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USE OF MICROTRACERS AS A RELIABLE AND INEXPENSIVE TOOL FOR RAPID ASSESSMENT OF MICROINGREDIENT DISTRIBUTION IN DIETS FOR FEEDLOT CATTLE: MOLASSES- AND FORAGE-LEVEL EFFECTS

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ABSTRACT: We have developed anew technique for the application of microtracer technology to the on-site assessment of microingredient uniformity in diets for feedlot cattle. The influence of dietary forage (12 vs 24%) and molasses levels (6, 12, 18, and 24%) on the efficiency of recovery of microtracer (33 g/ton) using this new technique was compared with that of chromic oxide (87.4 g/ton) and laidlomycin propionate (101.5 g/ton). The order of ingredient addition to the batch mixer was as follows: grain, mineral supplement, forage, fat, and molasses. Markers were premixed with 10 kg of mineral supplement in a small cement mixer before being added to the batch mixer. The grain and mineral supplements were mixed together for I min before addition of the remaining ingredients. After all ingredients were added to the mixer, the batch was mixed for an additional 5 min. An 8-kg sample was taken from each feed batch (341 kg) as it exited the mixer. Eight separate batches (replications) of each dietary treatment were produced. Marker recovery averaged 103.5, 78.3, and 97.2% for microtracer, chromic oxide, and laidlomycin, respectively. The corresponding CV for marker recovery averaged 8.1, 7.2, and 13.0%, respectively. There were no treatment effects ($P > .20$) on recovery of microtracer and laidlomycin. With chromic oxide, recovery increased (linear effect, $P < .05$) with increasing molasses level, and decreased ($P < .10$) with increased forage level. The CV for microtracer recovery also tended (linear effect, $P < .10$) to decrease with increasing molasses level. Recovery of microtracer and laidlomycin were not different ($P > .20$), and both were greater ($P < .0 1$) than chromic oxide. The CV for marker recovery were not different ($P > .20$) for microtracer and chromic oxide, and both were less ($P < .01$) than that of laidlomycin. We concluded that the microtracer technique we have developed is a reliable and inexpensive tool for rapid on-site assessment of microingredient distribution in complete mixed diets for feedlot cattle. Very wide ranges in forage and liquid supplement content of the diet do not appear to pose an appreciable limitation to the reliability of the technique.

Key Words: Feed mixing, Marker, Molasses, Forage

Introduction

Variation in spacial distribution of microingredients in finished feed can depress growth performance (McCoy et al., 1994; Cromwell et al., 1997). Hence, the principal objective in feed mixing is to assure that an animal receives all of its formulated nutrient allowances, every day. Most feed manufacturers use the coefficient of variation or CV to measure mixer performance and mixture uniformity. A 5% CV is the industry standard for most ingredients. An ingredient mix CV of 5% permits that an animal receive at least 90% of its formulated dietary allowances 95% of the time. However, the magnitude of an acceptable CV can vary depending on the analytic precision for measuring the ingredient and the ingredient ratio in the diet. The CV for an ingredient assay (repeatability of the analytical procedure) should be less than the desired CV for mixer efficiency. With respect to ingredient ratio, the lower the ingredient concentration in the mix, the higher the CV. Thus, the CV is usually higher for trace mineral, vitamins and drugs because their ingredient ratios are low (less than 1: 10,000). Different substances including protein, macrominerals (Murthy and Das, 1990), salt, microtracers (Eisenberg, 1992), and drugs have been used or suggested (Zinn, 1999), as markers to measure feed mixing efficiency. However, we have not found any published research that establishes the reliability of the various techniques for assessing the uniformity of microingredient distribution in diets for feedlot cattle. The objective of

this study was to evaluate a new on-site microtracer technique for the assessment of mixing uniformity of microingredients in diets for feedlot cattle.

Experimental Procedures

Eight experimental diets consisting of 2 forage levels (12 vs 24% sudangrass hay) and 4 molasses levels (6, 12, 18, and 24% cane molasses) were evaluated in a 2x4 factorial arrangement. Composition of experimental diets is shown in Table 1. Steam flaked wheat was rolled at a density of .31 kg/L (24 lb/bushel). Sudangrass hay was ground to pass through a 7.5-cm screen. The order of ingredient addition to the batch mixer was as follows: grain, mineral supplement forage, fat, and molasses. Markers were weighed using a laboratory balance (± 1 mg) and premixed with 10 kg of mineral supplement in a small portable cylinder mixer (cement mixer) before being added to the batch mixer. The grain and mineral supplements were mixed together for 1 min before addition of the remaining ingredients. After all ingredients were added to the mixer, the batch was mixed for an additional 5 min. Three markers were evaluated: 1) microtracer (comprised of 35-mesh stainless steel grit coated with non toxic FD&C Blue #2 and FD&C Yellow #6 food coloring, and traces of a food-grade coating; Micro Tracers, Inc., San Francisco, CA.); 2) chromic oxide (Fisher cat. No. C333-3)and3) laidlomycin propionate (Hoffmann-La Roche, Inc., Nutley, NJ). Each batch of complete mixed diet weighted 341 kg. To each batch of feed was added 12.4g microtracer 32.8 g chromic oxide, and 38 g laidlomycin propionate. The microtracer contained approximately 57 colored particles/mg. An 8.17-kg sample, consisting of eighteen scoops (454 g/scoop) of feed was taken from the beginning and ending portion of each batch of mixed feed as the feed exited the mixer. Within one week of feed preparation and sampling, DM of samples were determined using a microwave oven technique: 450g of sample were placed on a glass plate in rotary microwave oven and cooked on high (power setting 7) for 3 min; the sample was then spread on a piece of paper (100 x 80 cm) to accelerate lose of moisture, and then returned to the microwave and cooked an additional 3 min (this process was repeated twice until there was no further weight loss). A 390-g (±.01g) sample was ground in a food processor (Black and Decker, Power Pro FP1000) for 2 min. A demagnetizer unit (Bulk tape eraser Radio Shack, cat. No 44-232) was passed over the sides of the food processor to demagnetize the microtracer particles (Lowe, 1998). The sample was then ground in a coffee grinder (Krups, North America Inc., New York, Mod. No. 208-70) for 7 seconds. The sample was divided into triplicate. Each triplicate was then passed slowly (1.5 min) through the magnetic separator (Micro tracers, Inc), onto filter paper (Whatman #4; 8 cm), and then very carefully transferred (with the finger tips) into a Whatman #4 (19.5 cm) filter paper that had been well wetted with 7% (w/v) sodium carbonate solution. The filter paper was then dried on hot plate (250 'C) to develop the color. The filter paper was then cleaned with a tissue paper, and the stained points counted using a hand counter. After microtracer was magnetically separated, the triplicates were composited and two subsamples of 150g each, were taken for determination of chromic oxide (atomic absorption spectrophotometry; Jackson et a]., 1980) and laidlomycin propionate (Hoffmann La Roche, Inc., Belvidere, NJ). The trial were analyzed as a randomized complete block design experiment with a 2 x 4 factorial arrangement of treatments (Hicks, 1973).

Results and Discussion

Treatment effects on markers recovery are shown in Table 2. Marker recovery averaged 103.5, 78.3, and 97.2% for microtracer, chromic oxide, and laidlomycin, respectively. The corresponding CV for marker recovery averaged 8.1, 7.2, and 13.0%, respectively. There were no treatment effects ($P > .20$) on recovery of microtracer and laidlomycin. Treatment effects on marker recovery are shown in Tables 3 and 4. With chromic oxide, recovery increased (linear effect, $P < .05$) with increasing molasses level, and decreased ($P < 10$) with increased forage level. The CV for microtracer recovery also tended (linear effect, $P < 10$) to decrease with increasing molasses level.

The apparent absence of a negative effect of molasses level on efficiency of marker recovery supports the generalization (Heidenreich, 1998; Zinn, 1999) that provided microingredients are thoroughly mixed with the concentrate portion of the diet before the addition of liquid supplements, the impact of the liquid supplements on spacial distribution of the microingredients will be minimal.

Recovery of microtracer and laidlomycin were not different ($P > .20$), and both were greater ($P < .01$) than chromic oxide. The CV for marker recovery were not different ($P > .20$) for microtracer and chromic oxide, and both were less ($P < .0 1$) than that of laidlomycin. All three markers had higher CV than the 5% recommended by Zinn (1999). Across treatments, the recovery of microtracer was slightly greater ($P > . 10$) at the beginning than at the end of the batch.

Implications

The microtracer technique we have developed is a reliable and inexpensive tool for rapid on-site assessment of microingredient distribution in complete mixed diets for feedlot cattle. Very wide ranges in forage and liquid supplement content of the diet do not appear to pose an appreciable limitation to the reliability of the technique.

Literature Cited

Cromwell, G. L., NRC-42 and S-145 Regional Committees. Variability of mixing efficiency and laboratory analysis of diets at 25 experiment stations. J. Anim. Sci., 75 (Suppl. 1): 196 (Abstr.).

Eisenberg, D. A. 1992. Microtracers (trn,F*) and their uses in assuring the quality of mixed formula feeds. Advances in Feed Technology. Spring, No. 7. FRG.

Heidenreich, E. 1998. Addition of feed additives and the danger of carry-over. Muhle Mischfuttertechnik 135: 10, 297-300.

Hicks, C. 1- 1973. Fundamental concepts in the design of experiments. Holt, Rinehart and Winston, Inc.

Jackson, F. J., J. 1. Read and B. E. Lucas. 1980. Determination of total chromium, cobalt and silver in foodstuffs by flame atomic absorption spectrophotometry. Analyst 105. 359.

Lowe, R. 1998. Electrostatic behaviour of feedstuffs - effects on additive carry-over and contamination. Mhule, Mischfuttertechnik. 135: 4, 101-106.

Murthy, K. S., and Das, C. T. Evaluation of mixer efficiency test. 1990. Indian J. Anim Nutr. 7: 2, 159-160.

Zinn, R_ A. 1999. A guide to feed mixing. Research Updates and Reports Desert Research and Extension Center, Department of Animal Science, UC Davis, http://animalscience.ucdavis.edu/faculty/zinn

Zinn, R. A., Shen, Y., C. F. Adams, M. S. Tame and J. Resale. 1996. Influence of dietary magnesium level on metabolic and growth-performance responses of feedlot cattle to laidlomycin propionate. J. Anim.

Sci. 74:1462-1469.

Table 1. Composition of diets containing microtracer, chromic oxide, laidlomycin propionate and different levels of molasse and forage (%, DM basis)[a].

	Treatments							
Item	1	2	3	4	5	6	7	8
Flaked wheat	77.1	71.1	65.1	59.1	65.1	59.1	53.1	47.1
Sudangrass	12	12	12	12	24	24	24	24
Cane molasses	6	12	18	24	6	12	18	24

[a] Diets contained an additional 4.9% of the following: Yellow grease, 2.43%; limestone, 1.19%; urea, 0.81%; TM salt, 0.40% ($CoSO_4$, .068%; $CuSO_4$, 1.04%; $FeSO_4$, 3.57%; ZnO, 1.24%; $MnSO_4$, 1.07%; KI, .052%; and NaCl, 92.96%); Magnesium oxide, 0.13%; microtracer, 33.0 g/ton; chromic oxide, 87.4 g/ton; laidlomycin propionate, 101.5 g/ton.

Table 2. Efficiency and CV of recovery (%) of microtracer, chromic oxide and laidlomycin propinate in diets for steers containing different levels of molasses and forage.

Item	Microtracer	Chromic oxide	Laidloycin propionate
Recovery, %	103.46[a]	78.31[b]	97.15[a]
SD	6.75	6.81	10.39
CV of recovery, %	8.07[a]	7.18[d]	12.93
SD	3.91	5.8	9.44

[a,b,d] Means within the same row with different superscripts differ ([a,b]P<.001; [b,d]P<.05).

Table 3. Effect of the interaction of different levels of molasses and forage on efficiency of recovery and CV (%), of microtracer chromic oxide and laidlomycin propionate in diets for steers.

	12% forage				24% forage				
	Molasses level, %				Molasses level, %				
Item	6	12	18	24	6	12	18	24	SD
Marker recovery in mix, %									
Microtracer									
First portion to exit mixer	110	105.5	107	107.5	109.5	112.5	103.5	109	8.81
Last portion to exit mixer	103	97	103	88.5	98	101	100	95	10.6
Complete batch									
Microtracer	106.5	101.3	105	98	103.8	106.8	101.8	102	8.3
Chromic oxide	78	80.5	80.5	83.5	73	73	71	87.0	5.67
Laidlomycin propionate [a]	102	94	97	94.5	88	113.5	94.5	93.5	9.9
CV of recovery, %									
Microtracer									
First portion to exit mixer	11	4.8	12.5	3.3	17.4	6.8	6.6	4.4	4.2
Last portion to exit mixer	6.2	8.8	7	6.3	11	11	4.9	7.3	3.8
Complete Batch									
Microtracer[b]	8.8	6.7	9.8	4.6	14.4	8.8	5.7	5.7	3.3
Chromic oxide	4.5	4.3	7.2	3	9.5	12.7	9.3	6.8	6.6
Laidlomycin propionate	10.5	3.8	8.8	14.4	20.5	24.7	11	10.7	9.7

[a]Molasses x Forage effect (P<.10).

Table 4. Effect of different levels of molasses and forage on efficiency of recovery and CV (%), of microtracer, chromic oxide and laidlomycin propionate in diets for steers (main effects).

	Molasses, %				Forage level, %		
Item	6	12	18	24	12	24	SD
Marker recovery in mix, %							
Microtracer							
First portion to exit mixer	109.8	109	105.3	108.3	107.5	108.6	8.81
Last portion to exit mixer[a]	100.5	99	101.5	91.8	97.9	98.5	10.6
Complete batch							
Microtracer[b]	105.1	104	103.4	100	102.7	103.6	8.31
Chromic oxide[b,c]	75.5	76.8	75.8	85.3	80.6	76	5.67
Laidlomycin propionate	95	103.8	95.8	94	96.9	97.4	9.96
CV of recovery, %							
Microtracer							
First portion to exit mixer[d,f]	14.2	5.8	9.5	3.8	7.9	8.8	4.29
Last portion to exit mixer[e]	8.6	9.8	5.9	6.8	7.1	8.5	3.83
Complete batch							
Microtracer[d,e]	11.6	7.7	7.8	5.2	7.5	8.7	3.38
Chromic oxide[f]	7	8.5	8.2	4.9	4.8	9.6	6.68
Laidlomycin propionate[g]	15.5	13.8	9.9	12.5	9.4	16.5	9.72

[a]Molasses linear effect (P < .10).
[b]Molasses linear effect (P < .05).
[c]Forage effect (P < .10).
[d]Molasses linear effect (P < .01).
[e]Molasses effect (P < .10).
[f]Molasses effect (P < .05).

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