Effects of zinc source and dietary concentration on zinc status, growth performance, and wool characteristics in developing rams

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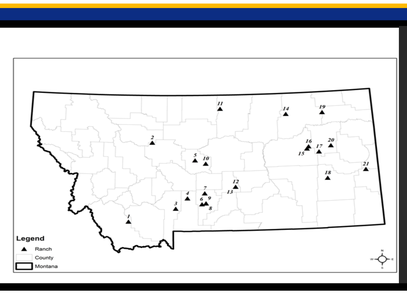
INTRODUCTION

Western sheep production systems rely largely on rangeland plant communities as the primary feed source. This reliance on the rangeland plant community could lead to mineral deficiencies, which may limit the productivity of livestock operations. Mineral concentrations in forages are highly variable across rangelands with influential factors such as soil geochemistry and forage stage of maturity. Numerous studies have suggested that the chemical form of a mineral source plays an important role in bioavailability; generally with organic sources being more bioavailable than inorganic sources (Spears, 2003). A survey conducted to quantify serum Zn concentrations in Montana ram lamb populations indicated that approximately 14% of ranches sampled were categorized as being deficient and 52% marginally deficient in Zn (Page et al., 2016). Subclinical deficiencies in Zn could be more frequent than other trace minerals because the body does not sequester large amounts of available Zn in any one organ (NRC, 2007; Herdt and Hoff, 2011). Optimal concentrations of dietary Zn are not well understood, and with such high tolerance to dietary Zn in most mammals, there is potential for higher supplementation levels than the recommended concentrations for sheep (NRC, 2007).



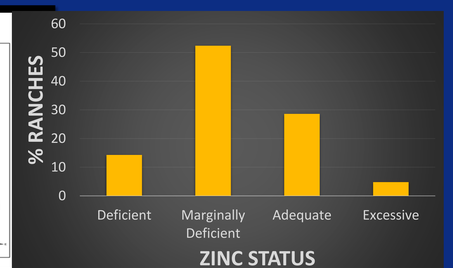


Table 2. Effect of mineral supplementation on ram lamb serum mineral concentrations

	Mineral Supplement				
	Supplemented, *n* = 131		Un-supplemented, *n* = 90		
Mineral	LS Mean	SEM	LS Mean	SEM	P - value
Co, ng/mL	1.18	0.09	0.58	0.11	<0.0001
Cu, µg/mL	0.83	0.02	0.84	0.02	0.960
Fe, µg/dL	156.66	4.55	156.19	5.49	0.948
Mo, ng/mL	44.52	5.91	28.32	7.13	0.082
Mn, ng/mL	2.80	0.27	2.08	0.32	0.087
Se, ng/mL	134.41	3.20	58.92	3.87	<0.0001
Zn, µg/mL	0.760	0.017	0.689	0.021	0.009

OBJECTIVE

Evaluate the effects of dietary zinc source and concentration on Zn status, growth performance, and wool characteristics in developing Targhee rams.

HYPOTHESIS

We hypothesized greater dietary Zn concentrations, and a more bioavailable chemical form would result in greater serum Zn concentrations, growth performance and efficiency and wool characteristics.

ACKNOWLEDGMENTS

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MATERIALS AND METHODS

- Forty-four Targhee rams (14 mo of age; 68 ± 18 kg BW) were used in an 84-d completely randomized design.

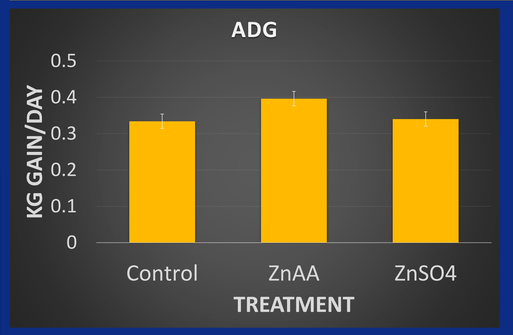
Treatment Groups

1. control diet without fortified zinc (CON; 47.5 ppm Zn; n = 15)
2. diet fortified with a Zn amino acid complex (ZnAA; 95.5 ppm Zn; n = 14)
3. diet fortified with $ZnSO_4$ ($ZnSO_4$; 91.5 ppm Zn; n = 15)

- Growth and wool traits measured e.g., ADG, DMI, G:F, BW, loin muscle depth (LMD), back fat (BF), wool staple length (SL), and average fiber diameter (AFD).
- Jugular venous samples were collected from each ram at four time periods to quantify serum Zn concentrations by ICPMS.

RESULTS

- There were no differences in DMI, BW, LMD, BF, and AFD among treatment groups.
- $ZnSO_4$ had greater serum Zn concentrations compared to ZnAA and CON treatments.
- Rams consuming ZnAA had greater ADG than $ZnSO_4$ and CON.
- There tended to be differences among groups for G:F, with ZnAA being greater than $ZnSO_4$ and CON.
- Wool staple length was greater in the $ZnSO_4$ treatment group and tended to be longer in ZnAA treatment group compared to CON.



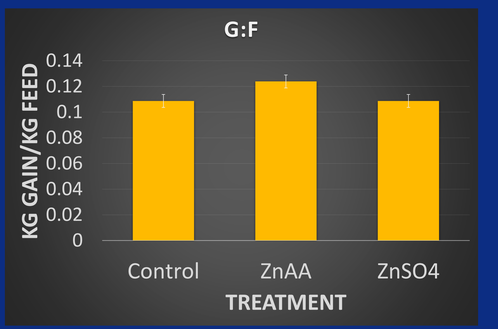


Table 2. Effects of dietary Zn source and period on the performance of rams, carcass traits, serum Zn concentrations, and wool traits

	Treatment[1]					Period				
Item	CON	ZnAA	$ZnSO_4$	SEM[2]	*P* – value	d 0 to 28	d 29 to 56	d 57 to 84	SEM[2]	*P* – value
ADG, kg/d	0.33[b]	0.40[a]	0.34[b]	0.18	0.03	0.44[a]	0.40[a]	0.23[b]	0.20	<0.001
DMI, kg/d	3.11	3.32	3.18	0.81	0.18	2.81[a]	3.43[b]	3.37[b]	0.57	<0.001
G:F	0.109[b]	0.124[a]	0.109[b]	0.005	0.06	0.158[a]	0.115[b]	0.068[c]	0.005	<0.001

[1]Dietary treatments: 1) control diet without fortified zinc (CON; Table 1); 2) a diet fortified with a Zn amino acid complex (ZnAA, Zinpro Corp); and 3) a diet fortified with $ZnSO_4$.
[2]Greatest SEM presented (n = 15).
[a-c] LS means, within a row, lacking common superscripts differ (P < 0.05).

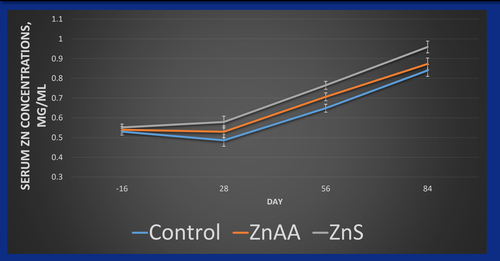


Figure 1. Effects of Zn source on serum Zn concentrations in rams. Treatment x day: *P* = 0.22; dietary treatment: *P* = 0.002; and day: *P* <0.0001.

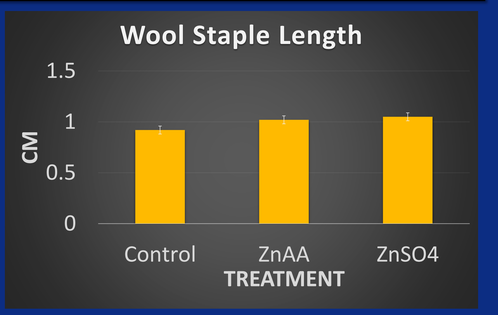


Table 3. Effects of dietary Zn source and day on the performance of rams, carcass traits, serum Zn concentrations, and wool traits

	Treatment[1]					Day					
Item[3]	CON	ZnAA	$ZnSO_4$	SEM[2]	*P* – value	0	28	56	84	SEM[2]	*P* – value
BW, kg	83.7	87.0	84.1	2.02	0.45	68.4[a]	80.8[b]	92.1[c]	98.4[d]	1.30	<0.001
LMD, mm	30.02	29.80	29.13	0.55	0.48	25.30[a]	28.34[b]	30.56[c]	34.41[d]	0.50	<0.001
BF, mm	4.45	4.70	4.70	0.17	0.47	2.98[a]	4.28[b]	5.25[c]	5.96[d]	0.15	<0.001
Serum Zn, µg/mL[4]	0.63[b]	0.66[b]	0.71[a]	0.16	0.002	0.54[a]	0.53[a]	0.71[b]	0.89[c]	0.02	<0.001
SL, cm	0.92[b]	1.02[b]	1.05[a]	0.04	0.003	—	—	—	—	—	—
AFD, micron	22.1	22.1	22.0	0.34	0.96	—	—	—	—	—	—

[1]Dietary treatments: 1) control diet without fortified zinc (CON; Table 1); 2) a diet fortified with a Zn amino acid complex (ZnAA, Zinpro Corp); and 3) a diet fortified with $ZnSO_4$.
[2]Greatest SEM presented (n = 15).
[3]LMD: loin muscle depth; BF: back fat; SL: wool staple length; AFD: average fiber diameter.
[4]d 0 measurements were collected d -16.
[a-d] LS means, within a row, lacking common superscripts differ (P < 0.05).

IMPLICATIONS

- Zn source and concentration affected ADG, serum Zn concentrations, staple length, and tended to increase feed efficiency.
- Results indicate that greater dietary Zn concentrations can enhance nutritional strategies in ram development.
- These findings might be especially applicable to producers developing white-face type rams for fall ram sales in the mountain west and northern plains regions.