Lubabegron and betaine for finishing steers: Impacts on carcass measurements, meat quality and yield

Kasey Maddock Carlin[1], Amy Volk[1], Pauliane Pucetti[1], Christy Finck[1], Kiersten Gundersen[1], Wanda Keller[1], Jacob Arntzen[1], Erin Beyer[1], Jessie Syring[1], Zachary Carlson[1], Nathan Pyatt[1] and Kendall Swanson[1]

Lubabegron (Experior®) improved USDA Yield Grade through increased hot carcass weight and ribeye area and decreased 12th rib backfat measurements. However, lubabegron also decreased USDA Quality Grade due to lower marbling scores, which also resulted in slightly lower tenderness measurements in strip steaks on day 21 of aging. Lubabegron also increased purge in wholesale strip loins during refrigerated storage. Betaine (Betafin®) increased USDA Yield Grade in beef carcasses, which was due to increased 12th rib backfat measurements while not impacting USDA Quality Grade. However, betaine, when supplemented with lubabegron, prevented the loss of water due to purge that was observed when lubabegron was supplemented alone.

Summary

This study evaluated the effects of lubabegron (Experior®, 0.032% DM for 56 days) and betaine (Betafin®, 0.28% DM for seven days) on carcass yield and quality, as well as meat quality measurements related to tenderness and water-holding capacity. While lubabegron improved upon USDA Yield grades through greater lean yield and less fat, there was also decreased tenderness and water-holding capacity. While betaine was detrimental to USDA Yield Grade by increasing the percentage of carcasses grading in Yield Grade 4 and 5, it decreased drip loss in strip steaks and prevented the purge loss that was observed when lubabegron was supplemented alone.

[1]NDSU Department of Animal Sciences

Introduction

Lubabegron fumarate is the newest beta-adrenergic agonist approved for use in finishing cattle (Experior®; Elanco Animal Health) and is labeled primarily for reduction of ammonia emissions. Although the use of lubabegron has become widespread, little is known about potential impacts on meat quality. Vogel et al. (2023) reported that lubabegron supplementation increased carcass weights and ribeye area in crossbred steers, and they observed a decrease in marbling score, resulting in a USDA quality grade shift from USDA Choice to USDA Select.

Betaine (Betafin®; Danisco Animal Nutrition and Health) is an amino acid derivative that serves as a methyl donor for the conversion of homocysteine to methionine, and it is considered a zwitterionic molecule with antioxidant properties that protect cells from osmotic and ionic stresses (Lipinski et al., 2012). Although there is little information on the impact of betaine on beef quality, research on rumen-protected betaine in lambs showed that it increases pH in the semimembranosus and gluteus medius and decreases shear force values and drip loss (Dong et al., 2020). A recent study (Soares et al., 2022) evaluated betaine supplementation in combination with the beta-agonist ractopamine hydrochloride in finishing pigs and observed a decrease in cooking water loss when the combination of the two supplements were fed, as well as a decrease in shear force value and an increase in intramuscular fat in the longissimus muscle when betaine was supplemented without ractopamine.

The impacts of supplementation of beta-agonists in beef feedlot diets on meat quality have been well researched with consistent themes of increased carcass weight, yield and efficiencies, but also detriments related to meat quality traits of tenderness and marbling scores. Preliminary research with lubabegron fumarate is showing similar tendencies to previously well-researched beta-agonists such as ractopamine hydrochloride. The osmotic and antioxidant protections of betaine — resulting in increased water-holding ability, decreased shear force values and increased intramuscular fat observed in some meat animal species (lamb and pork) — could potentially help to mitigate the detrimental

changes observed in beef quality when supplementing lubabegron. Therefore, the objectives of this study were to evaluate the impacts of lubabegron fumarate (LUB) and betaine (BET) supplementation on carcass characteristics and strip loin meat quality traits of finishing steers.

Procedures

All animal procedures were reviewed and approved by the North Dakota State University Institutional Animal Care and Use Committee (IACUC Protocol #: 20240033). Sixty steers (initial body weight [BW] 1050 ± 11.6 lbs), predominantly of Angus and Simmental breeding, were stratified by weight into two groups: heavy (fed for 119 days before slaughter, n = 38) and light (fed for 147 days before slaughter, n = 22). Steers were randomly assigned to one of four treatments in a 2 × 2 factorial arrangement: the control treatment (no additive; n = 16), Lubabegron (0.032% of dietary dry matter [DM] for 56 days, followed by a seven-day withdrawal; n = 14), Betaine (0.28% of dietary DM for the final 7 days; n = 15) and Lubabegron + Betaine (n = 15).

All steers received a growth-promoting implant (200 mg trenbolone acetate, 20 mg estradiol 17β+, and 29 mg tylosin tartrate; Elanco Animal Health) and were fed a diet containing 10% forage (corn silage and grass hay) and 90% concentrate (dry-rolled corn, DDGS, urea, limestone, salt, vitamin and trace mineral mix and monensin). Individual feed intake was monitored using the Insentec feeding system, and steer served as the experimental unit. Steers were weighed on two consecutive days at the beginning and end of the experiment, during Lubabegron and Betaine supplementation periods and every 28 days throughout the experiment. Steers were transported to a commercial beef processing plant on two different days. Carcass data were collected, and strip loins (IMPS 180, n = 53) were transported to the NDSU Meat Science Laboratory for further fabrication and analyses. Loins not collected were either lost in the packing plant due to sorting, or their fabrication was delayed and could not be collected within the time that personnel were at the plant. The loins were aged in vacuum packaging for 14 days at 4 degrees Celsius. Loins were fabricated into four 2.5-cm thick steaks for further analysis. Tenderness was evaluated by Warner-Bratzler Shear Force (WBSF) on 14- and 21-day-aged steaks, with cook loss percentage calculated. Drip loss was measured with 14-day-aged samples with 50 g samples that were either suspended for 48 hours or were stored in plastic storage bags for six days. Simulated retail display was evaluated on 14-day-aged steaks placed on Styrofoam trays overwrapped with PVC and displayed in a retail cooler for 14 days, where daily measurements of L*, a* and b* were taken with a Minolta colorimeter. Data were analyzed using PROC MIXED in SAS as a randomized complete block design for effects of treatments and their interaction. For performance data including hot carcass weight, marketing date was included as the block and initial BW was used as a covariate. For carcass and meat quality data, marketing date was used as a covariate. Significance was declared at $P \leq 0.05$, and trends were considered for $0.05 < P \leq 0.10$.

Results

Supplementation with LUB decreased ($P < 0.006$; Table 1) marbling score and USDA yield grade and increased ($P = 0.04$) ribeye area. Supplementing BET increased ($P < 0.009$) 12th rib backfat and, therefore, also USDA Yield Grade ($P < 0.002$). Kidney, pelvic and heart fat percentages were not impacted by treatment.

Supplementing LUB increased ($P < 0.02$; Table 2) 14-day purge loss in vacuum-package boneless strip loins. Supplementing BET tended ($P < 0.06$) to decrease purge loss and drip loss. Neither supplementation with LUB nor BET impacted cook loss or water loss. However, numerical values for cook loss and water loss are consistently lower for BET compared to no-BET, although statistical significance was not found. Fu et al. (2023) determined that long-term supplementation of betaine to finishing pigs decreased cooking loss.

Strip loins aged for 14 days were not impacted by LUB or BET supplementation for WBSF; however, 21-day strip loins had greater ($P < 0.01$) shear force values when LUB was fed. When observing the improvement in shear force value from day 14 to day 21, LUB steaks did not have the same magnitude of reduction in shear force values as non-LUB steaks, indicating that less aging occurred. Corona et al. (2025) observed that LUB increased shear force on day 14 of aging at a higher dose of LUB; however, the lowest dose of LUB was not different from controls, and by day 21 of aging, the magnitude of reduction of shear force was not different between LUB and controls, indicating continuing improvements in shear force values. It's important to note that all shear force values were within the threshold of acceptability for tenderness.

Supplementation with LUB and BET did not affect L* values (lightness) on steaks displayed for 14 days. However, supplementation with LUB decreased a* values (redness; Figure 1) after d 10 of display. This decrease in redness occurred well after a typical retail display time for fresh beef in overwrap packages (two to seven days), so it would have limited implications on purchasing decisions at the retail level. When LUB was

Table 1. Least-squares means (interactive means) of the effects of lubabegron and betaine supplementation of beef cattle on hot carcass weight, dressing percentage, final USDA yield grade, ribeye area, marbling, 12th rib backfat and KPH

						P-value		
Item	Control	Betaine	Lubabegron	Lubabegron + Betaine	SEM	Lubabegron	Betaine	Interaction
USDA Yield Grade	3.7^{bc}	4.2^{a}	3.3^{c}	3.9^{ab}	0.2	0.04	**0.002**	0.83
Ribeye area (in^2)	14.5^{ab}	13.8^{b}	15.0^{a}	14.8^{ab}	2.3	0.04	0.17	0.46
Marbling[2]	525.1^{ab}	567.1^{a}	465.2^{c}	481.2^{bc}	26.3	0.006	0.26	0.61
12th rib backfat (in)	0.72^{ab}	0.79^{a}	0.64^{b}	0.77^{a}	0.1	0.18	**0.009**	0.40
KPH[3] (%)	1.9	1.9	1.8	1.9	0.03	0.19	0.33	0.61

[1]Dressing percentage = Hot carcass weight/Live weight x 100
[2] Marbling scores = Small 400-499; Modest 500-599
[3]Kidney, Pelvic, and Heart fat as a percentage of total carcass weight

Table 2. Least-squares means (interactive means) of the effects of lubabegron and betaine supplementation of beef cattle on purge loss, drip loss, water loss, cook loss and Warner-Bratzler shear force values (WBSF)

						P-value		
Item	Control	Betaine	Lubabegron	Lubabegron + Betaine	SEM	Lubabegron	Betaine	Interaction
Purge[1], %	1.25^{b}	1.01^{b}	1.88^{a}	1.33^{b}	0.18	**0.02**	**0.08**	0.55
Drip loss[2], %	0.65	0.46	0.72	0.52	0.09	0.81	**0.06**	0.67
Water loss[3] D1, %	1.08	0.92	1.20	1.04	0.18	0.48	0.34	0.99
Water loss[3] D6, %	2.78	2.58	3.10	2.72	0.32	0.44	0.33	0.76
Cook loss[4] D14, %	17.43	17.09	16.83	16.47	0.57	0.25	0.51	0.99
Cook loss[4] D21, %	18.58	17.62	17.85	16.72	0.83	0.29	0.17	0.92
WBSF[5] D14, kg	2.55	2.34	2.58	2.58	0.14	0.29	**0.39**	0.38
WBSF[5] D21, kg	2.40^{ab}	2.11^{b}	2.53^{a}	2.52^{a}	0.11	**0.01**	0.14	0.18

[1]Percentage of weight lost in primal beef loins stored for 14 days in vacuum packages.
[2] Percentage of weight lost in 50-g samples after suspension for 48 hours.
[3]Percentage of weight lost in 50-g samples stored in storage bags.
[4]Percentage of weight lost in 2.5-cm steaks after cooking.
[5]Warner-Bratzler shear force values

supplemented, BET decreased ($P <$ 0.03) a* and b* values (yellowness) on day 2 of retail display, but this difference was not observed on any other day of display. Corona et al. (2025), who evaluated the effects of LUB supplementation duration and dose, also did not observe changes in L*; however, they did observe that as LUB dose increases, a* and b* values decrease on unaged *Longissimus lumborum* muscle. In this study, instrumental color was not measured until after 14 days of aging, and there was only one dose concentration when compared to control. Previous research with other beta-agonists has had mixed results on impacts on redness (a*) or yellowness (b*; Quinn et al., 2008).

In conclusion, supplementation with LUB improved carcass yield but decreased measurements of tenderness and purge. However, supplementation with BET tended to decrease purge and may be able to mitigate some of the purge loss due to LUB supplementation. However, BET supplementation increased backfat, which increased USDA Yield Grades. Although LUB supplementation decreased the redness of steaks in simulated retail display, this was not observed until after 10 days of display, which is outside of typical retail display times.

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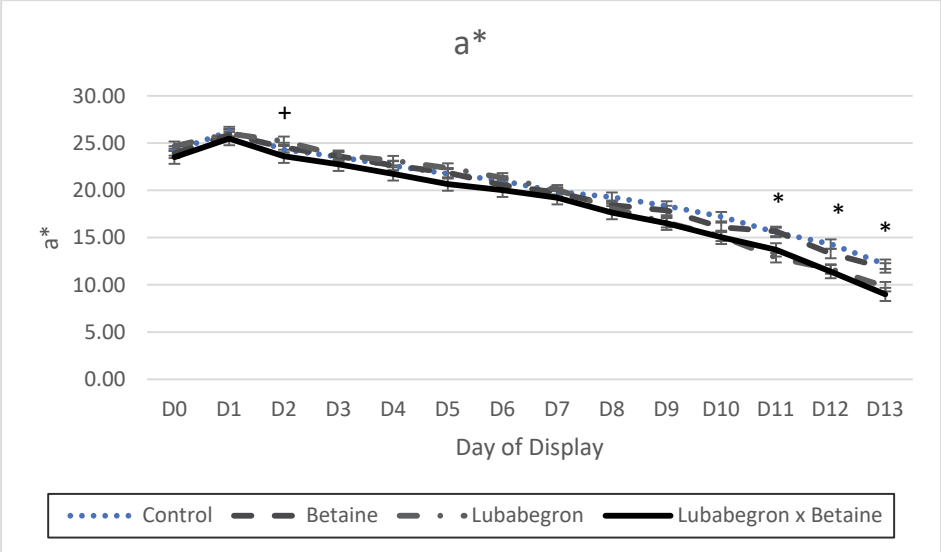
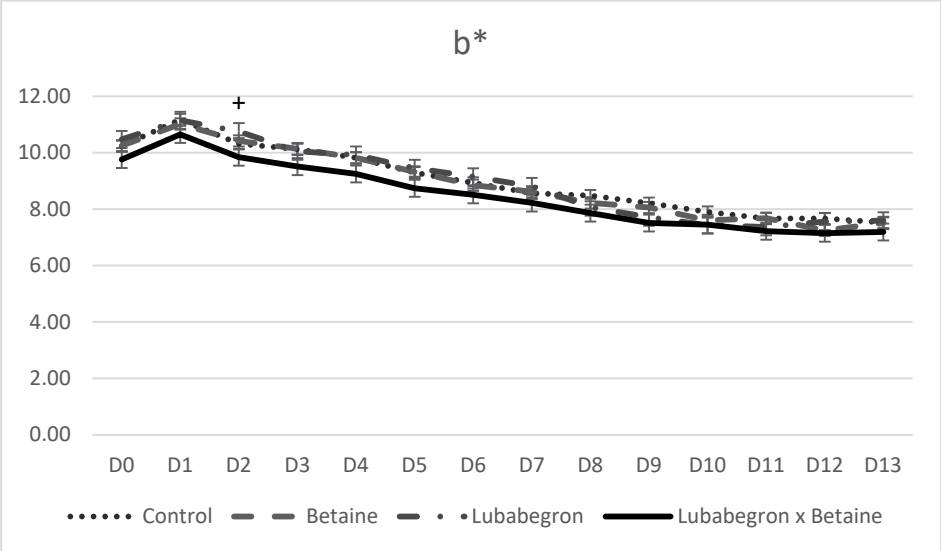


*The a** value indicates redness to greenness (+ = red; - = green)
* Lubabegron treatment decreased a* (redness; $P < 0.05$) on days 11-13 of retail display.
+ Interaction ($P < 0.05$) between betaine and lubabegron, where betaine decreased a* (redness) when lubabegron was also included.



The b* value indicates yellow to blue (+ = yellow; - = blue)
+ Interaction ($P < 0.05$) between betaine and lubabegron, where betaine decreased b* (yellowness) when lubabegron was also included.

Figure 1. Change in a* and b* values of beef strip loin steaks displayed in a retail cooler across a 14-day period

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