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Fatty Acid Composition of Beef Fed OmniGen- AF at Receiving or Finishing

Katherine I. Domenech
University of Nebraska-Lincoln

Michael D. Chao
University of Nebraska - Lincoln

Joe O. Buntyn Buntyn
University of Nebraska–Lincoln, jbuntyn2@unl.edu

Ty B. Schmidt
University of Nebraska-Lincoln, tschmidt4@unl.edu

Chris Calkins
University of Nebraska - Lincoln, ccalkins1@unl.edu

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Summary with Implications

Beef fatty acid profiles and superoxide dismutase activity were determined for cattle receiving OmniGen-AF supplementation (a patented nutritional supplement) at receiving (first 28 d at the feedlot) or throughout finishing (all 210 d of finishing) vs. a control group (non-supplemented). The most meaningful change in fatty acid composition from inclusion of OmniGen-AF was total poly-unsaturated fatty acid (PUFA) content where beef from the finishing group had more PUFA content in relation to the receiving group and was not different from the control group. Despite this increase in PUFA, cattle supplemented through finishing tended to have less lipid oxidation than the other two treatments yet this difference could not be explained by the superoxide dismutase activity.

Introduction

OmniGen-AF (Phibro Animal Health, Quincy, IL) is a patented nutritional supplement designed to augment and support the immune system of cattle. This nutritional supplement consists of live yeast and premixes of vitamins and minerals that have been carefully selected through nutrigenomics to aid in the nutritional modulation of genetic expression to promote cellular health. Although originally designed with dairy cattle in mind, the beef cattle industry might benefit from using this supplement to further improve the immune response of cattle under stress as well as potentially incorporating antioxidants into muscle foods to maintain meat quality over longer aging periods and retail display times. Thus, the objectives of this research were to assess the impact of feeding OmniGen-AF on beef fatty acid profiles as well as attempting to decipher a mechanism of how added oxidative stability could be achieved by quantifying superoxide dismutase activity.

Procedure

A total of 288 steers were sorted into three treatment groups (96 hd/treatment): a control group that received no OmniGen-AF supplementation and two groups supplemented with OmniGen-AF either at receiving (first 28 d at the feedlot) or throughout finishing (210 d). At the receiving phase, cattle were fed 30 % alfalfa hay, 30% dry rolled corn, 36% Sweet Bran® (corn gluten feed, Cargill, Blair, NE), and 4% supplement. The finishing diet consisted of 50% high moisture corn, 40% Sweet Bran®, 5% wheat straw, and 5% supplement. At both the receiving and finishing phases, OmniGen-AF was top dressed at 4 g/45.4 kg BW/hd/d. Cattle were sorted 8 hd/pen for a total of 12 pens/treatment. After harvest, 24 USDA low Choice carcasses were selected within each dietary treatment (n = 72) and strip loins were obtained. Vacuum packaged loins were aged 8, 22 and 29 days (33°F). At 8 days of age, a portion of the strip loin was fabricated at which time a ½-inch steak was trimmed of subcutaneous fat (for fatty acid analysis) and was vacuum packaged and stored immediately in an ultra-low freezer (-112°F) until analysis. Similarly, at 29 days of age and after 7 days of retail display, ½-inch steak were vacuum packaged and stored in an ultra-low freezer (-112°F) for superoxide dismutase activity determination.

Fatty acid profile

Frozen samples were diced into small pieces, with no subcutaneous fat, and flash frozen in liquid nitrogen. Gas chromatography was done using a Chromopack CP-Sil (0.25 mm x 100 m) column. Fatty acids were identified by their retention times in relation to known standards and the percent of fatty acid was determined by the peak area in the chromatograph. Data were converted from percentage of individual fatty acids to mg/100 g of tissue after determining the overall fat content of each sample.

Superoxide Dismutase Activity

Superoxide dismutase (SOD) activity was determined with a colorimetric assay kit (ab65354; Abcam, Cambridge, MA). The SOD units of activity are reported over mg of protein (SOD U/mg protein).

Statistical analysis

The experimental design was a completely randomized design where the PROC GLIMMIX procedure in SAS (SAS Inst., Inc., Cary, N.C.) was used to determine the effects of dietary treatment on fatty acid content as well as superoxide dismutase activity. All means were separated with the LS MEANS statement and the TUKEY adjustment with an alpha of 0.05.

Results

In an earlier beef report (2016 *Nebraska Beef Report*, pp. 161–163) the fatty acid data were presented on this set of cattle on a percentage basis. However, after adjusting composition data with total fat content of samples, several fatty acids were found to differ in terms of total content on a mg/100 g sample basis (Table 1). Beef from cattle supplemented throughout the entire finishing phase had more ($P < 0.05$) C18:1, C18:2, C19:0, total, unsaturated fatty acids (UFA), and mono-unsaturated fatty acids (MUFA) in relation to beef from cattle supplemented through the receiving phase. However, beef from non-supplemented cattle did not differ from supplemented cattle ($P > 0.05$).

There was more ($P = 0.05$) C20:5ω3 fatty acid in beef from the non-supplemented

Table 1. Fatty acid changes due to supplementation with OmniGen-AF on steaks aged for 8 d

Fatty acid[2]	Dietary Treatment[1]			*SEM*	*P*-value
	Control	Omni Gen-AF at Receiving	Omni Gen-AF at Finishing		
C4:0	40.68	40.18	55.84	13.61	0.64
C10:0	6.48	7.39	6.64	1.23	0.57
C12:0	7.50	7.38	7.78	0.52	0.82
C13:0	7.29	6.42	7.58	0.78	0.48
C14:0	328.19	309.13	324.29	15.76	0.68
C14:1	97.61	98.07	96.90	6.78	0.99
C15:0	62.36	61.35	60.70	4.22	0.94
C15:1	62.03	52.88	61.18	3.56	0.14
C16:0	2,823.89	2,766.27	2,889.82	74.91	0.51
C16:1T	54.08	40.47	45.83	7.45	0.44
C16:1	429.65	414.61	443.86	19.58	0.58
C17:0	156.40	150.63	159.87	6.66	0.61
C17:1	134.23	124.41	131.46	7.27	0.65
C18:0	1,471.92	1,469.44	1,582.63	49.94	0.19
C18:1T	230.04	220.63	254.45	14.85	0.23
C18:1	4,290.04[ab]	4,141.40[b]	4,546.06[a]	113.48	0.05
C18:1V	725.56	625.80	763.83	44.97	0.09
C18:2TT	24.45	16.27	15.67	2.89	0.08
C18:2	414.88[ab]	376.39[b]	443.09[a]	15.40	0.01
C18:3ω6	8.68	8.57	9.41	0.41	0.35
C18:3ω3	18.09	17.40	19.64	0.70	0.08
C19:0	16.66[ab]	16.20[b]	18.26[a]	0.62	0.05
C20:1	56.28	57.96	62.03	3.33	0.46
C20:2	3.89	3.83	6.77	2.30	0.39
C20:3ω6	27.50	22.97	27.84	1.62	0.07
C20:4ω6	80.23	67.05	78.89	4.94	0.13
C20:5ω3	7.92[a]	6.04[b]	7.50[ab]	0.54	0.05
C22:5	34.38	17.13	19.54	7.68	0.24
C24:1	13.23	11.80	12.29	0.67	0.31
Total	11,570.06[ab]	11,112.04[b]	12,107.25[a]	263.78	0.04
Other	113.44	103.14	123.68	12.72	0.52
SFA	4,895.38	4,826.70	5,082.91	127.02	0.34
UFA	6,674.69[ab]	6,285.33[b]	7,024.34[a]	158.61	0.01
SFA:UFA	0.74[ab]	0.77[a]	0.73[b]	0.01	0.05
MUFA	6,076.35[ab]	5,758.73[b]	6,414.27[a]	146.87	0.01
PUFA	598.34[a]	526.60[b]	610.07[a]	20.05	0.01
Trans	213.25	245.05	312.04	21.17	0.09
ω6	113.10	97.84	110.89	5.85	0.14
ω3	22.41	21.34	23.22	1.16	0.54
ω6: ω3	5.28	4.73	4.71	0.31	0.32

[1]Control: no OmniGen-AF supplementation; OmniGen-AF at Receiving: first 28 d at the feedlot; OmniGen-AF throughout Finishing: all 210 d at the feedlot. OmniGen-AF was top dressed at 4 g/45.4 kg BW/hd/d.
[2]Fatty acids reported on a mg/100 g tissue basis
[a-b]Different superscripts indicate differences within each row ($P < 0.05$)

group than the receiving group, with the finishing group being intermediate. The saturated to unsaturated fatty acid ratio (SFA:UFA) was greater ($P = 0.05$) in beef from the receiving group, intermediate in beef from the non-supplemented group, and lowest in beef from the finishing group.

More importantly in terms of evaluating beef shelf life, dietary treatment did alter total poly-unsaturated fatty acid (PUFA) content in beef samples. Beef from the finishing and non-supplemented groups had greater ($P = 0.01$) PUFA content than the receiving group.

Typically, greater PUFA content leads to greater lipid oxidation under retail display conditions and thus shortens meat shelf life. However, based on lipid oxidation measures previously reported (2016 *Nebraska Beef Report*, pp. 161–163), beef from cattle supplemented throughout the finishing phase with OmniGen-AF had a tendency ($P = 0.10$) of having decreased lipid oxidation values despite having greater PUFA content. Superoxide dismutase activity (SOD) was determined in an attempt to further understand and explore the added oxidative stability seen in the supplemented finishing group. Superoxide dismutase is an enzyme that helps combat the accumulation of excessive amounts of reactive oxygen species (the initiators of lipid oxidation). It is thought to be the primary line of defense that converts superoxide's (most toxic reactive oxygen form) to less toxic forms of oxygen, at which point other enzymes such as catalase and glutathione peroxidase can further detoxify the reactive oxygen forms to less toxic compounds for the cell and thus provide cells a built-in antioxidant mediation system. Figure 1 shows the primary and secondary antioxidant mediators that can be explored to better understand oxidative stability, with SOD being the leading innate mechanism of interest. Figure 2 depicts the major reactive oxygen species, where the top of the pyramid represents the most toxic reactive oxygen form (superoxide anion) and the bottom contains secondary reactive oxygen species that are derived as by-products of primary free radicals.

Despite the fact that meat from the finishing group had increased PUFA content as well as decreased lipid oxidation, meat from cattle fed OmniGen-AF throughout finishing did not show meaningful differences ($P = 0.92$) in superoxide dismutase

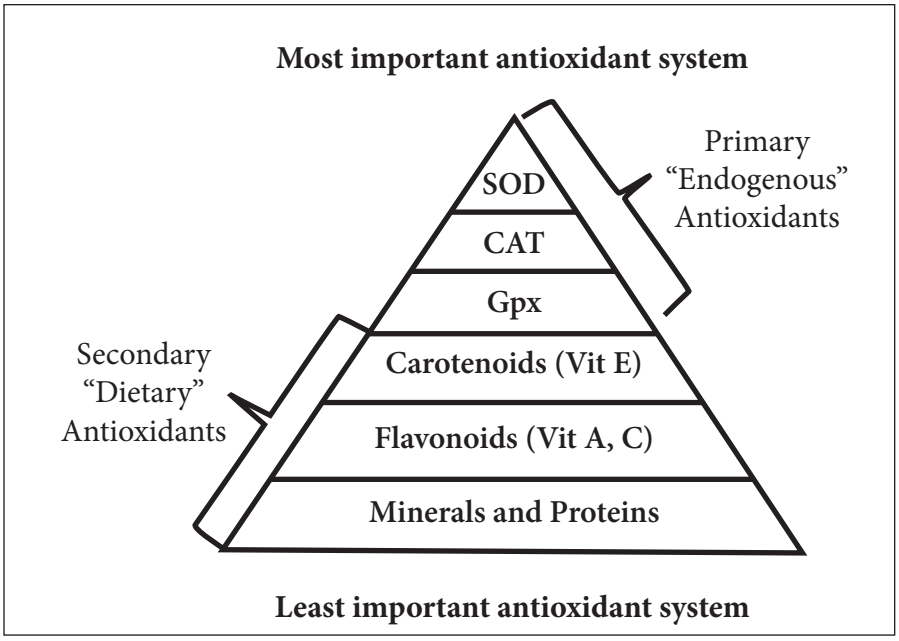

Figure 1. Mechanisms to protect against toxic oxygen forms. Primary or endogenous mechanisms include: Superoxide dismutase, Catalase and Glutathione peroxidase. Secondary or dietary mechanisms include: Vitamins, Minerals and Proteins.

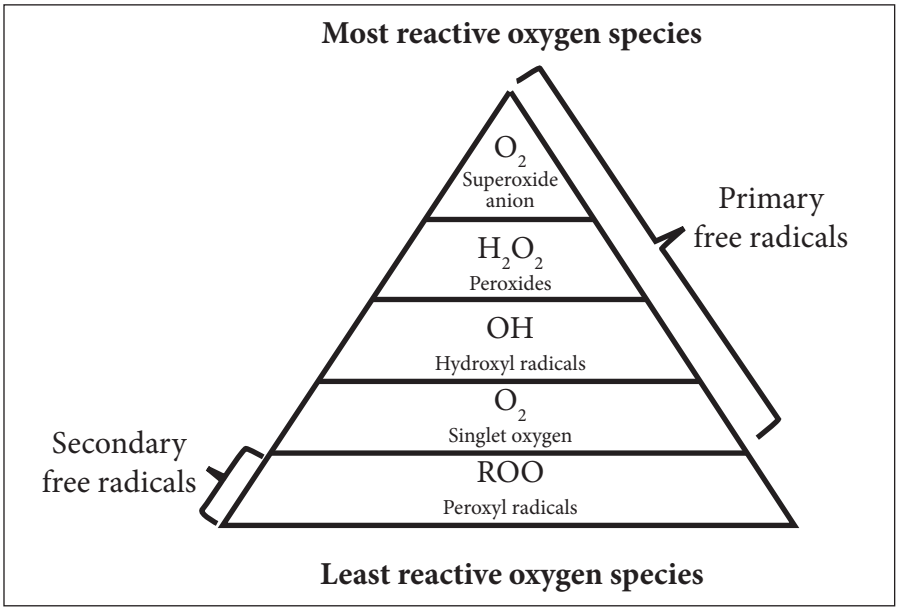

Figure 2. Reactive oxygen forms. Toxicity of free radicals increases towards top of pyramid. Primary free radicals are highly reactive and eventually form secondary free radicals. The function of SOD is to convert superoxide's to less toxic forms such as peroxides and singlet oxygen.

activity compared to meat from cattle that were not supplemented (18.98 vs. 19.11 U/mg protein, respectively).

In summary, dietary supplementation with OmniGen-AF did alter the fatty acid composition with the most meaningful difference being the increased PUFA content in beef from cattle supplemented throughout finishing. Despite greater propensity for lipid oxidation due to increased PUFA content, supplementing with OmniGen-AF for long periods of time tended to enhanced lipid stability (determined by TBARS). Even though SOD activity was not found to differ with the extended supplement feeding, it could be speculated that the tendency for added lipid stability could potentially be coming from downstream enzymes following SOD such as catalase and glutathione peroxidase. Another alternative could simply be that phenolic-rich compounds in the supplement can successfully be incorporated into tissues thus providing oxidative stability during retail display.

Conclusion

In conclusion, OmniGen-AF did not negatively impact beef shelf life despite causing an increase in PUFA content when supplemented throughout the finishing phase. In order for OmniGen-AF to be considered as a potential antioxidant source for beef cattle the supplement may need to be fed at greater concentrations.

Katherine I. Domenech, graduate student

Michael D. Chao, assistant professor, California State University-Chico College of Agriculture

Joe Buntyn, graduate student

Ty Schmidt, assistant professor

Chris R. Calkins, professor, University of Nebraska—Lincoln Department of Animal Science