Effect of Optaflexx® 45 (Ractopamine-HCl) on Five-Day Retail Shelf-Life of Muscles from the Beef Loin and Round

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Supplementation with 200 mg•hd^{-1}•d^{-1}of Optaflexx® 45 (Ractopamine-HCl) to steers during the final 28 days of feeding prior to harvest did not affect L*,a*,b*, or visual panel beef lean and fat color scores of muscles originating from the round during 5-day retail display. However, visual panel steak surface discoloration scores indicated that Optaflexx® 45 increases the rate of discoloration in several muscles originating from the round.

Summary

*The goal of this study was to evaluate the effects of Optaflexx® supplementation to steers during the final 28 d of feeding on the shelf-life properties of steaks from the round and loin. Thirty-four steers were separated into four harvest groups and fed at the University of Florida Beef Teaching Unit. Within each harvest group, steers were separated into two pens. Both pens were fed a control diet of 85% corn, 7.5% cottonseed hulls, and 7.5% commercially produced protein/vitamin pellet. When pens were visually 28 d from reaching a pen average of 0.4 inch of backfat, pens were supplemented with a top dress that contained 0 and 200 mg•hd^{-1}•d^{-1}of Optaflexx®. After d 28 of supplementation for each harvest group, steers were transported to the University of Florida Meats Laboratory and harvested. Seventy-two hours postmortem, the top round and knuckle were removed from the right side of each carcass. The Semimembranosus and Adductor were separated from the top round and the Rectus femoris and Vastus lateralis were separated from the knuckle. Whole denuded muscles were then vacuum packaged, wet aged until day 13 postmortem, and cut into half-inch steaks for five-day simulated retail display. Once daily, steaks were subjectively evaluated for lean color, fat color, and surface discoloration by an eight-member trained visual panel. In addition, steaks were also objectively measured for L*a*b* values by a HunterLab MiniScan XE spectrophotometer. Results of the study indicate that L*, a*, and b* values were not affected (P>0.05) by Optaflexx® supplementation. Additionally, visual panel scores revealed that beef lean color and fat color was not significantly (P>0.05) affected by Optaflexx® supplementation. However, visual panelists did detect significant differences (P<0.05) between treatments when evaluating surface discoloration of the Vastus lateralis, Semimembranosus, Rectus femoris, and Adductor. Results of the study indicate that supplementation of cattle with Optaflexx® has a detrimental effect on the shelf-life of steaks originating from the round.*

Introduction

The supplement Optaflexx® 45 (Ractopamine-Hydrochloride) was approved by the FDA in 2003 for cattle fed in confinement during the last 24 to 42 d of feeding before slaughter. This compound and the class of compounds it belongs to, beta-agonists, are commonly referred to as a “repartiontiong agent” due to their ability to increase skeletal muscle accretion by redirecting dietary nutrients away from adipose tissue accretion to skeletal muscle growth (Mersmann, 1979). Numerous studies with swine and emerging data with cattle indicate ractopamine elicits positive effects on both live and carcass performance parameters. Optaflexx® commonly improves live performance by increasing average daily gain, average daily feed intake, and feed to gain ratio. In addition to the live performance benefits, at the carcass level, ractopamine can increase hot carcass weight and ribeye area, decrease fat, and increase dressing percentage by as much as 3.6% (Schroeder et al.,

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2005; Winterholler et al., 2007). Therefore, in today's market conditions of elevated feed prices, the use of ractopamine to improve average daily gain, gain to feed ratio, and carcass characteristics becomes an attractive option for producers as a means to lower the cost of beef production.

However, within the muscle, the muscle fiber isoform distribution is shifted from an oxidative isoform to a glycolytic isoform (Gonzalez et al., 2006). The shift toward more glycolytic muscle fibers inherently reduces the ability of the muscle to reduce metmyoglobin (brown, discoloration) to oxymyoglobin (cherry red). Therefore, it is expected that steaks originating from Optaflexx® supplemented cattle will have reduced shelf-life in the retail display case. Because color represents the single most important visual component that determines if a consumer will purchase a meat product (Hedrick et al., 1994) the effect of Optaflexx® on shelf-life needs to be explored. Therefore, the objective of our study was to investigate the effect of Optaflexx® on subjective and objective color measurements during a five-day retail display period.

Materials and Methods

Animals and Dietary Treatments

Thirty-four steers were selected from steers housed at the University of Florida Beef Teaching Unit. Upon selection, steers were separated into four harvest groups based on time until the cattle would reach a harvest endpoint of 0.4 inch of backfat. All cattle followed the same implantation program consisting of a Ralgro (Intervet, Millsboro, DE) implant followed by a Revalor-S (Intervet, Millsboro, DE) implant. Within each harvest group, steers were stratified by weight and visual backfat thickness into two pens. Steers were fed daily in concrete bunks that provided 2.25 feet per head of bunk space. Steers were fed a concentrate diet consisting of 85% corn, 7.5% cottonseed hulls, and 7.5% commercially produced protein pellet (Jacko 52 medicated concentrate pellet, Lakeland Nutrition Group, Lakeland, FL). This pellet was comprised of 23 components including cottonseed meal, dehydrated alfalfa meal, wheat middlings, and various vitamins including vitamin A, D_3, and E. When pens were visually 28 d from reaching a pen average of 0.4 inch of backfat, pens were supplemented with a top dress that contained 0 and 200 $mg \cdot hd^{-1} \cdot d^{-1}$of Optaflexx® (Elanco Animal Health, Greenfield, IN). Approximately two wk before the beginning of the 28 d Optaflexx® supplementation period, both the control and treatment pens were top dressed with a blank top dress (33.33% corn meal, 50.83% alfalfa meal, 12.50% calcium carbonate, and 3.33% stable feed fat) at a rate of 1 lb per head per day to allow the steers time to adjust to the top dress. Once the supplementation period began, the control pen continued to receive the blank top dress at a rate of 2 lb per head per day. The treatment pens received 2 lb per head per day of top dress designed to provide 200 $mg \cdot hd^{-1} \cdot d^{-1}$ of Optaflexx®. All top dressings were hand mixed into the ration daily.

Harvesting and Sample Collection

Steers were harvested at the University of Florida Meat Laboratory following the Humane Methods of Slaughter Act of 1978. Seventy-two hours postmortem, the bone-in strip loin, knuckle, and top round were excised from the right side of each carcass. Whole muscles were removed from the subprimals including the the *Rectus Femoris* (RF) and *Vastus lateralis* (VL) from the knuckle; and the *Adductor* (ADD) and *Semimembranosus* (SM) from the top round. Whole muscles were placed in heat shrink vacuum bags, vacuum packaged, and were wet aged for 13 d postmortem at 33 ± 3°F.

Steak Cutting, Packaging, and Display

Following aging, muscles were removed from their vacuum bags and cut into half-inch steaks. Steaks were cut from the same end of each muscle, perpendicular to the orientation of the muscle fibers. Steaks from the LD and VL were placed on 17S Styrofoam trays, steaks from the ADD, GRA, and VL were placed on 1S Styrofoam trays, and steaks from the SM were placed on 10S Styrofoam trays. Each tray contained a Dri-Loc 40 gram white meat pad and was overwrapped with polyvinylchloride film Steaks were displayed in a Hill coffin-style retail case at 35 ± 2°F for 5 d. Cases were illuminated with GE T8 Linear Fluorescent lamps that emitted a case average of 106.7 footcandle with a 12 hour on, 12 hour off lighting schedule. Steaks were rotated daily to compensate for uneven temperature and light distribution within the case.

Subjective and Objective Color Analysis

Subjective color measurements were collected using an eight-member experienced panel. Panelists evaluated steaks for beef lean color (8 = extremely bright cherry red; 1 = extremely dark red), fat color (5 = yellow; 1 = white), and surface discoloration (7 = total [100%] discoloration; 1 = no [0%] discoloration) daily for 5 days. Objective color measurements, L*, a*, b* reflectance data, of the samples were taken using a HunterLab MiniScan XE. Spectrophotometric measurements were captured using illuminant A and 10° standard observer. Before each data collection period, the MiniScan was calibrated on both a black and white tile. Two measurements per steak were obtained to represent the average color of the entire steak.

Statistics

Data was analyzed using carcass as the experimental unit. Objective, and subjective color data was analyzed as a split-plot design with repeated measures. Harvest group and treatment was considered the whole plot and muscle was considered the sub-plot. Day was the repeated measure with animal within treatment as the subject. All measured variables were analyzed with the PROC MIXED procedure of SAS (SAS Inst. Inc., Carry, NC, 2002). Pair-wise comparisons between the least square means of the factor levels were computed using the PDIFF option of the LSMEANS statement. Differences were considered significant at an alpha = 0.05 and tendencies at an alpha = 0.10.

Results

Objective color data for all steaks are presented in Table 1. Supplementing Optaflexx® did not affect the darkness (L*), redness (a*), and yellowness (b*) of the steaks during the entire display period. Visual panel scores of the six muscles indicate that Optaflexx® supplementation did not affect either beef lean color or fat color (Table 2). Surface discoloration scores for all muscles are located in Figure 1. Historically, a discoloration score higher than a value of 2 is when consumers will begin to discriminate between packages of meat and be less willing to purchase discolored product. Noticeable differences can be observed between muscles, with some muscles having a better shelf-life than other muscles. Optaflexx® did not affect ($P > 0.05$) surface discoloration scores from d 0 to d 3 of the display period in the *Semimembranosus*, *Rectus femoris*, or the *Vastus lateralis*. However, *Vastus lateralis* steaks from Optaflexx® animals had more surface discoloration on d 4 ($P = 0.05$) and maintained greater surface discoloration on d 5 ($P = 0.07$). Similarly, *Rectus femoris* and *Semimembranosus* steaks from Optaflexx® supplemented steers exhibited higher surface discoloration ($P = 0.009$ and $P = 0.04$, respectively) than control steaks at d 5. The *Adductor* steaks discolored rapidly, with Optaflexx® steaks scoring higher ($P = 0.05$) than control by d 2. The *Adductor* is identified as having a very short shelf-life (approximately three days). Therefore, this result indicates that shelf-life in this muscle was decreased by 1 d by supplementing Optaflexx®.

Implications

In the retail display case, consumers visually evaluate numerous factors when considering which product to purchase. These factors include portion size, leanness, ease of preparation, and color. Historically, color is the single most important visual component that determines if a consumer will purchase a meat product. The oxidation state of myoglobin, the heme-containing protein that stores oxygen in the muscle, determines the color that a consumer sees when purchasing meat. As the myoglobin is exposed to oxygen it is converted into oxymyoglobin, which is typically the bright cherry red color that the consumer desires. However, as meat ages, oxymyoglobin experiences oxidation and the formation of metmyoglobin occurs. As more metmyoglobin is formed the amount of discoloration observed by a consumer increases. Literature indicates that as the amount of oxidative muscle fibers in muscle decreases, the ability of the muscle to reduce metmyoglobin to oxymyoglobin decreases. In the current study, we did observe an Optaflexx®-induced shift of muscle fibers to more glycolytic fibers (data not shown). The observed shift caused the Optaflexx® supplemented steaks to have decreased shelf-life at the end of each steak's respective life. With the results, we estimate that supplementing Optaflexx® reduces the amount of days that steaks are available for sale by 1 to 2 d. Therefore, the negative effect that Optaflexx® elicits on steak surface discoloration requires attention and consideration when deciding whether to use this growth enhancing technology.

Literature Cited

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Table 1. LSMEANS of HunterLab MiniScan XE L*, a*, and b* values from steaks originating from the round of steers fed with (RAC) and without (CON) ractopamine-HCl displayed under simulated retail display conditions for 5 days

		Muscle							
		Adductor		*Rectus femoris*		*Semimembranosus*		*Vastus lateralis*	
Item	Day	CON	RAC	CON	RAC	CON	RAC	CON	RAC
L*[1]	0	49.1	49.3	47.9	47.7	43.5	42.7	44.4	44.5
	1	46.3	46.1	45.7	46.9	42.8	40.8	42.1	41.8
	2	45.4	45.2	43.8	44.4	42.0	41.5	41.7	41.8
	3	45.5	44.7	43.7	44.4	41.5	40.4	41.2	41.8
	4	43.4	44.2	42.5	42.4	41.3	40.1	41.1	40.8
	5	44.9	43.5	43.6	43.6	41.3	40.0	41.0	41.0
	SEM	1.6		1.6		1.6		1.6	
a*[2]	0	32.8	32.3	32.4	30.4	34.7	34.0	34.7	33.7
	1	28.3	27.1	30.9	28.6	33.6	34.4	35.9	35.6
	2	24.9	24.2	28.6	26.7	32.0	31.7	33.4	31.4
	3	22.7	22.1	27.1	25.1	30.9	30.4	32.2	29.3
	4	22.3	21.1	25.9	25.0	29.9	29.1	31.4	29.4
	5	20.8	19.5	24.8	22.8	28.5	27.6	30.0	27.7
	SEM	1.4		1.4		1.4		1.4	
b*[3]	0	30.6	30.1	29.2	27.3	32.5	31.9	31.5	30.5
	1	28.6	27.6	29.5	27.2	32.2	33.3	33.6	33.1
	2	26.5	26.2	28.2	26.3	31.3	31.1	31.5	29.7
	3	25.6	25.5	27.3	25.5	30.6	30.7	30.8	28.4
	4	25.5	24.9	27.1	25.7	29.8	29.8	30.1	28.5
	5	25.0	24.6	25.9	24.6	29.1	29.0	29.3	27.6
	SEM	1.1		1.1		1.1		1.1	

[1] Lightness: 100 = White; 0 = Black.
[2] Redness: 60 = Red; -60 = Green.
[3] Yellowness: 60 = Yellow; -60 = Blue.

Table 2. LSMEANS of visual panel scores for steaks from the round displayed under simulated retail display conditions for 5 days from cattle fed with and without ractopamine-HCl

		Muscle							
		Adductor		*Rectus femoris*		*Semimembranosus*		*Vastus lateralis*	
Item	Day	CON	RAC	CON	RAC	CON	RAC	CON	RAC
Beef	0	5.5	5.4	5.8	5.6	5.4	5.4	5.6	5.3
Lean	1	4.5	4.3	5.7	5.2	5.0	4.7	5.1	5.0
Color[1]	2	4.1	3.9	5.6	5.4	5.0	4.6	4.9	4.9
	3	3.9	3.7	5.6	5.3	4.7	4.4	5.0	4.6
	4	3.6	3.3	5.3	5.3	4.5	4.2	4.9	4.7
	5	3.4	3.2	5.5	5.3	4.5	4.1	5.0	4.5
	SEM	0.3		0.3		0.3		0.3	
Fat	0	1.9	1.9	1.8	1.8	1.9	1.9	1.9	1.8
Color[2]	1	2.0	2.0	2.0	2.0	2.0	2.1	2.0	2.0
	2	2.0	2.1	2.0	2.1	2.1	2.1	2.1	2.0
	3	2.0	2.0	2.1	2.0	2.0	2.1	2.0	2.0
	4	2.4	2.5	2.2	2.2	2.2	2.2	2.2	2.2
	5	2.7	2.6	2.3	2.4	2.3	2.4	2.2	2.4
	SEM	0.1		0.1		0.1		0.1	

[1]8 = Extremely bright cherry-red; 7 = Bright cherry-red; 6 = Moderately bright cherry-red; 5 = Slightly bright cherry-red; 4 = Slightly dark cherry-red; 3 = Moderately dark red; 2 = Dark red; 1 = Extremely dark red.
[2]5 = Yellow; 4 = Moderately yellow; 3 = Slightly yellow; 2 = Creamy white; 1 = White.

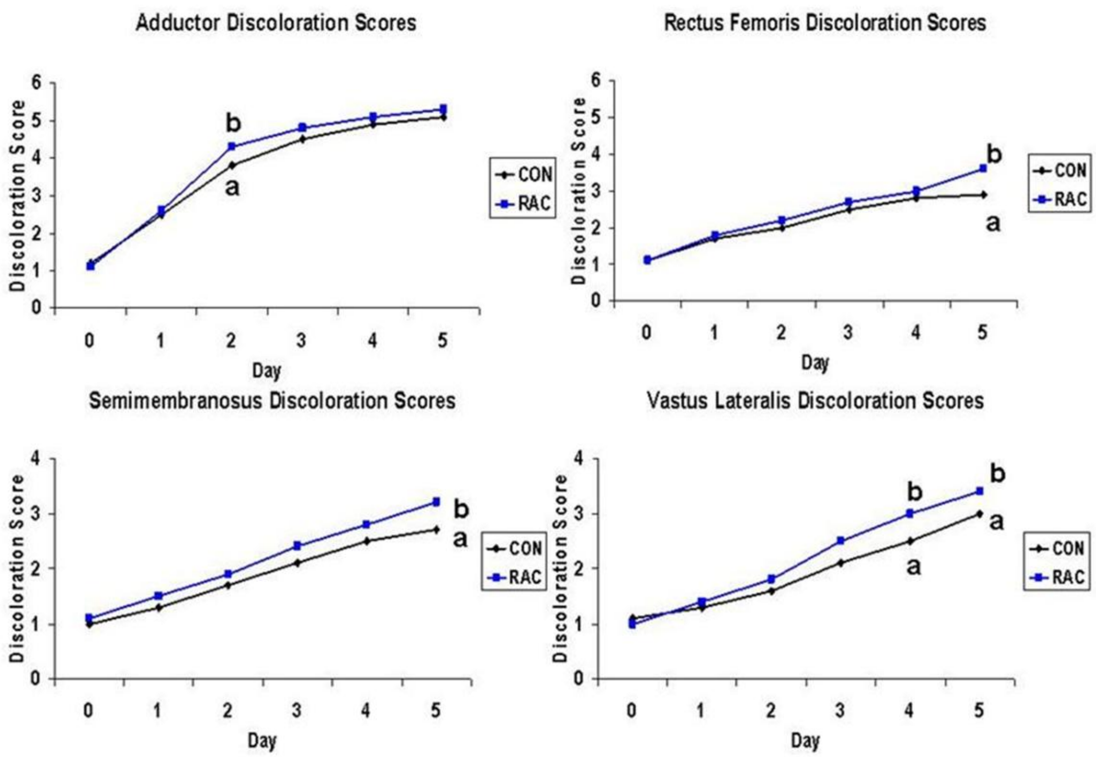

Figure 1. Surface discoloration scores from steaks originating from the round of steers fed with and without ractopamine-HCl displayed under simulated retail display conditions for 5 day. Means within a row with different letters are significantly different ($P < 0.05$). 1 = No discoloration (0%); 2 = Slight discoloration (1-19%); 3 = Small discoloration (20-39%); 4 = Modest discoloration (40-59%); 5 = Moderate discoloration (60-78%).