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The Feasibility of using Natural Rocks as Sources of Zinc and Cobalt Inlivestock 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 useful minerals and toxic minerals as well. This being the case, the present study was conducted to determine the Zinc and Cobalt content of samples of limestone, Gypsum 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 very small amounts. In present work the Zn content of the lime stone ranged (ppm) 18.4--50.8(with an average of 28.8),In marble powder ranged 16.3—58.88 (with an average of 37.59) and in that of Gypsum from Mugger cement was containing (an average of 10.87 the value of which was almost similar with the Zn content of Calcium-carbonate and calcite powder(21.33 ±1.20) and(37.50± 2.39%) respectively, showing that Zn content in gypsum of the present study is a beat lower than the content of limestone, marble powder and Calcite powder.

Keywords: *gypsum powder, lime stone, livestock, marble powder, minerals.*

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The Feasibility of using Natural Rocks as Sources of Zinc and Cobalt Inlivestock 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 useful minerals and toxic minerals as well. This being the case, the present study was conducted to determine the Zinc and Cobalt content of samples of limestone, Gypsum 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 very small amounts. In present work the Zn content of the lime stone ranged (ppm) 18.4--50.8(with an average of 28.8),In marble powder ranged 16.3—58.88 (with an average of 37.59) and in that of Gypsum from Mugger cement was containing (an average of 10.87 the value of which was almost similar with the Zn content of Calcium-carbonate and calcite powder(21.33 ±1.20) and(37.50± 2.39%) respectively, showing that Zn content in gypsum of the present study is a beat lower than the content of limestone, marble powder and Calcite powder. The Cobalt content of limestone ranged (ppm) 205.13---249.87(with an average of 238.2),the cobalt in marble powder is 249.4 and the cobalt in gypsum is 248.8,showing cobalt content of the present stud is almost equal in all the three samples (limestone, marble powder and gypsum)

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 Zn and Co supplement for livestock feeding. Testing the bioavailability of these materials with animal and identifying other toxic minerals 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. 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 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. Keeping the above in view the present study was carried out

To study the content of zinc and cobalt in calcium carbonate ($caco_3$) or limestone, Marble powder and gypsum obtained from different locations of Ethiopia (natural sources, cement factories etc.)

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II. Materials and Methods

a) Collection of samples

For this study certain samples of calcium carbonate or lime stone with two samples of marble powder which was wet and dry, one sample of gypsum and one sample of silica powder were procured from different sources/ locations (Efforts were made to procure as many batch samples as possible. The detail is given in table 2.1.

b) Analysis of samples

The samples that had been collected from various sources were analyzed in triplicate for dry matter (DM), total ash, acid insoluble ash (AIA), Zn and Co as trace minerals.. Total ash and AIA were analyzed by the method of AOAC (2002). Zn and Co as trace minerals were analyzed using AAS (Atomic Absorption spectrophotometer) AOAC. (2002).

Table 2.1 : 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	Amhara (Gojam) filiklik Abyssinia cement factory
4	17/07/2013	calcium carbonate	Amhara (North showa) Jamma Abyssinia cement factory
5	17/07/2013	gypsum	Amhara(Go jam) filiklik
6	17/07/2013	calcium carbonate	oromia (Durba) Mugger cement factory
7	17/07/2013	silica powder	oromia (Durba) Mugger cement factory
8	17/07/2013	calcium carbonate	oromia (Durba) Durban cement factory
9	18/07/2013	calcium carbonate	Hungshan cement factory Mojo Hirnna (Harar)

c) Analytical procedures

i. *Processing of minerals supplement samples*

1 gm of dried mineral supplements sample were 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 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, Zn, Co, Pb and Cd.

ii. *Estimation of Zn, Co,Cd and Pb*

Minerals (Zn, Co, Pb and Cd) will be estimated by atomic absorption spectrophotometer (AAS) using acetylene as fuel and air as oxidant, specific hallow cathode lamps were used for the determination of each element. After adjusting the instrument, the standards and unknown will be monitored through the samples spraying device to get the constant reading in the digital display The detail of preparation of standard solutions for various elements is shown in table2.2.

Table 2.2 : Preparation of standard solutions for zinc and cobalt

Element	Salt	Quantity in mg will be made to 100 ml distilled water	Yield	Standard range
Zinc	ZnSo4.7H2O	44.235	100 ppm	0.4—2 ppm
Cobalt	CoSo4. 7H2O	49.17	100 ppm	1.6—16 ppm

Stock solution containing 100 ppm of .Zn and Co were prepared by taking the accurately weighed amount of each salt and making the volume as indicated in table2.2.

III. Results and Discussion

Total Ash and Acid Insoluble Ash

The total ash, AIA, Zn and Co 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 factory, 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.

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

SAMPLE N0	Places of collections	DM %	AIA % of DM	Total ash	Zn ppm	Co ppm
1	Marble powder wet *Addis marble factory	99.73	1.09	99.31	16.13	249.39
2	Marble powder dry *Addis marble factory	99.78	1.33	99.39	58.88	249.43
3	Lime stone Gojam (Filiklik)*Abyssinia cement factory	0.08	8.29	97.12	22.27	239.54
4	Limestone Abyssinia cement factory(Jamma)	99.73	3.27	98.69	50.79	249.38
5	Limestone Abyssinia cement factory(Jamma)*	82.07	4.24	77.16	18.38	205.13
6	Gypsum Mugger cement factory (durba*)	99.49	8.43	97.27	10.87	248.79
7	silica Mugger cement factory (durba)*	99.96	95.72	99.58	29.04	250.05
8	Limestone durban cement factory (dubra)*	98.40	0.29	97.70	29.04	246.88
9	Limestone hungshan cement factory (Hirna)*	99.89	3.29	99.20	23.50	57.83

*N.B. * Wet, –While cutting the marble in the factory they are pouring water (wet)*

**Dry- While cutting the marble in the factory without pouring water (dry)*

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

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

Limestone and calcium carbonates are the same

a) Zinc (Zn)

Zinc concentration in browses ranged from 38.1 to 171 ppm with a mean of 73.6±6.08 ppm in the wet season and 14.3 to 130 ppm with a mean of 56.7±6.08 in the dry season. In the dry season,10% of the sampled browses contained below the recommended (McDowell and Arthington 2005) concentration for ruminants. Mean concentration of Zn in sampled browses were higher than the critical level for ruminants in both the wet and the dry seasons indicating adequate concentration of Zn in forages for different classes of camels. Higher concentration of Zn was obtained in the wet season compared to the dry season. Mtimuni et al (1990) also reported a variation on Zn concentration of forages with high concentration in wet seasons in Malawi.

McDowell *et al* (1978) considered 30 mg/kg to be a critical level of dietary Zn, although the ARC (1980) has suggested that concentrations of 12-20 mg/kg are adequate for growing cattle. The crop residues may thus constitute a marginal supply of Zn; the necessity for supplementary Zn needs to be kept under review particularly for sheep, which require some 35 mg Zn/kg diet (ARC, 1980). Nutrient quality of forages in Ethiopia with particular reference to mineral elements **E. Kabaija** and **D.A. Little** International Livestock Centre for Africa P.O. Box 5689, Addis Ababa, Ethiopia P.O. Box 5689, Addis Ababa, Ethiopia.

According to the result of this study (Table 3), Zn content in marble powder ranged **(16.13—58.88ppm)** with an average of **37.5** which is better than what the browses spices are getting specially in dry season and better than from what Mc Dowell mentioned **12—20** mg/kg which is enough for growing cattle Zn in lime stone ranged (**22.27---50.79ppm**) with an average of **28.8ppm** which sill enough for supplementing most of the live stock's. Zn in gypsum analyzed is **10.87** which is very low. Where the AIA is <3.5% the material can be used confidently but if it is >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.

b) Cobalt (Co)

Most forages and feedstuffs fed to dairy and beef animals do not contain adequate quantities of cobalt to support the rumen and animal requirements. Consequently supplemental cobalt must be added to beef and dairy rations. Common acceptable sources of cobalt include: cobalt carbonate; cobalt sulfate; cobalt chloride and cobalt gluco heptonate (Henry, 1995). Cobaltous oxide is not an acceptable source of cobalt, as it has low bioavailability relative to the aforementioned sources (Henry, 1995). Cobalt propionate may be a slightly better source of cobalt compared to cobalt carbonate. Steers supplemented with 0.10 ppm of cobalt as cobalt-propionate had higher plasma glucose and ruminal propionate concentrations then those steers receiving 0.10 ppm cobalt from cobalt carbonate. However, average daily gains were not significantly different between the two cobalt sources (Tiffany, et al, 2003).

The National Research Council (NRC) cobalt requirement for dairy cattle is 0.11 ppm and 0.10 ppm for beef cattle. There is evidence that dietary cobalt concentrations exceeding the NRC requirements may have further beneficial effects on both ruminal bacterial activity and animal performance. In situ dry matter digestion of alfalfa hay, corn cobs, corn leaves and corn stalks were all improved when incubated in the rumen (via porous Dacron bags) of non-lactating cows supplemented with cobalt at 2.5 times the NRC requirements compared with cows not supplemented with cobalt (see Table 1;Lopez-Guisa and Satter, 1992).

In a lactating dairy cow study conducted at Washington State, fat-corrected milk production was improved with mature cows but not first calf heifers, when cobalt

The NRC (2001) requirement for Co is set at 0.11 ppm of dietary DM (approximately 1.2 mg/day for a dry cow and 2.4 mg/day for a lactating cow).Cobalt concentration in Some Selected Acacia Species in lowlands of Ethiopia ranged from 1.6—2.6 mg/kg dm with an average of 2.3 mg/kg DM (Gebeyew, et al., 2015) which can fulfill the requirements of browse animals or animals having access to acacia species in lowlands parts of Ethiopia.

According to the result of this study (Table 3) in samples 1,2,4,8,9 ranged 23.5—249.43 ppm with an average of 203.6 ppm, Thus an average of I kg studied sample can support 169 dry and 84 lactating cows /day.

Sample 3,5,6 are not taken into account because if AIA is >3.5% 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 and sample 7(Table 3)cannot be used as animal feed just done **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 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(AIA) Acid Insoluble Ash content of limestone from Gojam (Filiklik)*Abyssinia cement factory and Gypsum Mugger cement factory (durba*)is very high those samples coudnot be used as mineral supplement as 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 The results obtain showed that the 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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