

## Daily weight gain of goats until weaning receiving two schemes of mineral supplementation

*Ganho de peso diário de caprinos até o desmame recebendo dois esquemas de suplementação mineral*

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### ABSTRACT

The objective of this study was to evaluate the effects of commercial mineral supplementation and selective mineral supplements in which only elements known to be deficient in the animal's diet. In an experiment conducted in Federal Rural University of Rio de Janeiro, Brazil, were analyzed: daily weight gain, nutritional and economic aspects of goats mixed breed receiving two types of mineral supplements. The sixteen animals were divided into two groups. For one group a commercial mineral mixture was used, and to the other group selective mineral mixture containing only sodium (Na) and copper (Cu) was offered. There was no difference in daily weight gain when the selective or commercial mixture was given. The selective mineral supplementation was 4,8 times more economic than conventional supplementation with a commercial mineral mix. The animals showed an increase of hair pigmentation around the eyes, attributed to the correction of copper deficiency. Thus, when an adequate concentrate and good quality forage is given, only the deficient mineral element(s) should be supplemented. The result of this experiment confirms the hypothesis that selective mineral supplementation is correct and can result in reduction of the cost with mineral supplementation of a herd.

**KEYWORDS:** *Capra hircus*; copper deficiency; selective mineral salt.

### RESUMO

O objetivo deste estudo foi avaliar os efeitos da suplementação mineral comercial e suplementos minerais seletivos em que apenas elementos sabidamente deficientes na dieta do animal. Em experimento conduzido na Universidade Federal Rural do Rio de Janeiro, Brasil, foram analisados: ganho de peso diário, aspectos nutricionais e econômicos de caprinos sem raça definida recebendo dois tipos de suplementos minerais. Os dezesseis animais foram divididos em dois grupos. Para um grupo foi utilizada mistura mineral comercial, e para o outro grupo foi oferecida mistura mineral seletiva contendo apenas sódio (Na) e cobre (Cu). Não houve diferença no ganho de peso diário quando a mistura seletiva ou comercial foi dada. A suplementação mineral seletiva foi 4,8 vezes mais econômica que a suplementação convencional com mistura mineral comercial. Os animais apresentaram aumento da pigmentação dos pelos ao redor dos olhos, atribuído à correção da deficiência de cobre. Assim, quando um concentrado adequado e uma forragem de boa qualidade são fornecidos, apenas o(s) elemento(s) mineral(is) deficiente(s) deve(m) ser suplementado(s). O resultado deste experimento confirma a hipótese de que a suplementação mineral seletiva é correta e pode resultar em redução do custo com suplementação mineral de um rebanho.

**PALAVRAS-CHAVE:** *Capra hircus*; deficiência de cobre; sal mineral seletivo.

## INTRODUCTION

It is well established the importance that disabilities and mineral supplementation exert on health, productivity and in the economy of the Brazilian livestock activity. Despite that, cannot lose sight of the impact that supplementation mineral represents in the operating costs of a farm (BARBOSA et al. 2018).

This way, besides the need to eat organic nutrients (carbohydrates, proteins, lipids and vitamins), animals also need to consume inorganic elements (minerals) to ensure its maintenance, growth and normal productive and reproductive activities. While the macro minerals (calcium, phosphorus, sodium, chloride, potassium, magnesium and sulfur) are needed in larger quantities, trace minerals (iron, copper, cobalt, iodine, manganese, zinc and selenium) are required in smaller amounts in the diet.

The needs of the minerals vary with production level, race, gender, age and stage of lactation. There are also extrinsic variations, caused by climatic parameters, food intake, antagonisms and presence of phytates. All these variations make it difficult to establish the exact requirements of minerals by animal's value (MALAFAIA et al. 2004a)

Mineral deficiencies occur in various parts of the world varies between regions and within regions. They can range from severe, with symptomatology, even moderate, clear deficiencies whose symptoms are difficult to detect. Contrary to what many think, the (sub - clinical) mild disabilities often cause even more serious problems than severe deficiencies, due to the difficulty of their detection and cause symptoms that are mistaken for other diseases (TOKARNIA et al. 2003). For the correct diagnosis of mineral deficiencies, several factors must be taken into account. The first, and most important, is the examination of the flock. For ratification of disability, there are the chemical dosages (in tissues such as bone and liver) and experimentation. The main way to detect if a mineral deficiency is the observation, because some symptoms are often very evident.

Copper deficiency in sheep and goats can cause: weakness and loss of waviness or depigmentation of the wool or black hair; congenital or contracted alterations of myelin (enzootic ataxia) in which lambs and kids in the first weeks of life show incoordination of the hind limbs, which may result in paraplegia and death; osteoporosis; anemia; low immunity to infectious diseases and reduced growth (SUTTLE 2010). The effect of Cu on lipid metabolism may be associated with the relative mRNA abundance of genes involved in lipid metabolism. However, there is no literature available in this area. We hypothesized that the changes in lipid metabolism observed in meat goats fed diet with Cu supplementation could be related to a modification in gene expression. ZHANG et al. (2023) Studying dietary copper supplementation on the performance of meat goat observed that the higher intramuscular fat in goats supplemented with Cu may be due to the greater utilization of glucose by the muscle. Higher intramuscular fat content in goats supplemented with Cu may improve meat quality.

MALAFAIA et al. (2004a) studying weight performance, economic, nutritional aspects and Weight performance, economic, nutritional and Clinical studies of goats submitted to two regimens Clinical studies of goats submitted to two regimens of mineral supplementation mineral supplementation found that by mineral analysis of grass and feed, as well as as the quantification of the daily consumption of these foods, observed that only the consumption of concentrated feed was sufficient to meet the requirements of both groups of animals. These facts reinforce the hypothesis that that when animals are fed with good quality concentrated feed and roughage, few mineral elements will be supplied – specifically, in this breeding system in this region, only sodium and copper.

For the animals are adequately supplemented with mineral mixtures is necessary to have an idea of their nutritional requirements. Tables of requirements (AFRC, NRC, ARC) can be used as guides because they provide estimates of the daily needs of the animals. But other factors must be taken into account, since most available data requirements for ruminants are from other countries, which present conditions of climate, soil and different forage plants of Brazil (PEIXOTO et al. 2003).

Thus, technological innovations in goat farming, especially with regard to nutrition, are becoming increasingly necessary, as the rural company needs to be more competitive with other production chains to remain in the market, since agriculture is the basis economic, social sustainability, maintenance of local or regional culture, traditions, concern for workers, education and to sustain the country's progress (TEIXEIRA et al. 2013).

The objective of this study was to evaluate the effects of commercial mineral supplementation, which is considered ideal for being "complete" or "ideal", to study the relationship between selective mineral supplements that are supplemented and the deficient elements (of general knowledge) in the diet of the animal, on the weight gain of the animals and cost/benefit.

## MATERIAL AND METHODS

The study was carried out in the Caprinoculture Sector of the Instituto de Zootecnia of the Federal Rural University of Rio de Janeiro (UFRRJ), in Seropédica count, State of Rio de Janeiro (22° 46'59" S, 43° 40'45" W, shipment: 33m) in 2004 (between May and December), lasting 90 days. The study has a capril of and slatted floor with collective corrals. According to data collected at the Agricultural Research Corporation of the State of Rio de Janeiro - PESAGRO Seropédica - Rio de Janeiro, Brazil, the maximum and minimum average temperature was 27.4 and 16.6 and 29.7 °C in winter and 21.6 °C in summer and relative humidity was 65.0% in winter and 75.0% in summer.

Sixteen crossbred Boer-Saanen goats, with an average weight of 12. ±0.50 kg, aged 6 months, itself derived from the goat house UFRRJ were used. The animals were separated into two batches and kept in collective cages and taken to the solarium to receive daily solar radiation and exercise. Before starting the experiment were submitted to relevant health management endo and ectoparasites. Began the experiment when the animals reached an average weight of 6kg, aiming a better homogeneity of the diet consumed, and remained in the experiment until the weight from 14 to 15 kg when they were weaned after 90 days on average. The animals were weighed, in swine and sheep scale ICS-300 mobile electronic km3 - COIMMA, every 7 days in water and solid fasted at least 12 hours. To determine the consumption of nutrient samples of hay and concentrate offered were made. From these samples, we determined the dry matter (DM), crude protein (CP), phosphorus (P), calcium (Ca), sodium (Na), copper (Cu), zinc (Zn) and cobalt (Co). These nutrients were determined according to the protocols described in the AOAC (1990).

The diet consisted of milk, forage and concentrate, divided into two daily offerings, the first and the second at 8 o'clock to 15 o'clock. Cow's milk (Water 86.0%, Total solids 12.0%, Fat 3.5%, Protein 3.2%, Lactose 4.5%, Minerals 0.7%) was supplied in individual bottles in the amount of 1.5 kg of milk per animal. The forage offered was the Tifton 85 hay (*Cynodon* spp.) chopped, mixed with 400 g/head/day of concentrate formulated with wheat bran (450 g/kg), corn meal (250 g/kg) and soybean meal (300 g/kg), providing a surplus of 5 to 10% (uneaten leftovers). Water was provided "ad libitum" using an automatic system (4-liter automatic drinker for animals – Marca de inox). The average intake of roughage and mineral supplementation was measured by the difference of the offering for leftover food.

Each with eight crossbred animals received supplementation of mineral salts. Mineral supplements were regularly weighed and placed in wooden troughs (20x20x6 cm) within the bays, so as to provide an unrestricted supply. The composition of commercial mineral salt to goats (SMC) contained specified on its label: Ca 130 g/kg, Na 136.5 g/kg, 656 g P/kg, 12 g S/kg, 8 g Mg/kg, 1.500 Fe mg/kg Cu 1,200 mg/kg, Zn 2500 mg/kg, Mn 1000 mg/kg, 100 mg I/kg, Co 80 mg/kg and 8 mg/kg, while the selective mineral salt (SMS) contained only 400 g/kg Na and 1.250 mg/kg Cu.

The group 1 received as a mineral supplement for a specific business mix goat. Similarly, the second group, the animals received selective mineral formulated only with 1000 g of sodium chloride (Lavizoo) and 5 g of copper sulfate, known element in the second region deficient studies by TOKARNIA et al. (1971) and MALAFAIA et al. (2004a).

For calculations of mineral intake requirements and elements of 0.100 kg average daily gain were used, body weight used was 14 kg, which was the average BW observed at the end of the studies, and the total dry matter intake obtained by average of the two groups was at 3.5% of BW, ie, 0.490 kg and 0.210 kg of forage (1.5% BW) and 0.280 kg of concentrated feed (2% BW).

The variables analyzed were the average daily weight gain, consumption and expenditure on the two types of mineral supplements and general appearance of the animal (feces, urine, hair). The experiment was a completely randomized design and the analysis of variance given in the model  $Y_{ij} = m + t_i + e_{ij}$ , where:  $Y_{ij}$  equals the value observed in the  $j$ th experimental unit receiving the  $i$ th treatment,  $m$  is the average general;  $t_i$  equals the treatment effect, and  $e_{ij}$  the experimental error. The data of weight gain were subjected to analysis of variance and means were compared by Tukey test ( $P < 0.05$ ).

## RESULTS

No significant differences ( $p > 0.05$ ) in average daily gain between the animals fed the commercial mineral supplement (0089 kg/day) and rats which consumed the selective mineral (0.093 kg/day) (Table 1).

DATTA et al. (2007) testing the copper supplementation in goats found higher daily liveweight in animals that received the amount of 40 mg/head/day. Using the equations of MESCH (2000) to determine requirements mineral goats, and calculating the difference provided by the daily diet, it was found that the animals received sufficient amounts of minerals except copper (Table 2).

Table 1. Performance of goat's weight (kg) according to treatment of commercial mineral salt (SMC) and selective mineral salt (SMS).

Treatments	Mean (kg / day)
Control (SMC)	0.089 <sup>a</sup>
Test (SMS)	0.093 <sup>a</sup>
CV (%)	22.3

\*Means followed by the same letter, on the same line, do not differ statistically by Tukey's test ( $P < 0.05$ ).

Table 2. Mineral supply through the forage, concentrate and milk per day and the daily requirement of the animal.

Minerals	Forage (F)	Concentrate (C)	Milk (M)	Total (F+C+M)	Requirement *
P (g/d)	0.59	1.79	1.79	4.17	1.46 <sup>a</sup>
Ca (g/d)	0.76	0.59	1.83	3.18	2.94 <sup>b</sup>
Na (g/d)	0.08	0.11	0.46	0.65	0.21 <sup>c</sup>
Cu (mg/kgMS)	0.71	1.88	0.45	3.04	4.90 <sup>d</sup>
Co (mg/kgMS)	0.01	0.01	0.16	0.18	0.05 <sup>e</sup>
Zn (mg/kgMS)	6.51	10.92	3.69	21.12	19.60 <sup>f</sup>

\* According MESCHY (2000) the  $((0.081 + 0.88 \text{ DMI}) + 5.8 \times \text{GMD} / 0.75)$ , DMI is equivalent to the average intake (0.490 kg DM / d) and ADG was 0.100 kg, b  $((0.228 + 0.623 \text{ DMI}) + 9.4 \times \text{GMD} / 0.50)$ ; c 15 mg / kg body weight; d 10 mg / kg DM intake, e 0, 10 mg / kg DM intake; f 40 mg / kg DM consumed.

With the consumption of commercial and selective mineral salts, obtained by weighing the offer and left the supplement provided to the animal, we obtained the average daily intake per animal of the two treatments, which was 3.40 and 1.58 g/animal/day, respectively (Table 3).

Table 3. Consumption and expenditure of commercial mineral supplements (SMC) and selective (SMS) for 90 days with the Boer-Saanen crossbred goats.

Consumption	SMC	SMS
Total (g)	3647	1690
Daily (g / animal)	3.40	1.58
Daily expenditure (R\$/ animal)	0.0038	0.00079
Expenses (R\$/90 days/treatment)	2.74	0.57

\* Price of the commercial mixture and selective mining: 1.13 and 0.50 R\$ / kg, respectively. \*\* Quote of the U.S. dollar (average in 2004): 1 U\$ = 2,94 R\$.

Analyzing the minerals that were supplied by roughage by concentrate and milk, we can calculate whether the minerals provided by the two mineral supplements will be sufficient to meet the needs of goats (Table 4).

Table 4. Mineral deficiency after analysis of forage and concentrate offered (D min.), Complimentary daily intake of minerals for commercial mineral supplement (SMC) and selective mineral (SMS).

Minerals	D min.	SMC	SMS
P (g/d)	-	0.22	-
Ca (g/d)	-	0.44	-
Na (g/d)	-	0.46	0.63
Cu (mg/kgMS)	1.86	8.34	1.97
Co (mg/kgMS)	-	0.27	-
Zn (mg/kgMS)	-	8.50	-

## DISCUSSION

Similar results had been reported by PEIXOTO et al. (2003) studying cattle with commercial mineral supplementation and selective and MALAFAIA et al. (2004a) working with adult goats in the same region and supplemented the same way. MALAFAIA et al. (2004b) reported that in four experiments comparing the commercial salt with salt selective in cattle, three resulted in greater gains for animals receiving the selective

salt. DOMINGUES et al. (2008) supplementing cows with selective and commercial salt in northern Rio de Janeiro found statistically similar performances to the region and found that sufficient supplementation of sodium, copper and zinc.

ALMEIDA et al. (2022) studied the clinical, pathological and reproductive aspects of an outbreak of copper deficiency in dairy goats and kids in the semi-arid region of Pernambuco, Brazil. Mean serum copper concentration was  $6.1 \pm 2.8$  mmol/. In kids, the mean serum copper concentration was  $3.8 \pm 0.9$  mmol/L. Clinical signs in the goats consisted of pale mucous membranes, anemia, diarrhea, achromotrichia, dull and brittle hair, and alopecia. The main reproductive alterations consisted of prolonged anestrus, embryonic resorption and increased placental retention rate. The kids born alive from these goats were born weak, with neonatal ataxia or developed late ataxia within 70 days of life. Six dairy goats and four kids were necropsied. MALAFAIA et al. (2014) studying milk production and composition and body score of goats lactating women submitted to commercial mineral supplementation and selective and concluded that selective mineral supplementation, proposed based on the clinical-nutritional examination of lactating goats, results in the maintenance of milk production and composition and score body; it is an efficient prophylactic measure and; reduces the cost of mineral supplementation flock.

In present study the chemical composition of the forage and the concentrate was analyzed for macro minerals in dry matter content (% DM): P = 0.28 and 0.64, Ca = 0.36 and 0.21, Na = 0.04 and 0.04, and the trace minerals in milligram per kilogram of dry matter (mg / kg DM): Cu = 3.4 and 6.7; Co = 0.06 and 0.02, Zn = 31 and 39, respectively. The percentage of dry matter was 86.1 % and 89.4 % and the percentage of protein in the dry matter was 7.6 % DM and 22.4 % DM for forage and concentrate, respectively.

Cow's milk provided daily to the animals in their chemical composition contained the following minerals (mg / kg milk): 1.220 Ca, Mg 84.309 In, 418 K, 0.32 Fe, 0.298 Cu, Zn 2.46, Mn 0.082, Co 0.108; If 0.014, and P 1.190. (KHAN et al. 2006) and (PARK et al. 2007) analyzing the chemical composition of goat milk found higher values of mineral content compared to cow's milk, showing that the feeding of goats is made with goat's milk, they get more minerals, requiring less mineral supplementation.

SOLAIMAN et al. (2006) reported levels of toxicity in goats crossbred Boer, when the amount of copper exceeded 100 mg/head/day. These values are higher than stipulated by MESCHY (2000), but to examine the experimental herd, noted a satisfactory weight gain and increased pigmentation of the coat around the eyes (periorbital) , knowing that the mineral copper deficiency causes discoloration coat periorcular region (MALAFAIA et al. 2004a), it was considered that the quantity of copper described by MESCHY (2000) was sufficient to supply the deficiency of this mineral in the diet, however, we cannot say that with larger amounts of supplementation these animals would achieve greater gains.

Thus, as shown by MALAFAIA et al. (2004a), in relation to the cost of supplementation, we can see that the lowest intake of selective supplement along with your lowest price, provided an excellent source of economy (4.8 times the selective supplementation). The lower consumption is due to the higher content of sodium chloride (MALAFAIA et al. 2004b) contained in selective mineral, which was approximately 2.9 times greater. Expenditures on mineral supplementation are the second largest expense item on the farm of beef cattle, surpassed only by spending with hand labor (UNDERWOOD 1981). In goat, GONÇALVES et al. (2008) studied the production costs of farms with different production systems found spending on mineral supplementation ranging up to 30% of the total amount spent on food.

Proper mineral supplementation plays a decisive role in maintaining the health and production of healthy goats. Deficiency and toxicity can occur when the mixture is not properly balanced, the sources used do not submit required bioavailability or there is no adequate consumption of the mixture (MESCHY 2000). Mineral supplements greatly increased the amount of sodium in the diet. However, excessive sodium intake by ruminants was not an issue due to its huge tolerance (UNDERWOOD 1981). In this way, selective mineral supplementation, a concept that means.

CORDÃO et al. (2014) evaluated the performance and carcass characteristics and non-carcass constituents of sheep and goats in the caatinga area, supplemented with 3 levels of supplementation in caatinga grazing (mineral salt (SM); SM + plant species from the caatinga). herbaceous, shrub-tree extract in the caatinga (EVC); and EVC + buffel grass hay) and verified that supplementation together with hay for sheep and goats under direct grazing in the caatinga does not result in significant productive gains.

This way, according to PEIXOTO et al. (2003), the selective mineral supplementation, a concept that means supply only the mineral element(s) that are effectively lacking in the animals' diet, it must always be proposed based on the nutritional management of the animals and not clinical-epidemiological examination of the herds. The roughage consumption of copper in the concentrate and the milk was approximately 62 % of requirement. Copper deficiency was supplied at 105% with selective salt and 448 % with the commercial

salt. The supply of minerals, animals whose demands had been met by supply, only serve to burden the costs, causing possible antagonism or intoxication (GONÇALVES et al. 2008).

## CONCLUSION

Mineral mixtures for goats must remain continuously and uninterruptedly available to the animals in their own feeders. In general, mineral deficiencies in production animals occur or are associated with certain geographic areas, since, depending on the different types of soils that formed them, it is possible that there are deficient, subdeficient and non-deficient areas.

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