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The Feasibility of using Natural Rocks as Sources of Calcium, Magnesium and Phosphorus in Livestock Feeding in Ethiopia

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Abstract- In Ethiopia, feed industries are widely using limestone as a cheap source of Ca without adequate information on the bioavailability of its Ca content and the presence of other toxic minerals. This being the case, the present study was conducted to determine the Calcium, Phosphorus and Magnesium content of samples of limestone and marble powder collected from different parts of Ethiopia. Adequate quantities of lime stone, marble powder and gypsum were procured from different parts of Ethiopia and subjected to laboratory chemical analysis in triplicate. The results of this study clearly showed that the total ash content of all the materials analyzed in this study ranged between 81 and 99%, indicating the potential use of these materials (limestone, marble powder and gypsum) collected from different part of Ethiopia) as supplementary mineral feed source in a very small amounts. The Ca content of the samples collected varied from 16.62 to 89.19%, with mean value of 74.4% the value of which was significantly higher than the Ca content of Calcium-carbonate and Calcite powder (39.17 ± 0.3%). On the contrary, the mean P and Mg content of all the test materials was 0.12 and 0.32-0.69% the values of which are comparable to the P and Mg content of common animal feed in Ethiopia. In summary the results of this study showed that lime stone and marble powder widely available in different parts of Ethiopia seems to have potential value as a Ca supplement for livestock feeding. Testing the bioavailability of these materials with animal seems to be the future direction of research.

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I. Introduction

Successful animal production depends on genetic and environmental factors including nutrition and management practices. of which nutrition plays an important role. It is believed that more than 50% of the farm expenditure or cost of animal production goes towards feeding of animals. Dietary nutrients promote programming and expression of the metabolic pathways that enables the animal to achieve its genetic production potential. All the nutrients (carbohydrate, proteins, fat, vitamins, and minerals) are equally important as deficiencies of one or more of these nutrients hamper the health status and productivity level of animals.

There is variation in the mineral content of different animal tissues. 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 status of the animal are to be maintained. Continuous ingestion of diets that are deficient, imbalanced or excessively high in a mineral, induce change of the normal mineral concentration of body tissues. In such circumstances the biochemical and physiological functions of the animals are affected which in turn may result in structural disorders. The developed structural disorders are variable with the mineral element concerned and its toxicity, the degree and duration of dietary deficiency, and the age, sex and species of animal involved (Chesters and Arthur,(1988) Such a change could be prevented through the provision of balanced, palatable and adequate diet in desirable forms. According to McDowell et al (1993) mineral supplements differ in their bio-availability, one of the most important factors in mineral nutrition, which must be taken into consideration. Thus it is necessary to comparatively scan the available mineral supplements aimed at ensuring its adequacy and levels of toxicity incriminating minerals. This being the cases, the major objective of this research project was to study the feasibility of using natural rock as potential source Calcium and other mineral in livestock feeding in Ethiopia.

II. Materials and Methods

a) Sample Collection and Processing

Adequate quantities of Calcium carbonates, marble powder (both wet and dry), and gypsum and silica powder were collected from different locations as shown in Table1. Efforts were made to collect as many batch samples as possible during the field survey conducted. All the samples collected were transported to Jimma University college of Agriculture and Veterinary Medicine (JUCAVM). All the samples were dried at 100 0C and milled to pass through 1mm screen. The dried materials were stored in air tight contained until required for chemical analysis.

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b) Chemical Analysis

All the laboratory chemical analysis was done in Canada at the Faculty of Agriculture of Dalhousie University. One gm of dried sample materials were taken into silica basin, charred to remove the smoke and ashed at 550oC in a muffle furnace for two hrs. The ashed materials were transferred to clean and oven dried glass beakers, boiled with 20 ml of HCL acid for 5 minutes and filtered through what man filter paper No. 42 into 250 ml volumetric flask. The residue was washed with hot distilled water until free of acid and the volume was made to the mark with distilled water. This extract was used for analysis of different minerals using standard methods.

All the required standard solutions were prepared as shown in Table 2,and all the samples were analyzed in triplicate and Ca and Mg were estimated, according to (AOAC,2002), with the use of atomic absorption spectrophotometer (AAS) employing acetylene, air and specific hallow cathode lamps for the determination of individual mineral as the case may be. Strontium chloride was added during the estimation. Total phosphorus in the mineral supplement samples was estimated by spectrophotometric method (Tran and Simard, 1993).

Table 1 : Sources of calcium carbonate

Sr. No.	Date Of Collection	Name of Sample	Place of Collection
1	17/07/2013	Marble powder(wet)	Addis marble factory
2	17/07/2013	Marble powder (dry)	Addis marble factory
3	17/07/2013	calcium carbonate (Lime stone)	Amhara (Gojam) filiklik Abyssinia cement factory
4	17/07/2013	calcium carbonate (Lime stone)	Amhara (North showa) Jamma Abyssinia cement factory
5	17/07/2013	gypsum	Amhara(Go jam) filiklik
6	17/07/2013	calcium carbonate (Lime stone)	oromia (Durba) Mugger cement factory
7	17/07/2013	silica powder	oromia (Durba) Mugger cement factory
8	17/07/2013	calcium carbonate (Lime stone)	oromia (Durba) Durban cement factory
9	18/07/2013	calcium carbonate (Lime stone)	Hungshan cement factory Mojo Hirnna (Harar)

Table 2 : Preparation of standard solutions for various elements

Element	Salt	Quantity in mg will be made to 100 ml with distilled H_2O	Yield	Standard range
Calcium	$CaCl_2.2H_2O$	40.76	100 ppm	1-20 ppm
Magnesium	$MgSO_4.7H_2O$	102.43	100 ppm	0.06-0.6 ppm
Copper	$CuSO_4.5H_2O$	39.89	100 ppm	0.8-8 ppm
Zinc	$ZnSO_4.7H_2O$	44.235	100 ppm	0.4-2 ppm
Iron	$FeSO_4.7H_2O$	50.80	100 ppm	0.8-8 ppm
Manganese	$MnSO_4.H_2O$	31.39	100 ppm	0.5-5 ppm
Cobalt	$CoSO_4.7H_2O$	49.17	100 ppm	1.6-16 ppm
Lead	$(CH_3COO)_2Pb.3H_2O$	18.49	100 ppm	2.0-20 ppm
Cadmium	$CdCl_2$	16.81	100 ppm	0.6-6.4 ppm

III. Results and Discussion

a) Total Ash and Acid Insoluble Ash

The total ash, AIA, Ca, P and Mg contents of the limestone, marble powder, gypsum and silica collected from different part of Ethiopia are given in Table 3. According to Kabaija and Little (1993), the total ash content of most of the Ethiopian common animal feed is equal or lower than 12%. Total ash content of 10-12% and 4.6-8.7% was reported from range grasses and highland hays of Ethiopia respectively. The highest total ash content of 12% was reported from Chrysopogon aucheri grown in the highland of Ethiopia. According Table 3, total ash content of 99% was recorded from Addis Marble powder, Jamma Limestone (Abissinia Cement), Durban Silica Muger Cement, Durban limestone cement and from Hirna limestone hungshane cement, the value of which is very high compared to the others. The lowest total ash content of 81% was recorded from Durban Gypsum cement. The results of this study clearly showed that the total ash content of all the materials analyzed in this study ranged between 81 and 99% (on dry matter basis), indicating the potential use of these materials (limestone, marble powder, gypsum and silica collected from different part of Ethiopia) as supplementary mineral feed source in a very small amounts.

Acid Insoluble Ash content of animal feed seems to receive adequate attentions. The BIS (2002) restricted Acids Insoluble Ash content to 2.5 to 3.0%in the final mineral mixtures as high levels of AIA lowers the utilization of nutrient and palatability. Ammerman et al (1984) reported that high levels of AIA in the ration of livestock depressed the utilization of P and certain other micronutrients. Kabaija and Little (1993), reported ADF ash content of 3-5% from common Ethiopian animal feeds. ADF ash content of range grasses ranged between 4.06 and 7.61%. It is reported that high levels of ADF ash in animal feed negatively affect digestibility. It is also reported that the high levels of ADF ash in animal feed could be attributed to the presence of large amounts of silica which in turn may seriously reduce digestibility (van Soest, 1982). The result of this study showed that Durban Silica Mugar Cement contain 96 % Acid Insoluble Ash which makes it unfit as animal feed because of its insolubility. Jamma limestone, Durban gypsum Muger and Kiliklik limestone Gojam contain 4.2-8.3% Acid Insoluble Ash, the values of which are high for the use as animal feed compared to the others. On the other side (Table 3.1) the Acid Insoluble Ash content of the others (Limestone Abyssinia cement factory (Jamma), Limestone Durban cemnt factory (Durba), Limestone Hungshan cement factory (Hirna)) ranged between 0.29 and 3.29%, the values of which are lower than that reported from the Ethiopian highland range grasses and straw based dry period roughage feeds. Therefore, the results of this study clearly showed that Limestone from durba, Limestone (JN amma) and Limestone (Hirna) could be used as mineral supplant in livestock feeding based on their percent composition of Acid Insoluble Ash.

b) Calcium

Calcium content of 0.16-0.79% was reported from some hays from Ethiopian highlands and range grasses from Ethiopian Sidamo southern rangelands (Kabaija and Little (1993),. According to the result of this study (Table 3), the calcium content of all the materials studied (with the exception of Durban Silica Muger Cement and Jimma limestone cement) ranged between 77 and 89% indicating the potential use of these materials as Calcium supplement in livestock feeding. Addis Marble and Gojam limestone contain 88% of Calcium on dry matter basis. Moreover the mean Acid Insoluble Ash content of Marble powder was found to be 1.21%. The result obtained tends to indicate that one kg of marble powder or Filikliki limestone contains about 880 g of Calcium. It is reported that dietary Ca concentrations of 2-6 g/kg, with higher requirements for lactation have been variously recommended for cattle and sheep (NRC, 1978, 1984, 1985: ARC, 1980), the findings of Sykes and Field (1972) suggest that levels of 2.53. g/kg (0.25%) are adequate in most circumstances (Kabaija and Little (1993).. Thus one kg of Marble powder and/or Filikliki limestone could be adequate to feed 350 dairy cow placed on Calcium free basal diet/day.

The Calcium content in lime stone varied from 16.62 to 88.12 with an average of 68.6 which was quiet high compared to the Calcium content of Caco3 (Table 4.1). As compared to the results of the current study, Lall (1987) reported that carbonate of Ca were rich in Calcium content, contrary to sulphate forms of Calcium.. The sulphate forms of Ca such as gypsum and phosphor-gypsum were found to contain 12-35.6% Calcium. The Acid Insoluble Ash content of the limestone studied in the current study ranged between 0.29 and 8.29% with mean value of 3.88%. Thus, the high content of calcium and the low Acid Insoluble Ash content of limestone make it a suitable source of Ca supplement for livestock feeding under the current Ethiopian conditions.

c) Phosphorus

Kabaija and Little (1993),reported Phosphorus content of 0.12 -0.22% from some hays from Ethiopian highlands and range grasses from Ethiopian Sidamo southern rangelands. Maynard and Loosli (1969) 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. According to the result of this study, the men Phosphorus content of all the test materials was 0.12%, the value of which is comparable to the phosphorus content of common animal feed. As shown in Table 3, the materials tested contain large excess of Ca over P. resulting in Ca:P ratios approximating 500. It is reported that Ca:P ratio of 10 or more is deleterious to ruminants, Although much conflicting evidence occurs in the literature (reviewed by Little, 1970). In this context it is noteworthy that the ARC (1980) concluded that "...it is not possible to state the optimal ratio of calcium to phosphorus for animal performance or whether such a ratio actually exists." Where wide ratios occur, The general tendency is that the dietary concentration of P per se is almost certain to be inadequate in the common animal feed in Ethiopia.

Underwood (1981) considered a dietary P level of 1.7 g/kg to be marginal for grazing animals, in essential agreement with work of Little (1980, 1985) which indicated that 1.4 g/kg should be regarded as minimal for growing cattle. Most grasses and crop residues examined were marginal to deficient in P. and supplementation with P is likely to be beneficial. According to Table 3, the mean phosphorus content (1.2 g/kg) of all the test materials studied is below the minimum requirement for growing cattle (1.4g/kg) indicating that they are poor source of phosphorus for livestock feeding under the current Ethiopian conditions. From a survey of mineral status of soils, feeds and cattle in the Selale, Ethiopian highlands, Khalili et al (1991) , reported wide variation in the concentrations of minerals on different farms. Pasture grass and other feeds were found to be deficient in P and Mg in relation to dietary requirements. Analyses of blood plasma from crossbred and local cattle showed that a number of samples contained P below the critical level of 1.45 mmol/litre. Effects of year and season were significant for Ca, P and Mg. The effect of age was also found to be significant for P ($P < 0.001$).

d) Magnesium

It was evident from the (Table 3.1), that the Mg content in the lime stone powder obtained from filiklik (Gojam) was highest (1.59%) followed by samples procured from Durba cement factory(2.56%). The other test materials (except Silica factory) contain 0.32-1.06% of magnesium the values of which are comparable to the magnesium content of common Ethiopian animal feeds. This result is also comparable or better than that of -Kabaija and Little (1993), who reported Magnesium content of 0.1-0.2% from some hays from Ethiopian highlands and range grasses from Ethiopian Sidamo southern rangelands. The result of this study showed that the presence of Mg in lime stone powder was low so that additional supplement is required. This result agree that of Gohl (1981), who suggested that t lime stone that contained 36.4% Ca can safely be fed free choice mixed with salt to livestock, however due to high Mg CO3 content (about 5% in dolomite limestone) it should not be used in feeding of poultry. From a survey of mineral status of soils, feeds and cattle in the Selale, Ethiopian highlands,

IV. Conclusions

Samples of lime stone powder (CaCo3) powder were collected from different parts of Ethiopia were subjected to laboratory chemical analysis in triplicates. The results obtained showed that the total ash content of all the materials analyzed in this study ranged between 81 and 99% (on dry matter basis), indicating the potential use of these materials (limestone, marble powder, gypsum and silica collected from different part of Ethiopia) as supplementary mineral feed source in a very small amounts. The Acid Insoluble Ash content of limestone from abycinia,cement factory (Jamma), Limestone Durbacemnt factory.(Durban), Limestone Hungshan cement factory (Hirna)) ranged between 0.29 and 3.29%, the values of which are lower than that reported from the Ethiopian highland range grasses and straw based dry period roughage feeds. Therefore, the results of this study clearly showed that - Limestone from durba, Limestone(Jamma) and Limestone(Hirna) could be used as mineral supplant in livestock feeding based on their percent composition of Acid Insoluble Ash. According to the results of this study, the high content of calcium and the low Acid Insoluble Ash content of limestone make it a suitable source of Ca supplement for livestock feeding under the current Ethiopian conditions. Moreover, the results obtain showed that the P and Mg content of the test materials are comparable to that of the common Ethiopian animal feed stuffs. However, animal evaluation of the bioavailability of the test materials seems to be the future direction of research.

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