Carcass and Color Characteristics of Three Biological Types of Cattle Grazing Cool-Season Forages Supplemented with Soyhulls

R.T. Baublits[1], *A.H. Brown, Jr.*[1], *F.W. Pohlman*[1], *Z.B. Johnson*[1],
B.A. Sandelin[1], *and D.O. Onks*[2]

Story in Brief

Soyhull supplementation to divergent biological types of cattle on forage-based systems was studied to determine the impact on carcass and color characteristics. Weaned calves (n = 107) biologically classified as large-, medium-, or small-framed and intermediate maturing rates were allocated to three cool season grazing systems consisting of either orchardgrass pasture or fescue pasture, each with soyhull supplementation, or fescue pasture with no supplementation for a control. Supplementing cattle with soyhulls allowed for heavier ($P < 0.05$) live and carcass weights; larger ($P < 0.05$) loin eyes; increased ($P < 0.05$) backfat; kidney, pelvic and heart fat, and yield grades; and increased ($P < 0.05$) marbling scores, and quality grades. Utilizing cattle biologically classified as large- or medium-framed allowed for heavier ($P < 0.05$) carcass weights without reducing ($P > 0.05$) marbling scores or quality grades when compared to small-framed cattle. Instrumental color analysis of lean and adipose tissue revealed improved ($P < 0.05$) lightness (L*) in lean color for supplemented carcasses as compared to the control. There were no differences ($P > 0.05$) between dietary treatments for L*, a* or b* values of adipose tissue. Other than adipose b* values being lower ($P < 0.05$) for medium-framed cattle, there were no differences ($P > 0.05$) between biological types for instrumental color values. These results indicate that supplementing forage-grazing cattle with soyhulls can improve carcass merit, and utilizing large- or medium-framed cattle can allow for increased carcass weights without decreasing carcass quality. Both of these factors could be beneficial in forage-based finishing systems.

Introduction

Retaining cattle after weaning and even up to a finished weight, and allocating different types of beef cattle to specific forages can allow for increased productivity and profit to producers. However, on a similar time scale, forage-fed cattle typically do not have the same degree of finish as grain-fed cattle due to the decreased energy available in the forage. Although typical forage-fed beef is lean and warrants an acceptable USDA yield grade, it is often inferior to traditional grain-fed beef in terms of both USDA quality grade and forage-fed beef's darker lean and more yellow fat color. The color of the lean and external fat of cuts of meat has been shown to be influential on the purchasing ability and visual acceptability by the consumer (Dikeman, 1990; Kropf, 1980)

Supplementing cattle on forage can provide sufficient additional energy to obtain a desirable degree of finish. However, concentrate supplementation can cause decreased forage utilization, and because the objective of forage-feeding cattle is to maximize utilization of available forages, alternative forms of supplementation could be considered to achieve a desirable production system. Utilization of appropriate biological types of cattle with the proper dietary regimen could allow for superior end product either in carcass weight or carcass quality. Therefore, the objectives of this study were to determine the effects of the supplementation of soyhulls, a highly digestible fiber source, to different biological types of forage-fed cattle on carcass quality and adipose and lean color.

Experimental Procedures

Animals. British and British x Continental fall- and spring-born beef steers and heifers from two consecutive years (n = 108) of small (SI), medium (MI), or large (LI) frame size and intermediate maturing rate were selected from a commercial cow herd at the University of Tennessee Experiment Station, Springhill, TN, to be utilized in this study. Biological types were estimated using the equation set forth by McCurley et al. (1980). This study was replicated over two consecutive years consisting of 54 animals utilized each year. One small-framed intermediate maturing heifer was removed from the first year's study due to chronic illness.

After weaning in October of each year, all calves chosen for the study were backgrounded for 2 weeks, receiving orchardgrass hay ad libitum and were started on pelleted soyhulls before being allocated to the trial. The randomly chosen calves were stratified across either orchardgrass (*Dactylis glomerata*) predominated pasture supplemented with pelleted soyhulls (Orchard), tall fescue (*Festuca arundinacea* Schreb.) pasture with pelleted soyhull supplementation (Fescue), or tall fescue pasture with no supplementation (Control). A commercial salt and mineral mix was available to all animals throughout the study.

Six animals (two from each biological type) were allocated to each paddock. There were three paddocks of each forage allowing for three replications each year (n = 36 per treatment). Utilizing a rotational system, each paddock allowed for 0.5 acre/calf in the fall and spring and 1 acre/calf in the winter. Pelleted soyhulls were fed to the supplemented treatments and were allocated at 1% BW/calf/day. Adjustments to supplementation were performed every 28 days when the cattle were reweighed. Grazing continued into the summer months (mean days of age = 555) until forage availability started to diminish and cattle had attained a relative degree of finish determined by visual appraisal, whereupon all cattle, within a year, were sent to a commercial slaughtering facility.

Carcass. Carcasses were chilled for 48 h before carcass data were obtained by a USDA Grader. Carcass data obtained included 12th rib backfat, maturity score, hot carcass weight, marbling score, percent kidney, pelvic and heart fat (KPH), loin eye area, quality grade and yield grade.

[1] Department of Animal Science, Fayetteville
[2] University of Tennessee Experiment Station, Springhill

Instrumental color. Instrumental color data were obtained by a qualified technician using a Minolta chromatographer (Model CR-300; Minolta Corp., Ramsey, NJ). Instrumental color data included lean and adipose CIE L*, a* and b* values. The lean values were obtained at the central, medial and lateral areas of the exposed longissimus at the 12th rib. Adipose values were obtained at the external fat located between the 10th and 12th rib region.

Statistical analysis. The experiment was set up as a split-plot design with random effects of year and replicate within year, and fixed effects of treatment and biological type. The whole plot consisted of treatment and the sub-plot consisted of biological type. The three-way interaction of year x replicate x treatment was the error term for the whole plot, and the four-way interaction year x replicate x treatment x biological type was the error term for the sub-plot and for the interaction of treatment x biological type. Although year is generally considered to have a significant effect on performance, it is likely due to temporary environmental effects causing pasture conditions to vary between years (Vallentine, 1990). Due to this, and that year was considered a random effect, no interactions pertaining to year were included in the final model. Days of age of individual animals was included in the final model as a covariate for all traits analyzed. Data were analyzed using the MIXED procedure of SAS (SAS Inst., Inc., Cary, NC.). Means were generated using the LSMEANS option and separation was performed using the PDIFF option.

Results and Discussion

Main effect results for carcass traits, by treatment and biological type, are reported in Table 1. The live weights prior to slaughter and the carcass weights of the cattle supplemented with soyhulls were heavier ($P < 0.05$) than cattle without supplementation, although there were no differences ($P > 0.05$) between the Orchard and Fescue supplemented cattle. Similarly, loin eye area was larger ($P < 0.05$), and KPH, marbling score and quality grade were greater ($P < 0.05$) for the soyhull supplemented cattle than the Control, although the soyhull supplemented treatments did not differ ($P > 0.05$). Soyhull supplementation of cattle grazing fescue and orchardgrass allowed carcasses to obtain USDA Choice quality grades compared to USDA Standard quality grades for traditional grazing cattle. The LI cattle had heavier ($P < 0.05$) live and carcass weights and larger ($P < 0.05$) loin eye areas than SI, whereas there were no differences ($P > 0.05$) between the biological types for marbling score or quality grade.

The treatment x biological type interaction ($P < 0.05$) on carcass backfat means is reported in Table 2. Carcasses from the three biological types within the Control treatment had less ($P < 0.05$) backfat than biological types within either the Fescue or Orchard treatments. Excluding Fescue-MI carcasses, the LI carcasses within the Orchard treatment had more ($P < 0.05$) backfat than all other biological types represented within each treatment. There were no differences ($P > 0.05$) for backfat between the LI, MI and SI carcasses within the Fescue treatment and MI and SI within the Orchard treatment. An interaction of treatment x biological type was also found to be significant for yield grade of the carcasses (Table 3). Similar to backfat, Control carcasses from the three biological types did not differ ($P > 0.05$) in numerical values for yield grade, but were lower ($P < 0.05$) than carcasses from the three biological types within both soyhull-supplemented treatments. There were no differences ($P > 0.05$) for yield grade between biological types within the Fescue treatment, and the LI carcasses from the Orchard treatment had a higher ($P < 0.05$) yield grade than all other biological types within treatments except the MI carcasses within the Fescue treatment.

Typically, increased forage ingestion allows for carcasses with a darker lean appearance or fat that is yellow in appearance. The darker lean can be attributed to increased myoglobin, decreased muscle glycogen, or both, and the yellow fat is due to forages having increased carotenoids compared to concentrates (Priolo et al., 2001). The instrumental color results from the present study are reported in Table 4. The lean L* values, corresponding to degrees of lightness or darkness, resulted in the Control carcasses having a lower ($P < 0.05$) L* value, indicating a darker lean than the soyhull supplemented treatments. The lean b* values, indicating degree of yellow appearance, revealed the Control carcasses had a lower lean b* value ($P < 0.05$), indicating a less yellow appearance than the Fescue or Orchard carcasses. However, the lean b* values reported did not reveal a drastically yellow appearance, as the values were below the mean values from a survey from 1,000 carcasses evaluated at commercial processing plants (Page et al., 2001). There were no differences ($P > 0.05$) between feeding treatments for adipose instrumental values. Instrumental color results for biological type revealed no differences ($P > 0.05$) for lean characteristics, but MI carcasses had lower ($P < 0.05$) adipose b* values than LI or SI carcasses. Even though the mean b* values between biological types were statistically different, the numerical difference was not drastic

Table 1. Least-squares means for carcass traits by treatment and biological type (n = 107).

	Treatment			Biological type[a]		
Trait	Control	Fescue	Orchard	LI	MI	SI
Live weight (lb)	847 ± 13[x]	1192 ± 13[w]	1203 ± 13[w]	1144 ± 13[w]	1065 ± 13[x]	1034 ± 13[x]
Hot carcass weight (lb)	438 ± 11[x]	671 ± 11[w]	680 ± 11[w]	629 ± 11[w]	596 ± 11[x]	561 ± 5[y]
Loin eye area (in^2)	9.63 ± 0.25[x]	11.81 ± 0.25[w]	11.79 ± 0.26[w]	11.69 ± 0.26[w]	11.09 ± 0.25[wx]	10.46 ± 0.27[x]
KPH	1.52 ± 0.06[x]	2.26 ± 0.06[w]	2.32 ± 0.06[w]	2.06 ± 0.06	2.01 ± 0.06	2.03 ± 0.06
Maturity[b]	164.72 ± 3.67	157.49 ± 3.65	156.70 ± 3.72	159.41 ± 3.79	162.01 ± 3.65	157.48 ± 3.83
Marbling score[c]	178.62 ± 16.07[x]	473.85 ± 15.99[w]	446.94 ± 16.27[w]	367.34 ± 16.59	368.77 ± 15.98	363.30 ± 16.78
Quality grade[d]	535.02 ± 8.51[x]	718.03 ± 8.46[w]	704.26 ± 8.61[w]	653.06 ± 8.78	657.05 ± 8.46	647.20 ± 8.89

[a] LI = large-framed, intermediate maturing; MI = medium-framed, intermediate maturing; SI = small-framed, intermediate maturing

[b] 100 to199 = A maturity

[c] PD = 100 to 199, Tr = 200 to 299, Sl = 300 to 399, Sm = 400 to 499, Mt = 500 to 599, Md = 600 to 699

[d] Standard = 500 to 599, Select = 600 to 699, Choice = 700 to 799

[wxy] Within treatment or biological type, within a row, means without a common superscript letter differ ($P < 0.05$)

and probably would not have been visually influential in terms of the degree of yellowness. Therefore, supplementing soyhulls to cattle on forage may slightly improve lean color, but overall does not seem to largely affect lean or adipose color. Biological type within these feeding conditions does not seem to be an influential source of variation in lean or adipose color as well.

Implications

These results illustrate that supplementing forage-fed cattle with soyhulls can improve carcass merit in terms of increased weights and quality grade values, but can negatively affect leanness due to higher yield grades. Utilizing cattle with potential for a larger mature size could allow for increased carcass weights without negatively impacting quality. Future studies utilizing different supplementation rates and cattle types might be necessary to achieve maximal production and carcass merit.

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Table 2. Least-squares means for the treatment x biological type interaction on 12th rib backfat (in).

	Biological Type[a]		
Treatment	LI	MI	SI
Control	0.11 ± 0.04[z]	0.10 ± 0.04[z]	0.08 ± 0.04[z]
Fescue	0.35 ± 0.04[xy]	0.42 ± 0.04[wx]	0.39 ± 0.04[x]
Orchard	0.51 ± 0.04[w]	0.36 ± 0.04[xy]	0.26 ± 0.04[y]

[a] LI = large-framed, intermediate maturing; MI = medium-framed, intermediate maturing; SI = small-framed, intermediate maturing

[wxyz] Means without a common superscript letter differ (P < 0.05)

Table 3. Least squares means for the treatment x biological type interaction on yield grade.

	Biological type[a]		
Treatment	LI	MI	SI
Control	1.52 ± 0.12[z]	1.62 ± 0.11[z]	1.65 ± 0.11[z]
Fescue	2.60 ± 0.11[xy]	2.85 ± 0.11[wx]	2.61 ± 0.11[xy]
Orchard	3.01 ± 0.11[w]	2.52 ± 0.11[y]	2.58 ± 0.12[xy]

[a] LI = large-framed, intermediate maturing; MI = medium-framed, intermediate maturing; SI = small-framed, intermediate maturing

[wxyz] Means without a common superscript letter differ (P < 0.05)

Table 4. Least-squares means for carcass instrumental color by treatment and biological type (n = 107).

	Treatment			Biological type[a]		
Item	Control	Fescue	Orchard	LI	MI	SI
Lean						
L *	30.51 ± 0.47[x]	32.98 ± 0.47[w]	32.58 ± 0.47[w]	32.03 ± 0.48	32.00 ± 0.47	32.03 ± 0.49
a *	19.34 ± 0.35	20.47 ± 0.35	19.92 ± 0.35	19.80 ± 0.36	19.91 ± 0.35	20.03 ± 0.36
b *	7.71 ± 0.35[x]	9.65 ± 0.35[w]	9.47 ± 0.35[w]	8.77 ± 0.36	9.03 ± 0.35	9.01 ± 0.36
Adipose						
L*	73.83 ± 1.08	70.12 ± 1.07	71.56 ± 1.08	72.35 ± 0.84	71.49 ± 0.81	71.68 ± 0.85
a *	1.36 ± 0.55	2.80 ± 0.54	2.56 ± 0.53	1.83 ± 0.43	2.55 ± 0.42	2.34 ± 0.43
b *	18.37 ± 0.77	20.97 ± 0.77	18.94 ± 0.64	21.37 ± 1.05[w]	19.44 ± 0.63[x]	21.10 ± 0.62[w]

[a] LI = large-framed, intermediate maturing; MI = medium-framed, intermediate maturing; SI = small-framed, intermediate maturing

[wx] Within treatment or biological type, within a row, means without a common superscript letter differ (P < 0..05).