Fatty Acid Profile of Beef from Steers Fed Wet Distillers Grains Plus Solubles (WDGS) and Vitamin E

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Summary

The aim of this work was to investigate the fatty acid profile of m. teres major *(TER) and* m. infraspinatus *(INF) from steers fed 0 or 40% WDGS (DM basis) with or without 500 I.U. of vitamin E/steer daily for 100 days. Thirty-two steers were allocated to 4 treatments: Corn; Corn + vit. E; 40% WDGS; or 40% WDGS + vit. E. After 7 days of aging, 2 TER and 2 INF muscles were excised from the shoulder clods of each animal. Fatty acids were analyzed from raw TER and INF, pan fried TER and INF, and grilled INF. For all muscles, higher levels of polyunsaturated and 18:1 trans fatty acids and lower values of 18:1(n-7) were observed in beef from animals fed WDGS ($P < 0.05$). Vitamin E supplementation did not affect the fatty acid profile of either muscle. Feeding WDGS increased polyunsaturated fatty acids and decreased 18:1 (n-7), which may lead to oxidation and off flavors, respectively.*

Introduction

Feeding wet distillers grains plus solubles (WDGS) is often practiced during beef cattle finishing in a period that may vary from 100 to 160 days. Although research demonstrated a linear increase in average daily gain, feed conversion, hot carcass weight, and marbling score when steers were fed up to 40% WDGS (*2008 Nebraska Beef Report*, pp. 107-109), feeding 30% WDGS increased polyunsaturated fatty acids (PUFA) in the ribeye (m. *longissimus thoracis*) (*2009 Nebraska Beef Report*, pp. 107-109). Higher levels of PUFA contribute to higher oxidation, lower shelf life, and off flavor development. Our research was conducted to verify the effects of feeding WDGS and vitamin E supplementation on fatty acid profile of m. *teres major* (TER) and m. *infraspinatus* (INF).

Procedure

Yearling steers (n = 32) were allocated to four dietary treatments (Corn, Corn + vit. E, 40% WDGS, or 40% WDGS + vit. E) and fed for 100 days. Vitamin E dose was 500 I.U./steer daily. After 7 days of aging, TER and INF muscles were excised from shoulder clods, trimmed of subcutaneous fat and epimysial connective tissue, and frozen until cooking and fatty acid analysis could be made. Muscles were pan fried (TER and INF) and grilled (INF) until internal temperature reached 160°F. For fatty acid analysis, raw and cooked samples were submerged in liquid N, pulverized and stored at -112°F. Compounds were analyzed by gas chromatography and separated using a capillary column. Oven temperature was programmed from 284 to 428°F at 35.5°F/min and held at 428°F for 20 min. Injector and detector temperatures were maintained at 518 and 572°F, respectively. The carrier gas was Helium at a flow rate of 30 mL/min. Fatty acids were identified by comparison of retention times with known standards.

Fatty acid profile was arranged on a 4x3 factorial design for INF (4 dietary treatments and 3 cooking procedures: raw, pan fried, and grilled) and on a 4x2 factorial for TER (2 cooking procedures: raw and pan fried). Data were analyzed using the GLIMMIX procedure of SAS (Version 9.1, Cary, N.C., 2002). When significance ($P \leq 0.05$) was indicated by ANOVA, means separations were performed using the LSMEANS and DIFF functions of SAS.

Results

No interactions of treatment and cooking method and main effect of vitamin E supplementation were observed either for TER or INF ($P > 0.05$). Therefore, muscles were analyzed for treatment differences between raw and within each cooking procedure.

For raw TER samples, feeding WDGS increased levels of 18:0, 18:1 trans, 18:1Δ13, 18:1Δ14, 18:2(n-6), 18:3(n-3), PUFA, ω 6, and ω 3 fatty acids (Table 1), whereas no differences were observed in values of 18:1 trans,

Table 1. Weight percentage of fatty acids[1] of raw m. *teres major* from steers fed WDGS and Vitamin E.

	Treatments					Contrast
Fatty acid	Corn	Corn + vit E	40% WDGS	40% WDGS + vit E	*P*-value	Corn vs WDGS
17:1(n-7)	1.34[a]	1.36[a]	0.87[b]	1.00[b]	0.0005	< 0.0001
18:0	12.39[b]	12.91[b]	14.65[a]	13.71[ab]	0.01	0.004
18:1 trans	2.35[b]	2.18[b]	3.95[a]	3.79[a]	< 0.0001	< 0.0001
18:1(n-9)	39.87[a]	40.00[a]	36.83[b]	36.40[b]	0.0005	< 0.0001
18:1 (n-7)	0.70[ab]	0.81[a]	0.50[c]	0.59[bc]	0.01	0.002
18:1Δ13	0.06[b]	0.12[b]	0.23[a]	0.14[b]	0.004	0.005
18:1Δ14	0.08[c]	0.12[bc]	0.19[a]	0.17[ab]	0.002	0.0006
19:0	0.02	0.00	0.05	0.00	0.09	0.27
18:2(n-6)	3.85[b]	3.48[b]	5.88[a]	5.62[a]	< 0.0001	< 0.0001
18:3(n-3)	0.16[a]	0.12[b]	0.19[a]	0.19[a]	0.004	0.0009
PUFA	5.97[b]	5.49[b]	7.87[a]	7.72[a]	0.0008	< 0.0001
ω 6	5.80[b]	5.37[b]	7.68[a]	7.53[a]	0.0009	< 0.0001
ω 3	0.16[a]	0.12[b]	0.19[a]	0.19[a]	0.004	0.0009
ω 6 / ω 3	36.00	37.00	40.38	40.39	0.32	0.09

[1]Weight percentage values are relative proportions of all peaks observed by gas chromatography.
[a,b,c]Means in the same row having different superscripts are significant at $P \leq 0.05$ level.

18:2(n-6), 18:3(n-3), PUFA, ω 6, and ω 3 for INF (Table 2). For both muscles, lower levels of 17:1(n-7) and 18:1(n-7) were observed when steers were fed WDGS.

The PUFA are more easily oxidized by factors such as reactive oxygen species and other free radicals. High levels of PUFA in beef are associated with higher values of oxidation and compromised beef color. In addition, oxidation of lipids produces ketones and aldehydes which may affect beef flavor. Higher levels of 18:1 trans fatty acids and 18:0 in raw lean samples may be a response of WDGS composition, which has higher lipid content and greater fat digestibility when compared with corn (*2006 Nebraska Beef Report*, pp. 51-53). Conversely, feeding WDGS decreased 17:1(n-7) in both raw muscles and 18:1(n-7) in raw TER. A numeric decrease of 18:1(n-7) in INF was observed and values approached significance ($P = 0.06$).

When cooked (TER pan fried and INF pan fried and grilled), samples from animals fed WDGS showed higher 18:1 trans values and increased PUFA compared to samples from steers fed corn (Table 3). In contrast, values of 18:1(n-7) did not differ between cooked muscles from steers fed WDGS and corn.

Higher levels of PUFA in cooked beef may also develop a rancid/oxidized flavor, commonly called warmed-over flavor, when meat is re-heated. Additionally, research showed a negative correlation of off flavor intensity and 18:1(n-7) (2007, *Journal of Animal Science*, 85:3072-3078). Therefore, lower values of this fatty acid in raw muscle from animals fed WDGS may represent a risk to off flavor development.

Grilled INF had higher values of 20:3(n-6), 20:4(n-6), 22:4(n-6), and 22:5(n-3) when compared with raw samples. Similar results were observed in pan fried TER, except for 20:3(n-6). However, no major effects of cooking were observed in other fatty acids.

Feeding WDGS modifies the fatty acid profile of m. *teres major* and m. *infraspinatus,* and vitamin E supplementation does not mitigate these changes.

Table 2. Weight percentage of fatty acids[1] of raw m. *infraspinatus* from steers fed WDGS and Vitamin E.

	Treatments (% WDGS (DM basis), Vitamin E)					Contrast
Fatty acid	Corn	Corn + vit E	40% WDGS	40% WDGS + vit E	*P* - value	Corn vs WDGS
17:1(n-7)	1.38[a]	1.39[a]	1.00[b]	0.96[b]	0.0004	< 0.0001
18:0	13.60	13.44	14.75	14.10	0.31	0.10
18:1 trans	2.27[b]	2.19[b]	3.41[ab]	3.68[a]	0.05	0.01
18:1(n-9)	40.07	41.30	38.83	38.50	0.13	0.03
18:1 (n-7)	0.86[ab]	0.94[a]	0.66[c]	0.73[bc]	0.03	0.06
18:1Δ13	0.19	0.21	0.23	0.21	0.64	0.30
18:1Δ14	0.17	0.18	0.22	0.20	0.15	0.06
19:0	0.07	0.11	0.14	0.14	0.06	0.02
18:2(n-6)	2.68[b]	2.41[b]	4.56[a]	4.77[a]	< 0.0001	< 0.0001
18:3(n-3)	0.15[b]	0.14[b]	0.19[a]	0.21[a]	< 0.0001	< 0.0001
PUFA	3.83[b]	3.55[b]	5.82[a]	6.24[a]	< 0.0001	< 0.0001
ω 6	3.41[b]	3.68[b]	5.63[a]	6.03[a]	< 0.0001	< 0.0001
ω 3	0.15[b]	0.14[b]	0.19[a]	0.21[a]	< 0.0001	< 0.0001
ω 6 / ω 3	24.86	24.78	30.11	29.64	0.17	0.03

[1]Weight percentage values are relative proportions of all peaks observed by gas chromatography.
[a,b,c]Means in the same row having different superscripts are significant at $P \leq 0.05$ level

Table 3. Weight percentage of fatty acids[1] of cooked m. *teres major* (TER) and m. *infraspinatus* (INF) from steers fed wet distillers grains plus solubles WDGS and Vitamin E.

	Treatments					Contrast
Muscle	Corn	Corn + vit E	40% WDGS	40% WDGS + vit E	*P* - value	Corn vs WDGS
Pan fried TER						
18:1 trans	2.06[b]	2.30[b]	4.17[a]	4.23[a]	< 0.0001	< 0.0001
18:1(n-7)	0.73	0.85	0.59	0.57	0.06	0.01
PUFA	7.06[b]	6.27[b]	8.57[a]	8.84[a]	0.002	0.0004
Pan fried INF						
18:1 trans	2.16[b]	1.95[b]	3.84[a]	3.91[a]	< 0.0001	< 0.0001
18:1(n-7)	0.78	0.96	0.71	0.61	0.07	0.03
PUFA	4.56[b]	4.05[b]	6.09[a]	6.19[a]	0.0004	< 0.0001
Grilled INF						
18:1 trans	2.16[b]	1.98[b]	3.72[a]	3.27[a]	0.01	0.001
18:1(n-7)	0.86	0.97	0.81	0.74	0.37	0.14
PUFA	4.73[b]	4.77[b]	6.58[a]	6.78[a]	0.002	0.0002

[1]Weight percentage values are relative proportions of all peaks observed by gas chromatography.
[a,b]Means in the same row having different superscripts are significant at $P \leq 0.05$ level.

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