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EFFECT OF INORGANIC AND VARIOUS ORGANIC SOURCES OF ZINC AND THEIR COMBINATIONS ON *IN VITRO* GAS PRODUCTION AND *IN VITRO* DIGESTIBILITIES

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ABSTRACT

An in vitro study was undertaken to study the effect of various sources of organic zinc in combination with inorganic zinc source on digestibilities of dry matter, organic matter, cellulose and gas production. The feed grade $ZnSO_4$ was the inorganic source and the organic sources of Zn were Zn methionine (Zn met), Zn amino acid complex (Zn aa), Zn proteinate (Zn pr) and Zn propionate (Zn pro), which were added to sorghum stover based diet with organic (O) and inorganic (I) combinations of 0O-100I, 25O-75I, 50O-50I and 100 O-0 I to supply 33 ppm of supplemental Zn. The study indicated that different organic sources of Zn had varied effect on in vitro digestibilities and ME values and hence an appropriate combinations of organic and inorganic mineral sources has to be evolved for optimizing its effect on various functions in ruminants. Zn supplementation with organic-inorganic combinations of 25: 75 for Zn proteinate and Zn propionate resulted in higher in vitro digestibilities and ME value and with regard to Zn methionine and Zn aa complex the combination 75:25 and 100:0, respectively showed better effect.

KEY WORDS

Organic Zn, Gas production, in vitro dry matter digestibility, Organic-inorganic combinations

INTRODUCTION

Zinc is an essential component of over 300 metalloenzymes that play a role in carbohydrate, energy , protein and lipid metabolism and also required for normal development and functioning of immune system, in cell stability and gene expression. Organic trace minerals have been used in ruminant diets and found to be more effective and bioavailable than inorganic forms [1]. Various organic sources of zinc available differ in regard to type of ligand or ligands used to form the complex or chelate, thus could vary in their bioavailability and hence their effect on performance and rumen fermentation. Higher nutrient digestibility co-efficients and nutritive value was observed in cows supplemented with 10g Zn methionine/head/d [2] and in lambs with 20 ppm Zn from Zn methionine [3]. The organic mineral sources though are more bioavailable, the cost of these mineral sources has to be considered for economic livestock production. One of the viable approaches to economize the cost is to replacing a portion of inorganic mineral supplements with organic source could help in addressing the cost concerns. Thus the present study was undertaken to study the effect of various organic sources of zinc in various inorganic-organic Zn combinations on *in-vitro* digestibility and gas production.

MATERIALS AND METHODS

A sorghum stover based diet (sorghum stover 40%, maize grain 40%, soyabean meal 6.5%, red gram husk 1.4%, molasses 8.5%, urea 1.0%, salt 0.207%, dicalcium phosphate 1.531%, limestone powder 0.641%, trace mineral and vitamin premix 0.2072%) was formulated using locally available feed ingredients low in zinc to meet the nutrient requirements of dairy cattle [4] except Zn. The estimated Zn content in the basal diet was 29.11 ppm. The inorganic form of Zn was feed grade zinc sulphate ($ZnSO_4.7H_2O$) (Venvet chemicals Pvt. Ltd., India) containing 22% Zn, while the organic sources of Zn used were Zn methionine (Zn Met; Mintrex Zn®, 16% Zn, Novus International, Inc), Zn amino acid complex (Zn aa; Zinpro®, 10% Zn, Avitech, India), Zn proteinate (Znpr; 15% Zn, ABT Corporation, India) and Zn propionate (Znpro; Kemtrace®; 27% Zn; Kemin Industries, Inc). The $ZnSO_4$ and various organic sources of Zn were added in the above diet with organic (O) and inorganic (I) combinations of 0O-100I, 25O-75I, 50O-50I and 100 O-0 I to meet the NRC recommended concentration of 33ppm [4]. According to the zinc concentration in these sources the appropriate amounts were added to the basal diet to supply 33ppm Zn and these diets with various organic-inorganic combinations were used for *in vitro* studies.

Air dry samples of 200mg were weighted into 100ml calibrated syringes incubated with rumen inoculum collected from permanently fistulated buffalo bull fed the above basal diet, incubated at 39°C with parallel incubation of blanks and standards according to [5] Gas volume (Gv) was measured at 24h and net gas production at 24h was corrected for blank and standards. The *in vitro* organic matter digestibility (IVOMD, mg) and metabolizable energy (ME, MJ/kg DM) were estimated as per the formula of Krishnamoorthy et al. [6] and Menke and Steingass [7], respectively.

$$\text{IVOMD (mg)} = Gv \times 2.2$$

$$\text{ME (MJ/kg DM)} = 2.2 + 0.136 \times Gv + 0.0057 \times \text{CPDM/kg}$$

Where, CPDM= Crude protein in dry matter of sample

The IVDMD was studied my modified two stage *in vitro* technique [8] using buffalo rumen liquor collected from buffalo fed on sorghum stover based diet. The cellulose was estimated in feed and residue samples to arrive at *in-vitro* cellulose digestibility. The crude protein and cellulose in the samples was estimated by methods of AOAC [9] and Van Soest et al [10], respectively. All the assay for each sample were carried out in triplicate and the data was subject to two way factorial analysis with source and combination as factors [11] and means were compared with Duncan's multiple range test [12].

RESULTS AND DISCUSSION

Significant ($P<0.01$) interaction of Zn source and proportion of Zn supplied by these sources was observed on all *in-vitro* parameters investigated. No differences on *in vitro* gas production and IVOMD were observed among organic sources when their proportion was 25% and 50% of total Zn supplementation. At 75% supplementation of Zn through organic source the gas volume and IVOMD and ME content of diet improved with Zn aa complex and at 100% supplementation from organic source they were higher when supplemented from Zn methionine and Zn aa complex compared to other two sources. Supplementation of Zn methionine and Zn propionate in combination with $ZnSO_4$ from 0-100% had no affect on gas volume, IVOMD and ME value, while supplementing Zn from Zn aa complex increased the IVOMD and ME content with increase in its concentration from 25 to 50% and further with 100%. With regard to Zn proteinate IVOMD and ME value was higher ($P>0.01$) at organic-inorganic combination of 25:75 and further increase in Zn proteinate gradually decreased the IVOMD and ME value. Similarly, supplementation of 5g of Zn methionine per day to cows resulted in significant increase in nutrient digestibilities and nutritive value of diet compared to unsupplemented cows, but no further improvement was observed with 10g supplementation from Zn met [2].

An increase in acid detergent fibre (ADF) digestibility was observed with supplementation of ZnMet compared to $ZnSO_4$ in lambs [3] and goats [13]. Supplementing 15ppm Zn from ZnMet improved DM, ADF and other nutrient digestibilities and also the nutritive value compared to those fed 25 ppm Zn from $ZnSO_4$ and no effect was observed with replacement of $ZnSO_4$ with Zn methionine supplying 25 ppm Zn [14]. Similarly, the cellulose digestibility was higher with organic-inorganic combination of 75:25 compared to 100% inorganic group and no further improvement was observed with 100% replacement of $ZnSO_4$ with Zn methionine. While no affect on IVDMD and cellulose digestibility was observed with replacement of $ZnSO_4$ with Zn aa complex from either 25 to 100% level. Similar to these findings, Shinde et al. [15] reported no affect on nutrient digestibilities with either complete or 50% replace of $ZnSO_4$ with Zn aa complex supplementation in guinea pigs. Mandal et al. [16] reported no effect on DM, OM and ADF digestibilities with total replacement of $ZnSO_4$ with Zn propionate supplying 33ppm Zn in crossbred calves. In the present study also, no affect on *in vitro* DM and cellulose digestibilities was observed with 75-100% replacement of $ZnSO_4$ with Zn propionate or Zn proteinate, while the digestibilities improved with replacement of 25% $ZnSO_4$ with these two organic Zn sources.

CONCLUSION

The study clearly indicated that different organic sources of zinc had varied effect on in vitro digestibility and ME values and hence an appropriate combinations of organic and inorganic mineral sources has to be evolved for optimizing its effect on various functions and improving the cost benefit ratio in ruminants. Zn supplementation with organic-inorganic combinations of 25:75 for Zn proteinate and Zn propionate resulted in higher *in vitro* digestibilities and ME value and with regard to Zn methionine and Zn aa complex the combination 75:0 and 100:0, respectively showed better effect.

REFERENCES

[1] Spears JW, Zinc methionine for ruminants: relative bioavailability of zinc in lambs and effects of growth and performance of growing heifers. J Anim Sci, 67: 835-843, (1989).
[2] Gaafar HMA., Bassiouni MI., Ali MFE., Shitta AA and Shamas ASE. Effect of zinc methionine supplementation on productive performance of lactating Friesian cows. J Anim Sci Biotechnol, 2: 94-101, (2011).
[3] Garg AK., Vishal M and Dass RS. Effect of organic zinc supplementation on growth, nutrient utilization and mineral profile in lambs. Anim Feed Sci Technol, 144: 82-96, (2008).
[4] NRC., Nutrient requirements of dairy cattle. 7th ed. Washington, DC, USA: National Research Council/National Academy Press, (2001)
[5] Menke KH., Raab L., Salewski A., Steingass H., Fritz D and Schneider W. The estimation of the digestibility and metabolzable energy content of ruminant feedstuffs from the gas production when they are incubated with rumen liquor in vitro. J Agri Sci, 92: 217-222, (1979).
[6] Krishnamoorthy U., Rymer C and Robinson PH. The in vitro gas production technique: Limitations and opportunities. Anim Feed Sci Technol, 123-124 (1): 1-7, (2005).
[7] Menke KH and Steingass H. Estimation of the energetic feed value obtained by chemical analysis and in vitro gas production using rumen fluid. Anim. Res. Dev. 28: 9-55, (1988).
[8] Goering HK and Van Soest PJ. Forage fiber analysis (apparatus, reagents, procedures and some applications) In: Agricultural Handbook No. 397, Washington, DC: Agricultural Research Service, USDA, 1-20, (1970).
[9] AOAC. Official Methods of Analysis. 17th ed. Washington DC, USA: Association of Official Analytical Chemists, (2000).
[10] Van Soest PJ., Robertson JB and Lewis BA. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. J Dairy Sci, 74: 3583-3597, (1991).
[11] Snedecor GW. and Cochran WG. Statistical Methods, 8th ed. Ames, Iowa, USA: Iowa state university Press; (1989).
[12] Duncan DB., Multiple range and multiple F-tests. Biometrics, 11: 1-42, (1955).
[13] Jia W., Zhu X., Zhang W., Cheng J., Guo C and Jia Z., Effects of source of supplemental zinc on performance, nutrient digestibility and plasma mineral profile in cashmere goats. Asian-Austr J Anim Sci, 22: 1648-1653, (2009).
[14] Hassan AA., El Ashry GM and Soliman SM. Effect of supplementation of chelated zinc on milk production in ewes. Food Nutr, 2: 706-713, (2011).
[15] Shinde P., Dass RS., Garg AK., Chaturvedi VK and Kumar R. Effect of zinc supplementation from different sources on growth, nutrient digestibility, blood metabolic profile, and immune response of male Guinea pigs. Biol Trace Elem Res, 112: 247-262, (2006).
[16] Mandal GP., Dass RS., Isore DP., Garg AK and Ram GC., Effect of zinc supplementation from two sources on growth, nutrient utilization and immune response in male crossbred cattle (Bos indicus×Bos taurus) bulls. Anim Feed Sci Technol, 138: 1-12, (2007).

Table 1 *In vitro* gas production, organic matter, dry matter and organic matter digestibility and metabolizable energy value of diets supplemented with various combination of organic and inorganic sources of zinc

Combination	Zn - Methionine	Zn - aa Complex	Zn -Proteinate	Zn - Propionate
Gas production (mg/200mg DM)			P<0.004; SEM: 0.580	
0O-100I	41.67^{bc}	41.67^{bc}	41.67^{bc}	41.67^{bc}
25O-75I	43.83^{abc}	41.17^{bc}	46.33^{ab}	40.83^{bc}
50O-50I	42.50^{bc}	43.83^{ab}	39.50^{bc}	39.83^{bc}
75O-25I	37.17^{c}	46.33^{ab}	37.83^{c}	37.83^{c}
100O-0I	45.50^{ab}	49.83^{a}	38.17^{c}	37.67^{c}
In vitro organic matter digestibility (mg/200mg DM)			P<0.004; SEM: 1.275	
0O-100I	91.67^{bc}	91.67^{bc}	91.67^{bc}	91.67^{bc}
25O-75I	96.43^{abc}	90.57^{bc}	101.93^{ab}	89.83^{bc}
50O-50I	93.50^{bc}	96.43^{abc}	86.90^{bc}	87.63^{bc}
75O-25I	81.77^{c}	101.93^{ab}	83.23^{c}	83.23^{c}
100O-0I	100.10^{ab}	109.63^{a}	83.97^{c}	82.87^{c}
Metabolizable energy (MJ/Kg DM)			P<0.005; SEM: 0.079	
0O-100I	8.52^{bc}	8.52^{bc}	8.52^{bc}	8.52^{bc}
25O-75I	8.82^{abc}	8.46^{bc}	9.14^{ab}	8.43^{bc}
50O-50I	8.64^{bc}	8.83^{abc}	8.22^{bc}	8.29^{bc}
75O-25I	7.91^{c}	9.15^{ab}	7.99^{c}	8.01^{c}
100O-0I	9.06^{ab}	9.63^{a}	8.06^{c}	7.99^{c}
In vitro DM digestibility (%)			P<0.001; SEM: 0.454	
0O-100I	55.19^{bcd}	55.19^{bcd}	55.19^{bcd}	55.19^{bcd}
25O-75I	49.38^{f}	54.33^{cd}	60.32^{a}	60.28^{a}
50O-50I	55.73^{bcd}	50.27^{ef}	60.35^{a}	59.91^{a}
75O-25I	58.21^{abc}	55.77^{bcd}	56.75^{abcd}	57.35^{abcd}
100O-0I	53.46^{de}	54.20^{cd}	56.64^{abcd}	59.15^{a}
Cellulose digestibility (%)			P<0.005; SEM: 0.773	
0O-100I	45.01^{b}	45.01^{b}	45.01^{b}	45.01^{b}
25O-75I	47.46^{ab}	52.54^{ab}	56.96^{a}	56.91^{a}
50O-50I	53.94^{ab}	48.35^{ab}	56.98^{a}	56.54^{a}
75O-25I	56.28^{a}	54.26^{ab}	55.24^{a}	55.83^{a}
100O-0I	51.67^{ab}	52.28^{ab}	53.28^{ab}	55.78^{a}

^{abc}Means with different superscripts in a row or column: P<0.01; O-organic source of Zn; I-inorganic source of Zn

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