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Posted Date: 24 June 2024

doi: 10.20944/preprints202406.1514.v1

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Article

Evaluation of a Phytogenic Feed Additive with Essential Oils and Plant Extracts on Growth Performance in Auction-Derived Beef Steers[1]

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[1] This research was supported by the Beef Nutrition Program and funds appropriated to South Dakota State University by USDA-NIFA (HATCH-SD00H690-19) and DOSTOFARM, Westerstede, Germany.
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Abstract: This study used 10 replicate pens per treatment in a randomized complete block design and each pen contained 8 steers (initial BW = 305 ± 30.4 kg; n=80 steers/treatment) to determine if a phytogenic feed additive (PFA) with essential oils and plant extracts (PHYTOsolvan 200; DOSTOFARM, Westerstede, Germany) influences measures of growth or growth efficiency during the feedlot receiving phase in auction-derived beef steers. No steers were removed from the study; one steer from the control treatment was treated for respiratory disease. No mortality was noted in the present experiment. No appreciable differences were noted for BW, ADG, DMI, or feed conversion efficiency from d 1 to 29, 29 to 53, or during the cumulative receiving period ($P \geq 0.12$). Performance based NEm and NEg were not influenced by dietary treatment ($P \geq 0.79$). The ratio of observed-to-expected dietary net energy was not impacted by dietary treatment ($P \geq 0.71$). These were healthy, high-growth potential Northern Plains steers. There was minimal morbidity (0.63%) and no mortality noted during the 53 d receiving study. Steers performed well and met growth performance expectations (the ratio of observed-to-expected NEm = 1.00), hence, it was not anticipated that the phytogenic compound would appreciably influence growth or health outcomes under the conditions of this experiment.

Keywords: beef; essential oil; newly arrived; receiving

Introduction

The period when calves are newly received to the feedlot following transportation is a critical time in the beef production system. This period is arguably the most stressful event of a beef calf's life as they are transported, deprived of feed and water, and introduced to an unfamiliar feed source [1]. This period of reduced feed intake and transit stress can lead to respiratory distress such as bovine respiratory disease complex (BRD). Loneragan, et al. [2] identified BRD as the largest cause of death in feedlots and is responsible for approximately 75% of feedlot morbidity. Respiratory disease accounted for 68% of all deaths in a 30 feedlot analysis including nearly 1 million head of cattle [3]. Furthermore, it was noted that approximately 10% of all lungs evaluated during the 2011 and 2016 National Cattleman's Beef Association—Beef Quality Audit had lung lesions associated with pneumonia [4]. It is likely that many of these cattle were not treated for BRD, based on results observed in lung evaluations and treatment records for nearly 6,000 feedlot cattle fed in Iowa [5]. Furthermore, antimicrobial resistance is a large concern to animal producers. Continued and unwarranted use of antimicrobials in livestock production results in increased pools of antimicrobial resistant genes among bacteria. On January 1, 2017, all medically important antimicrobials to human medicine were listed in the Veterinary Feed Directive (VFD). The VFD requires veterinarian oversight and the prescription of feed based antimicrobials from a veterinarian that has a working patient-client relationship with the producer. Essential oils (EO) and phytomolecule (PM) compounds have been shown to reduce inflammation and modulate immune function. There is potential that the use of

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these products in combination with commonly employed therapeutic strategies (i.e., antimicrobial treatment) might aid in controlling systemic inflammation that in turn might reduce the need to use in feed antimicrobials to control disease or repeated antimicrobial use after unsatisfactory initial antimicrobial treatment. Although many phytogenic compounds have been investigated as antimicrobial replacements in many livestock species, results have been variable due to differences in the composition and source of phytogenic compounds, diet type fed, stage of production (i.e., growing and fattening or lactation), and the degree of stress challenge [6]. The objective of this research was to determine if a phytogenic feed additive (PFA) with essential oils and plant extracts based upon thymol, anise, and carvacrol (PHYTOsolvan 200; DOSTOFARM, Westerstede, Germany) influences measures of growth or growth efficiency during the feedlot receiving phase.

Materials and Methods

Animal Use Approval

All procedures involving the use on animals were approved by the Institutional Animal Care and Use Committee at South Dakota State University (Approval # 2209-055A) and the study was conducted between January and March of 2023.

Dietary Treatments and Diet

The dietary treatments included:

1) Fed no PFA (Control)

2) Fed PFA at a rate of 0.25 g/45.4 kg of BW (PFA)

Supplements for dietary treatment inclusion were manufactured at the SDSU feed mill in Brookings, SD using dried distillers grains plus solubles (DDGS) as a carrier. The PFA carrier was formulated to contain 4.0 g in every 0.454 kg of DDGS carrier.

This study used 10 replicate pens per treatment in a randomized complete block design and each pen contained 8 steers (n=80 steers/treatment). No tylosin phosphate was fed during this experiment, nor was a steroidal implant used, but monensin sodium (Rumensin-90, Elanco Animal Health) was fed at 25 g/907 kg (DM basis). The basal diet included corn silage, dried distillers grains plus solubles, and a liquid supplement (Table 1) that was fortified with vitamins and minerals to exceed nutrient requirements for growing and finishing beef steers [7]. Actual diet formulation was based upon weekly DM determination and tabular ingredient nutrient values [8].

Table 1. Actual diet formulation and tabular nutrient values based upon weekly feed batching records[1].

Item	Basal Diet
Corn Silage, %	73.84
Dried Distillers Grains Plus Solubles, %	20.91
Suspended Supplement[2], %	5.25
Diet DM, %	50.34
Crude Protein, %	12.83
Neutral Detergent Fiber, %	42.12
Acid Detergent Fiber, %	24.96
Ash, %	7.89
Organic Matter, %	92.11
Ether Extract, %	3.79
Net Energy for Maintenance (NEm), Mcal/kg	1.77
Net Energy for Gain (NEg), Mcal/kg	1.15

[1] All values except diet DM on a DM basis.

[2] The suspended supplement contained: 36.47% CP, 28.00% NPN, 1.54 Mcal/kg NEm, 0.99 Mcal/kg NEg, 0.78% fat, 4.62% Ca, 0.38% P, 2.62% K, 0.73% Mg, 5% NaCl, 0.48% S, 4 ppm Co, 200 ppm Cu, 400 ppm Mn, 1,800 ppm Zn, 44,092 IU/kg vitamin A, 441 IU/kg vitamin E, and 500 g/907 kg monensin sodium.

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Cattle and Feeding Management

One-hundred and sixty, single source, newly received, Charolais × Angus crossbred steers (initial BW = 305 ± 30.4 kg) were used in the 53 d receiving phase experiment. The steers were acquired from a Western South Dakota auction facility and transported 285 km (3.5 hours transit) to the Ruminant Nutrition Center (RNC) in Brookings, SD on January 7, 2023. Upon arrival, steers were group housed (10 steers/pen) in 7.62 × 7.62 m concrete surfaced pens and offered long-stem grass hay and *ad libitum* access to water; all pens were equipped with automatic heated waterers.

The following morning all steers were subjected to an individual BW measurement that was used for allotment purposes, given a unique identification ear tag, then vaccinated against viral respiratory diseases (Bovishield Gold 5, Zoetis) and clostridial species (Ultrabac 7/Somubac, Zoetis), and administered pour-on anthelmintic (Cydectin, Elanco) according to label directions. No metaphylaxis was administered upon arrival.

The morning following the initial processing day, steers (n = 160) selected from the larger population based upon temperament, health, and uniformity of body weight were allotted to treatment pens (n = 10 pens/treatment; 20 pens total). Throughout the entire study, steers were delivered 50% of their prescribed feed call twice daily (0800 and 1400 h). During the initial 14 d on feed, intakes were closely managed by feed calls to accommodate adaptation to the receiving diet. For the remainder of the experiment (d 15 to 53) bunks were managed using a slick bunk management approach such that bunks were managed to be devoid of feed by 0800 h most mornings. Bunks were evaluated daily at 0700 h for residual feed and a bunk score of 0 to 1 was targeted for all pens. Feed was manufactured twice daily in two batches for each treatment in a stationary mixer (2.35 m^3; Roto-Mix, Dodge City, KS), with a scale sensitivity of ± 0.45 kg. Feed for each pen was weighed and off-loaded into a feed delivery wagon not mounted on load cells and delivered to each pen. Batching sequence was: (-Control), (PFA), (Control), and finally (PFA). Following each batch of feed, long stem grass hay (~1.8 kg) was added to the mixer and used to flush out all residual feed remaining in the mixer.

Growth Performance Calculations

Steers were individually weighed on d 1, 29, and 53. Growth performance was calculated for each interim period (d 1 to 29 and d 30 to 53) and the cumulative receiving period. All BW measures used for growth performance calculations were pencil shrunk 4% to account for gastrointestinal tract fill. Average daily gain (ADG) was determined as the difference in body weight divided by days for that period. Dry matter intake (DMI) was tabulated at weekly intervals and summarized by interim period. Feed conversion ratio (G:F) was calculated using ADG divided by DMI.

Growth performance was used to calculate performance-based dietary NE to determine efficiency of dietary NE utilization. The performance-based dietary NE was calculated from daily energy gain (EG; Mcal/d): EG = $ADG^{1.097} \times 0.0557W^{0.75}$, where W is the mean equivalent shrunk BW [kg; [7]] from median feeding shrunk BW and final BW at 28% estimated empty body fatness (601 kg) was calculated as: [median feeding shrunk BW × (478/601), kg; [7]]. Maintenance energy (EM) was calculated by the equation: EM = 0.077 × median feeding shrunk $BW^{0.75}$. Dry matter intake is related to energy requirements and dietary NEm (Mcal/kg) according to the following equation: DMI = EG/(0.877NEm − 0.41), and can be resolved for estimation of dietary NEm by means of the quadratic formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2c}$, where a = −0.41EM, b = 0.877EM + 0.41DMI + EG, and c = −0.877DMI [9]. Dietary NEg was derived from NEm using the following equation: NEg= 0.877NEm − 0.41 [10].

Management of Pulls

Steers pulled from their home pen for health evaluation were monitored in individual hospital pens prior to being returned to their home pens. When a steer was moved to a hospital pen the appropriate amount of feed from the home pen was removed and transferred to the hospital pen. If the steer in the hospital returned to their home pen, the feed remained credited to the home pen. If

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the steer did not return to their home pen, all feed that was delivered to the hospital pen was deducted from the feed intake record for that particular pen back to the date the steer was hospitalized.

Statistical Analysis

Data were analyzed using a model appropriate for a randomized complete block design with pen serving as the experimental unit. The model included the fixed effect of treatment. Block (batch fraction) was considered a random variable. Least squares means were generated using the LSMEANS statement of SAS (SAS Inst. Inc., Cary, NC). Treatment effects were evaluated by the use pairwise comparisons PDIFF option in SAS 9.4.

Results and Discussion

No steers were removed from the study and morbidity was minimal in the present study (0.63%) as only one steer from the Control treatment was treated for respiratory disease. No mortality was noted in the present experiment. No appreciable differences were noted for body weight, average daily gain, dry matter intake, or feed conversion efficiency from d 1 to 29, 29 to 53, or during the cumulative receiving period ($P \geq 0.12$, Table 2). This is in contrast to what was observed in lambs fed a similar energy concentration diet as the present study where supplementation with a blend of encapsulated carvacrol, thymol, and cinnamaldehyde increased weight gain [11]. When a blend of eugenol, thymol, and vanillin was fed to finishing Nelore heifers, dry matter intake was increased by 13.8%; however, daily gain was not appreciably increased nor was feed efficiency [12]. Alternatively, when a blend of limonene and thymol was fed to finishing beef steers, no increase in growth performance was noted [13].

Table 2. Growth performance responses in auction derived steers fed a phytogenic feed additive (PFA). Treatments included: fed no PFA (Control) or fed PFA at a rate of 0.25 g/45.4 kg of BW (PFA; PHYTOsolvan 200; DOSTOFARM, Westerstede, Germany).

	Treatment			
Item	Control	PFA	SEM	*P* - value
Steers, n	80	80	-	-
Pens, n	10	10	-	-
Initial BW[1], kg	303	303	-	-
Initial to d 29				
d 29 BW[2], kg	346	342	2.3	0.13
ADG, kg	1.46	1.36	0.081	0.22
DMI, kg	7.71	7.64	0.054	0.28
G:F	0.189	0.177	0.0094	0.22
d 30 to d 53				
d 53 BW[2], kg	384	381	2.4	0.25
ADG, kg	1.62	1.66	0.059	0.53
DMI, kg	9.94	9.68	0.158	0.14
G:F	0.163	0.171	0.0047	0.14
Initial to d 53				
ADG, kg	1.53	1.49	0.045	0.40
DMI, kg	8.72	8.57	0.088	0.12
G:F	0.176	0.174	0.0041	0.68
Diet net energy, Mcal/kg[3]				
Maintenance	1.77	1.76	0.023	0.79
Gain	1.14	1.14	0.020	0.79

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Observed-to-expected dietary net energy				
Maintenance	1.00	1.00	0.013	0.89
Gain	0.99	0.98	0.014	0.71

[1] No shrink was applied to initial BW.
[2] A 4% shrink was applied to account for digestive tract fill.
[3] Calculated assuming a mature BW of 601 kg.

Performance-based NEm and NEg were not influenced by dietary treatment in the present study ($P \geq 0.79$). The ratio of observed-to-expected dietary net energy was not impacted by dietary treatment ($P \geq 0.71$), hence, it was not anticipated that the phytogenic compound would appreciably influence growth or health outcomes under the conditions of this experiment. While many phytogenic compounds have been investigated as antimicrobial replacements in ruminant species, results have been variable because of differences in composition and source of phytogenic compounds, diet type fed (i.e., forage versus concentrate), stage of production (i.e., growing and fattening versus lactation), and the degree of stress challenge imposed to the animal (i.e., auction-derived versus not auction-derived) [6]. The fact that the steers in the current experiment already had been weaned prior to arrival and had not been commingled with other cattle at any point limited the degree of stress imposed, and consequently those factors limited the ability for cattle to respond to any beneficial aspects of PFA supplementation.

Conclusions

These were healthy, high-growth potential Northern Plains feeder steers. There was minimal morbidity (0.63%) and no mortality noted during the 53 d receiving study. Steers performed well and met growth performance expectations (the ratio of observed-to-expected NEm = 1.00), hence, it was not anticipated that the phytogenic compound would appreciably influence growth or health outcomes under the conditions of this experiment.

Data Availability Statement: Data can be made available with a reasonable request to ZKS.

Acknowledgements: The authors would like to thank the staff at the Ruminant Nutrition Center and Ruminant Nutrition Laboratory, Brookings, SD, USA

Conflict of Interest Statement: The author declares no conflict of interest except for the fact that DOSTOFARM, provided partial funding to complete this research.

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