PRODUCTION CHARACTERISTICS AND CARCASS QUALITY OF ANGUS AND WAGYU STEERS FED TO U.S. AND JAPANESE ENDPOINTS

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Summary

We predicted that USDA quality grades of Angus and Wagyu steers would not differ unless the steers were fed to a typical Japanese endpoint (1,400 lb). Additionally, we postulated that Wagyu steers would perform better on higher roughage diets than Angus steers. Sixteen Angus and 16 Wagyu weaned steers were assigned to a corn-based diet for 8 or 16 months or hay-based diet for 12 or 20 months. USDA yield grades were greater for Angus steers than for Wagyu steers ($P \leq 0.01$). USDA quality grades were not different between breed types ($P \geq 0.30$), but steers fed to the Japanese endpoint had higher quality grades than those fed to the U.S. endpoint. Ribeye intramuscular lipid increased to over 20% in the Wagyu steers, but to only 14.7% in the Angus steers. Wagyu cattle must be raised to heavy weights before they differ from Angus cattle in intramuscular lipid concentration.

Introduction

Although Wagyu steers produce carcasses with higher quality grades than Angus steers when fed to a typical Japanese endpoint (1,400 lb), it is less clear whether Japanese cattle will produce higher quality carcasses if fed to a typical U.S. endpoint (1,200 lb). Japanese Black cattle fed in Japan typically are fed diets low in concentrate and high in fiber, but the concentration of intramuscular lipid in the ribeye increases throughout their extended feeding periods (Zembayashi et al., 1995). It is not known if Angus steers can deposit intramuscular lipid throughout extended feeding. Therefore, we compared Angus and Wagyu cattle fed a corn-based finishing diet or a hay-based diet to U.S. and Japanese weight endpoints. We predicted that Angus steers would produce carcasses of equal quality to Wagyu steers when fed to the U.S. endpoint, but that Wagyu steers would produce greater quality carcasses if fed to the Japanese endpoint.

Experimental Procedures

Animals and Diets

Sixteen Wagyu crossbred (7/8 Wagyu or higher) and 16 Angus steers were purchased as calves at weaning (approximately 8 months of age). Coastal bermuda grass hay containing 9.5% crude protein was fed free choice for 8 d after the steers were transported to the Texas A&M University Research Center, McGregor. Eight steers of each breed type were assigned to a high-energy, corn-based diet containing 48% ground corn, 20% ground milo, 15% cottonseed hulls, 7.5% molasses, 0.96% limestone, 0.56% trace mineral salt, and 0.08% vitamin premix (Table 1). The diet was designed to achieve an average gain of 3 lb per day, and was fed free choice for 8 or 16 months after weaning (n = 4 per breed and time on feed). The remaining 8 steers of each breed type were offered coastal bermuda grass hay free choice, supplemented with non-protein nitrogen in a cooked molasses carrier, and fed daily an amount of the corn-based diet estimated to achieve a targeted rate of gain of 2 lb per day. The hay-fed steers were fed for 12 or 20 months after weaning (n = 4 per breed and time on feed). The average initial weights for Wagyu and Angus steers were 382 lb and 462 lb, respectively. Targeted final body weights were 1,200 lb for steers fed for either 8 months on corn or 12 months on the hay-based diet (U.S. endpoint), and were 1,400 lb for steers fed for either 16 months on corn or 20 months on the hay-based diet (Japanese endpoint). Diet and time-on-feed were totally confounded in the trial but diet effect was not of particular interest; rather, different diets were utilized to produce similar carcass weights within breed at different ages and days-on-feed. Moreover, the corn-based diet was formulated to be similar to diets typically fed to Angus steers in the U.S., whereas the hay-based diet was intended to be more like diets Wagyu cattle might be fed in Japan.

After being fed for their respective time periods, the steers in each group were slaughtered on two

consecutive days. One Angus steer from the 8-mo, corn-fed group escaped the holding pen before slaughter, and had to be removed from the investigation.

Carcass Characteristics
Carcasses were chilled at 4°C for 48 h and quality and yield grade factors were evaluated by trained personnel (USDA, 1997). USDA quality grade factors include overall maturity score and marbling score, whereas USDA yield grade was calculated based on adjusted fat thickness, longissimus muscle cross-sectional (ribeye) area, carcass weight and percentage of kidney, pelvic and heart fat.

Fats and Moistures
A 4-oz portion of the longissimus muscle, completely trimmed of subcutaneous adipose tissue, was homogenized in a Virtis homogenizer (The Virtis Company, Inc., Gardiner, N.Y., USA). Fat and moisture content were determined by standard methods (AOAC, 1990).

Results and Discussion

Initial body weight was greater ($P = 0.01$) for weaned Angus steers than for weaned Wagyu steers (Table 2). This laboratory previously documented that Wagyu calves have lower weaning weights than Angus calves (Smith et al., 1992). Final body weight and carcass weights were also significantly greater for Angus steers than for Wagyu steers across diets and all times-on-feed ($P \leq 0.002$). The corn-based diet was formulated to provide the same average daily gain of 3 lb per day (approximately 700 lb over the 8-month period) for both breed types. This targeted gain was nearly achieved by the Angus steers in the U.S. endpoint group, as they gained an average of 695 lb over the duration of the feeding trial, but the corn-fed Wagyu steers had lower rates of gain, accumulating only 570 lb over the same period. The hay diet was designed to provide similar live weights at slaughter as the corn diet, i.e., 700 lb of gain over a 12-month period. Hay-fed Angus steers approached this objective, gaining an average of 704 lb, whereas hay-fed Wagyu steers gained 670 lb, so that, even on the hay diet, the Angus steers had greater rates of gain.

A similar breed effect was observed in the Japanese endpoint group of cattle. Cattle of both breed types in both diet treatment groups were anticipated to achieve a total gain of 1,200 lb. Neither breed achieved the targeted gain. Angus steers were heavier than Wagyu after either 16 monthes on the corn-based diet or 20 months on the hay-based diet. However, the difference in average final weight between the breeds was only 35 lb in the long-fed groups as opposed to a difference of 90 lb in the first endpoint comparison. This observation supports the hypothesis that Wagyu cattle would perform better on a hay-based diet than on a higher concentrate corn-based diet. In a previous study, Lunt et al. (1993) demonstrated that Angus steers fed a moderately high-roughage diet had greater rates of gain than Wagyu steers fed the same diet. Although a tendency for a breed effect on average daily gain was noted ($P < 0.06$), almost all of the difference was observed in the first 8 mo the cattle were on feed.

The goal of the study was to slaughter the cattle at the same physiological maturity at each slaughter interval. Over all time periods, no breed effect was apparent. Angus steers, however, tended to mature at a more rapid rate than the Wagyu steers ($P < 0.08$; Table 3). There were, of course, diet and endpoint effects on maturity scores ($P < 0.001$). The hay-fed steers were by design 4 months older than the corn-fed steers in both endpoint groups, and there was a significant breed x diet interaction for skeletal maturity ($P < 0.03$). All maturity values were within "A" maturity, the most youthful classification in the U.S. grading system.

Wagyu cattle are characterized by a greater ability to accumulate marbling than other breed types within the ribeye (Lunt et al., 1993; Oka et al., 2002; Zembayashi et al., 1995). Previously, these comparisons were made in steers fed to typical Japanese market endpoints, with steers fed in excess of 500 days (to B maturity). In the A maturity steers of the current study, marbling scores and USDA quality grades were not different between breed types ($P \geq 0.30$; Table 3). It should be noted, however, that most of the carcasses in the 16-month and 20-month groups were up into the USDA prime grade. At this high level of marbling, under the USDA grading system it is difficult to discern differences between such highly marbled carcasses.

Chemically extractable intramuscular lipid may be a more appropriate measure of differences in marbling scores in cattle raised to the Japanese

endpoint. Although no overall breed effect was observed, the interactions between breed and diet and breed and endpoint were significant ($P < 0.01$); the Wagyu carcasses in the Japanese endpoint group contained more than 20% lipid, as compared to 12% for the Angus at the same endpoint. Intramuscular lipid increased in Angus steers until 16 mo on feed and did not increase thereafter. In contrast, lipid continued to increase in the Wagyu cattle until the end of the study. In a previous investigation (Zembayashi et al., 1995), we demonstrated that intramuscular lipid in the ribeye of Japanese Black (Wagyu) cattle increased indefinitely with age (up to 900 days of age), whereas in Charolais x Japanese Black/Holstein crossbred cattle, the accumulation of intramuscular lipid ceased after approximately 500 days of age. In another study, we fed 126 Angus steers to 1,500 lb live weight (Cameron et al., 1993). In that investigation, we observed marbling scores that were similar to those achieved by the Angus steers in the present study but we were not able to reach the level of marbling like those of the Wagyu steers in this study or in any of our previous investigations where we have fed Angus and Wagyu cattle (Cameron et al., 1993; Lunt et al., 1993;).

The USDA yield grade is calculated based on carcass weight, ribeye area, adjusted fat thickness at the 12th thoracic rib, and percentage kidney, pelvic, and heart fat (USDA, 1997). There was sufficiently greater fat thickness in the Angus steers ($P = 0.001$) to cause a significant difference in yield grade ($P = 0.01$; Table 3). Not surprisingly, time-on-feed also had a significant effect on ribeye area, fat thickness, and USDA yield grade ($P < 0.01$). The higher yield grade of the Angus steers indicates the greater carcass fatness of this breed type, compared to Wagyu steers (Zembayashi, 1994; Mir et al., 2002).

Implications

Our previous results, combined with the data of the present study, indicate that differences in marbling between Wagyu cattle and British or Continental breed types may not become evident until the cattle are fed to a greater physiological maturity. We further conclude that Wagyu cattle should be fed a high roughage diet for a relatively lengthy feeding period in order to reach their genetic potential to deposit maximum levels of marbling.

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Table 1. Ingredients and chemical composition of the high-corn diet at each time on feed interval

	Diets at each time on feed interval			
Item	1 mo	2 mo	3 mo	4 mo to end
Ground milo	20.00	20.00	20.00	20.00
Ground corn	21.80	40.55	47.55	48.05
Cottonseed meal	10.00	8.00	6.50	6.00
Cottonseed hulls	35.00	20.00	15.00	15.00
Molasses	10.00	8.00	7.50	7.50
Limestone	0.96	0.96	0.96	0.96
Trace mineralized salt[a]	0.56	0.56	0.56	0.56
Dicalcium phosphate	0.23	0.23	0.23	0.23
Potassium chloride	0.16	0.16	0.16	0.16
Zinc oxide	0.01	0.01	0.01	0.01
Ammonium sulphate	0.00	0.25	0.25	0.25
Vitamin premix[a]	0.08	0.08	0.08	0.08
R-1500[a]	1.20	1.20	1.20	1.20
Total percentage	100.00	100.00	100.00	100.00
Nutritional composition[b]				
Dry matter, %	88.80	89.08	89.13	89.13
Crude protein, %	11.41	11.58	11.34	11.16
NEm (Mcal/kg)	1.48	1.72	1.81	1.81
NEg (Mcal/kg)	0.88	1.11	1.19	1.19
Acid detergent fiber, %	27.04	17.50	14.19	14.12
Calcium, %	0.58	0.54	0.52	0.52
Phosphorous, %	0.34	0.36	0.36	0.36

[a]Trace mineralized salt: NaCl, 98%; Zn, 0.35%; Mn. 0.28%; Fe, 0.175%; Cu, 0.035%; I, 0.007%; Co, 0.0007%. Vitamin premix: vitamin A, 2,200,000 IU/kg; vitamin D, 1,100,000 IU/kg; vitamin E, 2,200 IU/kg. R-1500: 1.65 g monensin sodium (Rumensin) per kg.

[b]Percentage of dry matter. Calculated values based on NRC (1996).

Table 2. Production characteristics from Angus and Wagyu steers fed corn or hay-based diets for 8, 12, 16, or 20 months

	Months on feed/diet											
	8 mo/corn		12 mo/hay		16 mo/corn		20 mo/hay			*P* - values		
Item	Angu	Wagy	Angu	Wagy	Angu	Wagy	Angus	Wagy	SE	Bree	Die	Endpoi
Initial body weight, lb	459	372	456	385	481	383	452	385	15	0.02	0.89	0.81
Final body weight, lb	1,155	940	1,162	1,054	1,458	1,261	1,458	1,327	16.8	0.01	0.32	0.01
Cumulative ADG, lb	1.29	1.05	0.89	0.83	0.90	0.81	0.75	0.70	0.56	0.06	0.01	0.05

Table 3. Carcass characteristics and longissimus proximate composition for Angus and Wagyu steers fed corn or hay-based diets for 8, 12, 16, or 20 mo

	Months on feed/diet													
	U.S. endpoint				Japanese endpoint									
	8 mo/corn		12 mo/hay		16 mo/corn		20 mo/hay			*P* - values				
Item	Angus	Wagyu	Angus	Wagyu	Angus	Wagyu	Angus	Wagyu	SE	Breed	Diet	Endpoint	BxD[w]	BxE[x]
HCW, lb	711	555	676	623	897	786	887	777	83	0.01	0.89	0.01	0.40	0.91
Skeletal maturity[a]	133.3	140.0	165.0	140.0	167.5	172.5	185.0	185.0	11.3	0.42	0.01	0.01	0.03	0.16
Lean maturity[a]	160.0	147.5	160.0	150.0	170.0	160.0	170.0	177.5	12.4	0.17	0.27	0.01	0.27	0.27
Overall maturity[a]	146.6	142.5	162.5	146.2	168.7	165.0	178.7	181.2	8.3	0.08	0.01	0.01	0.63	0.12
Marbling score[b]	673.3	612.5	580.0	572.5	802.5	897.5	672.5	762.5	135.3	0.55	0.05	0.01	0.80	0.20
Quality grade[c]	483.3	462.5	443.7	468.7	531.2	562.5	487.3	518.7	44.4	0.30	0.07	0.01	0.48	0.37
No. animals grading Prime	2/3	0/4	0/4	1/4	3/4	4/4	1/4	3/4						
Adjusted fat thickness, inches	0.56	0.37	0.51	0.41	0.99	0.60	0.75	0.51	0.18	0.01	0.19	0.01	0.35	0.20
Ribeye area, inches^2	12.5	10.6	11.1	10.6	11.8	13.5	13.2	12.8	8.8	0.75	0.90	0.01	0.59	0.10
KPH, %	3.00	2.88	2.63	3.13	2.75	3.00	2.50	3.25	0.51	0.07	0.86	0.86	0.14	0.40
Yield grade	3.33	2.75	3.33	3.08	5.17	3.27	4.04	3.29	0.56	0.01	0.32	0.01	0.07	0.03
Lipid, %	9.3	6.1	8.3	7.8	14.7	14.1	12.0	20.4	3.84	0.47	0.44	0.01	0.01	0.01
Moisture, %	67.7	70.6	68.7	68.1	62.9	62.1	67.2	59.6	3.35	0.24	0.01	0.04	0.01	0.01

[a]A = 100; B = 200; C = 300; D = 400; E = 500.
[b]Practically Devoid = 100; Traces = 200; Slight = 300; Small = 400; Modest = 500; Moderate = 600; Slightly Abundant = 700; Moderately Abundant = 800; Abundant = 900.
[c]Standard = 200; Select = 300; Choice = 400; Prime = 500.
[w]Breed x diet interaction.
[x]Breed x endpoint interaction. There were no significant breed x diet x endpoint interactions.