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Relationship Between Carcass End Points and USDA Marbling Quality Grades: A Progress Report

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Abstract
The least square means for actual percent intramuscular fat (PIFAT), ultrasonically predicted percent intramuscular fat (UPIFAT), fat thickness (FAT), and ultrasound fat thickness (UFAT) were computed for each marbling quality grade as defined by UDSA (devoid, traces, slight, small, modest, moderate, and slightly abundant). PIFAT and UPIFAT least square means are statistically significantly different for all marbling quality grade classes except for the classes modest and moderate. FAT and UFAT least square means are significantly different for low marbling quality grades, such as traces, slight, and small but they are not different for modest, moderate and slightly abundant quality grades.

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Summary

The least square means for actual percent intramuscular fat (PIFAT), ultrasonically predicted percent intramuscular fat (UPIFAT), fat thickness (FAT), and ultrasound fat thickness (UFAT) were computed for each marbling quality grade as defined by UDSA (devoid, traces, slight, small, modest, moderate, and slightly abundant). PIFAT and UPIFAT least square means are statistically significantly different for all marbling quality grade classes except for the classes modest and moderate. FAT and UFAT least square means are significantly different for low marbling quality grades, such as traces, slight, and small but they are not different for modest, moderate and slightly abundant quality grades.

Introduction

The amount of intramuscular fat is one of the primary factors in determining carcass quality. A percentage of intramuscular fat (PIFAT) of 4-5% confers a taste and palatability to beef that is very acceptable by consumers. Consequently, carcasses with PIFAT in this range are more prized than carcasses above or below this percentage. In order to evaluate the amount of intramuscular fat at the packing plant, carcasses are subjectively graded according to seven different categories or grades of marbling quality by USDA graders after a 24-hour chill period. Currently, the beef industry is searching for a more objective method of classifying carcasses according to their degree of marbling. For the past several years, Iowa State University (ISU) has been conducting many research projects related to the use of ultrasound technology to measure several carcass attributes in the live animal as well as in the carcass.

Most research consider n-hexane chemical extraction of a *Longissimus dorsi* sample between the 12th and 13th ribs as the actual PIFAT. This actual PIFAT is used to test the accuracy of ultrasonically predicted values of intramuscular fat (UPIFAT) in the live animal. In practice, however, the criteriom for classifying carcasses according to the amount of intramuscular fat is not PIFAT but marbling quality grade. Therefore, marbling quality grades must be related to corresponding PIFAT. The objective of this report was to study the relationship between marbling quality grades and carcasses fat end points such as PIFAT and FAT. Additionally, the relationship between marbling quality grades and the ultrasound predicted parameters for PIFAT and FAT such as UPIFAT and UFAT were studied.

Materials and Methods

The data consisted of carcass data and ultrasound image measurements from around 900 yearling bulls and steers. Animals were born and fed at two different ISU research farms under similar management. Cattle were born in the spring (March-April), weaned in the fall, and started on feed in November for a period of eight to nine months from 1990 to 1995.

After the feeding period, the *L. dorsi* (LD) of all animals were scanned by using a real time ultrasound (RTU) machine. Two ultrasound images of the LD were collected: a longitudinal image used to calculate UPIFAT and a cross-sectional image used to measure UFAT. Animals were slaughtered at a commercial packing facility within five days after scanning with an average age of 440 days. After a 24-hour chilling period, marbling quality grades (MARB) were scored by a USDA grader into seven different categories: devoid, traces, slight, small, modest, moderate, and slightly abundant. A rib facing across the LD muscle at the 12th rib was obtained from each carcass and was used to determine the actual PIFAT by using n-hexane chemical extraction.

The general linear model (GLM) and the correlation (CORR) procedures in SAS (SAS Institute Inc. Cary, N.C) were used to analyze the data. First, phenotypic correlation between all the parameters was computed. Second, the least square means of PIFAT, UPIFAT, FAT and UFAT for each class of marbling quality grade were computed. The model included MARB as the independent classificatory variable with seven classes according to USDA.

Results and Discussion

Results of the phenotypic correlations among fat carcass traits are presented in Table 1. The table indicates that there is a correlation of .6 between PIFAT and UPIFAT and of .66 between PIFAT and MARB. These traits are three different approaches to compute the amount of intramuscular fat, depending on

where the fat was measured: in the live animal (UPIFAT), in the carcass directly after 24-hour chill period (MARB), or as a chemical extractable fat (PIFAT), from a meat sample. It should be noted that MARB not only considers the amount of fat but also the distribution of intramuscular fat deposits. The phenotypic correlation between intramuscular fat and external fat is around 0.4.

Figure 1 shows the PIFAT and UPIFAT least square means (LS) for each marbling quality grade. The LS for the class devoid is higher than the LS for class traces. However, considering that only four observations graded devoid, the LS may not be very representative. PIFAT and UPIFAT LS increase as quality grade increases linearly from traces to slightly abundant. There are not substantial differences between PIFAT and UPIFAT means for each marbling quality grade. LS and standard errors are described in Table 2. PIFAT and UPIFAT LS for classes traces, slight, small and modest are significantly different from all other classes except devoid, as indicated in Table 2. PIFAT and UPIFAT LS for classes modest and moderate quality grades are statistically significantly different than the rest of the marbling quality classes but they are not different from each other (Table 2).

Results shown in Figure 2 indicate an increase in FAT and UFAT with marbling quality grade. The increase is not linear however, and probably is more appropriately fitted with a quadratic equation. Comparison of FAT and UFAT LS indicates that UFAT is underpredicted in relation to FAT for marbling quality classes above slight, and that these differences are maximum for class moderate. Significance levels for FAT and UFAT LS related to classes traces, slight, and small are similar to significance levels for PIFAT and UPIFAT LS. FAT and UFAT LS however, overlap for classes modest, moderate, and abundant (Table 2).

Implications

There is a moderate-high positive correlation among the different approaches of measuring percent intramuscular fat. All endpoints PIFAT, UPIFAT, FAT, and UFAT are clearly defined for each class of marbling quality grade. Therefore, an actual PIFAT measurement obtained from a meat sample or UPIFAT estimates from live animals measured directly in the farms can be associated easily with its corresponding marbling quality grade and vice versa. This approach is particularly important for beef producers who are more used to measuring the amount of intramuscular fat as marbling quality grade than as a percentage.

Table 1. Correlations among PIFAT, UPIFAT, FAT, UFAT, and MARB

VARIABLES	UPIFAT[a]	MARB[b]	FAT[c]	UFAT[d]
PIFAT	.60	.66	.39	.43
UPIFAT		.62	.44	.47
MARB			.42	.40
UFAT				.76

[a]Actual percent intramuscular fat.
[b]Predicted percent intramuscular fat.
[c]Fat thickness.
[d]Ultrasound fat thickness.

Table 2. Least square means and standard errors for PIFAT, UPIFAT, FAT, and UFAT

Marbling quality grades	PIFAT[b]		UPIFAT[c]		FAT[d]		UFAT[e]	
	mean	se[a]	mean	se	mean	se	mean	se
Devoid	3.22	.8	3.82	.4	1.91	.35	1.94	.3
Traces	2.54	.2	3.26	.2	1.69	.15	1.56	.13
Slight	3.76	.1	4.24	.1	2.50	.05	2.20	.05
Small	5.21	.1	5.69	.1	3.10	.05	2.71	.05
Modest	7.02	.15	6.96	.1	3.47	.1	3.05	.08
Moderate	7.14	.2	7.22	.2	3.55	.14	2.90	.12
Slightly abundant	8.96	.5	8.98	.4	3.95	.3	3.61	.25

[a]Standard error of the mean.
[b]Actual percent intramuscular fat.
[c]Predicted percent intramuscular fat.
[d]Fat thickness.
[e]Ultrasound fat thickness.

Figure 1. PIFAT and UPIFAT least square means for each marbling quality grade.

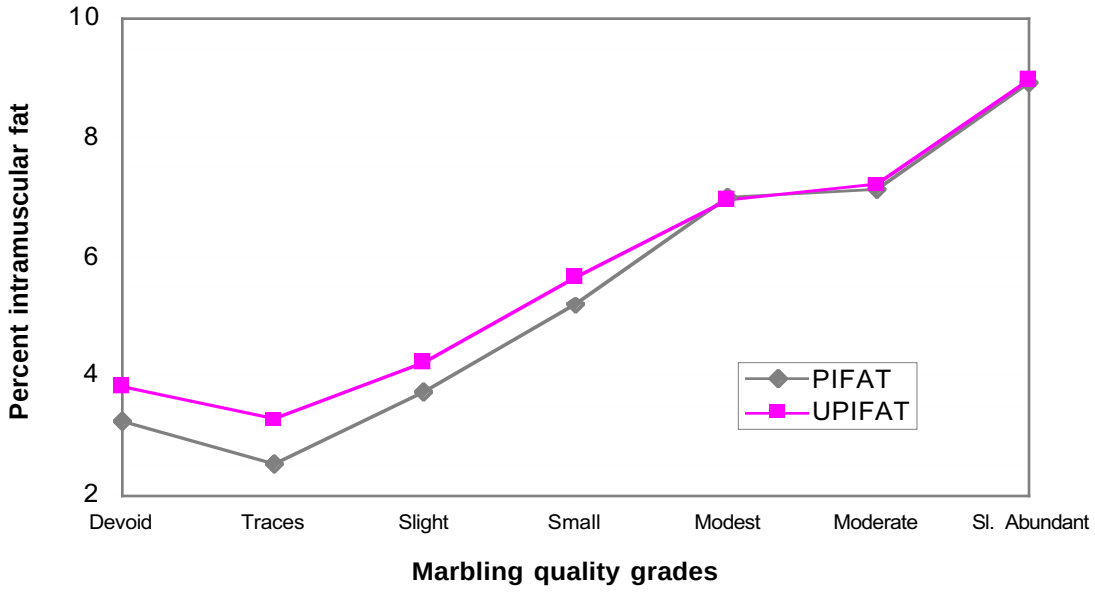

Figure 2. FAT and UFAT least square means for each marbling quality grade.