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An Evaluation of Three TRM Feed-Mixing Wagons

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Summary

Three mixer wagons, three-auger, reel-type auger, and four-auger, were used to evaluate the adequacy of mix of a grower diet. All three mixers were considered in good mechanical condition. The grower diet contained 12.4% rolled corn, 23.7% wet corn gluten feed, 42% soybean hulls, 15.8% grass hay, and 6.19% liquid supplement on an as-is basis. Monensin was added to the diet at 28g/ton on an as-fed basis. Samples were obtained after 2, 4, 6, and 8 minutes **(min)** of mixing. Following the 8-min mixing time, the feed was unloaded as a windrow onto a concrete pad. Samples were obtained from the beginning, middle, and end of the windrow. These samples were used for nutrient analysis and ionophore (Monensin) recovery. Dry matter **(DM)** content and crude protein **(CP)** showed little variance across treatments. The coefficient of variation **(CV)** was greater for acid detergent fiber **(ADF)** levels than for other assayed components. The three-auger mixer produced a ration that was adequately mixed after 8 min of mixing. The reel-type auger required 4 min and the four-auger required only 2 min of mixing based on the observed CV. Monensin recovery gave similar results. The three-auger mixer gave the most accurate Monensin levels as compared to theoretical values. These studies indicate any well-maintained mixer will work well if the timing and sequence of adding ingredients is correct for the type of mixing action.

***Key Words:** Mixer Wagon, Ration Quality Control, Ionophores*

Introduction

Feed represents a major cost in the production of livestock. Not only is it crucial that we supply an adequate amount of nutrients, but we must formulate and deliver a ration that will encourage optimum consumption without excessive feed wastage. Diets that are not properly and thoroughly mixed can result in erratic consumption patterns, which can cause cattle to go off feed, thus, costing the feedlot operator lost cattle performance and lost opportunity.

There are several different types of mixing equipment available. Mixers that are currently used by feedlots may need repairs and adjustments to produce an adequately mixed diet. The objective of this research was to evaluate three different mixer wagon types and evaluate methods used to determine the uniformity of the mix.

Materials and Methods

The mixers in this study included an Oswalt® three-auger, a Farm-aid® reel-type auger, and a Renn® four-auger. All three mixers were used, but considered in good condition.

Table 1 shows the ingredient composition (as fed basis) of the grower ration used in the experiment. Rolled corn was the first ingredient added to the mixer. Following the corn, soybean hulls and liquid supplement were added and allowed to mix for 30 seconds. Finally, wet corn gluten feed and grass hay were added to the load. Malted milk ball candies, styrofoam packaging peanuts, and cinnamon red hots were added to represent different particle sizes and bulk densities and were added markers for adequacy of mix. Once the last ingredient was added, the mixer was started and allowed to run for 2 minutes **(min)**. The mixer was stopped and a sample was taken off the top of the load from the front, middle and back. The mixer was then started again and stopped at 2-min intervals. Thus, samples were obtained after 2, 4, 6, and 8 min of mixing. After 8 min of mixing, feed was unloaded onto a concrete pad in

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windrows. Collection pans were strategically placed at the beginning, middle, and end of the windrow. Upon emptying the wagon, the malted milk balls, styrofoam packaging peanuts, and cinnamon red hots were counted from each collection pan. Representative samples were analyzed for dry matter (**DM**), crude protein (**CP**), and acid detergent fiber (**ADF**) according to standard wet chemistry procedures. Monensin recoveries were determined by Elanco Animal Health from representative samples of the windrow.

Samples collected from the front, middle, and back (top of load) were considered replicates one, two, and three at each time period. Mean values were calculated at each time period and the coefficient of venation (CV) was used to determine adequacy of mix.

Results and Discussion

Load Sampling

Table 2 illustrates the mean DM, CP, and ADF values by mixer. Table 3 illustrates the CVs associated with these sample means. Dry matter appeared to have been adequately mixed, as evidenced by the low CV, which is not surprising as the grower ration contained feed ingredients with similar dry matters. The CV for CP was not very useful in evaluating the integrity of mix. Acid detergent fiber values were more useful in evaluating the adequacy of mix. The three-auger required 8 min to adequately mix the ration. The CV for ADF decreased from 4.75% to 0.21%. The reel-type auger appeared to be mixed after 4 min of mixing and the four-auger after only 2 min of mixing. With increased time, these two types of augers appeared to have overmixed the diet, as evidenced by greater CV.

Windrow Sampling

Following the 8-min mixing period, feed was unloaded in a windrow onto a concrete pad. Three samples were obtained (beginning, middle, and end) for DM, CP, ADF, and candy marker analysis. Five samples (same three plus two additional) were obtained to determine ionophore (Monensin) recovery.

Table 4 illustrates the mean DM, CP, and ADF values for the three mixers in samples obtained from the windrows after 8 min mixing time and delivery.

Table 5 illustrates the CV of the three samples collected from the windrow. The CV for DM was quite low for the three mixers. Dry matter appeared to be adequately mixed, which is not surprising as the grower ration had a relatively high dry matter content. Crude protein CV's were variable, but still quite low. The three-auger mixer had the lowest CV for crude protein, again suggesting 8 min were required to thoroughly mix the diet. Finally, CV for ADF was relatively low in the windrow suggesting an adequate mix.

Exogenous markers included malted milk balls, cinnamon red hots, and styrofoam packaging peanuts. We included these items as markers due to differences in physical characteristics. These markers differed significantly in particle size, particle shape, bulk density, hygroscopicity, static charge, and adhesiveness. The added markers were sorted out of the collected samples (beginning, middle, and end). Recovery of these markers is illustrated in Table 6.

We were able to recover at least one of the markers in each load. We experienced relatively high CVs (>20%) for all markers in all wagons. The ability to use these items as quantitative markers is still in question.

The ultimate test for accurate mixing would be to analyze for a compound that is exogenous to natural feed. Ionophores or other feed additives would be an example of this. The ability to recover ionophore (Monensin) is shown in Figure 1. In this demonstration, five samples were obtained from the windrow to determine Monensin recovery. The Monensin recoveries were analyzed in comparison to the theoretical value of 28.5 g/ton (as is). The samples were expected to fall within the acceptable +/- 15% from the theoretical mean.

After 8 min, the three-auger gave the most accurate Monensin levels as compared to theoretical values (Figure 1). Values ranged from 28 g/ton to 35 g/ton. The average Monensin recovery of the sample for the three-auger was 113% of theoretical. The reel-type auger created the most variation in Monensin recovery. Recovered values ranged from 18 g/ton to 35 g/ton. The average recovery of the samples for the reel-type mixer was 84.1% of theoretical. The four-auger was fairly consistent. One outlier was present (41 g/ton) making the average 115.1% of theoretical.

The most consistent mix was obtained with the three-auger mixer. The reel-type mixer produced a wide range of ionophore levels from the beginning to the end of the load. One explanation of this large variation is the reel-type mixer required only 4 min to adequately mix the diet. By overmixing (8 min) the integrity of the mix apparently deteriorated. In contrast, the three-auger mixer required 8 min to produce an optimum mix.

These findings support the idea that each feed mixer and ration type needs to be evaluated to determine optimum mixing time. A well-maintained mixer will work, if the timing and sequence of adding ingredients is correct for the mixer type. Finally, a quality control test is necessary to routinely evaluate mix integrity and consistency.

Acknowledgements

The authors wish to thank Sioux Automation of Sioux Center, IA for providing the mixers used in this study. We also appreciate Beckman and Sons of Brookings, SD for providing tractors to power the mixers. Finally, our thanks are extended to Elanco Animal Health for conducting the Monensin assays.

Table 1. Ingredient Composition of Grower Diet Used to Evaluate Mixing Equipment[1]

Ingredient	% As Fed
Corn, rolled	12.4
Corn gluten feed	23.7
Soybean hulls	42.0
Grass hay	15.8
Liquid supplement	6.1
	100.00%

[1]As fed basis

Table 2. Assayed Nutrient Composition of the Grower Diet for Each Mixer Wagon[a,b]

Variable	Time, min	3-Auger	Reel-Type	4-Auger
Dry Matter	2	81.21	77.13	76.20
	4	77.96	76.90	76.99
	6	78.25	76.95	76.75
	8	77.94	76.84	76.51
Crude Protein	2	15.19	14.89	14.99
	4	15.05	15.62	15.40
	6	15.61	15.84	15.39
	8	15.76	15.15	15.66
Acid Detergent Fiber	2	31.96	30.30	30.44
	4	30.93	31.10	30.13
	6	30.48	30.95	30.37
	8	30.92	30.84	30.67

[a]n = 3
[b]DM basis, except DM

Table 3. Coefficients of Variation of the Grower Diet for Each Mixer

Variable	Time, min	3-Auger	Reel-Type	4-Auger
Dry Matter	2	1.28	1.90	2.79
	4	1.91	0.81	0.91
	6	0.48	0.35	0.90
	8	0.41	0.46	0.85
Crude Protein	2	1.90	1.73	3.83
	4	5.03	3.27	2.00
	6	0.39	1.71	1.97
	8	2.78	3.25	2.28
Acid Detergent Fiber	2	2.91	3.45	1.15
	4	4.75	1.27	2.46
	6	2.06	3.25	4.35
	8	0.21	2.37	2.54

Table 4. Assayed Nutrient Composition for Grower Diet in the Windrows[a,b]

Variable	Windrow Position	3-Auger	Reel-Type	4-Auger
Dry Matter	Beginning	78.65	77.24	78.31
	Middle	78.25	77.21	78.67
	End	78.44	77.02	78.56
Crude Protein	Beginning	15.26	16.03	14.87
	Middle	15.38	15.20	15.25
	End	15.39	15.38	14.92
Acid Detergent Fiber	Beginning	30.93	30.27	31.39
	Middle	31.44	29.65	30.77
	End	30.49	29.43	30.99

[a]n = 3
[b]DM basis, except DM

Table 5. Coefficients of Variation for the Grower Ration in the Windrows

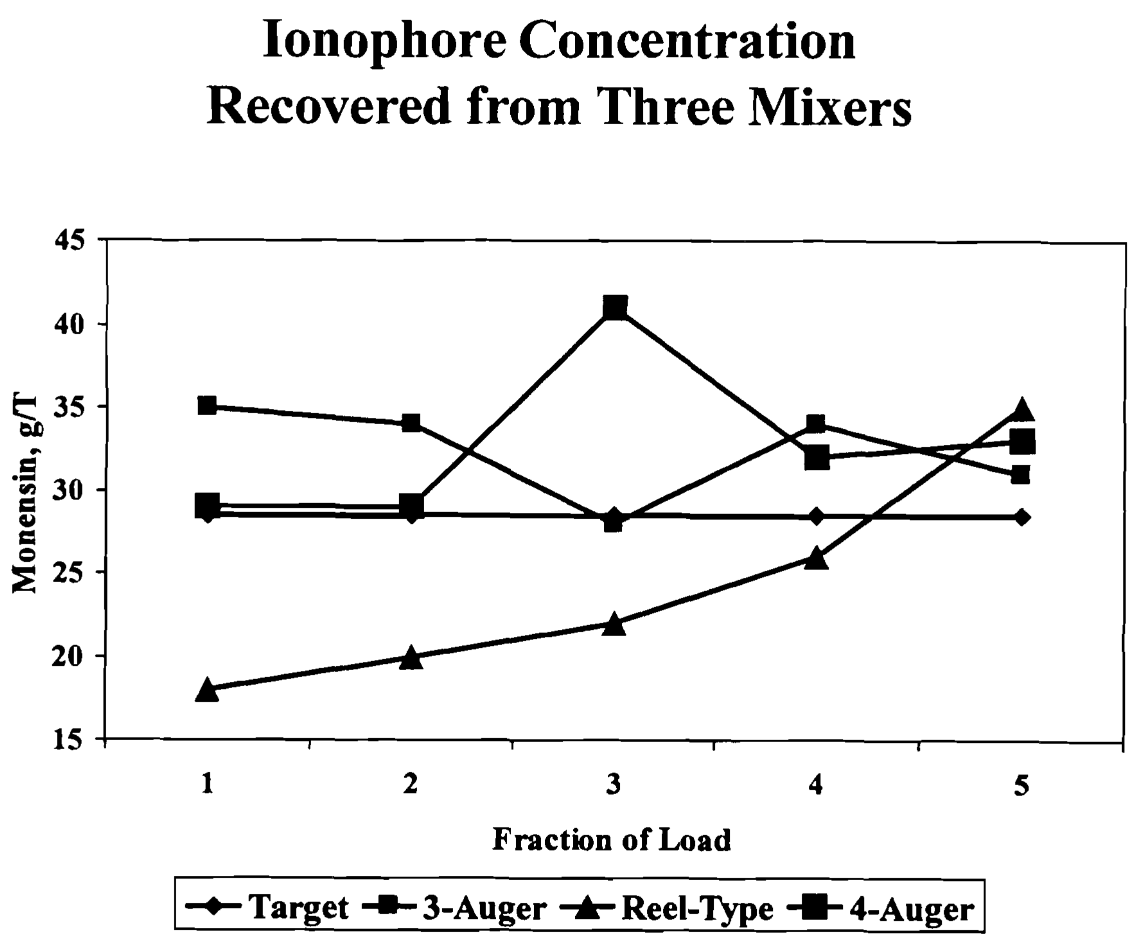
Variable	3-Auger	Reel-Type	4-Auger
Dry Matter	0.26	0.15	0.23
Crude Protein	0.47	2.81	1.38
Acid Detergent Fiber	1.54	1.46	1.01

Table 6. Recovery of Markers in Mixing Demonstrations[a]

	Beginning	Middle	End	Mean	CV
Three-Auger					
Cinnamon Red Hots	6	4	3	4.33	35.3
Malted Milk Balls	5	7	13	8.33	50.0
Styrofoam Packaging Peanuts	7	3.5	3	4.50	48.4
Reel-Type					
Cinnamon Red Hots	8	11	8	9.00	19.2
Malted Milk Balls	2	3	2	2.33	24.7
Styrofoam Packaging Peanuts	9	2.5	5	5.50	59.6
Four-Auger					
Cinnamon Red Hots	9	2	3	4.67	81.1
Malted Milk Balls	11	4	2	5.67	83.4
Styrofoam Packaging Peanuts	6.5	7	3	5.50	39.6

[a]3000 pieces of each item were added to each load with the exception of 2000 malted milk balls to the four-auger and 1000 malted milk balls to the reel-type

Figure 1.


Ionophore Concentration
Recovered from Three Mixers
45
40
35
30
25
20
15
Monensin, g/T
1
2
3
4
5
Fraction of Load
Target
3-Auger
Reel-Type
4-Auger