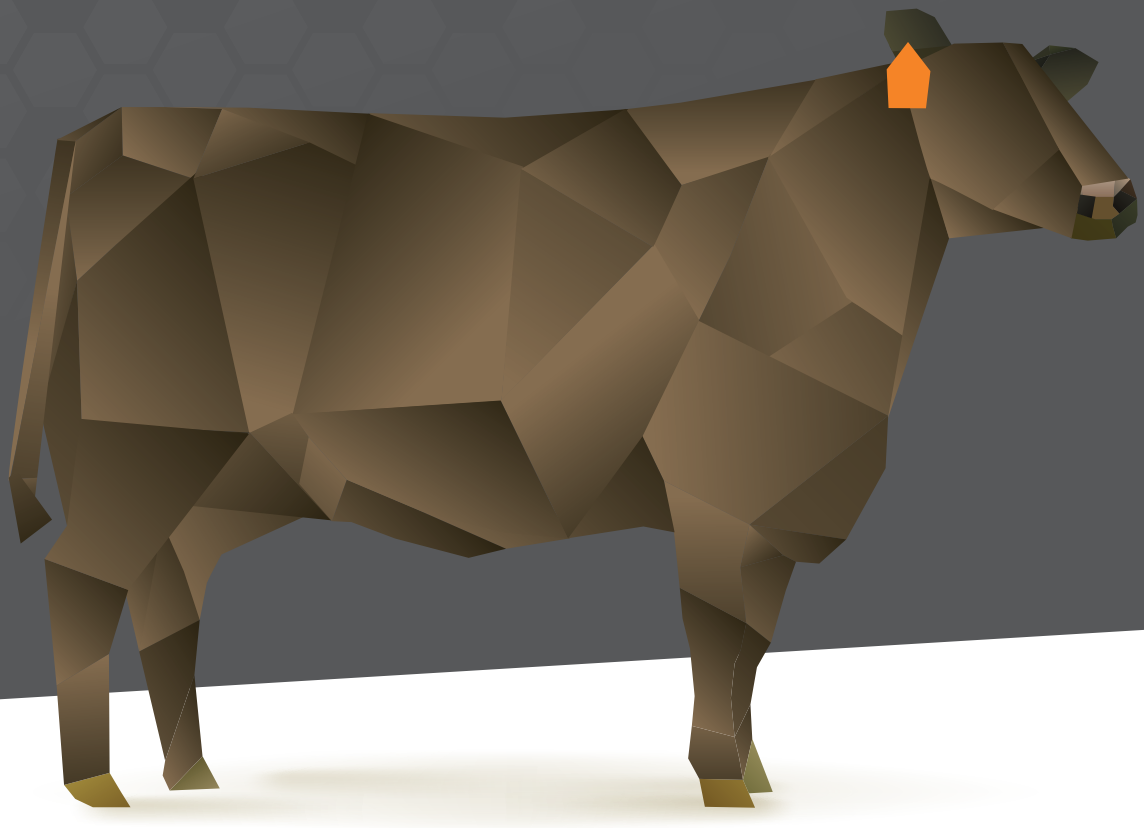
KemTRACE® CHROMIUM: IMPACT ON THE BEEF CARCASS



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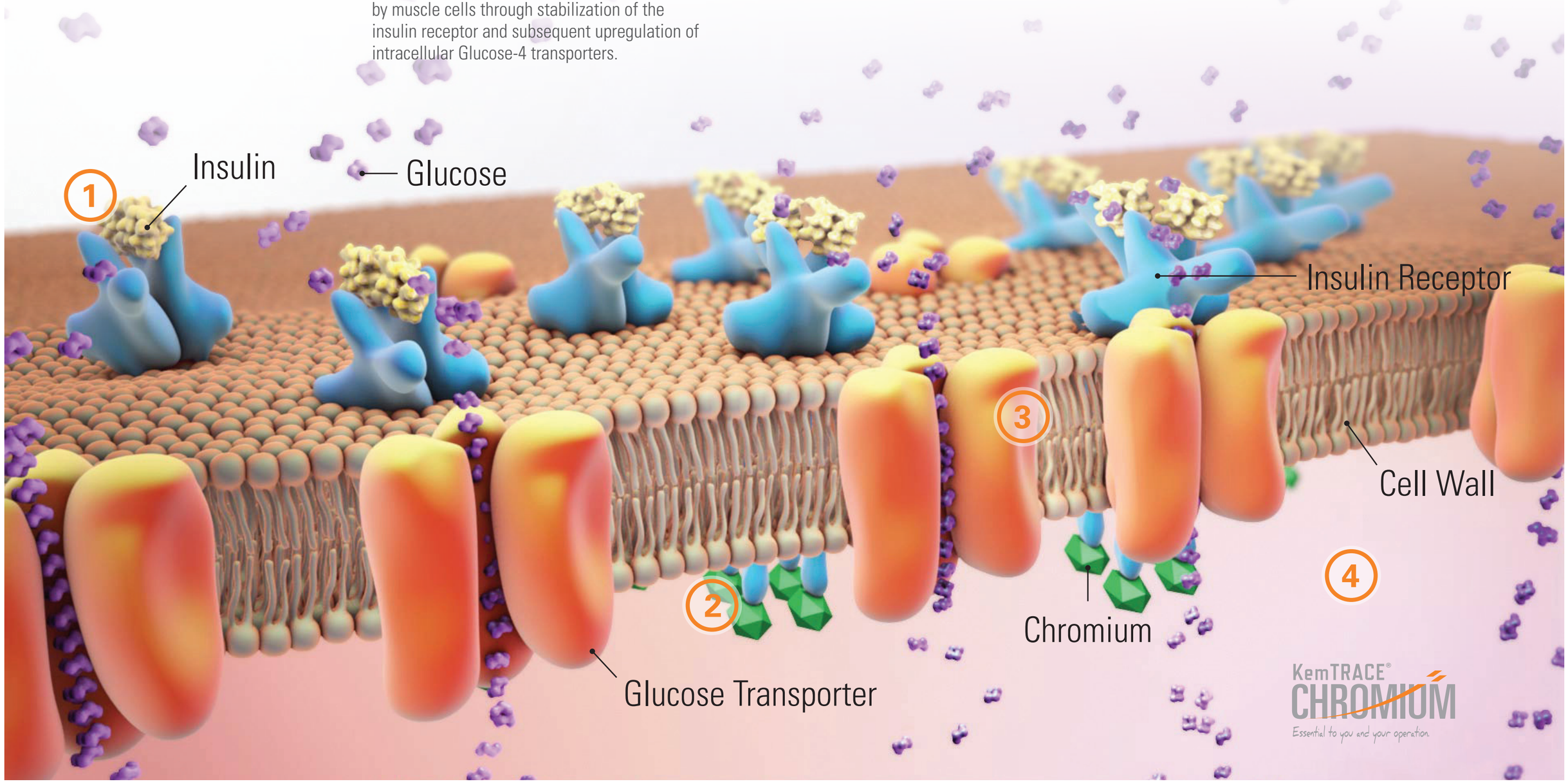
KemTRACE® Chromium Mode of Action

1. Insulin stimulates glucose uptake by muscle cells.[1]
2. Readily available chromium from KemTRACE® Chromium allows for increased glucose uptake by muscle cells through stabilization of the insulin receptor and subsequent upregulation of intracellular Glucose-4 transporters.
3. Greater glucose uptake by muscle cells increases protein synthesis.[2]
4. Increased protein synthesis may result in heavier carcass weight.[2]



1. Weekes, TEC. 1991. Hormonal control of glucose metabolism. In Proceedings of 7th International Symposium on Ruminant Physiology (ed. T. Tsuda, Y. Sasaki and R. Kawashima), pp. 183. Academic Press, San Diego, CA, U.S.A. 2. McGilchrist, P., et al., Whole body insulin responsiveness is higher in beef steers selected for increased muscling. Animal (2011), 5:10, pp 1579–1586.

Chromium Excretion in Response to Stress

The body stores chromium in extremely microscopic quantities (parts per billion).[3] During times of stress, chromium is rapidly used and released from the body. Research conducted in humans has shown chromium is not stored in the body and is excreted during stress: "Urinary chromium excretion may increase 10-300 times in stressful situations or due to a carbohydrates rich diet" (Table 1).[4]

Table 1: Chromium excretion in response to stress factors.[4-6]

Stress Factor	Cr in Urine (µg/day)	Reference
Basal state (no stress)	0.16 +/- 0.02	Anderson et al. (1982, 1983)
Acute stress	0.30 +/- 0.07 ← 2x	Anderson et al. (1982)
Diet rich in carbohydrates	0.28 +/- 0.01 ← 2x	Kozlovsky et al. (1986)

Insulin Response Versus Days on Feed

Research conducted at Ohio State University in feedlot animals demonstrated a positive correlation between days on feed and insulin response. As days on feed increased, the insulin response to the glucose tolerance test increased dramatically. Insulin response to glucose infusion was nearly double on Day 111 versus Day 41 (Figure 1).[7] The longer cattle are on feed, the more insulin resistance increases.

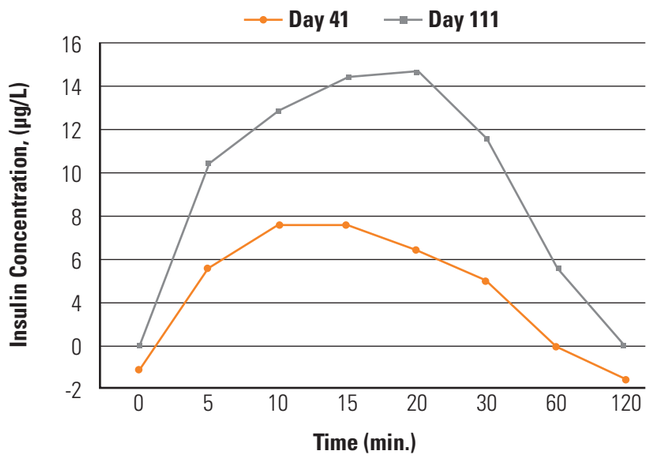


Figure 1. Insulin response versus days on feed.

Glucose	Day 41	Day 111	*P*-Value
Fasted, mg/dL	95.6	96.5	0.84
Clearance, mg/min	0.93	1.17	<0.001
Total AUC	16,143	17,365	0.02
Ins: Glc AUC	**0.023**	**0.049**	**0.0002**

Area Under the Curve (AUC)

3. K.E. Lloyd, V. Fellner, S.J. McLeod, R.S. Fry, K. Krafka, A. Lamptey, and J.W. Spears. Effects of supplementing dairy cows with chromium propionate on milk and tissue chromium concentrations. J. Dairy Sci. 2010; 93:4774-4790. 4. Kozlovsky, A., Moser, P.B., Reiser, S., Anderson, R.A. Effects of diets high in simple sugars on urinary chromium losses. Metabolism 1986; 35:515-8. 5. Anderson, et al. Effects of Cr supplementation on urinary Cr excretion of human subjects and correlation of Cr excretion with selected clinical parameters. Nutrition. 1983; 113:276-281. 6. Anderson, R.A., Polansky, M.M., Bryden, R.A., Roginski, E.E., Patterson, K.Y., Reamer, D. Effect of exercise (running) on serum glucose, insulin, glucagon and chromium excretion. Diabetes 1982; 31:212-16. 7. A.E. Radunz, F.L. Fluharty, A.E. Relling, T.L. Felix, L.M. Shoup, H.N. Zerby, and S.C. Loerch. Prepartum dietary energy source fed to beef cows: Effects on progeny postnatal growth, glucose tolerance, and carcass composition. J Anim Sci. December 2012; 90:4962.

Effects of High Energy Intake and Supplementation with Chromium Propionate on Insulin Resistance

Research has shown that chromium propionate may have an effect on insulin resistance parameters in cattle supplemented high energy diets.[8] Figure 2 demonstrates the effects of high energy intake and supplementation with chromium propionate on insulin resistance. The diets were fed to 1) meet the animals' metabolic energy (ME) requirements without chromium (Cr) supplementation (MAN), 2) provide 160% ME requirements without chromium supplementation (HIGH) and 3) provide 160% ME requirements with chromium supplementation (HIGHCR).

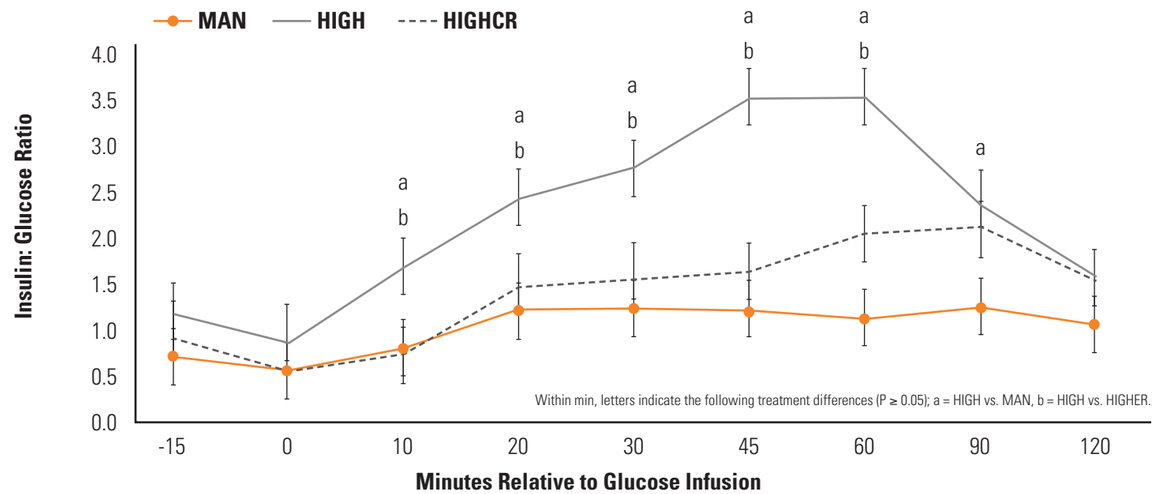


Figure 2: Effects of high energy intake and supplementation with chromium propionate (HIGHCR) on insulin resistance.

Effect of Chromium Supplementation on Live Performance of Feedlot Steers

Table 2: Effect of chromium supplementation on live performance of feedlot steers.[9]

	Treatment, ppb Chromium				
Weight, lb	0	150	300	450	***P*-value**
d 0	807	806	812	811	0.6453
d 28	923	918	941	949	0.3141
d 56	1025^{b}	1023^{b}	1061^{ab}	1088^{a}	0.0261
d 91	1180^{b}	1151^{b}	1194^{ab}	1241^{a}	0.0075
d 119	1267^{bc}	1233^{c}	1303^{ab}	1357^{a}	0.0037
d 147	1328^{b}	1311^{b}	1357^{ab}	1407^{a}	0.0243
ADG, lb					
d 0-56	3.88^{b}	3.88^{b}	4.41^{ab}	4.94^{a}	0.0367
d 56-119	3.86	3.33	3.84	4.28	0.1034
d 0-119	3.88^{b}	3.59^{b}	4.12^{ab}	4.59^{a}	0.0040
d 119-147	2.16	2.80	2.07	1.79	0.3976
d 0-147	3.55^{b}	3.44^{b}	3.73^{ab}	4.06^{a}	0.0284

^{*abc}Means within same row with different superscripts differ (P < 0.05).

8. Leiva, T., et al. Effects of excessive energy intake and supplementation with chromium propionate on insulin parameters, milk production, and reproductive outcomes. Livestock Science 180 (2015) 121-128. 9. Baggerman, J. O., Z. K. F. Smith, A. J. Thompson, J. Kim, P. W. Rounds, and B. J. Johnson. 2016. 0768 Chromium propionate supplementation alters feedlot performance and GLUT4 activity in feedlot steers. J. Anim. Sci. 94(Suppl5):369-370.

Effect of Chromium Supplementation on Carcass Characteristics of Feedlot Steers[9]

Table 3: Effect of chromium supplementation on carcass characteristics of feedlots steers.[9]

	Treatment, Supplemental Chromium (ppb)				
Item	**0**	**150**	**300**	**450**	***P*-value**
Live Wt, lbs	1328	1311	1357	1407	0.02
HCW, lbs	869	871	891	933	0.02
Dressing %	62.9	63.9	63.1	63.5	0.89
Marbling score	485	502	520	521	0.83
12th rib-fat, inch	0.36	0.51	0.37	0.56	0.38
LMA inch^2	13.50	14.30	14.10	14.39	0.78
KPH, %	2.1	2.2	2.1	2.1	0.94
Yield grade	2.7	2.9	2.7	3.2	0.64

Effect of Chromium Supplementation on GLUT4 Transporters

GLUT4 is the principle glucose transporter, responsible for facilitating the movement of glucose into the cell.[10] A recent study found that longissimus muscle biopsies from cattle supplemented chromium propionate had an increase in internalized GLUT4s after a 147-day feeding period.[11] This indicates that the animals supplemented chromium propionate had more sufficient insulin sensitivity compared to the controls at day 147. The decrease of GLUT4 density on day 147 in the control animals may be an indication of decreased insulin sensitivity or insulin resistance occurring.

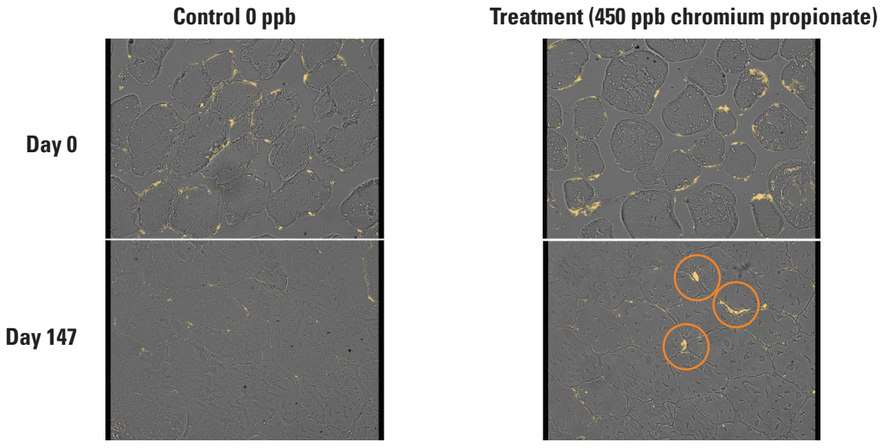


Figure 3: Longissimus muscle biopsies of feedlot steers supplemented with chromium propionate throughout the feeding period (Yellow indicated GLUT4 receptors).[10]

10. Shaohui Huang and Michael P. Czech. The GLUT4 Glucose Transporter. Cell Metabolism 5, April 2007. 11. Johnson, B., Baggerman, J., Kim, J., and Smith, Z., Chromium Propionate Enhances Feedlot Performance and Carcass Quality through Changes in Nutrient Metabolism. 2016 Plains Nutrition Conference. Presented April 14, 2016.

The Effect of Chromium Supplementation in Feedlot Cattle on Hot Carcass Weight (HCW) Responses, lbs[12]

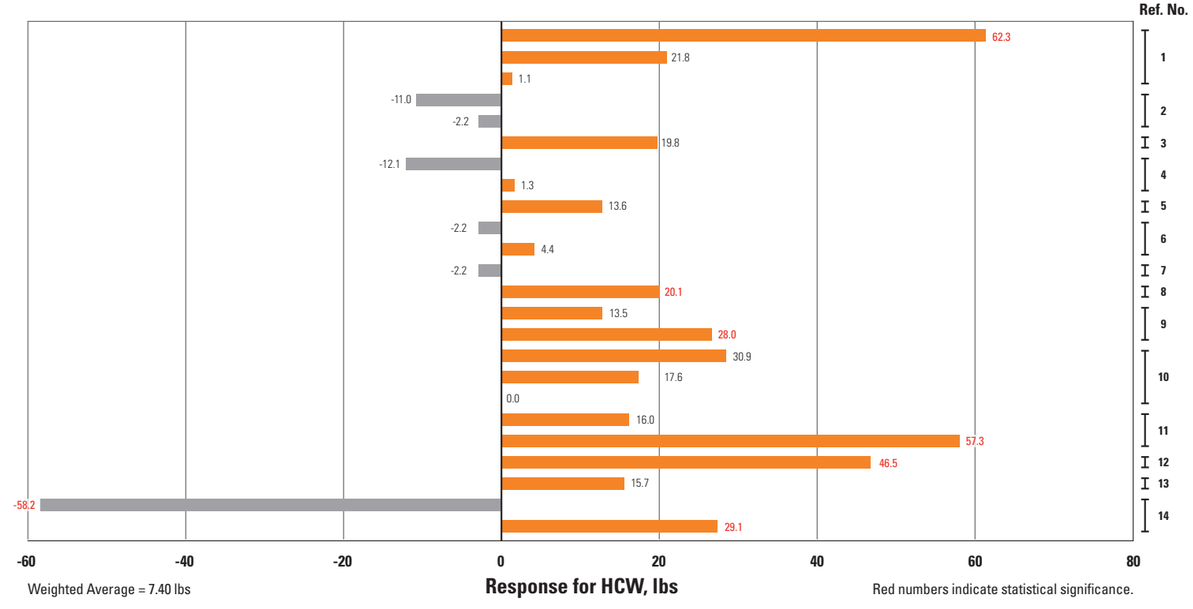


Figure 4: The effect of chromium supplementation in feedlot cattle on hot carcass weight (HCW) responses, lbs.

Insulin Responsiveness in Beef Cattle

- Insulin is the primary hormone responsible for the uptake and storage of glucose by insulin responsive tissues.[1]
- The selection for greater muscling increases the whole body's insulin responsiveness of these animals.[2]
- Transporting glucose is the rate limiting step in insulin-stimulated glucose utilization in muscle cells across most species.[13]
- Muscle and adipose tissue are the main insulin responsive tissues in ruminants, but muscle accounts for over 80% of the insulin-dependent uptake of glucose.[14]

Summary

- Chromium is recognized as an essential nutrient.[15]
- As an essential nutrient, chromium should be fed throughout the entire feeding period.
- Chromium acts to potentiate the action of insulin, increasing glucose availability within the cell.[16]
- Chromium increases the number of GLUT4s within muscle cells.[11]
- Additional glucose in the muscle cell provides the energy for optimizing protein synthesis resulting in improved live performance and increased HCW.[11]
- Feeding levels at 450 ppb maximize additional benefit.

12. The Effect of Chromium Supplementation in Feedlot Cattle on Hot Carcass Weight (HCW) Responses, lbs, BR-2017-00002. 13. Ziel, F.H., Venkatesan, N., and Davidson, M.B. 1988. Glucose transport is rate limiting for skeletal muscle glucose metabolism in normal and STZ-induced diabetic rats. Diabetes 37, 885–890. 14. Kraegen, E.W., James, D.E., Jenkins, A.B., and Chisholm, D.J. 1985. Dose-responsive curves for in vivo insulin sensitivity in individual tissues in rats. American Journal of Physiology, Endocrinology and Metabolism 248, E353–E362. 15. Update on Trace Mineral Requirements for Dairy Cattle. Bill Weiss, Ohio State University. 2015. 16. Insulin signaling and the regulation of glucose and lipid metabolism. Saltiel & Kahn. Nature 414, 799-806 (13 December 2001) | doi:10.1038/414799a.

KemTRACE® CHROMIUM

Essential to you and your operation.

KemTRACE® CHROMIUM: DESIGNED FOR YOU

Our commitment to chromium promises to provide you with a high **quality**, **safe** and **efficacious** product to help your animals reach their optimal performance while maintaining **profit**. It's what makes KemTRACE Chromium essential to you and your operation.

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