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BRIEF REPORT

Evaluation of batch fraction, corn silage inclusion level, and mixing duration on long particle distribution of finishing diets for beef cattle [version 1; peer review: 2 approved]

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Abstract

Background: Differing fractions of a batch of feed, differing ingredient characteristics, and inadequate mix time can lead to non-uniformity within a mix of feed.
Methods: The experiment was designed as a 5 x 2 x 2 factorial arrangement with seven replications per simple treatment mean. Factors included: 1) batch fraction (BF; n = 5); 2) corn silage inclusion level (CSLVL; n = 2) 15% or 30% inclusion (dry matter basis); and 3) mixing duration (DR; n = 2) of 20 or 25 mixer revolutions. Data were analyzed as a completely randomized design using a binomial approach. The Penn State Particle Separator was used to separate fractions of the total mixed ration (TMR).
Results: No interactions between BF, CSLVL, and DR were detected ($P \geq 0.31$) for any dependent variables. There was an increase ($P = 0.01$) in retention on the 19 mm sieve from the first BF compared to the last BF. CSLVL altered ($P = 0.01$) retention on the 19 mm sieve. Increasing DR from 20 to 25 revolutions had no appreciable influence ($P = 0.23$) on particles greater than 19 mm. CSLVL ($P = 0.01$) and DR ($P = 0.01$) altered particle retention on the 8 mm sieve. BF ($P = 0.01$), CSLVL ($P = 0.01$), and DR ($P = 0.02$), influenced particle retention on the 4 mm sieve. CSLVL impacted ($P \leq 0.01$) particles remaining in the bottom pan and particles greater than 4 mm. BF ($P = 0.01$) and CSLVL ($P = 0.01$) altered particles greater than 8 mm.
Conclusions: These data indicate that BF and CSLVL fed alters particle size distribution that in turn could alter dry matter intake, dietary net energy content, and influence daily gain. Mixing DR had no appreciable influence on particle size distribution of the TMR.

Keywords

corn silage, finishing diet, mixing duration, particle size

Open Peer Review

Reviewer Status ✓ ✓

	Invited Reviewers	
	1	**2**
version 1 02 Sep 2020	✓ report	✓ report

1. **Maghsoud Besharati**, University of Tabriz, Ahar, Iran

2. **Ahmed M. Abd El Tawab**, National Research Centre, Dokki, Egypt

Any reports and responses or comments on the article can be found at the end of the article.

This article is included in the Agriculture, Food and Nutrition gateway.

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Author roles: Buckhaus EM: Conceptualization, Data Curation, Investigation; **Smerchek DT**: Conceptualization, Data Curation, Investigation; **Smith ZK**: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Project Administration, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

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Introduction

Varying feed ingredient properties such as particle size, shape, density, hygroscopocity, static charge, and adhesiveness can influence how a beef cattle diet mixes prior to feeding. Differing fractions of a batch of feed, differing ingredient characteristics, and mix time can also lead to non-uniformity within a specific mix of feed.

Blom *et al.* (2020) demonstrated that as the mixer unloads, there is a linear increase in the proportion of long particles fed that results in greater intake, poorer gain, and reduced gain to feed (average daily gain/dry matter intake) in steers during the feedlot receiving phase. Smerchek *et al.* (2020) demonstrated that as particles greater than 4 mm increase, there is a reduction in average daily gain by approximately 0.02 kg for each percentage point increase in particles greater than 4 mm in the diet.

The objective of this research was to determine how batch fraction, diet roughage level, and mixing duration influenced particle distribution in finishing diets for beef cattle. The hypothesis was that batch fraction would influence the particles size distribution, greater corn silage inclusion (roughage level) would alter particle size distribution, and mixing duration would have no influence on particle size distribution of the total mixed ration.

Methods

Ethical statement

No Institutional Animal Care and Use Committee approval was obtained for this experiment since no animals were used to generate the data used in the present analysis. The study was conducted at the Ruminant Nutrition Center in Brookings, SD, USA.

Treatment structure, diet manufacturing, ingredient inclusion order, and total mixed ration separation

The experiment was designed as a 5 x 2 x 2 factorial arrangement with seven replications per simple treatment mean. Factors included: 1) batch fraction (BF; n = 5), where BF 1 was the first 20% of feed unloaded from the mixer and BF 5 was the last 20% of feed unloaded from the mixer; 2) corn silage inclusion level (CSLVL; n = 2) containing (dry matter basis) 15% corn silage or 30% corn silage replacing the corn blend; and 3) mixing duration (DR; n = 2) of 20 or 25 mixer revolutions (5 revolutions·minute^{-1}) prior to unloading. A 2.35 m^3 horizontal mixer (Roto-Mix; Dodge City, KS) was used to manufacture all diets. Diets contained corn silage, a 1:1 ratio of dry-rolled corn: high-moisture corn, a liquid supplement (5% dry matter inclusion), and a meal supplement (7% dry matter inclusion). Ingredients were added into the horizontal mixer in the following sequence: high-moisture corn, dry-rolled corn, liquid supplement, dry supplement, and finally corn silage.

The total mixed ration (TMR) samples were separated using the Penn State Particle Separator (PSPS) using the methods described by (Kononoff *et al.*, 2003). The PSPS had three sieves (19 mm, 8 mm, 4 mm, and pan). The particles retained on the top sieve (19 mm) were considered large, middle sieve (8 mm) were considered medium, and bottom sieve (4 mm) were considered small. Particles less than 4 mm were collected in the pan. Proportions of the TMR on differing sieves was determined on an as-is basis.

Statistical analysis

Data were analyzed as a completely randomized design appropriate for a 5 x 2 x 2 factorial arrangement of treatments using the GLIMMIX procedure of SAS 9.4 (SAS Inst., Inc., Cary, NC) using a binomial approach. There was a total of seven replications for each simple treatment mean (the combination of each BF, CSLVL, and DR). All data are presented as least squares means and the corresponding standard error of the mean. An α of 0.05 was used to determine significance.

Results

The effect of BF, CSLVL, and DR on TMR particle size distribution are presented in Table 1 and full results are available as *Underlying data* (Smith *et al.*, 2020). Visual representation of the TMR's fed are shown in Figure 1 (20 DR only). No interactions between BF, DIET, and REV were detected ($P \geq 0.31$) for any dependent variables. There was a 53.5% increase ($P = 0.01$) in retention on the 19 mm sieve from the first BF (first 20% of the TMR unloaded from the mixer) compared to the last BF (last 20% of the TMR unloaded from the mixer). The 15 CSLVL diet had a 71.3% decrease ($P = 0.01$) in retention on the 19 mm sieve compared to the 30 CSLVL diet. Increasing DR from 20 to 25 revolutions had no appreciable influence ($P = 0.23$) on particles greater than 19 mm. CSLVL ($P = 0.01$) and DR ($P = 0.01$) altered particle retention on the 8 mm sieve. BF ($P = 0.01$), CSLVL ($P = 0.01$), and DR ($P = 0.02$) influenced particle retention on 4 mm sieve. CSLVL impacted ($P \leq 0.01$) particles remaining in the bottom pan and particle greater than 4 mm. BF ($P = 0.01$) and CSLVL ($P = 0.01$) altered particles greater than 8 mm.

Conclusions

These results indicate that BF and CSLVL influences particle size distribution of the TMR fed to feedlot cattle. This potentially could alter dry matter intake, dietary net energy content, and influence animal average daily gain, by altering the actual diet fed from what was formulated to be fed. Mixing DR had no appreciable influence on particle size distribution of the TMR, a shorter mixing duration could have a pronounced impact on the distribution of particles in the TMR, however, a shorter mix DR was not investigated in the present experiment. Future experiments should determine what the shortest

Table 1. Influence batch fraction (BF), corn silage inclusion level (CSLVL), and mixing duration (DR) on particle size distribution of the total mixed ration (TMR) finishing diet[1].

	BF						CSLVL			DR			*P* - values						
Item	**1**	**2**	**3**	**4**	**5**	**SEM[2]**	**15%**	**30%**	**SEM**	**20**	**25**	**SEM**	**BF**	**CSLVL**	**DR**	**BF × CSLVL**	**BF × DR**	**CSLVL × DR**	**BF × CSLVL × DR**
Replicates, n	28	28	28	28	28	-	70	70	-	70	70	-	-	-	-	-	-	-	-
TMR, % (as-is basis)																			
Large (≥ 19 mm)	4.0^{c}	4.0^{c}	4.4b^{c}	5.2^{b}	6.2^{a}	0.34	2.1	7.4	0.22	4.6	5.0	0.22	0.01	0.01	0.23	0.02	0.54	0.39	0.44
Medium (8 to 19 mm)	33.4	33.1	32.9	33.2	33.3	0.32	29.9	36.5	0.20	33.6	32.7	0.20	0.81	0.01	0.01	0.10	0.85	0.41	0.42
Small (4 to 8 mm)	29.8^{a}	29.4^{ab}	29.0b^{c}	28.4^{cd}	27.9^{d}	0.16	31.5	26.3	0.16	28.7	29.2	0.16	0.01	0.01	0.02	0.14	0.59	0.13	0.35
Less than 4 mm	32.8	33.4	33.7	33.2	32.5	0.40	36.5	29.8	0.25	33.1	33.1	0.25	0.26	0.01	0.97	0.34	0.95	0.30	0.31
Greater than 4 mm	67.2	66.6	66.3	66.8	67.5	0.40	63.5	70.2	0.25	66.9	66.9	0.25	0.26	0.01	0.97	0.34	0.95	0.29	0.31
Greater than 8 mm	37.4^{bc}	37.1^{c}	37.3^{bc}	38.4^{b}	39.5^{a}	0.40	32.0	43.9	0.25	38.2	37.7	0.25	0.01	0.01	0.13	0.12	0.66	0.93	0.32

[1]Determined according to (Kononoff *et al.*, 2003).

[2]Standard error of the mean.

[a,b]Means with in a row without a common superscript differ ($P \leq 0.05$).

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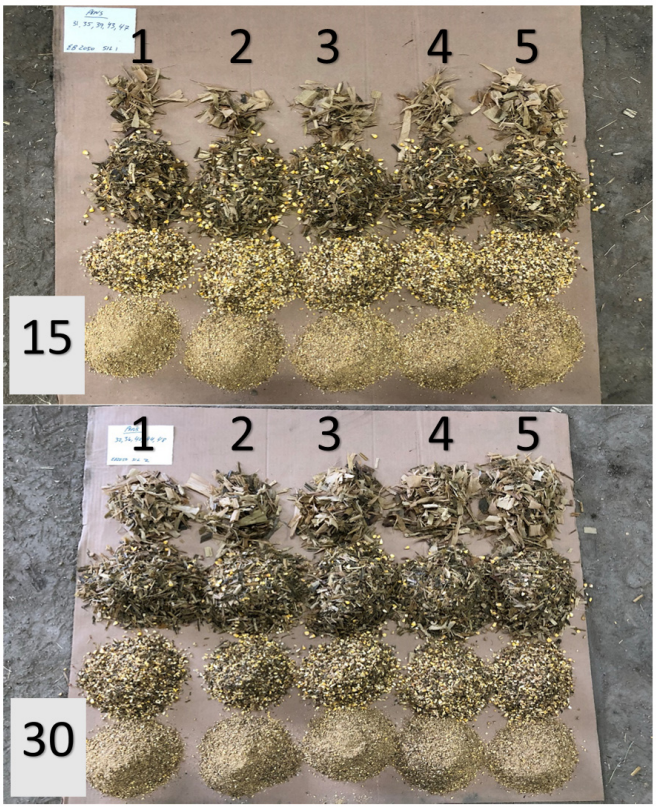

Figure 1. Visual illustration of the batch fraction (1, 2, 3, 4, or 5) and corn silage percentage (dry matter basis) fed (15 or 30) for the diets that were mixed for 20 revolutions.

possible mix duration could be to effectively manufacture finishing diets fed to feedlot cattle.

Data availability

Underlying data

Figshare: Evaluation of Batch Fraction, Corn Silage Inclusion Level, and Mixing Duration on Long Particle Distribution of Finishing Diets for Beef Cattle (Smith *et al.*, 2020). https://doi.org/10.6084/m9.figshare.12841469.v1

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Acknowledgements

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PubMed Abstract | Publisher Full Text

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PubMed Abstract | Publisher Full Text | Free Full Text

Smith Z, Buckhaus E, Smerchek D: Source Data: **Evaluation of Batch Fraction, Corn Silage Inclusion Level, and Mixing Duration on Long Particle Distribution of Finishing Diets for Beef Cattle.** *figshare.* Dataset. 2020.
http://www.doi.org/10.6084/m9.figshare.12841469.v1

Open Peer Review

Current Peer Review Status: ✔ ✔

Version 1

Reviewer Report 19 April 2021

https://doi.org/10.5256/f1000research.28673.r81344

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✔ **Ahmed M. Abd El Tawab**
Dairy Science Department, National Research Centre, Dokki, Giza, Egypt

1. Novelty Study and Clear the aims and Hypotheses: The particle size of feed plays an important role in animal feed strategies and consequence on productive performance and average daily weight gain. The author has studied to determine how batch fraction, diet roughage level, and mixing duration influenced particle distribution in finishing diets for beef cattle.

2. The title should be changed to Evaluation of batch fraction, corn silage inclusion level, and mixing duration on particles size distribution of finishing diets for beef cattle.

3. The keywords should be included "beef cattle".

4. The introduction should include information about the digestibility.

5. The materials and methods should be added experimental animal paragraph.

6. Table and figure are good.

7. Results are good. But the Author should add animal performance table beside the finding table.

8. Conclusion is good.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
I cannot comment. A qualified statistician is required.

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: I am an associate research professor, my scope is ruminants nutrition, animal nutrition, animal production, milk production, dairy and beef cattle, feed evaluation, feed technology and rumen simulation.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 08 April 2021

https://doi.org/10.5256/f1000research.28673.r82061

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Maghsoud Besharati
Department of Animal Science, University of Tabriz, Ahar, Iran

I would like to congratulate authors for the good-quality of the article, the literature reported used to write the paper, and for the clear and appropriate structure. The manuscript is well written, presented and discussed, and understandable to a specialist readership.

In general, the organization and the structure of the article are satisfactory and in agreement with the journal instructions for authors. The subject is adequate with the overall journal scope.
The work shows a conscientious study in which a very exhaustive discussion of the literature available has been carried out. The introduction provides sufficient background, and the other sections include results clearly presented and analyzed exhaustively.

However, to improve the manuscript, some revisions are recommended such as:

- English language needs to be checked;
- Update the used literature;
- Revise the paper according to journal's instructions.

1. The novelty of the study needs to be highlighted compare to other similar studies.

2. The scientific background of the topic is poor. In "Introduction" and "Discussion", the authors should cite recent references between 2016-2020 from JCR journals (with impact factor) about recent achievements on the subject.

3. Authors should state something about Selenium and Vitamin E. At least producer of the additives should stated.

So, I recommend the acceptance of the paper after revision.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Animal Nutrition, Ruminant Nutrition, Dairy cattle, Beef

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 15 Apr 2021

Zachary Smith, South Dakota State University, Brookings, USA

The authors appreciate the time you took to review our manuscript.

Best,

Zachary Smith

South Dakota State University

Competing Interests: No conflict of interest to declare.

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