The Influence of Zinc in Nutrition on Meat Quality of Young Goats

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Summary

A total of 22 young goats were used to assess the effect of two organic zinc sources, i.e. Zn lactate and Zn chelate, compared with Zn oxide and a control treatment without Zn supplementation on meat quality and zinc concentration in muscle. Muscle pH and colour (L*– lightness, a* – redness, b* – yellowness) were determined in the *triceps brachii* muscles, immediately after slaughter and chilling (24 h). Zn content, chemical composition (dry matter, fat, protein and collagen content), drip losses, cook losses, hardness, cohesiveness, pH (48 h) and colour (48 h) were determined. We did not found statistical significant differences in meat quality between treatments. Significant difference was found in concentration of Zn only between control and group receiving Zn oxide ($P < 0.05$).

Key words

organic Zn, inorganic Zn, meat colour, chemical analysis, goats

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Received: May 30, 2011 | Accepted: July 4, 2011

ACKNOWLEDGEMENTS
This research was supported by the Ministry of Education, Youth and Sports of the Czech Republic, Grant No. MSM6215712402 and Grant No. MSM6215712403

Aim

Goats are widely distributed around the world and have been source of human nutrition. Goat meat is without a doubt one of the staple red meats in human diets (Webb et al., 2005). There is some evidence for improved bioavailability of organic compared to inorganic trace mineral source (Spears, 1996). According to Bekhit et al. (2005) and Koohmaraie (1990) Zn could influence meat quality (for example colour and texture). The present study was therefore designed to compare the effect of organic and inorganic zinc forms on meat quality and concentration in muscle (*m. triceps brachii*) of young goats.

Material and methods

The experiment involved 22 male white shorthaired goats after weaning. The kids received experimental feed mixtures with the corresponding form of zinc (Zn) for three months. All kids were fed the same feed ration consisting of hay (*ad libitum*) and granulated feed mixture in the dose of 300 g/animal/day. Natural content of Zn in the granulated feed mixture was 40 mg/kg, and for the experimental groups, the mixture was supplemented with 60 mg/kg Zn in the corresponding form. We used following form of Zn for the supplementation: one inorganic form – Zn oxide; two organic forms – Zn trihydrate lactate (Zinc Chelate, Agrobac, Czech Republic) and Zn chelate (Bioplex Zn, Alltech, USA). The animals were divided into four groups: group ZnO (n = 5) received Zn in the form of Zn oxide, group ZnL (n = 6) received Zn trihydrate lactate, group ZnCh (n = 5) received Zn in the form of chelate and group C (n = 6) was a control group. After the end of the experiment, the kids were slaughtered.

Sample preparation. Muscle characteristics were determined in the leg muscle – *m. triceps brachii* muscles, immediately after slaughter and chilling (24 h). Muscles were trimmed of external connective tissue and fat and part (100 g) minced for chemical analysis. For texture measurement meat samples were heat treated. The way of heat treating: meat was heat treated in plastic bags separately in water bath, the core temperature of samples was hold at 72°C for 30 min (Rodbøtten et al., 2004). Samples were cooled at room temperature and stored overnight at 4 ± 2°C (Coró et al., 2003) for texture studies.

Chemical parameters.The Zn concentrations in muscles were measured using the F-AAS method and the AAS Solaar M6 (Unicam, Great Britain) device. The mineralization of samples was performed by microwave digestion system Milestone Ethos TC (Milestone, Italy). Dry matter was determined by sea-sand drying for 24 hours at 103 ± 2°C (CSN ISO 57 6021). Protein content was determined as an amount of organically bound nitrogen (recalculating coefficient f1 = 6.25) after precipitation with hot tannin solution using a Kjeltec System 2300 (Tecator, Sweden) semiautomatic analyzer according to the method recommended by the producer (AN 86/87). Collagen was computed from the content of hydroxyproline amino acid (recalculating coefficient f2 = 8). Hydroxyproline was determined quantitatively by photometric measurement of absorbance at 550 nm on a UV/VIS spectrophotometer Genesys ™ 6 (Thermo Electron Corporation, USA). Fat was analysed on the Soxtec instrument made by Tecator, with diethyl ether as extraction agent.

Physical parameters. Samples for texture measurement were tested by Texture Profile Analysis (TPA) Instron Universal Testing Machine (model 5544) (Instron Corporation, UK). Parameters were obtained using Merlin computer software. For TPA, cylindrical samples (1 cm high, 1.25 cm in diameter) were compressed twice to 50% of their original height with a compression platen of 36 mm in diameter. Force time curves were recorded at a crosshead speed of 50 mm/min. Hardness (N) defined as a peak force required for the first compression, cohesiveness defined as a ratio of positive force area during the second compression to that in the first compression were evaluated (Szczesniak, 2002; Desmond et al., 2005). Meat samples for determination of drip losses of approximately 50 g were put into PE bag. These samples were stored at 4°C for 24 hours. Drip loss was expressed as a percentage of the initial weight of the meat constituted to exudates. Cooking loss was analysed as [samples weight before cooking (core temperature of samples was 72°C, 30 min) minus sample weight after cooking] x100/ weight before cooking. The pH was measured in duplicate with a pH meter (pH 340i, WTW, Germany) with a needle tip pH electrode (SenTIX SP, WTW, Germany). The values of pH were measured 24 h and 48 h post mortem. Instrumental colour analysis (CIELAB colour system) of samples was made by a Konica Minolta Spectrometer CM 2600d (Konica Minolta, Japan) using CIE standard illuminant as the light source. L* describes the lightness of the sample, a* redness and b* yellowness. Red colour was expressed as a* value; the higher a* value the redder the sample. Five measurements were made directly on each samples surface selected location with a measuring area of 8 mm, D65 light and standard observer with a 10° field of view. The instrument was standardized using white standard plates. Colour parameters were measured 24 h and 48 h post mortem.

Statistical analysis. Statistical data analyses were conducted using the Statistica 7 CZ statistical program (StatSoft, Czech Republic). The significance of differences between samples was determined by the analysis of variance (ANOVA) using Tukey's test. The 0.05, level of significance was used. The results are quoted as a mean value with standard deviation.

Results and discussion

The results of meat quality are shown in the Table 1.

Goats subjected to the ZnO treatment tended to have somewhat higher intramuscular fat content of leg muscle than goats in the organic treatment and control, although differences were not significant ($P > 0.05$). Kessler et al. (2003) reported higher intramuscular fat content of the bulls' muscles in ZnO group compared with control and Zn proteinate group. Addition of zinc methionine and zinc oxide tended to increase the quantity of carcass fat over control steers. Percentage fat also tended to increase, especially when zinc methionine was fed (Greene et al., 1988). We found no significant differences between control group and Zn treated groups in amount of dry matter, collagen content and pure protein. Goat meat tends to be darker red, have a coarser texture with a detectable different flavor and aroma from lamb (Schonfeld et al., 1993a, 1993b). Zn supplementation in inorganic or organic form had no effect on meat colour, drip loss, cook loss and instrumental tenderness measured as texture

Table1. Goat meat quality (*m. triceps brachii*)

Trait	Treatment			
	Control C	ZnO	ZnL	ZnCh
Dry matter (%)	24.82 ± 1.05	25.24 ± 1.16	24.39 ± 0.81	25.85 ± 1.69
Protein (%)	22.19 ± 1.03	22.01 ± 1.70	22.22 ± 0.95	20.13± 1.44
Collagen (%)	1.43 ± 0.22	1.53 ± 0.19	1.43 ± 0.15	1.37 ± 0.26
Fat (%)	2.37 ± 0.28	2.70 ± 0.32	2.44 ± 0.23	2.34 ± 0.26
Hardness (N)	21.19. ± 3.52	16.47 ± 3.12	16.66 ± 3.75	19.75 ± 1.42
Cohesiveness	1.23 ± 0.02	1.23 ± 0.02	1.23 ± 0.01	1.25 ± 0.01
Drip loss (%)	2.03 ± 0.64	1.44 ± 0.39	2.19 ± 0.76	1.80 ± 0.59
Cook loss (%)	26.74 ± 2.41	25.86 ± 1.16	25.65 ± 3.16	24.37 ± 2.43
pH value 24 h	5.73 ± 0.35	5.61 ± 0.13	5.67 ± 0.13	5.49 ± 0.07
pH value 48 h	5.75 ± 0.32	5.68 ± 0.13	5.78 ± 0.18	5.62 ± 0.07
L* 24 h	40.87 ± 1.96	40.67 ± 1.95	40.20 ± 2.46	39.56 ± 3.84
L* 48 h	41.13 ± 1.84	39.07 ± 2.72	39.33 ± 2.16	37.78 ± 3.48
a* 24h	14.85 ± 1.40	14.78 ± 1.47	13.33 ± 1.57	13.95 ± 0.65
a* 48 h	12.35 ± 1.36	11.69 ± 0.52	10.81 ± 1.08	12.00 ± 1.81
b* 24 h	12.67 ± 1.13	13.63 ± 1.25	12.65 ± 1.47	12.92 ± 1.89
b* 48 h	12.69 ± 0.93	11.32 ± 1.56	11.32 ± 1.56	10.40 ± 2.29

profiles analysis. Texture is a very important quality parameter. Hardness assessment using the Texture profile Analysis (TPA) revealed no statistical significant between Zn supplemented groups and control group. Zn treatment groups were tenderer than control group. Kohmaraie (1990) reported that the infusion of $ZnCl_2$ toughens meat. Furthermore, dietary Zn sources (Zn oxide, Zn polysaccharide complex, Zn proteinate; 10 mg Zn per kg) did not influence the meat quality parameters colour, drip loss and instrumental tenderness (Kessler et al., 2003). The pH value of leg muscle 24 h and 48 h post mortem did not differ between treatments. The pH value 48 h post mortem showed an increasing trend in all groups. The colour of group ZnCh seems to be darker than of other groups. The group ZnL had less red colour (lower a* value) than control group and Zn oxide and Zn chelate groups. But the differences were not statistically significant ($P > 0.05$). It has been suggested that organic and inorganic forms of zinc are metabolized differently following absorption. Of the inorganic forms of the mineral, the sulfate form seems to be the most available. Organic sources tend to have equal or greater availability than sulfate forms (Wedekind et al., 1992).

Zn supplementation increased the concentration of Zn in muscles. Average Zn concentration in individual groups was: group C: 24.72 ± 2.35 μg/kg; ZnO: 30.58 ± 4.73 μg/kg; ZnL: 27.22 ± 2.56 μg/kg, and ZnCh: 30.73 ± 5.55 μg/kg. The Zn concentration was in all experimental groups higher than in control, but due to higher variability in individual groups significant difference was found only between control and group receiving Zn oxide ($P < 0.05$). The influence of Zn supplementation on the Zn concentration in muscles was relatively low, because the increase of Zn concentration in muscles was only around 5 μg/kg. Similarly Henry et al. (1997) did not find big differences of Zn concentration in muscles after supplementation of different doses of Zn in sheep. We did not find any significant differences between experimental groups; there was only tendency of lower concentration of Zn in group receiving Zn lactate. We did not confirm higher absorption of Zn from organic forms in comparison with inorganic form. Mandal et al. (2007) found, that apparent absorption of Zn was lower ($P<0.01$) in the $ZnSO_4$ group compared to the control group, indicating higher bioavailability of the metal from the organic source versus the inorganic source in male cattle.

Conclusions

Zn supplementation of young goats in the form of Zn oxide, Zn lactate and Zn chelate did not have significant effect on meat quality. Concentration of Zn in muscle was in all experimental groups higher than in control group.

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