% plus a regular trace mineral supplement (TMS) 6.8%; B = NaCl 86.4%, plus TMS 6.8%, plus dicalcium phosphate 6.8%; C = NaCl 86.4% plus TMS 6.8%, plus rock phosphate 6.8%. At the end of the experimental period three goats from each treatment were slaughtered and the meat from the shoulder and the leg collected and analyzed. Cholesterol content in goat meat ranged from 61.5 to 76.1 mg/100 g. It was significantly ($P<0.05$) lower in the meat from goats offered the calcium supplements (treatments B and C) than in the meat from goats without calcium supplement (treatment A). Meat phospholipid varied from 6.2 to 8.2 mg/100 g and was significantly ($P<0.05$) lower in goats offered dicalcium phosphate (treatment B) than in goats offered the mix without calcium supplement or the one containing rock phosphate (treatments A and C). Both cholesterol and phospholipid were significantly ($P<0.05$) higher in goat shoulder meat than in goat leg meat for the supplemented animals, and did not show any difference for the unsupplemented animals.

Index terms: calcium supplement, goat meat, cholesterol, phospholipid.

NÍVEIS DE COLESTEROL E FOSFOLÍPIDIOS EM CARNES CAPRINAS INFLUENCIADOS POR DIETAS DE CÁLCIO

RESUMO - O objetivo deste estudo foi determinar os conteúdos de colesterol e fosfolípidios em carne de caprinos alimentados com dietas contendo suplementos de cálcio. As análises foram feitas na carne de nove animais machos, castrados, sem raça definida, com 17 a 23 meses de idade e peso médio de 22,5 kg. Os animais foram criados por 28 semanas em pastagem nativa, recebendo suplementação de minerais e duas fontes de cálcio, de acordo com os seguintes tratamentos: A = 93,2% de NaCl e 6,8% de uma mistura regular de microelementos minerais (MEM); B = 86,4% de NaCl mais 6,8% de MEM e 6,8% de fosfato bicálcico; C = 86,4% de NaCl mais 6,8% de MEM e 6,8% de fosfato de rocha. Ao final do período experimental, os animais foram abatidos, e as carnes da paleta e do pernil coletadas para determinação do seu conteúdo de colesterol e fosfolípidios. O nível de colesterol das carnes caprinas variou de 61,5 a 76,1 mg/100 g, sendo significativamente ($P<0,05$) menor na dos animais alimentados com suplementos de cálcio (tratamentos B e C) que na dos animais alimentados sem suplemento de cálcio (tratamento A). O nível de fosfolípidios das carnes caprinas variou de 6,2 a 8,2 mg/100 g, sendo significativamente ($P<0,05$) maior na carne dos caprinos sem suplementos de cálcio ou com suplemento de fosfato de rocha (tratamentos A e C). Os níveis de colesterol e fosfolípidios de carne dos animais suplementados foram significativamente ($P<0,05$) maiores na paleta que no pernil, e no tratamento sem suplementação não houve diferença significativa entre estes.

Termos para indexação: cálcio suplementar, carne caprina, colesterol, fosfolípidios.

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INTRODUCTION

Lipid content of red meats is one of the most important factors for consumer acceptance and meat buying decision.

Cholesterol is an important component of red meat lipids since high levels of this substance in the diet has been associated with incidence of coronary disease and heart attack.

Feeley et al. (1972) observed that several researchers and consumer groups tend to associate high levels of fat in food with high content of cholesterol. However, it has been shown that in many meat animals marbled meat is not different from lean meat as the level of cholesterol is concerned and high levels of this substance have been detected in both the separated fat and the lean portion of the tissue. Park et al. (1991) reported that fat and cholesterol contents in goat meat are influenced by dietary calcium, breed and type of tissue. The authors found low levels of cholesterol in *longissimus dorsi* and *biceps femoris* muscles from goats fed high levels of dietary calcium. Elevated dietary calcium may reduce serum cholesterol and increase fecal excretion of bile acids and fat.

Phospholipid have been associated with warmed-over-flavor of cooked meats (Igene & Pearson, 1979) and with lipid oxidation of raw and cooked meats. Phospholipid content, therefore, is an important factor of meat stability since oxidation occurs at relatively high rate in foods containing this type of fat (Dugan Junior, 1971).

The main purpose of this study was to assess the cholesterol and phospholipid contents of goat meat from animals reared under semi-arid tropical conditions and submitted to calcium supplemented diets.

MATERIAL AND METHODS

The animal experiment

The feeding trial was conducted with 63 castrated undefined breed goats at the Centro Nacional de Pesquisa de Caprinos - CNPC/Embrapa (National Center for Research with Goats), in Sobral, CE, Brazil, during a period of 28 weeks. Animals were identified, divided into three groups and allowed to feed for 10 hours during the day in a common area of "caatinga" (native low bushes). At night animals were kept in pens and offered water and a mineral mix *ad libitum*. The treatments consisted of the following mineral mixes: A = NaCl 93.2% and a regular trace mineral supplement (TMS) 6.8%; B = NaCl 86.4%, TMS 6.8% and dicalcium phosphate 6.8%; C = NaCl 86.4%, TMS 6.8% and rock phosphate 6.8%. The content of minerals in TMS was: Mn 0.14%, Zn 0.24%, I 0.11%, Cu 0.12%, Fe 0.21%, Co 0.003%. Dicalcium phosphate and rock phosphate contained Ca 24.35%, P 18.32% and Ca 32.94%, P 14.06%, respectively.

Meat sampling

At the end of the experimental period three goats from each treatment, 17 to 23 months old, weighing 21.9 to 23.0 kg, were slaughtered under federal inspection.

Carcasses were chilled for 24 hours at 0°C and then cut in halves. The leg and the shoulder of each half carcass were separated, deboned and ground to prepare two composite samples from each origin. Meat samples were ground through a grinder with 0.5 cm diameter hole plate and kept at -20°C until analysis.

Lipids were extracted from meat samples as described by Folch et al. (1957).

An aliquot of the lipid extract containing about 0.12 g lipid material was evaporated to dryness at 55°C to 60°C in a boiling water bath under nitrogen. From this point the cholesterol analysis was followed according to the colorimetric method described by Rhee et al. (1982).

For the phospholipid determination an aliquot equal in size to that used for the cholesterol determination was evaporated in the same way described above. Ashing of the samples was performed according to the method described by Zipser et al. (1962) and phosphorous content was determined according to the Association of Official Analytical Chemists (1980) procedure. Total phospholipid content was calculated using the factor 25.5 to correct the phosphorus content of the meat (Pikul et al., 1985).

Statistical analysis

Data were submitted to analysis of variance as a factorial design utilizing a general linear model procedure (Snedecor & Cochran, 1972). Separation of means was conducted using the Tukey's procedure.

RESULTS AND DISCUSSION

Cholesterol

Cholesterol values in goat meat ranged from 61.5 to 76.1 mg/100 g (Table 1). These values were similar to those reported by Feeley et al. (1972) and Kühne (1977), in tables of food composition and by Reiser (1975) and Park et al. (1991) for Alpine and Nubian goat kids.

Statistical differences ($P<0.05$) in meat cholesterol values were detected for the variable treatments (A, B and C), meat origin (leg and shoulder) and also for the interactions between these two factors.

Calcium supplements (treatments B and C) produced leg meat with cholesterol values significantly ($P<0.05$) lower than the unsupplemented diet (treatment A). In shoulder meat, however, just the diet supplemented with dicalcium phosphate (treatment B) produced meat with cholesterol significantly ($P<0.05$) lower than that in the meat from the unsupplemented goats (treatment A, Table 1). This observation agrees with that made by Park et al. (1991) who found low levels of cholesterol in *longissimus dorsi* and *biceps femoris* muscles from goats fed high levels of dietary calcium. Diersen-Schade et al. (1984), however, did not find any significant effect of dietary calcium on cholesterol content of young goat tissue.

Goats fed the unsupplemented diet (treatment A) showed no significant ($P<0.05$) difference in cholesterol content of the meat from the shoulder or the leg. Supplemented diets (treatments B and C), however, produced shoulder meat with cholesterol levels significantly ($P<0.05$) higher than those in the leg meat (Table 1). This was probably due to the fact that lipid content in shoulder meat is usually higher than that in leg meat (Almeida, 1990).

TABLE 1. Cholesterol content (mg/100 g) in meat from goats submitted to different calcium supplementation treatments¹.

Meat origin	Calcium supplementation treatments		
	(A) Salt	(B) Salt + dicalcium phosphate	(C) Salt + rock phosphate
Shoulder	75.83 ± 1.75 Aa	69.63 ± 3.91 Ab	76.10 ± 1.85 Aa
Leg	74.70 ± 3.23 Aa	61.53 ± 3.37 Bb	63.57 ± 1.47 Bb

¹ Values followed by different small letters in the same row and by different capital letters in the same column are statistically different ($P<0.05$).

Phospholipid

Phospholipid levels in goat meat ranged from 6.20 mg/100 g to 8.25 mg/100 g (Table 2). These values were found to be lower than those reported by Prabhakar & Rao (1983) for goat *longissimus dorsi* muscle but higher than those reported by Keller & Kinsella (1973) for ground beef.

Significant ($P<0.05$) interactions between feed treatments (A, B and C) and meat origin (leg and shoulder) were also found for the content of phospholipid in goat meat.

Meat from goats fed on the diet supplemented with dicalcium phosphate (treatment B) showed phospholipid content significantly ($P<0.05$) lower than that from treatments A and C (Table 2).

TABLE 2. Phospholipid content (mg/100 g) in meat from goats submitted to different calcium supplementation treatments¹.

Meat origin	Calcium supplementation treatments		
	(A) Salt	(B) Salt + dicalcium phosphate	(C) Salt + rock phosphate
Shoulder	8.15 ± 0.07 Aa	7.35 ± 0.07 Ab	8.25 ± 0.07 Aa
Leg	7.95 ± 0.07 Aa	6.20 ± 0.00 Bb	8.10 ± 0.00 Ba

¹ Values followed by different small letters in the same row and by different capital letters in the same column are statistically different ($P<0.05$).

The meat from the shoulder was higher in phospholipid content than that from the leg. This difference was significant ($P < 0.05$), however, just for treatments B and C. Again, the high fat content of shoulder cuts might account for this difference.

Similarly to that observed for cholesterol dicalcium phosphate (treatment B) tended to decrease the level of phospholipid in a more sensible way than the rock phosphate (treatment C). This might be associated to a higher availability of calcium from dicalcium phosphate than from rock phosphate.

Lower levels of phospholipid in meat are considered desirable since these compounds participate in lipid oxidation reactions and also in the development of meat warmed-over-flavor (Igene & Pearson, 1979).

CONCLUSIONS

1. The offer of dicalcium phosphate as a dietary supplement to goats fed on native pasture decreases the content of cholesterol and phospholipid in shoulder and leg meat.
2. When goats receive supplements of either dicalcium phosphate or rock phosphate the meat from the leg is lower in cholesterol and phospholipid than the meat from the shoulder.

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