Effect of feeding ethanol by-products on marbling composition of beef cattle

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Introduction

• Distillers grains feeding has been implicated as a cause of declining marbling scores
• Reports have been inconsistent
  – Decrease
    • Corah and McCully, 2006; Reinhardt, 2006
  – No change
    • Huls et al., 2008; de Mello et al., 2008
  – Depends
    • Trenkle, 2006, 2007; Doud, 2007
• Decreased starch availability

Objective: Evaluate effects of feeding ethanol by-products with high concentrate or high forage on cattle performance, ruminal VFAs, blood glucose and insulin, and carcass characteristics

Experimental Design

• 137 crossbred yearling steers
• High concentrate diet (15 % hay)
  – 0 % distillers grains
  – 20 % distillers grains
  – 40 % distillers grains
• High forage diet (40 % hay)
  – 0 % distillers grains
  – 20 % distillers grains
  – 40 % distillers grains

Methods

• Day 98
  – 6 steers per treatment (36)
  – Selection based on average weight within treatment
  – 0 time, 16 hours without feed
  – Plasma collected
  – Rumen fluid sampled by stomach tube
• Slaughtered at 1274 lbs
  – 3 timepoints – 3 to 4 weeks apart
• ADG, feed intake, carcass characteristics, propionate, insulin, glucose
  – Proc Mixed

• All diets formulated for 17.6 % CP
• Oil concentration constant
• Energy concentration
• Component TE-S implant on d 0
Results

<table>
<thead>
<tr>
<th></th>
<th>High Conc.</th>
<th>High Forage</th>
<th>Diet</th>
<th>Dist</th>
<th>Diet x Dist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial wt., lb</td>
<td>860.8</td>
<td>858.2</td>
<td>0.17</td>
<td>0.70</td>
<td>0.99</td>
</tr>
<tr>
<td>Final wt., lb</td>
<td>1274.0</td>
<td>1273.3</td>
<td>0.93</td>
<td>0.36</td>
<td>0.71</td>
</tr>
<tr>
<td>Hot carcass wt., lb</td>
<td>785.5</td>
<td>744.9</td>
<td>0.01</td>
<td>0.15</td>
<td>0.23</td>
</tr>
<tr>
<td>Dressing %</td>
<td>61.6</td>
<td>58.5</td>
<td>0.01</td>
<td>0.08</td>
<td>0.31</td>
</tr>
<tr>
<td>Days on feed</td>
<td>119</td>
<td>155</td>
<td>0.01</td>
<td>0.67</td>
<td>0.84</td>
</tr>
</tbody>
</table>

40% distillers grains increased dressing percentage compared with 0%.

- **Average daily gain (lb/d):**
  - HC0: 2.00
  - HC20: 2.40
  - HC40: 2.80
  - HF0: 3.20
  - HF20: 3.60
  - HF40: 4.00

  **P-value:** Diet (P < 0.01); Dist (P < 0.25); Diet x Dist (P < 0.98)

- **Daily dry matter intake (lb/d):**
  - HC0: 15.0
  - HC20: 17.0
  - HC40: 19.0
  - HF0: 21.0
  - HF20: 23.0
  - HF40: 25.0

  **P-value:** Diet (P < 0.01); Dist (P < 0.35); Diet x Dist (P < 0.91)

- **Total dry matter intake (lb):**
  - HC0: 2000
  - HC20: 2250
  - HC40: 2500
  - HF0: 2750
  - HF20: 3000
  - HF40: 3250

  **P-value:** Diet (P < 0.01); Dist (P < 0.04); Diet x Dist (P < 0.51)

- **Feed conversion (lb/lb):**
  - HC0: 4.0
  - HC20: 6.0
  - HC40: 8.0
  - HF0: 10.0
  - HF20: 12.0
  - HF40: 14.0

  **P-value:** Diet (P < 0.01); Dist (P < 0.02); Diet x Dist (P < 0.46)

- **Longissimus dorsi area (in²):**
  - HC0: 10.0
  - HC20: 10.5
  - HC40: 11.0
  - HF0: 11.5
  - HF20: 12.0
  - HF40: 12.5

  **P-value:** Diet (P < 0.08); Dist (P < 0.02); Diet x Dist (P < 0.46)

0% distillers grains cattle were the least efficient.
Effect of wet distillers grains inclusion on fat thickness

- Diet (P < 0.01); Dist (P < 0.05); Diet x Dist (P < 0.08)
- 40% distillers grains steers had the lowest fat thickness

Effect of wet distillers grains inclusion on yield grade

- Diet (P < 0.01); Dist (P < 0.03); Diet x Dist (P < 0.47)
- 0% distillers grains steers had the highest yield grade

Effect of distillers grains and amount of concentrate on marbling score

- Diet (P < 0.01); Dist (P < 0.01); Diet x Dist (P < 0.01)
- 40% distillers grains steers had the lowest marbling score

Effect of distillers grains inclusion on molar percentage of propionate in the rumen

- Diet (P < 0.01); Dist (P < 0.71); Diet x Dist (P < 0.75)

Why?

- Glucose – 50 to 75% of acetyl units (Smith and Crouse, 1984)
- Propionate is gluconeogenic
- Rumen fermentation
  - Forage → acetate
  - Starch → propionate
- Distillers grains = high fiber

Effect of wet distillers grains inclusion on plasma glucose concentration

- Diet (P < 0.19); Dist (P < 0.21); Diet x Dist (P < 0.53)
Effect of distillers grains inclusion on plasma insulin concentration

- Insulin regulates glucose
- What's affecting insulin?
  - SFA stored
    - Increased insulin
  - PUFA can increase lipolysis
    - Decreased insulin
- Unsaturated fatty acids can inhibit adipocyte growth (Smith et al., 1996)
- Unsaturated fatty acids in distillers grains bypasses rumen fermentation (Vander Pol et al., 2009)

Effect of distillers grains inclusion on polyunsaturated fatty acid content of muscle

- How do PUFA’s increase lipolysis and decrease adipocyte growth?
  - Affect master regulators of lipid metabolism – transcription factors
  - Peroxisome proliferator activated receptor gamma

Relationship between polyunsaturated fatty acid content of muscle and % lipid in steers fed distillers grains

Vitamin A

- Restricting Vitamin A improved intramuscular fat deposition (Gorocica-Buenfil et al., 2007a)
- Supplemental Vitamin A reduced intramuscular fat deposition (Gorocica-Buenfil et al., 2007b)
- Vitamin A binds to PPAR gamma
Effect of distillers grains inclusion on plasma retinol

Relationship between plasma retinol and marbling in steers fed varying amounts of distillers grains

Effect of wet distillers grains inclusion on plasma retinol: β-carotene ratio

Relationship between plasma retinol: β-carotene ratio and marbling in steers fed distillers grains

Conclusion

- Intake
  - High concentrate – decrease appears linear
  - High forage – decrease at 40% inclusion rate
- Distillers grains improved feed efficiency
- Distillers grains decreases fat thickness
- Distillers grains decreases marbling score when high concentrate is fed but not when high forage is fed

Conclusion

- Distillers grains increased L. dorsi area
  - Dilution of marbling?
  - Partitioning of nutrients
- Diet x distillers grains interaction for plasma insulin
- Distillers grains did not decrease ruminal propionate, forage did
Conclusion

• PUFA negatively correlated with marbling
  – Form?
  – Reduced oil distillers grains?
• Vitamin A positively correlated with marbling
  – Is beta carotene involved?
• Are transcription factors involved?
  – Developing assay

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