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Effects of the Synthetic Antioxidants on Shelf Life of m. *psoas major* and m. *triceps brachii* Muscles from Beef Fed Wet Distillers Grains

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Summary

Feedlot finishing steers (n = 483) were randomly allotted to four dry-rolled corn based diets containing 0 or 30% wet distillers grains with or without the synthetic antioxidants supplementation (ethoxyquin and tertiary butyl hydroquinone in AGRADO® PLUS). This study intended to minimize detrimental effects of feeding wet distillers grains on color and lipid oxidation of beef tenderloin and clod heart muscles during retail display by feeding a synthetic antioxidant mixture. Feeding AGRADO® PLUS significantly reduced meat discoloration and lipid oxidation.

Introduction

de Mello Jr., et al. (*2008 Nebraska Beef Cattle Report*, pp. 116-117) and Senaratne et al. (*2009 Nebraska Beef Cattle Report*, pp. 110-111) reported wet distillers grains (WDGS) diets increase polyunsaturated fatty acids (PUFA) in beef, and thereby it negatively affects beef color, lipid oxidation, and flavor during retail display. Senaratne et al. (*2009 Nebraska Beef Cattle Report*, pp. 113-115) reported vitamin E supplementation (500 IU/head/day for last 100 days) significantly reduced these detrimental effects of feeding WDGS on beef retail displayed. A mixture of synthetic antioxidants, ethoxyquin, and tertiary butyl hydroquinone in AGRADO® PLUS (AG) might be beneficial in reducing the negative effects of feeding WDGS on beef shelf life. This study was a part of a previous study conducted by Senaratne et al. (*2011 Nebraska Beef Cattle Report,* pp. 105-108). Since muscles are structurally and biochemically different from each other, this study aimed to investigate the effects of AG supplementation on shelf life of tenderloins (m. *psoas major*) and clod heart (m. *triceps brachii*) muscles from finishing beef steers fed WDGS.

Procedure

Crossbred steers were allotted to one of four dry-rolled corn-based diets containing 0% and 30% WDGS (DM basis) with or without AG supplementation at 150 ppm/head/day. All conditions at feeding, slaughter, and grading were similar to procedures described by Senaratne et al. (*2011 Nebraska Beef Cattle Report*, pp. 105-108). In addition to beef loin, short loin, beef chuck, and shoulder clod (IMPS # 144; NAMP, 2007) were also collected and aged for either 8 or 29 days in a cooler. After each aging period, tenderloins (m. *psoas major*; IMPS # 1190A; NAMP, 2007) and clod hearts (m. *triceps brachii*; IMPS # 114E; NAMP, 2007) were fabricated. Tenderloins were cut into three 1-inch-thick steaks from the posterior end, whereas three 1-inch-thick steaks were removed from the middle of the clod hearts. The first anterior steaks of each muscle were vacuum packaged and stored at -4ºF. Additional steaks were aerobically packaged on Styrofoam trays and assigned for 4 or 7 days retail display. Lipid oxidation measurements (0, 4, and 7 days) and subjective surface discoloration ratings (1 to 7 days) were conducted. All conditions at packaging, retail display, discoloration evaluation, lipid oxidation measurements, and statistical analysis were similar to procedures mentioned by Senaratne et al. (*2011 Nebraska Beef Cattle Report*, pp. 105-108).

Results

There were significant ($P < .0001$) three-way interaction effects of treatment × aging × day on percentage discoloration of tenderloin and clod heart (Table 1) steaks. Discoloration of all muscle steaks increased during retail display time after each aging period. No significant discoloration differences ($P > 0.05$) were detected among dietary treatments for 8- and 29-day aged tenderloin and clod heart steaks until three days of retail display. After that, steaks (from both aging periods) from cattle fed corn with AG supplementation had the lowest discoloration ($P < 0.05$). Both steaks from WDGS-fed cattle (with or without AG) had significantly ($P < 0.05$) higher surface discolorations compared to steaks from corn-fed cattle (with or without AG). The effectiveness of AG supplementation in reducing discoloration was prominent when meat was aged longer. However, the anti-discoloration effect of AG supplementation were not significant when cattle were fed WDGS. The reason for high discoloration even after adding AG into the diet is likely due to the increase of easily oxidizable, PUFA in beef from feeding WDGS. de Mello Jr., et al. (*2008 Nebraska Beef Cattle Report*, pp. 116-117) and Senaratne et al. (*2009 Nebraska Beef Cattle Report*, pp. 110-111) reported that feeding WDGS increased PUFA level in beef compared to corn control diets and compromised color.

There were significant two-way interaction effects of treatment × day on lipid oxidation of tenderloins (Table 2; $P = 0.0279$) and clod heart (Table 2; $P = 0.0011$) steaks. As aging and retail display time increased lipid oxidation also increased ($P < 0.0001$). Both steak types from cattle fed AG had significantly ($P < 0.05$) lower TBARS values

(Continued on next page)

Table 1. Means of percentage discoloration of 8 and 29 days aged tenderloins (m. psoas major) during 7 days of simulated retail display conditions.

Muscle	Aging (days)	Treatments	Retail display (days) 0	1	2	3	4	5	6	7	Contrasts(*P* value) Corn vs. WDGS	Corn vs. Corn + AG	WDGS vs. WDGS+AG	No AG vs. AG
Tenderloins	8	Corn+AG	0.2	0.26^{e}	0.91^{e}	4.24^{de}	9.05^{dB}	18.20^{cC}	31.61^{bC}	44.25^{aC}	<.0001	0.17	0.0008	0.0008
		30% WDGS+AG	0.40^{f}	0.36^{f}	1.12^{ef}	6.16^{e}	13.46^{dB}	28.40^{cB}	46.18^{bB}	63.84^{aB}				
		Corn	0.55	0.92^{e}	1.48^{e}	5.07^{e}	11.50^{dB}	25.05^{cBC}	43.16^{bB}	61.12^{aB}				
		30%WDGS	0.71^{f}	1.15^{f}	3.17^{f}	11.98^{e}	26.55^{dA}	49.34^{cA}	76.92^{bA}	87.40^{aA}				
	29	Corn+AG	0	0.00^{e}	0.53^{e}	3.05^{e}	19.79^{dB}	32.29^{cB}	50.00^{bC}	62.77^{aC}	0.0016	0.46	0.52	0.33
		30%WDGS+AG	0.00^{f}	0.00^{f}	0.79^{ef}	5.74^{e}	29.93^{dA}	52.49^{cA}	69.42^{bA}	80.62^{aA}				
		Corn	0	0.00^{e}	0.33^{e}	2.21^{e}	18.71^{dB}	39.23^{cB}	58.80^{bB}	72.03^{aB}				
		30%WDGS	0.00^{f}	0.00^{f}	2.88^{f}	9.63^{e}	34.51^{dA}	54.68^{cA}	75.65^{bA}	81.18^{aA}				
Clod hearts	8	Corn+AG	0.00^{g}	0.41^{g}	5.02^{f}	12.10^{e}	19.78^{d}	33.75^{cB}	50.97^{bB}	64.13^{aB}	0.24	0.42	0.29	0.19
		30%WDGS+AG	0.04^{f}	0.26^{f}	4.16^{f}	11.66^{e}	19.78^{d}	35.75^{cAB}	54.80^{bAB}	72.60^{aA}				
		Corn	0.02^{g}	0.32^{fg}	4.18^{f}	11.61^{e}	21.70^{d}	36.32^{cAB}	54.41^{bAB}	72.19^{aA}				
		30%WDGS	0.09^{g}	0.36^{g}	5.15^{f}	13.56^{e}	25.33^{d}	42.48^{cA}	$60.81^{bA}7$	1.08^{aA}				
	29	Corn+AG	0	0.00^{e}	0.33^{e}	2.91^{e}	15.39^{dB}	32.10^{cB}	46.89^{bB}	60.58^{aC}	0.01	0.55	0.61	0.43
		30%WDGS+AG	0	0.00^{e}	0.36^{e}	3.66^{e}	22.09^{dAB}	43.86^{cA}	64.53^{bA}	76.18^{aA}				
		Corn	0	0.00^{e}	0.17^{e}	2.79^{e}	16.48^{dB}	35.94^{cB}	50.93^{bB}	68.21^{aB}				
		30%WDGS	0.00^{f}	0.00^{f}	0.74^{f}	5.51^{e}	23.67^{dA}	43.03^{cA}	69.51^{bA}	82.41^{aA}				

[a-g]Comparison within a row, means lacking a common superscript were different at $P < 0.05$.
[A-C]Comparison within a column by muscle type and aging time, means lacking a common superscript were different at $P < 0.05$. WDGS = wet distillers grains; AG = AGRADO®PLUS.
P-value for treatment × aging × day - <0.0001 for tenderloins and clod hearts.

Table 2. Means of thiobarbituric acid reactive substances (TBARS) values of tenderloins (m. *psoas major*), aged for 8 and 29 days, during 7 days of simulated retail display conditions.

Muscle	Day (days)	Treatments Corn	30% WDGS	Corn +AG	30% WDGS +AG	Contrasts (*P* value) Corn vs. WDGS	Corn vs. Corn+AG	WDGS vs. WDGS+AG	No Agrado vs. AG
Tenderloins	0	0.04^{ABc}	0.07^{Ac}	0.01^{Bc}	0.01^{Bc}	0.41	0.29	0.02	0.02
	4	1.16^{ABb}	1.38^{Ab}	0.59^{Cb}	0.88^{BCb}	0.14	0.02	0.04	0.003
	7	1.81^{ABa}	2.06^{Aa}	1.40^{Ba}	1.64^{ABa}	0.27	0.20	0.18	0.06
Clod hearts	0	0.23^{Ac}	0.10^{Bc}	0.08^{Bc}	0.03^{Bc}	0.04	0.03	0.32	0.02
	4	1.84^{ABb}	2.00^{Ab}	1.42^{Bb}	1.66^{ABb}	0.35	0.16	0.26	0.08
	7	3.27^{ABa}	3.78^{Aa}	2.46^{Ba}	3.05^{ABa}	0.10	0.08	0.12	0.02

[A-C]Comparison within a row, means lacking a common superscript were different at $P < 0.05$.
[a-c]Comparison within a column by muscle type, means lacking a common superscript were different at $P < 0.05$.
WDGS = wet distillers grains; AG = AGRADO® PLUS.
P-value for treatment × day = 0.0279 for tenderloins and 0.0011 for clod hearts.

compared to steaks from cattle fed no AG supplementation. The highest lipid oxidation was observed for all muscle steaks from cattle fed 30% WDGS diets with no AG; whereas, the lowest oxidation values were detected for steaks from corn plus AG fed cattle during retail display ($P < 0.05$). However, the effectiveness of AG supplementation in reducing lipid oxidation of both muscle steaks was reduced with feeding WDGS. Feeding AG helped to reduce oxidation of increased PUFA content when cattle were fed WDGS.

In conclusion, feeding feedlot cattle a mixture of antioxidants (ethoxyquin and tertiary butyl hydroquinone) contained within AGRADO® PLUS shows positive antioxidant effects against myoglobin (color) and lipid oxidations of beef tenderloins and clod hearts muscles during retail display. However, the antioxidant effect of AGRADO PLUS in reducing lipid and color oxidations of beef steaks appears to be reduced with feeding wet distillers grains, likely due to increase of polyunsaturated fatty acids in beef. The AGRADO PLUS feed supplement appears to be a viable means to increase lipid and color stability of beef tenderloins and clod heart steaks during retail display.

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