Effects of Iodine Source and Dose in Lactating Dairy Cows

A.S. Leaflet R2602

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Summary and Implications

Lactating Holstein cows were assigned to 1 of 2 dietary iodine treatments at the Iowa State University Dairy farm. Objectives were to compare the bioavailability and production responses of an experimental product vs. an established iodine feed ingredient. The two commercial iodine sources were both fed at increasing doses. Results indicate a similar bioavailability between products and a linear increase in blood and milk iodine levels with increasing dose. Dairy producers now have the necessary information to make educated decisions on choosing dietary iodine products.

Materials and Methods

Forty-eight lactating Holstein cows (3.25 ± 1.21 parity, 133 ± 47 DIM, 670 ± 56 kg BW, 45.2 ± 8.4 kg milk yield) were assigned to 1 of 7 treatments at the Iowa State University Dairy farm. Cows were milked twice daily (0700, 1900 h) and milk yields were recorded at each milking. All cows were fed a total mixed ration (**TMR**) twice daily (0800 and 1600 h; there were no dietary changes throughout the trial) and orts/weigh-backs were not recorded. The TMR was formulated by Dairy Health Services (Sanborn IA) to meet or exceed the predicted requirements of energy, protein, minerals and vitamins (Appendix 1). All procedures were reviewed and approved by the Iowa State University Institutional Animal Care and Use Committee.

Cows were selected and moved to a common pen (48 head capacity) 10 days prior to experiment initiation. Cows were assigned to 1 of 7 possible treatments based upon parity, days in milk (DIM) and milk yield.

Iodine products were weighed (to 0.1 mg accuracy), inserted into size 11 (10 mL) porcine gelatin capsules (Torpac Inc. Fairfield, NJ). EDDI was 80% iodine, therefore 37.5, 75.0 and 112.5 mg of product was utilized for the 30, 60 and 90 mg supplements, respectively an referred to as "Product A". The Test Product (Zinpro's iodine product) was 46% iodine, therefore 65.2, 130.4 and 195.7 mg of product was utilized for the 30, 60, and 90 mg supplement, respectively and referred to as "Product B". Farm staff and students were "blind" to treatment classification (i.e. which was A or B). All capsules were orally administered (by bolus) daily to all cows for 14 consecutive days. Cows assigned to the control treatment received a capsule containing neither product. Bolusing occurred while cows were "locked-up" immediately after cows returned to the pen after the AM milking. Cows were observed for 5 min following bolusing to ensure against regurgitation.

Milk samples from each cow (from both the AM and PM milking) were collected on d -2, -1, 3, 7, 10, 14, 17, 21, 24 and 28 relative to treatment initiation. One sample from each collection was stored at 4°C with a preservative (bronopol tablet; D&F Control System, San Ramon, CA) until analysis by Dairy Lab Services (Dubuque IA) using AOAC approved infrared analysis equipment and procedures for milk components. A weighted average (based upon the respective AM and PM milk yield) was calculated for each parameter. An additional sample from each cow and each collection was shipped to Michigan State University's Diagnostic Center for Population & Animal Health (Lansing, MI) for milk iodine analysis.

Blood samples were obtained via coccygeal venipuncture on d – 3, -1, 3, 7, 10, 14, 17, 21, 24 and 28 relative to treatment initiation using vacutainers designed for trace element testing (BD Vacutainer Ref 368380; Franklin Lakes, NJ). Serum was harvested following centrifugation at 1500 x g for 15 min, and subsequently frozen at -20°C until analysis. Serum samples were sent (on dry ice) to Michigan State University's Diagnostic Center for Population & Animal Health (Lansing, MI) for serum iodine analysis.

Effects of treatment (1 to 7) and day (-4 or 28) and their interactions were assessed as a completely randomized design using PROC MIXED (SAS Inst. Inc., Cary, NC). A repeated measures analysis with an autoregressive covariance structure and day as the repeated effect was used to determine effects of treatment day and their interaction on repeated measurements (i.e. milk and serum iodine levels, milk yield etc.). Data from this model are represented in the figures. Production data and iodine levels (milk and serum) from d 7 to 14 (2nd week of supplementation) were combined for each cow and statistically analyzed using the PROC MIXED procedure of SAS. All statistically analyzed data were covariately adjusted using their respective pre-supplementation (d -4 to -1) values. Results are reported as least squares means and considered different when $P \leq 0.05$.

Results and Discussion

Both serum and milk iodine values for the 2nd week (average of d 7, 10 and 14) are presented in Table 1. The smallest A dose (30 mg) did not increase ($P > 0.05$) blood iodine levels (compared to control) but B30 dose increased ($P < 0.05$) serum insulin 69% (compared to controls). Serum iodine levels did not differ amongst the lowest A or B dose ($P > 0.05$). Compared to controls and A30, A60 increased ($P > 0.05$) serum iodine by 106 and 50%, respectively and there were no differences between A60 and B60 (Table 1). Interesting, B30 was statistically similar (*P* > 0.05) to both A60 and B60. Both A90 and B 90 had a similar > 2 fold greater serum iodine concentration than controls and both had a 23% increased compared to A60 and B60. There were no differences (*P* > 0.05) between the time point when (d 10) each dose reach maximum serum levels (Table 2). Maximum serum iodine levels mirrored that of the 2nd week average (Table 2).

The serum AUC data was similar to the 2nd week average, indicating that B30 (although not different [P > 0.05] than A30) was similar to A60 and B60. By d 14, both A90 and B90 serum iodine levels were larger (37%; P < 0.05) than the A60 and B60 doses. In every measure, within every dose and within every day, product B always had a numerically higher serum iodine level compared to product A (Table 1 and 2).

In general, the differences between product, dose, day, and temporal pattern were similar in milk iodine concentrations compared to serum iodine levels (Table 1 and 2. Maximum milk iodine levels occurred on d 8 of supplementation but there were no differences amongst product or dose (*P* > 0.05; Table 2). The increase above control levels during the 2nd week of supplementation for the 30, 60 and 90 mg dose (independent of product) averaged 62, 157 and 293%, respectively (much higher than observed in the serum iodine concentrations; Table 1 and 2).

No treatment differences in any production parameter measured were detected (Table 1). There was no treatment effect on milk SCC (Table 1) or SCS nor was there a relationship between milk iodine levels and SCS.

Acknowledgments

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Table 1. Effects of increasing supplemental dietary iodine products (A and B) on production parameters and milk and serum iodine concentrations.

	Treatment								
Variable	Con	A30	B30	A60	B60	A90	B90	SEM	*P*
Milk Yield, kg/d	43.17	45.46	44.49	44.32	43.86	43.53	45.02	0.84	0.53
Fat, %	3.45	3.38	3.50	3.43	3.49	3.40	3.41	0.13	0.99
Protein, %	2.91	2.93	2.93	2.95	2.90	2.90	2.89	0.03	0.74
Lactose, %	4.80	4.76	4.79	4.78	4.79	4.77	4.79	0.03	0.98
Total Solids, %	12.03	11.96	12.09	12.10	12.09	11.99	12.00	0.12	0.98
MUN[a], mg/dL	12.4	12.9	13.7	13.4	11.9	12.2	12.7	0.5	0.10
SCC[b]	56	288	131	182	182	261	127	84	0.53
Ln SCS[c]	1.69	1.87	1.92	1.95	1.84	2.00	1.78	0.11	0.50
Milk Iodine, mu g/L	376[a]	561[ab]	664[b]	947[c]	983[c]	1113[cd]	1246[d]	74	<0.01
Serum Iodine, ng/mL	78[a]	107[ab]	132[bc]	161[c]	161[c]	197[d]	200[d]	13	<0.01

Data are from days 7 through 14 of supplemental period
[a]Milk urea nitrogen
[b]Milk somatic cell count
[c]Milk somatic cell score
[abcd]Indicates *P* < 0.05

Table 2. Effects of increasing supplemental dietary iodine products (A and B) on milk and serum iodine parameters.

	Treatment								
Variable	Con	A30	B30	A60	B60	A90	B90	SEM	*P*
Milk AUC[a], mu g x L x d									
day 14	.	4422[a]	5301[a]	8286[b]	9788[b]	10279[bc]	11990[c]	732	<0.01
Serum AUC, ng x mL x d									
day 14	.	707[a]	909[ab]	1200[bc]	1252[bc]	1610[d]	1745[d]	130	<0.01
Day of maximum milk I	.	8.2	8.7	10.7	7.7	10.7	9.9	1.3	0.44
Day of maximum serum I	.	8.3	9.5	12.9	10.6	10.2	9.0	1.2	0.16
Maximum milk I, mu g/L	.	689[a]	814[a]	1012[ab]	1238[b]	1225[b]	1381[b]	84	<0.01
Maximum serum I, ng/mL	.	118[a]	145[ab]	178[bc]	175[bc]	215[cd]	240[d]	17	<0.01

[a]Area under the curve

[abcd]Indicates $P < 0.05$