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Possibility of Using Calcite Powder as A Calcium Supplement for Livestock

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Abstract - This research project was conducted to study the possibility of using calcite powder as a calcium supplement for livestock feeding. Samples of calcite powder procured from different parts of India were analyzed for dry matter (DM), total ash, acid insoluble ash and major and trace minerals using Atomic Absorption Spectrophotometer followed by determination of ruminal solubility of calcium carbonate, calcite, dolomite, lime stone powder and di-calcium phosphate powder as source of calcium. The results showed that samples of calcite powder procured from different parts of India, varied in Ca content (%) from 39.0 to 41.3 with an average of 40.03 ± 0.27%. These values were comparable to the Ca content of calcium carbonate samples (39.17 ± 0.3%). However, P and Mg contents of calcite powder were higher than that of calcium carbonate. Mn content of both the calcium sources was similar, but Cu and Zn contents of calcite powder were higher than in calcium carbonate. Levels of toxic minerals like lead and cadmium were lower in calcite powder than in calcium carbonate but the fluorine content in the later was lower than in calcite powder indicating that calcite powder has the potential to be used as a source of calcium in the animal ration.

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I. Introductions

Animal production depends on several factors like genetic, environmental, nutritional and manage - mental practices followed. Nutrition plays an important role in animal production, as more than 50% of the farm expenditure goes towards feeding of animals. All the nutrients (carbohydrate, proteins, fat, vitamins, minerals, and water) are equally important as one or more of these can hamper the productivity of animals when requirements are not fulfilled. Minerals may constitute a small fraction of the total ration but perform vital role in the body. Mineral elements exist in the cells and tissues of the animal body and their characteristic concentrations vary with the element and tissue. The concentrations of essential elements must usually be maintained within the narrow limits, if the functional and structural integrity of the tissues is to be safeguarded and the optimum growth, health and productivity of the animal are to be maintained. Continued ingestion of diets that are deficient, imbalanced or excessively high in a mineral develop biochemical lesions since physiological functions are affected adversely resulting in structural disorders based on the type of the element, degree and duration of dietary deficiency (9).

Large number of livestock in many parts of the world consume diets which do not meet their exact requirements (21), necessitating the need for mineral supplementation. Mineral supplements are nutritional devices to fortify the normal feeds and fodders in the areas to meet the mineral needs of livestock and poultry at specific levels of animal productivity. Mineral supplements are available under various trade names in the market. The Bureau of Indian Standards (BIS) imposes compositional standards of feeds and mineral mixture for different categories of livestock and modifies the standards periodically. (14) recommended the use of bone meal, chalk powder and di-calcium phosphate as a source of Ca and P in mineral mixture. Quality specifications were also laid down (15). (16) allowed the use of calcined bone meal, in addition to steamed bone meal, chalk powder and di-calcium phosphate. In 1982, ISI recommended the use of ground limestone in the list of ingredients for use in formulation of mineral mixture. In 1992 specifications for Mg and S were laid down (5).

In 2002, the BIS withdrew the use of supplements of animal origin i.e. bone meal, di-calcium phosphate of animal origin, calcined bone meal, etc., and allowed the use of calcite powder in mineral mixture. Indian cattle feed industry is using calcite powder on wide scale on account of it's being easily available and cheaper source of calcium (22). (21) reported that various mineral supplements differ in their bio-availability, which must be taken into consideration. Before the use of any such supplement it is necessary to comparatively scan them for availability of useful elements and ensuring the absence of toxic levels of incriminating minerals.

Unfortunately there is no literature on the availability/ utilization of Ca from calcite powder in livestock although; calcite has been used as a buffer in

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high milk producing cows (18). Keeping the above in view it was proposed to study the possibility of using calcite powder as a calcium supplement for livestock with the following objectives:

- To study the content of calcium and other minerals in calcite powder obtained from different parts of India (locations).
- To determine ruminal distribution and disappearance of calcium from calcite powder and its influence on rumen fermentation.

II. Materials and Methods

a) Sample Collection and preparation

Samples of calcite powder were procured from different sources/ locations and compared with pure $CaCO_3$ (Table 1). During the collection efforts were made to procure as many batch samples as possible. Approximately 1-2 gm of dried mineral supplement sample was taken in silica basin and charred to remove smoke and ashed at 550°C in a muffle furnace for two hrs. Acid extract was prepared by quantitative transfer of ash to a dried clean glass beaker to which 20 ml of 5 N HCl was added. This was boiled for 5 minutes and filtered through what man filter paper No. 42 into 250 ml volumetric flask. The filter paper was washed with hot distilled water until free of acid; the volume was made to the mark with distilled water. This extract was used for analysis of Ca, P, Mg, Fe, Cu, Zn, Mn, Pb and Ca.

b) Laboratory Chemical Analysis

The laboratory analysis was run in triplicate for dry matter (DM), total ash, acid insoluble ash (AIA) and major (Ca, P and, Mg), trace (Fe, Mn, Zn and Cu) and toxic minerals (Pb, Cd and F). Total ash and AIA were analyzed by the method of (4). Macro, trace and toxic minerals were analysed using AAS (Hitachi Z-500). Fluorine was estimated using Ion selective electrode method (25) whereas P was analysed by the spectrophotometer method (6) using molybedate reagent.

c) Determination of Ruminal Solubility

In vitro experiments were conducted to determine ruminal solubility of Ca from various Ca supplements at different pH. The calcium supplements included dolomite, dicalcium phosphate (DCP), lime stone powder (LSP) and calcite powder. The solubility data were compared with those of pure calcium carbonate. The procedure of (26) with slight modification was used in the determination. Determination of Ca was made with the help of Atomic Absorption Spectrophotometer. Finally Ca solubility from different Ca sources was estimated by the method given (27) following the formula given below.

$$\text{Ca solubility in SRL (\%)} = \frac{\text{Amount of Ca present in the supplement obtained from 25 ml of ruminal buffer (Aliquot I) - Blank}}{\text{Amount of Ca presen tin 25 ml of uncentrifuged ruminal buffer (Aliquot II) - blank}}$$

III. Results and Discussions

a) Calcium and other Mineral Content of Calcite Powder

The mineral chemical composition of the calcite powder samples analyzed are shown in Table 2, 3, and 4. In the present experiment compositional quality of calcite powder was compared with $CaCO_3$ which is a conventional source of Ca supplement for livestock. It was evident from Table 2, that the content of AIA in calcite powder varied from 0.74 to 4.07 with an average of 2.84± 0.39. The AIA content in $CaCO_3$ was observed to be 1.34 to 1.48 with an average of 1.42 ± 0.04 for AIA. The Ca content in calcite powder varied from 39.0 to 41.3 percent which was quite high and similar to that of $CaCO_3$ (Table 2). (19) reported that carbonate of Ca were rich in Ca contrary to sulphate forms of Ca. The sulphate forms of Ca such as gypsum and phosphogypsum were found to contain 12 - 35.6% Ca. Acid insoluble ash (AIA) content in the calcite powder varied from 0.74 to 4.07 percent with an average of 2.41 ± 1.67 percent. Since calcite powder contained high amount of Ca and low amount of AIA so it could be considered a suitable source of Ca supplement for livestock.

The (7) restricted AIA content to 2.5 to 3.0% in the final mineral mixtures as high levels of AIA lowers the utilization of nutrients and palatability. (3) reported that high levels of AIA in the ration of livestock depressed the utilization of P and certain other micronutrients. It was evident from the (Table 2) that Mg content in the calcite powder obtained from Delhi was highest followed by samples procured from Itola and Dehradoon. The presence of Mg in calcite powder moderate quantity was an added advantage. (13) suggested that lime stone that contained 36.4% Ca can safely be fed free choice mixed with salt to livestock, however due to high Mg CO_3 content (about 5% in dolomite limestone) it should not be used in feeding of poultry. Table 2 further showed that calcite powder contained moderately high levels of Fe and Mn which could be of added advantage in livestock feed. The fluoride content in calcite powder samples varied from 370 to 600 ppm as compared to $CaCO_3$ which contained 380 ppm. (19) reported that marble powder which is also a carbonate form of Ca contained 45-68 ppm F which was much lower than that found in calcite powder. (20) reported that Ca and P content in rock phosphate varied from 20 to 36% and 12 to 18% respectively and that Ca and P content of rock phosphate are observable. They

suggested that high fluoride content present in this supplement to be harmful. In the present study the F content in all the samples of calcite powder was lower than 4000 ppm. (20) suggested that phosphate was safe as it contained <0.4% F.

In India mineral supplements for livestock feeding are marketed under various trade names. The quality standards of such products are regulated according to specification of ISI/ BIS (1962, 1968, 1982, 1992 and 2002). In most cases due to cost considerations Ca sources in mineral mixtures are included in the forms of ores, rocks and other locally available natural sources. Apart from compositional variabilities, in such sources there could be one or more toxic mineral elements (2) which may limit the use of such ingredients, (17) recommended the use of bone meal, chalk powder and DCP as Ca supplements in mineral mixtures. Recently in 2002 in view of growing concern against the use of bovine origin ingredients as mineral supplements to ruminants, in its fourth revision the BIS withdrew the use of mineral supplement of animal origin and has proposed the use of calcite powder in mineral mixture (7). Indian cattle feed industry is using calcite powder on a wide scale on account of its cheaper and easy availability, but the literature is scanty on the efficiency utilization of calcite from calcite powder in livestock, although it has been used as buffer in high milk producing cows (18).

The trace and toxic mineral compositions of the calcite samples analyzed are shown in Table 3 and 4. According to Table 3 and 4, it is evident that all samples of calcite powder investigated in the present study were safe and had low F content. However, F content may vary in samples obtained from different areas and thus need to be checked before incorporating in mineral supplement/ feeds. Perusal of Table 3, further indicated that calcite powder samples contained 39.10 to 106.1 and 1.5 to 6.0 ppm Pb and Cd, respectively where as $CaCO_3$ was found to contain 123.1 to 123.2 and 6.4 ppm Pb and Cd, respectively. (19) observed that various sources of Ca and P contained from 0-100 ppm Pb and 0-5.0 ppm Cd. (12) found that lambs tolerated 15 mg Cd Kg^{-1} DM whereas (11) observed that diet containing as little as 3.0 to 3.4 mg Cd Kg^{-1} DM lowered the Cu status of pregnant ewes and subsequently of the lambs. In view of above discussion Cd concentration of 1.5 to 5.92 ppm found in calcite powder was quite safe even if calcite powder was used as sole supplement in the ration of livestock for meeting the requirement of Ca. According to the results of this study, it could be concluded that calcite powder could be used as a possible alternate source of Ca, because of low AIA and other toxic elements i.e. Cd, Pb and F. However, actual use needs to be confirmed on the basis of solubility studies in the rumen and availability of Ca to the animals. In summary the Compositional scanning of calcite powders obtained from various locations of India suggested that calcite powder had the potentiality of being used as calcium supplement as it contained 40.43 ± 0.27% Ca. The AIA content of calcite powder was also within the limits. Apart from being a potential source of Ca, calcite powder contained moderate quantities of Mg, Fe and Mn which could be of added advantage to livestock.

b) In Vitro Ruminal Solubility

The solubility data of different Ca supplement and pure CaCO3 are presented in Table 5 and Fig. 1. It was observed that at any pH studied, Ca solubility from different chemical forms of supplements was essentially not-similar. At pH 6.0 Ca from calcite powder showed better solubility of 11.15±4.65% while dolomite showed the least solubility than the others. At pH 2.5 calcium carbonate, limestone powder and calcite powder showed higher solubility i.e.72.74±5.47, 72.63±6.12% and 72.39±12.34 respectively. The data (Table 5) further revealed that Ca solubility from various Ca supplements, such as dicalcium phosphate, dolomite, lime stone powder, calcite powder and pure calcium carbonate was not similar even at neutral pH 7. At neutral pH 7 of the buffer the solubility ranged from 1.74 % (dolomite) to 2.94% DCP. By scaling down the pH of the ruminal buffer the Ca solubility was seen to increase in all the cases which are in concurrence with the findings of (19). In case of CaCo3 it reached to 72.74%, whereas in case of dolomite and calcite it was 47.84 and 72.39% respectively. (19) reported the solubility of $CaCl_2$ to the extent of 98.8% in ruminal buffer at pH 4.0. It was further evident as pH approached that of abomasal fluid, the solubility of all forms of Ca studied (Table 5) increased.

Many mineral elements do not have similar solubility in different part of gastrointestinal tract. Solubility of any mineral element in the gastrointestinal tract is an important criteria to assess its availability to the animal (10). (1) observed that ferrous sulphate and ferric chloride had higher biological availability to sheep than ferrous carbonate and ferric oxide as the latter two compounds were less soluble sources of iron. Similarly, (23) reported that Mg from MgO is more utilized by sheep than Mg from dolomite limestone because Mg from former source is more soluble, thus any other mineral which is less soluble is supposed to be less available to ruminants.

Solubility of any mineral in the gastrointestinal tract is related to the prevailing pH at that part of the gut. (24) found that Ca and Mg present in the abomasal contents of sheep were in soluble form. (8) studied the changes in concentration and solubilities of Zn, Mn and Cu in the different parts of alimentary, tract of sheep and found that a relationship existed between the solubilities of the metal and pH values of the gut content. This pattern of changes could be reproduced *in vitro* by adjusting the pH of rumen and abomasal samples.

The calcium solubility at pH 6 and 2.5 increased in all the calcium sources under study. (24) reported that all the Ca and Mg present in abomasal content of sheep

existed as insoluble form in the pH range of 2-3. (8) suggested that pH of gut influenced solubility and availability of certain trace elements. He studied the changes in the concentration and solubility of Zn, Mn and Cu in the different parts of the alimentary tract of sheep and found that a relationship existed between the solubilites of the metal and pH of the gut contents.

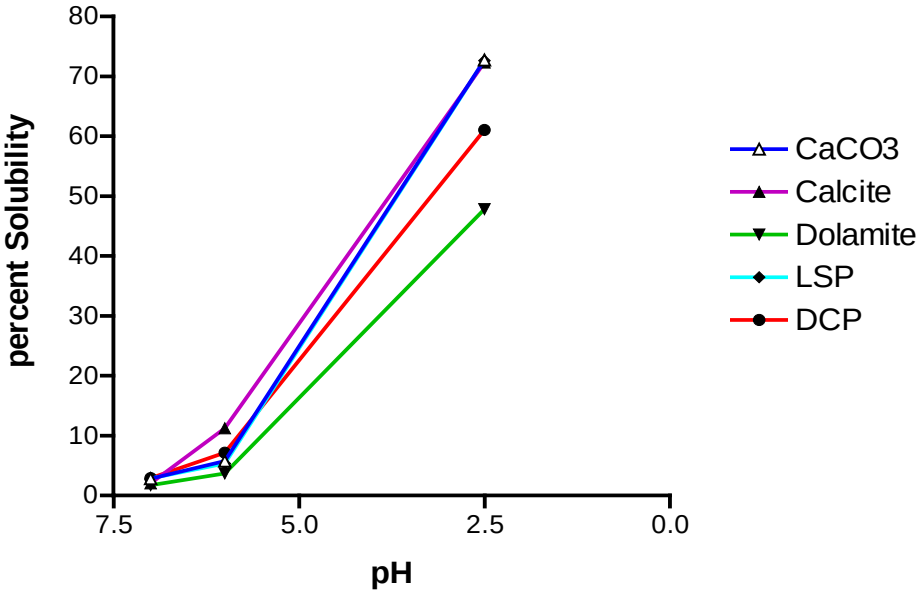

Fig. 1 : In vitro ruminal calcium solubility at different pH

If reaction of the gut influenced the solubility of Ca from different Ca supplement sources to such a great extent, it might be anticipated that the distribution of Ca into soluble and particulate phases in the rumen and flow rates of the two phases from the rumen may influence the rate at which Ca could be made available at the absorption sites lower down the gut. Therefore, different sources of Ca supplements may not be of similar value. Evidently, there is need to modify the quantitative proportion of alternate sources of Ca in a mineral mixture not only on the basis of composition but also on the basis of solubility and net availability. The solubility results of the *In vitro* experiments were compared with that of pure $CaCO_3$. At pH 7.0 the solubility values ranged from 1.74% in case of dolomite to 2.94% in case of dicalcium phosphate. Even the Ca solubility in case of pure $CaCO_3$ was 2.81% at pH 7.0. With decrease in buffered SRL pH these values increased to as high as 47.74 percent in case of pure $CaCO_3$. On decreasing the buffered SRL pH from 7.0 to 2.5, the solubility of all the Ca supplements increased to variable proportions. In summary it was concluded that calcite and lime stone powders may be good source of Ca under the conditions when ruminal pH is towards lower side.

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