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The Feasibility of using Natural Rocks as Sources of Iron, Manganese and Copper in Livestock Feeding in Ethiopia

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The Feasibility of using Natural Rocks as Sources of Iron, Manganese and Copper 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 considering the source variability's and the amount of other minerals 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 iron, Manganese and copper content of samples of limestone , marble powder and gypsum 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 very small amounts.

The samples of lime stone, marble powder and gypsum were procured from different parts of Ethiopia, which varied in Fe content *(ppm)* from *548.59 to 8238.67* with an average of *2797.69.* These values were very high when compared to the Fe content of calcium Carbonate and Calcite powder samples *(0.12 ± 0.00ppm).* Also the, Mn content(ppm) from *9.92-262.08* with an average *(91.02)* These values were low when compared to the Mn content of calcium Carbonate and Calcite powder of previous work which was *(233±2.33)* and Cu contents(ppm) from 3.17-*12.75* with an average (*7.73* ppm) the samples analyzed were almost the same (*8.00± 0.00ppm*) with those of calcite powder and Ca carbonate of previous work Abegaze Beyene (*2012*). the values of the Fe is much higher ,Mn and Cu content is comparable with 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 Trace elements supplement for livestock feeding. Testing the bioavailability of these materials with animal seems to be the future direction of research.

Keywords: calcite powder; lime stone; livestock; marble powder; minerals.

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. Minerals may constitute a small fraction of the total ration but perform vital role in the body.

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 (Chester 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 Trace elements 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 (silica powder analyzed for just curiosity

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only because it cannot be used as animal feed supplement) 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 ^{0}C and milled to pass through 1mm screen. The dried materials were stored in air tight contained until required for chemical analysis.

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 550^{o}C 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 Fe, Mn and Cu 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.

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, Fe, Mn and Cu 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 (Abyssinia Cement), Durban Silica Mugger Cement, Durban limestone cement and from Hirna limestone hungshan 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 and gypsum 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 Mugger Cement contain 96 % Acid Insoluble Ash which makes it unfit as animal feed because of its insolubility. Jamma limestone, Durban gypsum Mugger and filiklik 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) 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 (Jamma) and Limestone (Hirna) could be used as mineral supplant in livestock feeding based on their percent composition of Acid Insoluble Ash.

b) Iron

Iron content of some hays from Ethiopian highlands and range grasses from Ethiopian Sidamo southern rangelands contains 191-974mg/kg an average of 485.14mg/kg and Range grasses contains 452-882 mg/kg an average of 697.3 mg/kg Kabaija, E., Little, D.A., ILRI (1988).in which in both cases it can be enough for the requirement of the animals.

Iron concentration in browses ranged (ppm) from 93 to 693 with a mean of 340±22.1 in the wet season and 51.3 to 188 with a mean of 97.8±22.1 in the dry season. The Fe content in all sampled browses was well above the recommended level for ruminants in feeds in both the wet and the dry seasons with higher concentration in the wet season than the dry season Temesgen and Y.K. Mohammed 24(3)2012. The forages in the study areas adequately supply the requirements of Fe for different classes of camels. Sousa et al (1981) reported high concentration of Fe in forages in both the wet and the dry seasons in northern Mato Grosso, Brazil. Most forage contains Fe concentration

considerably in excess of the requirements of herbivorous animals McDowell (1992). McDowell (1992) reported that Fe contents of most feed ingredients is highly variable, reflecting differences in soil and climatic conditions as well as differences in variety or processing procedures. According to the result of this study (Table 3), the iron content of all the materials studied are very high except in lime stone from Abyssinia cement factory (Jamma), Marble powder Addis cement factory and lime stone from Durban cement factory which ranged from (548.59- 911.08ppm) while Limestone Abyssinia cement factory(Jamma) 2836.25ppmFe which is very high. Dietary Fe requirement for dairy is 50-100 ppm, for beef 50 ppm (NRC, 1984, 1985, 1988.1989.1994)Thus one kg of Addis Marble powder or Limestone Abyssinia cement factory(Jamma) can be enough to feed7 and 28 dairy cow or14 and 56 beef cows respectiely placed on iron free basal diet/day. In our finding the Acid Insoluble Ash content of the limestone studied in the current study ranged between 0.29 and 8.29% with mean value of 3.26%. Thus, the high content of iron and the low Acid Insoluble Ash content of limestone collected from all places seems suitable source of Fe supplement for livestock feeding under the current Ethiopian conditions. but those having more than 3.5% AIA it is difficult to use according 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.

c) Manganese

Manganese content of some hays from Ethiopian highlands and range grasses from Ethiopian Sidamo southern rangelands contains 96-322mg/kg an average of 223.57mg/kg and Range grassescontains 45-72 mg/kg an average of 63 mg/kg Kabaija, E., Little, D.A., ILRI (1988).in whjch in both cases it can be enough for the requirement of the animals.

Manganese content in browses ranged from 9.52 to 371 ppm with a mean of 162±21.1 ppm in the wet season and 17.2 to 325 ppm with a mean of 82.8±21.1 ppm in the dry season . In the wet and the dry seasons, 5 and 40% of the sampled browses contained below the recommended concentration of Mn McDowell and Arthington (2005) in feeds for ruminants. The mean *concentration* of Mn in forage plants is well above the minimum requirement indicated in both wet and dry seasons with higher concentration in the wet than in the dry season . The mean concentration of Mn in browses is adequate to different classes of camels in the study areas in both seasons. Concentration of Mn in crops and forages is dependent on soil factors, plant species, and stage of maturity, yield, crop management, climate, and soil pH (McDowell 1992).

According to the result of this study (Table 3.), the manganese content of all the materials studied are reneges from 30.2 (ppm) limestone Abyssinia cement factory (jamma) which is very low while lime stone from Gojam (Filiklik)containing 262.08 (ppm) which is very high and having an average of 101.2 (ppm). Dietary Mn requirement for dairy is 40 (ppm), for beef also 40 (ppm) (NRC, 1984, 1985, 1988.1989.1994)Thus one kg of limestone powder Abyssinia cement factory (jamma) could be adequate to feed 3 dairy cow or 3 beef cow placed on iron free basal diet/day. In our finding the Acid Insoluble Ash content of the limestone studied in the current study ranged between 0.29 and 8.29% with mean value of 3.26%. Thus, the high content of manganese and the low Acid Insoluble Ash content of limestone collected from many places except samples collected from Abyssinia cement factory (Jamma). marble powder (wet)Addis marble factory are suitable source of Mn supplement for livestock feeding under the current Ethiopian conditions. the rest because of its high AIA it is difficult to use.

d) Copper

Copper content of some hays from Ethiopian highlands and range grasses from Ethiopian Sidamo southern rangelands contains 5.9--7.9mg/kg an average of 6.87mg/kg and Range grasses contains 3.6-5.6mg/kg an average of 4.35 mg/kg Kabaija, E., Little, D.A., ILRI (1988).in which in both cases it can be enough for the requirement of the animal.

Concentration of copper in sampled browses ranged (ppm) from 8.91 to 30.8 with a mean of 19.4±1.38 in the wet season and 3.64 to 23.9 with a mean of 12.2±1.38 in the dry season /In the wet and the dry seasons, 10 and 45%, respectively of sampled browses contained Cu in a concentration lower than the critical level suggested for ruminants McDowell and Arthington (2005). Based on the critical level of Cu in feeds established for ruminants, forages in the study areas could supply adequate amount Cu for camels of different classes in both the wet and the dry seasons. Copper deficiency is a severe limitation in grazing ruminants and has been observed in many parts of the world McDowell (1992). However, the current result and that of Woldu (1984) indicates that browse forages can supply adequate amount of Cu for browsing camels. This could be due to differences in soil factors, plant species and stage of maturity, climate, and soil pH (McDowell 1992). Copper concentration in the wet season was higher than that in the dry season.

Dietary Cu requirement for dairy is 10 (ppm), for beef 8 (ppm) (NRC, 1984, 1985, 1988.1989.1994).Thus

According to the result of this study (Table 3), the copper content of all the materials studied are reneges from 3.17—12.75 (ppm)with an average of 8.2 ppm showing a beat less than the requirement of dairy cow but ,if the supplement is given from Addis marble factor (wet), limestone Abyssinia cement factory (jamma) it will meet the requirements of the dairy.

Table 3 : Total ash,AIA(on percent DM basis)and trace minerals content in gypsum,lime stone and marble powder (ppm)

SAMPLE NO	Place of collection	Dm%	AIA % of DM	Total ash	Fe ppm	Mn ppm	(Cu ppm
1	Marble powder wet # Addis marble factory	99.73	1.09	99.31	765.75	31.91	249.39
2	Marble powder dry #Addis	99.78	1.33	99.39	850.67	*39.50*	
	marble factory						
3	Lime stone Gojam (Filiklik)*Abyssinia cement factory	0.08	8.29	97.12	8238.67	262.08	239.54
4	Limestone Abyssinia cement factory(Jamma)	99.73	3.27	98.69	2836.25	122.58	249.38
5	Limestone Abyssinia cement factory(Jamma)*	82.07	4.24	77.16	548.58	30.25	205.13
6	Gypsum Mugger cement factory (durba*)	99.49	8.43	97.27	7823.25	211.33	248.78
7	silica Mugger cement factory (durba)*	99.96	95.72	99.58	1621.25	9.92	250.04
8	Limestone durban cement factory (dubra)*	98.40	0.29	97.70	911.08	53.83	246.88
9	Limestone hungshan cement factory (Hirna)*	99.89	3.29	99.20	1583.67	57.83	249.87

N.B. # Wet, Dry –While cutting the marble in the factory they are pouring water (wet)sample is taken, the other is without water (dry)

** This are local names where the respective factories are taking the row materials (lime stone ,gypsum or marble powder*

silica cannot be used as feed its content is analyzed just for curiosity only.

IV. Conclusions

Samples of lime stone powder ($CaCo_3$) 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 Abyssinia, cement factory (Jamma), Limestone Durban cement factory. (Durban), Limestone Hungshan cement factory (Hirna)) ranged between 0.29 and 3.29%, the values of which are lower with the exception of lime stone from Gojam (Filiklik). Gypsum Mugger cement factory (durba) and lime stone abysinia cement fctory (Jamma) which seems very high AIA than reported from the Ethiopian highland range grasses and straw based dry period roughage feeds. Therefore, the results of this study clearly showed that – those analyzed trace minerals having less than 3.5% (AIA) could be used confidently according The BIS (2002) and Ammerman et al (1984). (Silica from Mugger cement factory is not used as mineral supplement it is analyzed just for curiosity only). However, animal evaluation of the bioavailability of the tested materials seems to be the future direction of research.

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