Phyllite (rock dust) as inorganic mineral source in rabbit supplementation

Filito (pó de rocha) como fonte de mineral inorgânica na suplementação de coelhos

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ABSTRACT  
Rabbit farming is a growing activity, which implies need for precision nutrition aimed at best animal’s performance and health. Given some restrictions on the use of mineral sources in animal nutrition, inorganic supplementation with rock dust becomes an interesting alternative. The objective was to evaluate the effect of rock dust as an alternative source of inorganic balsistic mineral in nutrition. Three treatments were tested: (1) control group without addition of rock dust or phyllite, (2) kale group, treated with 13g of cabbage/animal/day and (3) phyllite group, treated with 1.5% rock dust addition. Eight animals per group were evaluated in vivo for weight gain, feed intake, shank thickness, average daily weight gain, calcium excretion by bromatology in feces and urine. After slaughter, carcass weight, shin bone weight, urine test and viscera weight were evaluated. There was an increase in weight gain in the animals with rock dust and greater weight in the shin bones; calcium excretion was higher in the kale and control group. There was no difference between the other variables. The use of rock powder proved to be efficient for a better minerals deposition and absorption in the bones.

Keywords: basaltic mineral, calcium, cuniculture, minerals.

RESUMO  
A cunicultura é uma atividade crescente, que implica a necessidade da nutrição de precisão visando o melhor desempenho e saúde dos animais. Dada algumas restrições de uso de fontes minerais na nutrição animal, a suplementação inorgânica com pó de rocha se torna uma alternativa interessante. Objetivou-se avaliar o efeito do pó de rocha como fonte alternativa de mineral inorgânico balsístico na nutrição. Foram testados 3 tratamentos: (1) grupo testemunho sem adição de pó de rocha ou couve, (2) grupo couve, tratado com 13g de couve/animal/dia e (3) grupo filito, tratado com adição de 1.5% de pó de rocha. 8 animais por grupo foram avaliados in vivo para ganho de peso, consumo de ração, espessura de canela, ganho de peso médio diário, excreção de cálcio por bromatologia das fezes e urina. Após o abate avaliou-se: peso de carcaça, peso dos ossos da canela, exame de urina e peso das vísceras. Observou-se um aumento do ganho de peso dos animais com pó de rocha e um maior peso nos ossos da canela; a excreção de cálcio foi maior no grupo couve e testemunho. Não houve diferença entre as demais variáveis. O uso do pó de rocha mostrou-se eficiente para uma melhor deposição e absorção de minerais nos ossos.

Palavras-chave: cálcio, cunicultura, minerais, mineral balsítico.

1 INTRODUCTION  
Rabbit farming deals with the productive, economic, and rational creation of domestic rabbit (FERREIRA et al., 2012). The demand for rabbit meat has increased because it is a protein
source in human food, and these animals have a short cycle, with a short period for weight gain and carcass construction. Taken together, rabbits have lean meat, with lower cholesterol content, less saturated fat and low sodium content (TANNO et al., 2016).

Rabbit meat still has little expression, with low creation and commercialization in Brazil. Each producer has a purpose in the rabbit’s production, which can be directed towards meat, skin, hair, genetic improvement with the sale of matrizes and breeders, laboratory animals or companion animals. Rabbit farming also offers several by-products such as leather in the fashion industry, ears for gelatin production and snacks for dogs, paws and tail as amulets and key chains, blood for culture medium and feces for organic fertilization (FERREIRA et al., 2012).

Raising rabbits requires an adequate animal health care, with nutrition being one of the most important areas. This factor is the most expensive creation process and deserves special attention. (TANNO & COUTO, 2015).

Due to the wide variety of commercial feeds, many owners end up choosing feeds based on visual appearance and price, without regard for nutritional composition. The owner's lack of information about type, quality and quantity of food offered to the animal can usually causes nutritional problems (TANNO et al., 2016).

All minerals are important for rabbit nutrition. Among minerals, calcium is the most abundant mineral in the body. Calcium in combination with phosphorus forms a dense and hard material constituting bones and teeth and is important for physiological functions in the intracellular and extracellular fluid. (FERREIRA et al., 2012). Calcium and phosphorus act on homeostasis in all vertebrate animals, being an essential mineral for the maintenance of bones and teeth, muscle contraction, blood clotting, membrane permeability and the nervous system. (FERREIRA et al., 2012; TANNO et al., 2016).

The body total calcium (99%) in rabbits is found within bones and teeth. Most mammals change their teeth up to twice, and in rabbits, there is continuous eruption of teeth throughout their lives, which plays a greater long-term need for calcium. The remaining 1% of total body calcium supports metabolic purposes including nerves, conduction, muscle contraction, heart rate and blood clotting (REBRODE et al., 2002).

Calcium metabolism in rabbits differs in several respects from other mammals, with its need 30% to 50% higher (ECKERMANN-ROSS,, 2008). Taken together, the digestive system of rabbits has some peculiarities, mainly in the calcium digestion, as it is more efficient and
largely independent of animal's needs. Furthermore, the role of hormones such as calcitonin and parathyroid hormone does not seem to be very relevant. (FERREIRA, et al., 2012).

Rock dust has been used as a soil fertilizer, demonstrating greater plant development when compared to the control group. As the rabbit has a cecum with bacterial microflora, with differences in calcium metabolism and physiology during absorption and excretion, added to some restrictions on the use of mineral sources in animal nutrition, inorganic supplementation with rock dust can becomes an interesting alternative, but without reports in use demonstrating its efficiency. Therefore, this work aimed to evaluate the performance of supplemented rabbits with an alternative inorganic mineral source - rock dust - in comparison to groups without supplementation or supplemented with kale.

2 MATERIAL AND METHODS

The experiment was conducted in ‘Faculdades Associadas de Uberaba’ (FAZU), located in the city of Uberaba, Minas Gerais, Brazil with Ethics Committee on Animal Experimentation at the University of Uberaba approval (CEUA/UNIUBE 056/2021).

This experiment used raising rabbits in a suspended metal cage system, measuring 60cm x 60cm x 40cm. Each cage contained two animals, totaling 24 animals.

The rabbits were divided into 3 groups: (1) control group, which received 150 g of pelleted feed per animal daily; (2) kale group, added 13g of kale with additional 150g of pelleted feed per animal daily and (3) phyllite group, animals were supplemented with 1.15g of rock dust (phyllite) weekly with 150g of pelleted feed per animal daily. The phyllite were diluted in 4ml water, and administered orally during four times a week (1ml/day).

The pelleted feed Saborosa Rações® for rabbits was used in this experiment, which contains 100mg/kg de mineral matter, being 8-16mg/kg and 4mg/kg of calcium and phosphor, respectively; according to the manufacturer’s specifications.

The bromatological kale analysis was carried out in the Bromatology laboratory of FAZU and detected 17,13% of mineral matter, 2,31% and 0,34% of calcium and phosphorus, respectively.

The phyllite or basaltic rock dust was donated by the company Jasfalto Indústria e Comércio de Massa Asfáltica e Construção Ltda, located in Uberaba, Minas Gerais, Brazil. Rock dust is a by-product from crushing - the process of transforming rocks into crushed stone.
Through this material analysis, the following data were obtained through the X-ray Fluorescence method (Table 1).

Table 1. Data on rock dust’s chemical composition.

<table>
<thead>
<tr>
<th>Analyzed Oxides</th>
<th>Rock Dust (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO2</td>
<td>49.78</td>
</tr>
<tr>
<td>TiO2</td>
<td>3.16</td>
</tr>
<tr>
<td>Al2O3</td>
<td>13.12</td>
</tr>
<tr>
<td>MnO</td>
<td>0.18</td>
</tr>
<tr>
<td>MgO</td>
<td>5.35</td>
</tr>
<tr>
<td>CaO</td>
<td>8.76</td>
</tr>
<tr>
<td>Na2O</td>
<td>2.29</td>
</tr>
<tr>
<td>K2O</td>
<td>1.01</td>
</tr>
<tr>
<td>P2O5</td>
<td>0.49</td>
</tr>
<tr>
<td>SO3</td>
<td>&lt; LQ</td>
</tr>
<tr>
<td>LOI</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>SUM</strong></td>
<td><strong>99.63</strong></td>
</tr>
</tbody>
</table>

Concentration below the quantifiable limit (LQ).
Source: Gazola, 2018.

For in vivo analysis, weighing’s and total weight gain of each animal were carried out weekly. Also, it was measured the shin performed on the right rear (right foot) and always made by the same person. Transparent bags were placed under rabbit's cage for feces and urine collection during 24 hours and sent for bromatological analysis of excretion. The Bromatology laboratory at FAZU carried out analyzes of dry matter, mineral matter, calcium and phosphorus.

After 70 days (10 weeks), the animals proceeded to the electroshock stunning process and subsequently, the animals underwent jugular bleeding. Urine collection was performed during slaughter, with a puncture directly into the animal's bladder, in a total volume of 5ml. Subsequently, using a urine analysis kit with colorimetric strip (Bioténica, Urine Strip), density, pH, occult blood, leukocytes, proteins, urobilinogen and urobilirubin were evaluated. Carcass weight, carcass yield, viscera weight, and foot and shin bone weight were also measured.

Data was expressed as mean ± standard deviation (SD) of treatments, using the Graph Pad Prism 6.0 program (GraphPad Software Inc). Zootechnical parameters submitted to the Shapiro-Wilk normality test. ANOVA test was performed followed by the Tukey or Friedman post-test, for urine analysis, feces excretion and weight measurements. All analysis proceeded with 5% significance.
3 RESULT AND DISCUSSION

Total weight gain (Figure 1A) kept increasing throughout the experiment, with the rock dust group having greater weight in the 9th and 10th week, when compared to the kale and control groups (ANOVA p<0.05). The mean of live weight of the animals in the 10th week of the experiment were 2.87, 2.65 and 2.60 kg for the phyllite, kale and control groups, respectively.

Average daily weight gain (Figure 1B) fluctuated over the weeks, remaining constant across groups (ANOVA p>0.05). The average weekly weight gain 1 to 3 may have occurred reducing values during the animals’ week of adaptation, housed with new individuals and feeding. Average weekly weight gain 4 to 7 showed a slight reduction in values, which may be associated with nutrient sequestration due to growth needs. In the eighth measurement, the animals with the phyllite treatment maintained a better mean when compared to the other groups (ANOVA p>0.05). Finally, the animals entered the adult phase and weight stability, arriving for slaughter with a minimum weight of 2.5 kilos.

Figure 1. Mean and standard deviation of total weight (A) and average daily gain (B) during the 10 experimental weeks of phyllite, kale and control groups.

The natural rabbits food is pasture (HARCOURT-BROWN, 1996). Thus, the most important green food is undoubtedly grass and its derivatives - hay and dry grass (LOWE, 1998). Grass represents a balanced protein source, digestible and indigestible fiber, vitamins and minerals (MEREDITH, 2006).

The rabbits’ foods are huge and varied. This means that pet owners can prepare a homemade diet; however, one must have knowledge of nutritional needs and the risks and benefits of each food (LOWE, 1998).
Currently, there is a substitution of natural food for production in rabbit farming. There is a line of foods intended for rabbits, which can be presented in the form of extruded feed, pellets, mixture of seeds and grains or supplements readily to be better used in the digestion and absorption system of these animals (TANNO & COUTO, 2015). Change in natural food source for feed must occurs jointly, being observed differences in the animals weight gain.

The highest weekly weight gain and the highest final weight were observed in the final period of *in vivo* inorganic mineral supplement. It was necessary to research the possible excretion sites and/or minerals deposit; assessing *in vivo* urine and mineral excretion; and *post mortem*, evaluating the carcass, viscera and bones.

Regarding the urine analysis (Figure 2), the values presented show that with the phyllite addition there was a reduction in urinary pH (2A) making the urine a little less basic than the kale and control groups (ANOVA p<0.05). The control group showed a slight occult blood presence (3D) (62.5%); the kale group, on the other hand, showed an intense occult blood presence (63.5%) and, unlike the other groups, the phyllite group did not have occult blood in 75% of the animals. Density (2B) and protein (2C) did not show significant differences between treatments (p>0.05), probably due to the large deviations presented.
Basic pH in the control and kale group may reflect negatively in urine occult blood presence, where the phyllite group had a pH reduction when compared to the others groups. The herbivores normal high of urine’s pH seems to predispose to the calcium aggregation in crystals or even in calculi (REDOBRE, 2002). Furthermore, urolithiasis clinical signs may include hematuria (HARCOURT-BROWN, 1996).

The urine normal color varies between white, white - yellowish and light brown. Sometimes rabbits can have orange or red-orange urine, which is usually due to temporary pigments caused by some vegetables ingestion, but which is often confused with hematuria (JENKINS, 2008). Although the study used kale, no change in color was observed, despite the occult blood presence in kale and control groups being more intense than in the phyllite group.

Urine normally contains a considerable amount of clear sediment (JENKINS, 2008) and a translucent urine indicates low urinary calcium excretion which may be pathological in adult animals (renal failure) but physiological in young rabbits (MELILLO, 2007). In this study, the
possibility of liver and kidney failure was ruled out due to the absence of urobilinogen, urobilirubin in urine samples, detected by the strip method in all groups. As well, infectious processes in the urinary tract were ruled out due to the absence of leukocytes in the urine (FISHER, 2006).

Therefore, it is always recommended to analyze the urine to rule out possible blood in the urine, which may indicate uterine pathology, urinary calculus, urinary tract infection/inflammation (MELILLO, 2007).

Considering the feces and urine minerals excretion, there was no difference in the excretion of dry matter (3A) in the evaluated groups (ANOVA p>0.05). The phyllite group excreted smaller amounts of mineral matter (3B) when compared to control group; however, there was no significant difference between the kale and phyllite groups. When evaluating the calcium excretion (3C) from animals feces and urine, the lowest excretion observed was in phyllite and kale group, when compared to the control group (ANOVA p<0.05). Similar to dry matter, phosphorus excreta (4D) had no significant difference in the experimental groups (ANOVA p>0.05).

Figure 3. Mean and standard deviation of dry matter in animal feces and urine: levels of dry matter (A), mineral matter (B), calcium (C) and phosphor (D).

Source: By the authors, 2023.
As calcium metabolism in rabbits is unique, since these animals do not control the intestinal mineral absorption, excess calcium is excreted in the urine in the form of calcium carbonate, giving the urine a thick and creamy appearance (MEREDITH, 2006). Hence, both urine and feces excreta were evaluated together.

Serum calcium levels depend on the calcium amount in the diet and are normally higher than in other mammals. Urinary calcium levels also vary according to ingested calcium (MEREDITH, 2006). Therefore, it was expected that groups supplemented with a source of calcium, such as kale and phyllite, would have a greater excretion of this mineral in its urine and feces.

Situations where the need for calcium increases, such as growing animals or metabolic changes, less calcium is excreted in the urine (REDOBRE, 2002).

Rabbits with balanced diet excrete 20% of the calcium in the feces, while animals fed with a lot of fat excrete 30% of the calcium in the feces. However, 56% of ingested calcium continues to be excreted in the urine (ECKERMANN-ROSS, 2008).

In figure 4, phyllite group showed the higher weight (4A) when compared to the control group; however, with no weight difference to kale group (ANOVA p<0.05). For carcass weight (4B), viscera weight (4C) and carcass yield (4D) no difference were observed between treatments (ANOVA p>0.05).
Regarding the bones, the shin thickness increase (5A) was observed over time (ANOVA p<0.05); however, with no difference between the evaluated groups (ANOVA p>0.05). The animals stabilized this growth between the 4th and 6th measurement, which may be a factor related to animals’ maturity, when they reach adult size and cease their growth.

Considering bone weights (5B), the phyllite group obtained greater weight when compared to the control group; however, there was no difference in weight when comparing the phyllite to kale group. These values demonstrated greater calcium deposit in the bones of phyllite group.
Harcourt-Brown (1996) found that rabbits fed commercial feed consumed only 0.11-0.34% of calcium, leading to an inversion of the calcium-phosphorus ratio - a factor that predisposes to a decrease in bone quality. Calcium and phosphorus high concentrations are normally tolerated, while low ratios will lead to pathologies in the future (LOWE, 1998). Recommended calcium levels in the diet vary between 0.5 - 1% (MEREDITH, 2006), showing that supplemented animals with a higher calcium and phosphorus ratio obtained a better final carcass weight when compared to the control group.

4 CONCLUSION

The phyllite or rock dust proved to be efficient for depositing calcium in the bones, reducing the minerals excretion in urine and feces when compared to the control group and kale group. Rock dust has the potential to serve as a supplement or even a calcium and phosphorus source in the manufacture of rabbit feed.

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