THE EFFECTS OF WHOLE COTTONSEED OR FUZZPELLET® (PELLETED WHOLE COTTONSEED) ON RETAIL SHELF LIFE AND WARNER-BRATZLER SHEAR FORCE OF BEEF STRIPLOIN STEAKS

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Introduction

When new meat products are developed or new practices are explored that could ultimately effect meat products, it is imperative that research scientist address potential problems that could affect the value and acceptability of the consumer's product. Because of the need to find balance between case longevity and meat palatability, a thorough and scientific approach is needed that specifically addresses the objectives of the cooperators. Thus, this project was designed to evaluate the effect of whole cottonseed or FuzZpellet® on retail shelf life and tenderness of beef steaks.

Objectives

To determine the effect feeding FuzZpellet®, Vitamin E and whole cottonseed on retail shelf life, oxidative rancidity and shear force of beef steaks.

Methodology

Experimental Diets. Treatment diets were: **STD** = standard 90% concentrate steam flaked corn based finishing diet; **WSC** = whole cottonseed, the finishing diet with all the cottonseed meal and added fat, and a portion of steam-flaked corn, replaced with 15% whole cottonseed; and **FUZZ** = a finishing diet similar to the WCS, except that FuzZpellet, a pelleted whole cottonseed product, was used in place of whole cottonseed (Buckeye Technologies, Inc., Memphis, TN). All diets were formulated to be isonitrogenous and to provide equal percentages of added fat and neutral detergent fiber (NDF) from "roughage" (NDF from alfalfa and cottonseed hulls for STD and NDF from whole cottonseed for WCS and FUZZ). Vitamins, minerals, Rumensin (30 g/ton DM basis), and Tylan (10 g/ton DM basis) were provided by a premix included at 2.5% of the dietary DM. The STD diet contained additional vitamin E to provide approximately 900 to 1,000 IU/steer daily, which was provided in the form of a ground corn-based premix (formulated at 0.25% of the dietary DM to supply an additional 93.6 IU/kg of DM) (Galyean et al., 2004).

Meat Collection. The cattle were transported to a harvesting facility (Excel Corporation, Plainview, TX). Trained personnel from Texas Tech University individually

identified each of the carcasses. Four cattle from each of the 30 pens were selected to represent each treatment and feeding block totaling 120 carcasses. However, one carcass tag was lost during carcass chilling and only 119 of the carcasses maintained identification. Beef loin, strip loin, boneless subprimals were obtained from one side of each carcass, vacuum packaged, and transported to the Texas Tech Meat Science Laboratory, Lubbock. Upon arrival to Texas Tech Meat Science Laboratory, the strip loins were stored at 2 °C for a 14 day period. Vacuum packages were checked daily for leaks and repackaged, as needed.

Strip loin Processing. On day 14, five 2.54 cm steaks were cut from each strip loin and were randomly assigned to either proximate analysis, Warner-Bratzler shear analysis, or 0, 3, and 5 day retail display periods. Warner-Bratzler shear steaks and day 0 steaks were individually vacuum packaged and stored at -10 °C until further analysis. Day 3 and day 5 steaks were placed on black Styrofoam trays and covered with polyvinyl chloride film (PVC). The steaks were then placed in a coffin-style retail case for their respective days. All steaks were subjected to 24 hour exposure of retail display lighting, and temperatures for each case were documented.

Warner-Bratzler Shear Force. The strip loin steaks for Warner-Bratzler Shear Force analysis (WBSF) were thawed for 18-24 hours at 2 °C. The internal temperature was obtained for each steak before and after cooking in the geometric center of the steak. Steaks were prepared on a Magi-Grill belt grill (MagiKitchen, Inc., Quakertown, PA) that was pre-heated for 15 minutes. Steaks were cooked to an internal temperature of 70 °C (± 2 °C). Cooked steaks were covered with Saran® film and allowed to cool for 24 hours at 2 °C before coring. Six, 1.27-cm-diameter cores were removed parallel to the muscle fiber orientation and sheared once, perpendicular to the muscle fibers, on a United Testing Machine (United Calibration Corporation, Huntington Beach, California). Degree of doneness was recorded for each steak according to Beef Steak Color Guide (AMSA, 1995).

Color Evaluation. Strip loin steaks allocated for 5 d retail display were evaluated daily by a trained panel, consisting of a least six members, for lean color, fat color, percent discoloration, and overall acceptability according to AMSA (1991) color guidelines. Also, Commission Internationale de l'Eclairage (CIE) L* (muscle lightness), a* (muscle redness), and b* (muscle yellowness) values were determined daily, through the overwrap, for all steaks allocated for the 5 d retail display period from two random readings per steak using a Minolta Spectrophotometer (Minolta Camera Co., LTD, Osaka, Japan). L*,a*, b* values were also obtained approximately 1.5 hours after the carcasses went through the bloom chain and were graded at Excel- Plainview on the day of meat collection.

Oxidative Rancidity. Oxidative rancidity was measured using Thiobarbituric Acid (TBA) analysis according to Assay of lipid oxidation in muscle samples (Buege and Aust, 1978, Methods in Enzymology 52:302). Samples were read at 531 nm against a Tetraethoxypropane (TEP) standard curve containing all the reagents (less the sample) on a spectrophotometer (Beckman Coulter Inc., Fullerton, CA). Standard curves were constructed each day that TBA analysis was performed. The standard curve had to have an R^2 value of 0.975 or greater before samples were run. All samples were run in

duplicate. Coefficients of variation (CV) values were calculated for the duplicates and were considered acceptable when calculated at ≤ 10.00 %.

Statistical Analyses. Thiobarbituric Acid analysis (TBA) and color evaluation were analyzed as a completely randomized design with repeated measures using PROC MIXED (SAS Inst. Inc., Cary, NC). Animal was the experimental unit, Steak ID was the repeated measure, and the residual was used to test for treatment effect. For TBA analysis, percent fat was included in the model as a covariate. Warner-Bratzler Shear Force data were analyzed as a completely randomized design using PROC GLM (SAS Inst. Inc., Cary, NC). Animal was the experimental unit and the residual was used to test for treatment effect. Least squares means were used to separate means when significant F-test for treatment was noticed.

Results & Discussion

Warner-Bratzler Shear Force. WBSF values are presented in Table 1. Dietary treatment had no affect on WBSF (P = 0.2925). In agreement, Brooks and Krehbiel (2001) reported that dietary treatment, which included FuzZpellet, had no effect on the WBSF of steaks tested.

Oxidative Rancidity. Dietary treatment did not effect (P = 0.2133) TBA values (Table 4). In contrast, Brooks and Krehbiel (2001) found that control steaks had significantly higher TBA values than steaks from dietary treatments that included FuzZpellet. However, steaks from STD treatment tended (P = 0.0798) to have lower TBA values than WCS treatment. Data analysis showed that day of retail display had an effect on TBA values (P < 0.001). An increase in TBA values was observed between day 0 and 3, as well as day 0 and 5 (P < 0.001). However, there was no difference (P = 0.3513) between day 3 and day 5 TBA values.

Color Evaluation. Data analysis revealed no treatment x day interaction for subjective color scores (P = 0.9987). Scores for lean color, fat color, percentage discoloration, and overall acceptability were analyzed for dietary treatment differences and results are presented in Table 3. Dietary treatment had an effect (P = 0.0001) on all color scores. FUZZ treatment resulted in higher (P < 0.05) lean color scores when compared to the STD and WCS treatments. Moreover, STD treatment resulted in higher (P = 0.0206) lean color scores than the WCS treatment. A significant dietary treatment effect was observed among fat color scores with FUZZ and STD treatments producing higher (P < 0.05) fat color scores when compared to the WCS treatment, while no difference (P = 0.8395) existed between FUZZ and STD treatments for fat color. Results of analysis of percentage discoloration scores were similar to fat color scores, showing that FUZZ and STD scores were similar, and resulted in higher (P < 0.05) percentage discoloration scores than WCS treatment. Finally, dietary treatment effects on overall acceptability scores showed that FUZZ and STD treatments yielded higher (P < 0.05) overall acceptability scores when compared to the WCS treatment, whereas no difference in overall acceptability existed between FUZZ and STD treatments (P = 0.2019). As expected, day of retail display had a significant effect on subjective color scores (P < 0.001; data not presented) showing that all scores declined as day of display increased. Because this is a natural digression and there was no dietary treatment x day interaction, data were not reported.

Color was evaluated objectively with L*, a*, b*, Chroma, and hue values (Table 2). Dietary treatment showed to have and affect on L* values (P = 0.0044) with FUZZ treatment resulting in higher L* values in comparison with STD (P = 0.0482) and WCS (P = 0.0011) treatments. However, no differences existed for L* between STD and WCS treatments (P = 0.1853). As a result of dietary treatment, STD a* values were higher (indicating more red and less green) than FUZZ (P = 0.0399) and WCS (P = 0.0184) treatments. However, no difference (P = 0.7523) existed between FUZZ and WCS treatments for a* values. Furthermore, the FUZZ treatment resulted in higher b* values (indicative of more blue and less yellow) than WCS treatment (P = 0.0101). Moreover, STD treatment tended (P = 0.0606) to have higher b* values than WCS treatment, while no difference existed between FUZZ and STD treatments for b* values (P = 0.4823). Chroma and hue values were calculated from the L*, a*, b* values and analyzed. Dietary treatment had no significant effect on chroma and hue values.

Conclusions

The results of the current study imply that FuzZpellet may replace whole cottonseed in finishing diets of cattle in order to increase consumer perception of overall acceptability of steak color over extended periods of time in a retail display case. FuzZpellet also exhibits the ability to produce more desirable lean colors and higher L* values than standard and whole cottonseed diets. Even though it is also implied that there is little significant difference between the feeding of a standard finishing diet and a diet containing FuzZpellet on the effects of retail case life or consumer perception of acceptability, it should be noted that the standard diet was supplemented with a substantial amount of Vitamin E. It may be implied that the additional Vitamin E accounted for the lack of difference between the two diets and that FuzZpellet could prove to be a more cost effective alternative to the direct addition of Vitamin E to cattle finishing diets.

References

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Tables and Figures

Table 1. Least squares means of Warner-Bratzler shear force (kg) values by treatment

Treatment[a]					
FUZZ	STD	WCS	SEM[b]	n[c]	*P*-value
2.39	2.30	2.42	0.06	119	0.2925

[a]Treatments were: FUZZ = finishing diet with 15% of the dietary dry matter (DM) as FuzZpellet cottonseed replacing all the roughage, added fat, and natural protein in the diet; STD = Standard 90% concentrate finishing diet; WCS = finishing diet with 15% of the dietary DM as whole cottonseed replacing all the roughage, added fat, and natural protein in the diet.

[b]SEM = Standard error of mean.

[c]n = Number of observations.

Table 2. Least squares means of L* a* b*, Chroma, and hue values by treatment

	Treatment[a]					
Color Value	FUZZ	STD	WCS	SEM[b]	n[c]	*P*-value
L*	46.37[x]	45.96[y]	45.69[y]	0.14	119	0.0044
a*	13.86[y]	14.14[x]	13.82[y]	0.10	119	0.0379
b*	3.20[x]	3.09[x]	2.80[y]	0.03	119	0.0288
Chroma	14.36	14.59	14.26	0.05	119	0.0522
hue	37.35	39.56	40.61	4.45	119	0.8689

[a]Treatments were: FUZZ = finishing diet with 15% of the dietary dry matter (DM) as FuzZpellet cottonseed replacing all the roughage, added fat, and natural protein in the diet; STD = Standard 90% concentrate finishing diet; WCS = finishing diet with 15% of the dietary DM as whole cottonseed replacing all the roughage, added fat, and natural protein in the diet.

[b]SEM = Standard error of mean.

[c]n = Number of observations.

[x,y]Within a row, means without a common superscript letter differ ($P < 0.05$).

Table 3. Least squares means of subjective color by treatment as evaluated by trained sensory panel

	Treatment[a]					
Trait	FUZZ	STD	WCS	SEM[b]	n[c]	*P*-value
Lean Color	5.31[x]	5.12[y]	4.90[z]	0.07	119	0.0001
Fat Color	6.01[x]	6.02[x]	5.78[y]	0.05	119	0.0004
Percentage Discoloration	7.23[x]	7.19[x]	7.02[y]	0.04	119	0.0016
Overall Acceptability	5.13[x]	5.01[x]	4.66[y]	0.07	119	<0.001

[a]Treatments were: FUZZ = finishing diet with 15% of the dietary dry matter (DM) as FuzZpellet cottonseed replacing all

the roughage, added fat, and natural protein in the diet; STD = Standard 90% concentrate finishing diet; WCS = finishing

diet with 15% of the dietary DM as whole cottonseed replacing all the roughage, added fat, and natural protein in the diet.

[b]SEM = Standard error of mean.

[c]n = Number of observations.

[x,y,z]Within a row, means without a common superscript letter differ ($P < 0.05$).

Table 4. Least squares means of Thiobarbituric Acid values (TBA) by treatment

Treatment[a]					
FUZZ	STD	WCS	SEM[b]	n[c]	*P*-value
0.88	0.84	0.92	0.03	119	0.2133

[a]Treatments were: FUZZ = finishing diet with 15% of the dietary dry matter (DM) as FuzZpellet cottonseed replacing all

the roughage, added fat, and natural protein in the diet; STD = Standard 90% concentrate finishing diet; WCS = finishing

diet with 15% of the dietary DM as whole cottonseed replacing all the roughage, added fat, and natural protein in the diet.

[b]SEM = Standard error of mean.

[c]n = Number of observations.