Evaluation of an Algal Biomass as an Ingredient in Cattle Feed

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Summary with implications

A study was conducted evaluating the effects of feeding condensed algal residue solubles (CARS; available in 2019 in Blair, NE area) to finishing cattle for 100 days. Four levels of CARS were evaluated with 5 steers and 5 heifers individually fed per level of inclusion. The diets consisted of 70% dry rolled corn with CARS displacing corn at 0, 2.5, 5, and 7.5% of dry matter. Increasing CARS inclusion resulted in a linear decrease in intake, a quadratic increase in daily gain, and a linear decrease in feed:gain. Calculations showed a linear increase in dietary net energy as CARS increased in the diet. Minimal differences in organ weights, blood chemistry, hematology, and urine were observed. Daily observations and histology results suggest no differences in cattle health due to dietary treatment. Including CARS at 5% of diet dry matter increased gain 4.2% and feed:gain 10.1% relative to a corn based finishing diet.

Introduction

With more interest in algae derived omega-3 fatty acids for both human and animal feeds, coproducts from the algae industry could result in an alternative feed ingredient for cattle. Condensed algal residue solubles (CARS; Veramaris, Netherlands) is produced from heterotrophic algae as a result of producing omega-3 fatty acids and is a potential source of protein, fiber and fat, which could contribute essential nutrients in cattle diets. The CARS is produced by condensing the residue from algal fermentation of dextrose after the oil has been extracted from the algal cells without organic solvents and has a syrupy consistency. CARS will be produced and available starting in 2019 in the Blair, NE area. Little research has been conducted on this novel feed ingredient; therefore, the objectives of this study were to evaluate the safety of CARS as a cattle feed and performance of cattle being fed increasing inclusion of CARS relative to corn for finishing cattle.

Procedure

A trial was conducted using forty crossbred cattle (20 steers, 20 heifers) blocked by initial body weight (BW; 563 ± 31 lb) into 10 blocks. Five days prior to trial initiation, cattle were limit fed at 2% of BW to reduce gut fill variation on a 50% Sweet Bran (Cargill wet milling, Blair, NE) and 50% alfalfa hay diet. Cattle were weighed on 3 consecutive days and the average was used as initial BW. The diets consisted of increasing inclusion of CARS (0, 2.5, 5, and 7.5%) displacing dry rolled corn in the diet (70.0, 67.5, 65.0, and 62.5%), 15% wet distillers grains, 10% grass hay, and 5% supplement (Table 1). All cattle were individually fed at ENREC (near Mead, NE) using the Calan gate system with two pens, one for steers and one for heifers.

Cattle were fed ad-libitum once daily. Feed refusals were collected weekly, weighed and then dried in a 60º C forced air oven for 48 hours to calculate accurate DMI per individual. Interim BW, urine, blood and veterinary observations were obtained on days 0, 33, 61, 90 and harvest day. Urine was analyzed at the UNL Veterinary Diagnostic Center for protein, pH, ketone bodies, bilirubin, urobilinogen glucose, and microscopic examination. Blood samples were sent to Iowa State University Veterinary Pathology Laboratory and analyzed for common hematology and blood chemistry, hematology, and urine were observed. Daily observations and histology results suggest no differences in cattle health due to dietary treatment. Including CARS at 5% of diet dry matter increased gain 4.2% and feed:gain 10.1% relative to a corn based finishing diet.

Table 1. Composition of diets containing increasing inclusions of Condensed Algal Residue Solubles (CARS) and individually fed to steers and heifers

<table>
<thead>
<tr>
<th>Ingredient, % diet DM</th>
<th>0%</th>
<th>2.5%</th>
<th>5%</th>
<th>7.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry rolled corn</td>
<td>70.0</td>
<td>67.5</td>
<td>65.0</td>
<td>62.5</td>
</tr>
<tr>
<td>Wet distillers grains</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Grass hay</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Algae</td>
<td>—</td>
<td>2.5</td>
<td>5.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Supplement</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Fine ground corn</td>
<td>2.28</td>
<td>2.49</td>
<td>2.70</td>
<td>3.12</td>
</tr>
<tr>
<td>Limestone</td>
<td>1.69</td>
<td>1.69</td>
<td>1.69</td>
<td>1.69</td>
</tr>
<tr>
<td>Tallow</td>
<td>0.125</td>
<td>0.125</td>
<td>0.125</td>
<td>0.125</td>
</tr>
<tr>
<td>Urea</td>
<td>0.34</td>
<td>0.405</td>
<td>0.27</td>
<td>—</td>
</tr>
<tr>
<td>Salt</td>
<td>0.30</td>
<td>0.225</td>
<td>0.15</td>
<td>—</td>
</tr>
<tr>
<td>Trace mineral premix</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Vitamin A-D-E premix</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
</tr>
</tbody>
</table>

1Differences in dietary treatments were due to CARS inclusion (0, 2.5, 5, or 7.5% of diet DM).
2Two supplements were formulated and blended together for the 2.5 CARS and 5 CARS treatments. Supplement provided Rumensin (330 mg/animal daily; Elanco, Greenfield, IN), and Tylan (90 mg/animal daily; Elanco)
3Trace mineral premix contained 10% Mg, 6% Zn, 4.5% Fe, 2% Mn, 0.5% Cu, 0.3% I, and 0.05% Co.
4Vitamin A-D-E premix contained 1500 IU vitamin A, 3000 IU vitamin D, and 3.7 IU vitamin E per g.

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chemistry. Hematology included white
blood cell count, red blood cell count, mean
corpuscular volume, mean corpuscular
hemoglobin, mean corpuscular hemoglobin
concentration, red blood cell distribution
width, mean platelet volume, platelet count,
and neutrophil, lymphocyte, monocyte,
eosinophil, basophil, plasma protein,
fibrinogen, hematocrit and hemoglobin
concentrations. Blood chemistry measures
included Na, K, Cl, Ca, P, Mg, blood urea
N, creatinine, glucose, total protein, albumin,
alanine aminotransferase, aspartate
aminotransferase, alkaline phosphatase,
gamma glutamyl transpeptidase, lactate
derhydrogenase, creatine kinase, total bile
acids, bicarbonate, and cholesterol. Daily
observations of each individual animal were
recorded after feeding by trained animal
care staff at the research facility.

Two blocks (4 steers, 4 heifers) were
harvested each week starting on day 97.
Blocks were harvested at a target body
weight of 1000 lb. On each harvest day,
carcasses were incinerated.

Data were analyzed using the mixed
procedure of SAS as a randomized com-
plete block design with treatment, gender,
and treatment by gender interaction as
orthogonal contrasts were used to test for linear, quadratic, and cubic
responses due to CARS inclusion.

Results

The nutrient profile of CARS is shown
in Table 2. It is a good source of protein
(29.3% of DM), but no research has been
done to determine the digestibility and
rumen degradation of this protein. It also
contains fairly high levels of S (2.54% of
DM), but no research has been done to
limit intake at very high dietary inclusion.

There were no interactions between sex
and treatment (P ≥ 0.25) for performance
data. Sex was significant for all variables
(P ≤ 0.04) with steers having greater DMI,
initial BW, ADG, HCW and final BW,
compared to heifers. As CARS inclusion in
the diet increased, DMI linearly decreased
(P < 0.01; Table 3). There was a quadra-
tic (P < 0.01) response for ADG with the
2.5% and 5% CARS treatments having the
greatest numerical values of 3.09 and 3.01
lb/d, respectively. Live final BW responded
quadratically (P < 0.01) and was greatest
for 2.5% and 5% CARS treatments, 944
and 941 lb, respectively. The 7.5% CARS
treatment had the lowest DMI and ADG
(P ≤ 0.02); however, this treatment also
had the least F:G (5.38; P < 0.01). The F:G
linearly decreased (P < 0.01) with increas-
ing CARS inclusion in the diet. The energy
content of the diets, measured as NEm and
NEg linearly increased (P < 0.01) as CARS
inclusion in the diet increased.

For hematology and blood chemistry
parameters, nearly all variables were
within the prescribed normal range. Both
hemoglobin and hematocrit concentra-
tions quadratically decreased (P = 0.05)
with increasing inclusion of CARS. The
red blood cell distribution width linearly
increased (P = 0.02) from 20.9 to 22% with
increasing inclusion of CARS. Blood Cl
and alkaline phosphatase concentrations
linearly decreased while blood bicarbonate
and creatinine concentrations linearly in-
creased with increasing inclusion of CARS.
Blood creatine kinase, gamma-glutamyl
transpeptidase, and lactate dehydrogenase
all had quadratic effects (P < 0.05). There
were no other significant differences (P ≥
0.11) in hematology or blood chemistry
measures between treatments. There were
no differences among treatments in urine
parameters measured (P ≥ 0.17), except pH
which increased quadratically (P < 0.01)

Table 2. Nutrient composition of Condensed
Algal Residue Solubles (CARS)

<table>
<thead>
<tr>
<th>Item</th>
<th>CARS 1 ppm, DM basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (DM), %</td>
<td>41.7</td>
</tr>
<tr>
<td>%, DM basis</td>
<td></td>
</tr>
<tr>
<td>Crude protein</td>
<td>29.3</td>
</tr>
<tr>
<td>Neutral detergent fiber</td>
<td>34.6</td>
</tr>
<tr>
<td>Acid detergent fiber</td>
<td>2.3</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.16</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.82</td>
</tr>
<tr>
<td>Potassium</td>
<td>1.51</td>
</tr>
<tr>
<td>Sulfur</td>
<td>2.54</td>
</tr>
<tr>
<td>Sodium</td>
<td>8.52</td>
</tr>
</tbody>
</table>

1Nutrient composition of CARS was analyzed by Ward Laboratories, Inc. (Kearney, NE)

Table 3. Performance of steers and heifers individually fed Condensed Algal Residue Solubles (CARS) at increasing inclusions

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th>Contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>2.5</td>
</tr>
<tr>
<td>Initial BW, lb</td>
<td>562</td>
<td>563</td>
</tr>
<tr>
<td>Final BW, lb</td>
<td>920b</td>
<td>944c</td>
</tr>
<tr>
<td>HCW, lb</td>
<td>525d</td>
<td>536c</td>
</tr>
<tr>
<td>DMI, lb/d</td>
<td>19.4a</td>
<td>19.8b</td>
</tr>
<tr>
<td>ADG, lb</td>
<td>2.89abc</td>
<td>3.09a</td>
</tr>
<tr>
<td>F:G, lb</td>
<td>6.02a</td>
<td>5.78a</td>
</tr>
<tr>
<td>NEm, Mcal/lb</td>
<td>4.01a</td>
<td>4.10a</td>
</tr>
<tr>
<td>NEg, Mcal/lb</td>
<td>2.62a</td>
<td>2.69a</td>
</tr>
</tbody>
</table>

1Differences in dietary treatments were due to CARS inclusion (0, 2.5, 5, or 7.5% of diet DM).

BW = body weight; HCW = hot carcass weight; DMI = dry matter intake; ADG = average daily gain; F:G = feed to gain; NEm = net energy for maintenance; NEg = net energy for gain

< 0.01 within a row, means without a common superscript differ (P < 0.05).

< 0.05. There were no other significant differences (P ≥ 0.05). There were no other significant differences (P ≥ 0.11) in hematology or blood chemistry measures between treatments.
with increasing CARS inclusion (range of 8.0 to 8.7).

Weight of the liver and pancreas, as a % of shrunk BW, linearly increased ($P < 0.01$; 21 and 16%, respectively) with increasing inclusion of CARS in the diet. The weight of the thyroid increased quadratically ($P < 0.01$) as CARS inclusion increased. Differences in organ weights due to CARS inclusion were relatively minor and likely due to nutrient load. There were no significant differences in histology results ($P \geq 0.24$) comparing the 0 and 7.5% CARS treatments, suggesting no differences in the health of the cattle. Daily cattle observations and veterinary visual health observations all suggested cattle were healthy and showed no adverse effects of dietary treatment.

**Conclusion**

The feedstuff CARS demonstrated to be a safe feed ingredient in cattle diets. Feeding CARS to finishing cattle improved F:G as inclusion in the diet increased up to 7.5% of diet DM. Cattle HCW, ADG, and DMI all increased quadratically with increasing inclusion of CARS from 0 to 7.5% of diet DM. No adverse effects of feeding CARS were observed in hematology, blood chemistry, or histopathology analyses. Further research is needed to determine the optimal level of CARS inclusion in a finishing diet and the impact on carcass traits, as well as potential for CARS to be used in growing cattle diets.