Relationship Between Chemical Percentage Intramuscular Fat and USDA Marbling Score

A.S. Leaflet R1529

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Summary

This paper presents the relationships found and developed into a set of regression formulas for marbling score (MS) and actual percentage intramuscular fat (PIMF) using data from real-time ultrasound (RTU) certification programs. MS was determined to the nearest 10th of a marbling degree by a USDA grader--that is, sm10, sm20, etc. The same USDA grader was used each year. Percentage intramuscular fat was determined by removing a 1/4 in. facing from the 12th rib. This facing was returned to the Iowa State University Meat Laboratory, trimmed so that the sample contained only the *longissimus dorsi* muscle, freeze-ground, and sub-sampled. Product moment correlations between PIMF and MS were .95, .82, and .89 for 1996, 1997 and combined years, respectively. The results shown in this paper are not characteristic of what is generally observed in the industry. However, it shows that there can be a high correlation between the subjective grading of marbling as compared to actual chemical fat in the *longissimus dorsi* muscle. The USDA grader that graded these cattle knew he was being compared to an instrument grading system. How much fairer might the current grading system be if this technology were to be embraced and implemented by the beef packing industry?

Introduction

Previous Beef Research Reports have addressed the relationship between real-time ultrasound (RTU) predicted percentage intramuscular fat, actual percentage intramuscular fat (PIMF), and USDA Marbling Score (MS) (Izquierdo et al., 1996 and Hassen et al., 1997). These reports have summarized several years of RTU PIMF predictions made from live-animal scans and chemical fat data collected from carcasses after slaughter. Generally, the regressions of actual PIMF on MS or for MS on actual PIMF have accounted for 49-83 percent of the variation, with correlations ranging from .66 to .90. Another set of similar data has accumulated through the RTU certification programs for PIMF that occurred in 1996 and 1997 at Iowa State University. These results are significantly different, and perhaps the relationship between MS and PIMF is more desirable, especially for young grain-fed animals. The purpose of this paper is to present the relationships found and developed into a set of regression formulas for MS and actual PIMF using data from RTU certification programs.

Materials and Methods

Live animals used to support RTU certification programs at Iowa State University (ISU) have generally come from beef cattle breeding project resources located at the Rhodes and McNay research farms. Each year 5-6 animals are supplied by the ISU Beef Teaching Farm. Sexes

Table 1. Summary of carcass data from animals used to support the RTU certification programs in 1996 and 1997.

Carcass trait	No.	Mean	SD	Min.	Max.
1996					
Fat thickness, in.	44	.32	.14	.1	.63
Ribeye area, in. sq.	44	12.53	1.09	10.40	14.20
Rump fat thickness, in.	44	.31	.15	.06	.69
% Intramuscular Fat	42	4.27	1.9	1.16	9.08
Marbling Score	42	1008	140	750	1280
1997					
Fat thickness, in.	44	.36	.16	.1	.93
Ribeye area, in. sq.	44	12.23	1.31	10.3	16.85
Rump fat thickness, in.	44	.28	.11	.12	.63
% Intramuscular Fat	43	3.74	1.53	1.46	7.97
Marbling Score	43	990	73	830	1170

included steers, bulls, and heifers; however, the majority of the animals were steers. The animals averaged 15 to 21 months of age and had been on a finishing ration for 174 days prior to the certification program. Carcass data for these animals are summarized in Table 1. Carcass traits of 12-13th rib fat thickness and ribeye area were measured by two qualified meat animal scientists, and significant measurement differences were mutually resolved by re-measuring. MS was determined to the nearest 10th of a marbling degree by a USDA grader--that is, sm^{10}, sm^{20}, etc. The same USDA grader was used each year. Percentage intramuscular fat was determined by removing a 1/4 in. facing from the 12th rib. This facing was returned to the ISU Meat Laboratory, trimmed so that the sample contained only the *longissimus dorsi* muscle, freeze-ground, and sub-sampled. The lipid was extracted using an n-hexane procedure in a Soxhlet apparatus. Rump fat measurements were made on live animals by two reference technicians on the live animals.

Results and Discussion

A scatter diagram showing the relationship between actual PIMF and USDA marbling score is shown in Figure 1 for both certification years. Product moment correlations between PIMF and MS were .95, .82, and .89 for 1996, 1997, and combined years, respectively.

Regression models were fitted using linear, quadratic, and fixed-year effects. Type I (year effect fit last) and Type III sums of squares were not significant for year effect ($p >$ .40), so year effect was not used in the developed regression models. A quadratic effect is slightly perceptible when looking at the scatter diagram, however, this effect is not statistical significant. The regression model parameter estimates and statistics are presented in Table 2. A line graph is presented in Figure 2 that can be used to generally categorize USDA MS given a RTU PIMF prediction. Table 3 summarizes the relationships among categories of USDA MS, PIMF, USDA Quality Grade, and Degrees of Marbling.

RTU PIMF fat predictions were made for each of the certification animals using software developed by ISU (Amin et al., 1997). The images were captured and processed by an ISU reference technician. (Correlations between actual PIMF and RTU PIMF predicted by this technician using the ISU software were .80 and .85 for certification years 1996 and 1997, respectively.)

Implications

RTU technology offers the beef cattle industry several opportunities. Tables and figures presented in this paper can be used by seed stock producers and feedlot operators to assess quality grades of live animals given RTU PIMF predictions. Knowing quality grades can be useful for marketing information or for sorting of cattle destined for specific end point targets.

The results shown in this paper are not characteristic of what is generally observed in the industry. However, it shows that there can be a high correlation between the subjective grading of marbling as compared to actual chemical fat in the *longissimus dorsi* muscle. The USDA grader that graded these cattle knew he was being compared to an instrument grading system. How much fairer might the current grading system be if this technology were to be embraced and implemented by the beef packing industry?

Acknowledgments

The authors wish to express their appreciation to Ron Sealock, Dennis Maxwell, and Marshall Ruble, as each has played a significant role in assisting with the RTU certification programs at Iowa State University. Appreciation is also expressed to Mr. John Crouch, Director of Performance Programs for the American Angus Association, and to Dr. John Hough, American Hereford Association, for their consistent and tireless support during the RTU certification programs conducted at Iowa State University in each of the years 1993 through 1997.

References

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Figure 1. Scatter diagram of actual percentage intramuscular fat measurements and USDA Marbling Score for the 1996 and 1997 RTU certification animals.

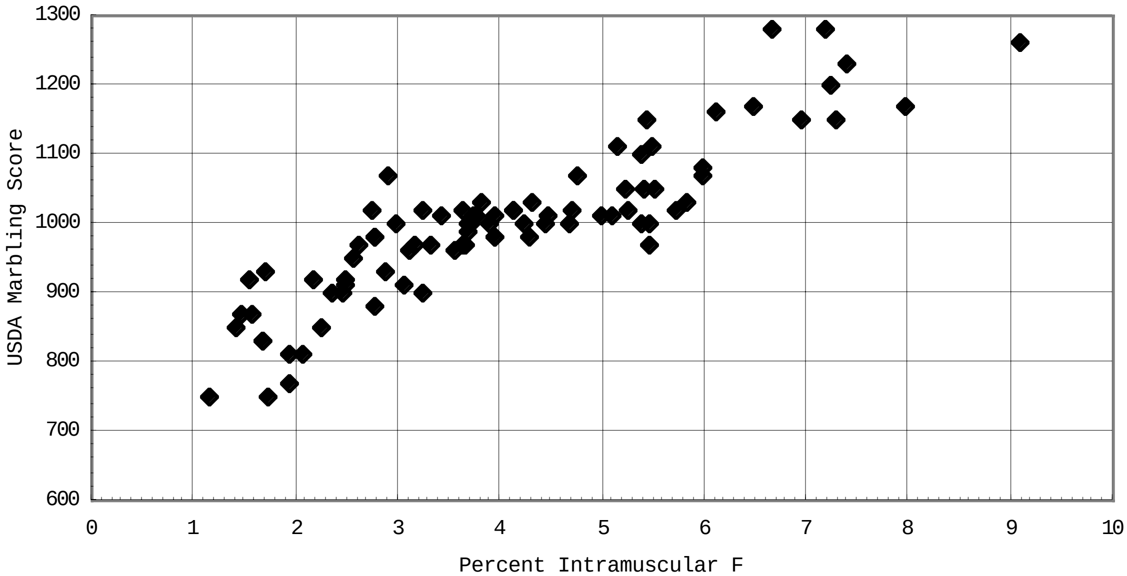

Table 2. Regression models for MS and PIMF.

Parameter	Estimate	Pr > F	R-Square
MS Linear Model			.79
Intercept	769.7		
PIMF	56.69	.0001	
MS Linear-Quadratic Model			.79
Intercept	749.8		
PIMF	67.20	.0001	
PIMF*PIMF	-1.17	.44	
PIMF Linear Model			.79
Intercept	-9.8727		
MS	.01393	.0001	
PIMF Linear-Quadratic Model			.79
Intercept	-4.104		
MS	.0024	.0001	
MS*MS	.00000569	.2207	

Figure 2. Graph of the USDA Marbling Score linear-quadratic regression model.

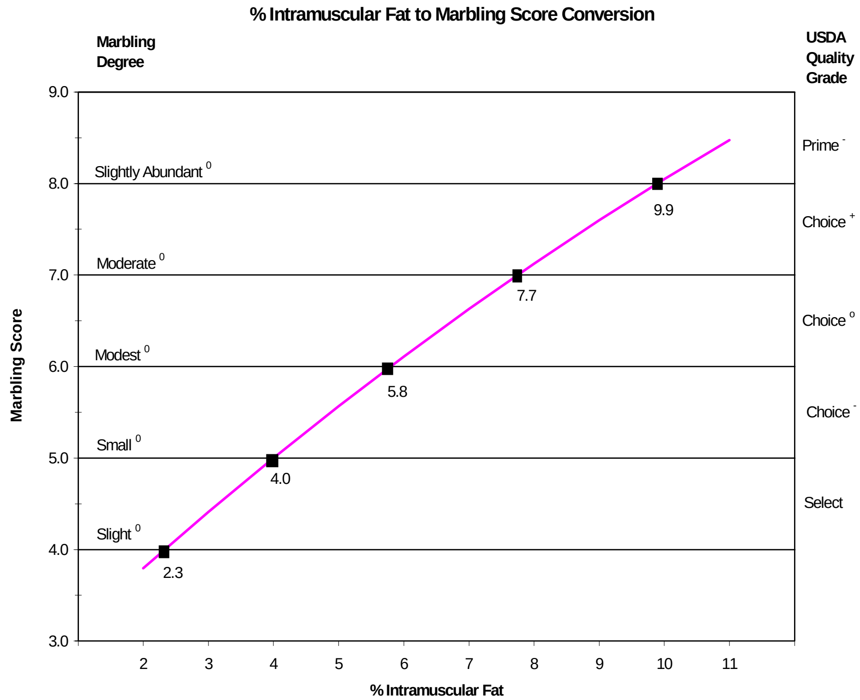

Table 3. Relationships among various methods of categorizing amounts of marbling in young beef cattle.

Percent Intramuscular Fat	USDA Quality Grade	Degrees of Marbling	Marbling Score
2.3 - 3.0 3.1 - 3.9	Select - Select +	Slight 0 - 40 Slight 50 - 90	4.0 - 4.4 4.5 - 4.9
4.0 - 5.7 5.8 - 7.6 7.7 - 9.7	Choice - Choice o Choice +	Small 0 - 90 Modest 0 - 90 Moderate 0 - 90	5.0 - 5.9 6.0 - 6.9 7.0 - 7.9
9.9 - 12.1 12.3 -	Prime - Prime o	Slightly Ab 0 - 90 Moderately Ab 0 -	8.0 - 8.9 9.0 -