Evaluation of an Algal Biomass as an Ingredient in Cattle Feed

Mitchell M. Norman
Zachary E. Carlson
F. Henry Hilscher
Andrea K. Watson
Galen E. Erickson
Bruce W. Brodersen
J. Dustin Loy
Jonathan W. Wilson

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.

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

	Treatment[1]			
Ingredient, % diet DM	0%	2.5%	5%	7.5%
Dry rolled corn	70.0	67.5	65.0	62.5
Wet distillers grains	15.0	15.0	15.0	15.0
Grass hay	10.0	10.0	10.0	10.0
Algae	—	2.5	5.0	7.5
Supplement[2]	5.0	5.0	5.0	5.0
Fine ground corn	2.28	2.49	2.70	3.12
Limestone	1.69	1.69	1.69	1.69
Tallow	0.125	0.125	0.125	0.125
Urea	0.54	0.405	0.27	—
Salt	0.30	0.225	0.15	—
Trace mineral premix[3]	0.05	0.05	0.05	0.05
Vitamin A-D-E premix[4]	0.015	0.015	0.015	0.015

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

[2]Two 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)

[3]Trace mineral premix contained 10% Mg, 6% Zn, 4.5% Fe, 2% Mn, 0.5% Cu, 0.3% I, and 0.05% Co.

[4]Vitamin A-D-E premix contained 1500 IU vitamin A, 3000 IU vitamin D, and 3.7 IU vitamin E per g.

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

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

Item	CARS[1]
Dry matter (DM), %	41.7
%, DM basis	
Crude protein	29.3
Neutral detergent fiber	34.6
Acid detergent fiber	2.3
Calcium	0.16
Phosphorus	0.82
Potassium	1.51
Sulfur	2.54
Sodium	8.52
ppm, DM basis	
Magnesium	0.33
Zinc	43.87
Iron	86.33
Manganese	13.5
Copper	6.00
Molybdenum	0.69

[1]Nutrient 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

	Treatment[1]					Contrast		
Item	0	2.5	5	7.5	SEM	Linear	Quadratic	Cubic
Initial BW, lb	562	563	568	560	4.1	0.94	0.27	0.33
Final BW, lb	920[ab]	944[a]	941[a]	891[bc]	11.7	0.10	< 0.01	0.71
HCW, lb	525[a]	536[a]	537[a]	498[b]	8.8	0.05	0.01	0.50
DMI, lb/d	19.4[a]	19.8[a]	18.1[b]	16.2[c]	0.45	< 0.01	0.01	0.32
ADG, lb	2.89[abc]	3.09[a]	3.01[ab]	2.67[c]	0.088	0.07	< 0.01	0.97
F:G, lb	6.02[a]	5.78[a]	5.41[b]	5.38[c]	—	< 0.01	0.36	0.30
NE_m, Mcal/lb	4.01[a]	4.10[a]	4.37[b]	4.58[b]	0.060	< 0.01	0.78	0.21
NE_g, Mcal/lb	2.62[a]	2.69[a]	2.93[b]	3.02[b]	0.053	< 0.01	0.78	0.21

[1]Differences 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; NE_m = net energy for maintenance; NE_g = net energy for gain

[abc]Within a row, means without a common superscript differ ($P < 0.05$).

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 dehydrogenase, 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, all cattle were weighed prior to feeding, cattle to be harvested were sorted off and then transported to the UNL Veterinary Diagnostic Center. Remaining cattle were returned to the corresponding pen and fed. At harvest, organs and tissues (brain, spinal cord, spleen, lung, pancreas, skeletal muscle, rumen reticulum, omasum, abomasum, duodenum, jejunum, cecum, colon, kidneys, urinary bladder, pituitary, thyroid, adrenal, liver, gall bladder, heart, mesenteric lymph node, skin, prostate, eye, bone and marrow, marrow smear, ileum, thymus, ovary, mammary gland, and uterus) were isolated, washed, weighed and sampled for histopathology analysis. After full tissue collection and necropsy, all tissues and carcasses were incinerated.

Data were analyzed using the mixed procedure of SAS as a randomized complete block design with treatment, gender, and treatment by gender interaction as main effects. 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) and Na (8.52% of DM), which may limit intake at very high dietary inclusion.

There were no interactions between sex and treatment ($P \geq 0.25$) for performance data. Sex was significant for all variables ($P \leq 0.04$) 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 quadratic ($P < 0.01$) 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 ($P \leq 0.02$); however, this treatment also had the least F:G (5.38; $P < 0.01$). The F:G linearly decreased ($P < 0.01$) with increasing 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 concentrations 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 increased 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 ($P \geq 0.11$) in hematology or blood chemistry measures between treatments. There were no differences among treatments in urine parameters measured ($P \geq 0.17$), except pH which increased quadratically ($P < 0.01$)

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.

Mitchell M. Norman, graduate student

Zachary E. Carlson, research technician

Henry F. Hilscher, research technician

Andrea K. Watson, research assistant professor

Galen E. Erickson, professor, Department of Animal Science, University of Nebraska, Lincoln, NE

Bruce W. Brodersen, associate professor, School of Veterinary Medicine and Biomedical Sciences, University of Nebraska, Lincoln, NE

J. Dustin Loy, associate professor, School of Veterinary Medicine and Biomedical Sciences, University of Nebraska, Lincoln, NE

Jonathan W. Wilson, project manager, DSM Nutritional Products, Parsippany, NJ