2021

Evaluation of Condensed Algal Residue Solubles as an Ingredient in Cattle Finishing Diets

John C. Gibbons

Bradley M. Boyd

Levi McPhillips

Andrea K. Watson

Galen E. Erickson

Evaluation of Condensed Algal Residue Solubles as an Ingredient in Cattle Finishing Diets

John C. Gibbons
Bradley M. Boyd
Levi J. McPhillips
Andrea K. Watson
Galen E. Erickson

Summary with Implications

A study was conducted to evaluate feeding 0, 2.5, or 5.0% of a novel liquid feed, Condensed Algal Residue Solubles (CARS), in one of two base diets with CARS replacing corn. The two base diets were fed to mimic Northern Great Plains (high moisture and dry rolled corn blend fed with wet distillers grains plus solubles) and Southern Great Plains (steam-flaked corn and dry distillers grains plus solubles) feedlot diets. There were no interactions between base diet and CARS inclusion. Feed intake and longissimus muscle area decreased as CARS inclusion increased in the diet. A quadratic effect was shown for average daily gain, feed efficiency, final adjusted body weight, hot carcass weight, 12th rib fat, and yield grade, increasing as CARS was included up to 2.5% of diet dry matter, then decreased at 5% inclusion. Marbling score improved with increased inclusion of CARS, with the highest score at 5% CARS inclusion. Including CARS at 2.5% of diet dry matter improved feed efficiency in both Northern and Southern Great Plains diets.

Introduction

Mass production of algae to harvest eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) Omega-3 fatty acids involves growing algae with sugars, then processing the cells to separate and remove the oil for the Omega-3 supplements as feed for pets and aquaculture. The liquid biproduct from this process is known as Condensed Algal Residue Solubles (CARS; 25.4% DM, 19.3% CP, 8.3% Fat, 9.96% Na on DM basis; Table 1), made up of the de-oiled algae cells and residual fermentation substrates. In a previous study, CARS was included up to 7.5% of diet DM and had no adverse effect on cattle with improved performance when fed up to 5.0% of diet DM (*2019 Nebraska Beef Cattle Report*, pp. 82–84). From this previous study, CARS was granted GRAS (generally recognized as safe) status and has become commercially available (Veramaris, Blair, NE). The objective of this study was to determine the feeding value of CARS in feedlot finishing diets that represent Northern and Southern Great Plains finishing diets.

Procedure

Crossbreed steers (n = 480; initial BW = 951 lb; SD 84 lb) were blocked and stratified by initial BW into 4 blocks and assigned randomly to pens (n = 48) after the first day of weight collections. Pens were assigned randomly to treatment. Treatments were designed as a 2 × 3 factorial with 3 inclusions of CARS (0, 2.5, 5% of diet DM) in 2 base diets representing Northern and Southern Great Plains diets (Table 2). All diets included a 4% dry meal supplement containing Rumensin-90 (fed to target 30 g/ton of diet DM, Elanco Animal Health) and Tylan-40 (fed to target 90 mg/hd/d, Elanco Animal Health), along with trace minerals, vitamins ADE, tallow, calcium, salt (not included in the 5% CARS diets) and 0.5 % urea to ensure RDP requirements were met. Diets were formulated to provide similar Ca and appropriate Ca:P ratios. Southern diets contained steam flaked corn (SFC) and 15% dry distillers grains (DDGS) while the Northern diets contained dry rolled (DRC) and high moisture corn (HMC) with 15% wet distillers grains (WDGS). The CARS feed is a liquid and replaced either DRC/HMC or SFC in the diets.

All steers were limit fed at 2% of body weight for 5 days prior to the start of the trial using 50% alfalfa and 50% Sweet Bran (Cargill, Blair, NE) as a common diet to minimize differences in gut fill. Steers were then weighed on two consecutive days before feeding to calculate average initial weight. Steers were implanted on d 1 with Revalor-IS (80 mg trenbolone acetate and 16 mg estradiol, Merck Animal Health) and on d 70 were re-implanted with Revalor-200 (200 mg trenbolone acetate and 20 mg estradiol, Merck Animal Health). On d 120 to d 148 Optaflexx (Elanco Animal Health) was included in the diet at 300 mg/hd daily. Feed refusals were collected as needed throughout the trial and analyzed for DM in order to adjust feed offered to actual dry matter intake (DMI).

All blocks were harvested after 148 days on feed. Hot carcass weight (HCW), liver abscess scores, and kill order were recorded. Carcass adjusted final body weights (BW) were calculated from HCW and a common 63% dressing percentage. Carcass adjusted

Table 1. Nutrient composition of CARS and FAME analysis (DM basis)

Item	CARS[1]
Dry Matter (DM), %	25.43
Dry Basis	
Crude Protein	19.30
Fat (Oil)	15.05
DHA	6.25
EPA	1.98
Calcium	0.44
Magnesium	0.45
Phosphorus	0.53
Potassium	0.80
Sulfur	3.05
Sodium	9.96
ppm, DM Basis	
Zinc	55.4
Iron	168
Manganese	13
Copper	8.2
Molybdenum	1.18

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

[2] DHA and EPA analyzed by Veramaris (Blair, NE)

Table 2. Dietary treatment compositions (DM basis) for finishing steers fed increasing inclusion of CARS in Northern or Southern Great Plains based diets

	Northern			Southern		
Ingredient, % diet DM	0%	2.5%	5%	0%	2.5%	5%
Dry Rolled Corn	36.5	35.25	34	-	-	-
High Moisture Corn	36.5	35.25	34	-	-	-
Wet Distillers Grains	15	15	15	-	-	-
Steam Flaked Corn	-	-	-	73	70.5	68
Dried Distillers Grains	-	-	-	15	15	15
CARS	0	2.5	5	0	2.5	5
Alfalfa Haylage	8	8	8	8	8	8
Supplement[1]	4	4	4	4	4	4

[1] Rumensin fed at 30 g/ton (DM); Tylan fed to target 90 mg/hd/d

final body weight was used to calculate average daily gain (ADG) and feed to gain (F:G). Dietary NEm and NEg values were calculated utilizing initial BW, adjusted final BW, BW at target endpoint (heaviest pen average BW by block), ADG and DMI. Carcass characteristics including marbling score, 12th rib back fat thickness, longissimus muscle (LM) area, and yield grade were recorded after a 48 hour chill.

Economic analysis of CARS, as feed cost of gain, was modeled with the assumptions that CARS was equal to the cost of corn, and Northern Great Plains and Southern Great Plains base diet costs were averaged together. Corn costs used were $3.00, $3.50, $4.00, and $4.50/bushel with equivalent costs at $0.06, $0.07, $0.08, $0.10/lb of DM. Results of this analysis are reported as feed cost of gain/cwt body weight gained.

Performance data were analyzed using the PROC MIXED procedure of SAS (SAS institute, Inc., Cary, N.C.) as a 2×3 factorial. CARS inclusion, base diet, the interaction between CARS and base diet, and body weight block were included as fixed effects. Pen was the experimental unit. Orthogonal contrasts were used to test linear and quadratic effects of CARS inclusion. If no interaction was detected, the main effects of CARS inclusion and base diet were evaluated and are presented.

Results

One steer died from bloat during the study and two others were removed (i.e. dislocated shoulder, heart and liver issues) There were no significant interactions between CARS inclusion and diet type ($P \geq 0.49$) for any variable tested. Therefore, main effects are discussed.

CARS inclusion main effects

Increasing inclusion of CARS resulted in a linear decrease ($P < 0.01$) in DMI. There was a positive quadratic response for ADG ($P < 0.01$), with 0% and 2.5% CARS having similar ADG and decreasing at the 5% CARS inclusion. This resulted in a quadratic response for F:G ($P < 0.01$) as CARS inclusion in the diet increased with 2.5% CARS inclusion having the lowest F:G with a 4.3% improvement compared to the control and 5% CARS treatment having the greatest F:G. There was a positive quadratic response for both NEm and NEg ($P < 0.01$), with 0% and 5% CARS having similar values and 2.5% CARS having the greatest value. Both carcass adjusted final BW and HCW had positive quadratic responses ($P < 0.01$) as CARS inclusion increased in the diet, with final body weights and HCW being the heaviest at the 2.5% inclusion level. Longissimus muscle area linearly decreased ($P < 0.01$) with increasing inclusion of CARS. Measures of 12th rib fat thickness showed a positive quadratic response ($P < 0.01$) with maximum 12th rib fat at 2.5% CARS inclusion and 5% CARS having the least. Marbling score linearly increased ($P < 0.01$) from 563 with 0% CARS to 598 with 5% CARS, but all treatments averaged choice grade. Yield grade had a positive quadratic response ($P < 0.01$), with a maximum yield grade observed at the 2.5% CARS inclusion, while 0% and 5% CARS inclusion had similar grades.

Main effects of diet

Main effects of diet indicated that DMI for both Northern and Southern Plains were similar ($P = 0.72$). Southern diets had greater ADG compared to Northern diets ($P < 0.01$) and F:G was 5.9% greater for Southern compared to Northern diets ($P < 0.01$). Steam-flaked corn diets commonly increase feed efficiency by 12% compared to dry rolled corn diets. The improved efficiency measured in this trial was only half that amount, likely due to differences between dry and wet distillers grains in these diets. Dietary NEm and NEg were different between base diets ($P < 0.01$), with Southern diets having greater energy concentration than Northern diets due to the SFC in the Southern diets. Steers fed the Southern diets had greater carcass adjusted final body weights and improved HCW compared to steers fed the Northern diets ($P < 0.01$). The longissimus muscle area was statistically similar for both diets ($P = 0.09$) while 12th rib fat thickness and YG were greater for Southern diets compared to the Northern ($P = 0.02$). Marbling scores were not statistically different ($P = 0.06$) but Southern diets had numerically greater scores compared to the Northern diets.

Economic Analysis

Economics are reported as feed cost of gain/cwt final body weight gain. In each scenario of different corn prices there was a quadratic decrease in feed cost of gain as CARS inclusion increased in the diet ($P < 0.01$). For all scenarios, 2.5% CARS inclusion had the lowest feed cost of gain. As corn price (feed costs) increased, the average savings increased from $1.74/cwt for 2.5% CARS compared to 0% CARS at $3/bu corn up to $2.60/cwt at $4.50/bu corn cost. Similarly, the average loss incurred also increased from $0.54/cwt to $0.81/cwt for the 5% CARS treatment compared to 0% CARS as corn cost increased from $3/bu to $4.50/bu. Therefore, if CARS can be purchased, delivered, and fed for similar costs as corn,

Table 3. Main effects of CARS inclusion on growth performance and carcass characteristics

	Treatment[1]				P-value[2]		
Item	CON (0)	2.5	5	SEM	*CARS*	*Linear*	Quadratic
Performance							
Initial BW, lb	951	951	951	0.8	0.81	0.55	0.80
Final BW, lb[3]	1566[a]	1576[a]	1504[b]	8.9	<0.01	<0.01	<0.01
DMI, lb/d	26.2[a]	25.5[b]	23.9[c]	0.256	<0.01	<0.01	0.05
ADG, lb[3]	4.15[a]	4.22[a]	3.74[b]	0.061	<0.01	<0.01	<0.01
Feed to Gain	6.32[a]	6.05[b]	6.41[a]	0.085	<0.01	0.32	<0.01
NEm, Mcal/lb	0.89[a]	0.92[b]	0.89[a]	0.018	<0.01	0.66	<0.01
NEg, Mcal/lb	0.59[a]	0.62[b]	0.59[a]	0.017	<0.01	0.70	<0.01
Carcass Characteristics							
HCW, lb	986[a]	993[a]	948[b]	5.5	<0.01	<0.01	<0.01
LM area, in^2	15.0[a]	14.8[a]	14.3[b]	0.16	<0.01	<0.01	0.28
12th Rib Fat, in	0.63[a]	0.67[b]	0.61[a]	0.016	<0.01	0.21	<0.01
Marbling Score[4]	563[a]	579[ab]	597[b]	10.4	<0.01	<0.01	0.88
Yield Grade	3.57[a]	3.67[b]	3.51[a]	0.038	<0.01	0.20	<0.01

[a,b] Means within a row that lack a common superscript differ ($P < 0.05$)

[1] Treatments were arranged as a 2×3 factorial and included CARS at 0, 2.5, and 5% of diet DM in both Northern and Southern Great Plains diets

[2] Main effects included CARS inclusion in the diet and diet type (Northern or Southern Great Plains). The interaction between diet and CARS was not significant for any variable measured ($P \geq 0.49$). Linear and quadratic orthogonal contrasts are shown for CARS inclusion in the diet

[3] Calculated from hot carcass weight, adjusted to a common 63% dressing percentage

[4] Marbling Score 400-Small00, 500 = Modest00

Table 4. Main effects of base diets on growth performance and carcass characteristics

	Treatment[1]			
Item	Northern	Southern	SEM	*P*-value[2]
Performance				
Initial BW, lb	951	951	0.8	0.71
Final BW, lb[3]	1531	1566	8.9	< 0.01
DMI, lb/d	25.2	25.1	0.256	0.72
ADG, lb[3]	3.92	4.16	0.061	< 0.01
Feed to Gain	6.45	6.07	0.085	< 0.01
NEm, Mcal/lb	0.88	0.92	0.008	< 0.01
NEg, Mcal/lb	0.58	0.62	0.017	< 0.01
Carcass Characteristics				
HCW, lb	965	987	5.5	< 0.01
LM area, in^2	14.6	14.8	0.16	0.09
12th Rib Fat, in	0.62	0.65	0.016	0.02
Marbling Score[4]	572	588	10.4	0.06
Yield Grade	3.54	3.62	0.038	0.01

[1] Treatments were arranged as a 2×3 factorial and included CARS at 0, 2.5, and 5% of diet DM in both Northern and Southern Great Plains diets

[2] *P*-value for the main effects of base diet

[3] Calculated from hot carcass weight, adjusted to a common 63% dressing percentage

[4] Marbling Score 400-Small00, 500 = Modest00

small improvements in economics would be expected at the 2.5% diet inclusion.

Conclusions

Including CARS at 2.5% of diet DM improved feed efficiency and hot carcass weight compared to a 0% CARS control diet. There were no interactions between type of diet (Northern and Southern Great Plains feedlot diets) and CARS inclusion (0, 2.5, and 5% of diet DM). There was greater feed efficiency and hot carcass weight in Southern diets compared to the Northern base diets. Feeding 2.5% CARS reduced feed cost of gain.

John C. Gibbons, graduate student

Bradley M. Boyd, research technician

Levi J. McPhillips, research technician

Andrea K. Watson, research assistant professor

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