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THE EFFECTS OF PROBE TYPE AND INTENSITY OF ULTRASOUND ON ACCURACY OF INTRAMUSCULAR FAT PREDICTION IN Longissimus dorsi MUSCLE OF PIGS**

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**Plenary invited paper

Abstract: This study evaluates the possibility of intramuscular fat prediction in live pigs using two different ultrasound probes (3.5 and/or 5.0 MHz) at three various levels of total ultrasound intensity. One hundred and forty-five hybrid pigs were weighed and scanned one to three days before slaughter by device ALOKA SSD 500. Each pig was scanned by both probes but at different levels of intensity. Cross-sectional images of longissimus dorsi muscle were processed by video image analysis for prediction of intramuscular fat content. Day after slaughter a sample of longissimus dorsi muscle was taken for laboratory analysis of true content of intramuscular fat. Correlation coefficients between predicted and true IMF content were calculated. Better results were achieved by probe 3.5 MHz than 5.0 MHz. Statistically significant correlation was found between analysed IMF and estimated one at intensity of 80 % (r = 0.31), less significant at intensity of 75 % (r = 0.20). After the improvement of accuracy of data proccessing and evaluation of sonographic images the ultrasound prediction of intramuscular fat in live pigs is feasible.

Key words: pigs, intramuscular fat prediction, ultrasound probes, intensity level

Introduction and literature review

The trend in modern pig production has lead in the last decades towards to leaner pork. Increased selection for lean meat content has caused considerable decrease in subcutaneous fat, even possibly the reduction of

intramuscular fat content (*Schwörer et al.,* 1995). This trait has very important role in expression of typical pork properties such as taste, juiciness, tenderness etc. (*Verbeke et al.,* 1999; *Suzuki et al.,* 2005). Numerous studies have suggested that deposition of intramuscular fat (on cut of muscle visible as marbling) influences positively the palatability of cooked meat (*Cameron and Enser,* 1991).

The results of many authors are consistent in the opinion that decrease in intramuscular fat content under level of 2.5 % leads to deteriorated eating quality of pork (*Gispert et al.,* 1990; *Fernandez et al.,* 1999).

Heritability estimates for intramuscular fat are quite high, from 0.29 to 0.68 (*Vries et al.,* 1994, *Knapp et al.,* 1997, *Liu et al.,* 1998). For that reason the effective selection for this trait is possible.

At present, breeding programs in pig husbandry focused on improving the pork quality require the collection of data from the slaughtering of pigs. Therefore, these programs are based on progeny testing. The promising alternative to these conventional breeding strategies is using the real-time ultrasound method in live animals (*Villé et al.,* 1997, *Newcom et al.,* 2001, 2002).

The objective of this study was to assess the feasibility of intramuscular fat prediction in longissimus dorsi muscle in live pigs using two ultrasound probes with different frequency, and to try to find the optimum level of total ultrasound intensity.

Material and methods

Data used for this experiment were collected from 146 hybrid pigs – crosses of White Meaty sows and Hampshire x Pietrain boars. Pigs were weighed and scanned one to three days before slaughtering by ultrasound device ALOKA SSD 500 using two probes with different frequency (3.5 and/or 5.0 MHz). The point of measurement was on the right side of the pig´s body in the last rib area. Each pig was scanned by both probes but different levels of total ultrasound intensity: 60, 65 and/or 70 % of total intensity at probe 5.0 MHz and 70, 75 and/or 80 % at probe 3.5 MHz (indicated as SONO_60 up to SONO_80). The sonographic images of cross-sectional cuts of longisimus dorsi mucle were digitized and stored in computer for later evaluation.

The computer video image analysis (software LUCIA – Laboratory Imagging, Prague) for prediction of intramuscular fat kontent (IMF) was

used. To determine the intramuscular fat area from sonographic images was used the method of peaks detection, that is defined by matrix type and number of measurements. The values „0“ (valley) and/or „1“ (peak) are being adjoined to single pixels in order to obtain the picture of valleys (black colour) – lean meat and/or of peaks (white colour) – intramuscular fat. Estimation of intramuscular fat percentage was calculated as proportion of intramuscular fat area to total marked eye muscle area in sonographic pictures.

The second day after slaughter the dissection of right half carcasses was done and a sample of longisimus dorsi muscle (100 g) at the last rib (the same place as sonographic pictures were made) was taken for laboratory analysis of intramuscular fat content by device Infratec (Germany). For calculation of correlation coefficients between analysed and predicted intramuscular fat content was used SAS/STAT(2002-2003) version 9.3.1., procedure CORR.

Results of investigations and discussion

True intramuscular fat analysed in laboratory was 2.26 %. The nearest value to actual IMF was predicted by probe 3.5 MHz and intensity level of 75 % (1.96 %). It means the underevaluation of only 0.3 % (table 1).Similar results were reported by *Bahelka et al.* (2006).

Table 1. Basic characteristics of experimental data set of pigs (n = 146)

Probe type	Intensity level	Mean	S.D.	Min.	Max.	Diff. to actual IMF
3.5 MHz	SONO_70	1.49	0.74	0.60	3.60	-0.77
	SONO_75	1.96	1.12	0.60	5.90	-0.30
	SONO_80	2.92	1.39	1.10	8.90	+0.66
5.0 MHz	SONO_60	1.23	1.15	0.10	2.40	-1.03
	SONO_65	1.48	0.94	0.10	2.90	-0.78
	SONO_70	1.64	1.31	0.50	3.20	-0.62
IMF actual		2.26	0.72	1.0	5.40	-

Correlation coefficients between analysed and estimated IMF by probe 3.5 MHz and its different intensity levels are showed in table 2. Statistically significant was the correlation between true IMF and estimated one at intensity of 80 % (r = 0.31). Lower significant correlation was found at

intensity of 75 % (r = 0.20). However, the correlations between analysed IMF and predicted one using probe 5.0 MHz were low and statistically non-significant at all three intensity levels (table 3).

Table 2. Correlations between actual and estimated IMF using probe type 3.5 MHz

Probe type	Intensity level	Mean	S.D.	Min.	Max.	Diff. to actual IMF
3.5 MHz	SONO_70	1.49	0.74	0.60	3.60	-0.77
	SONO_75	1.96	1.12	0.60	5.90	-0.30
	SONO_80	2.92	1.39	1.10	8.90	+0.66
5.0 MHz	SONO_60	1.23	1.15	0.10	2.40	-1.03
	SONO_65	1.48	0.94	0.10	2.90	-0.78
	SONO_70	1.64	1.31	0.50	3.20	-0.62
IMF actual		2.26	0.72	1.0	5.40	-

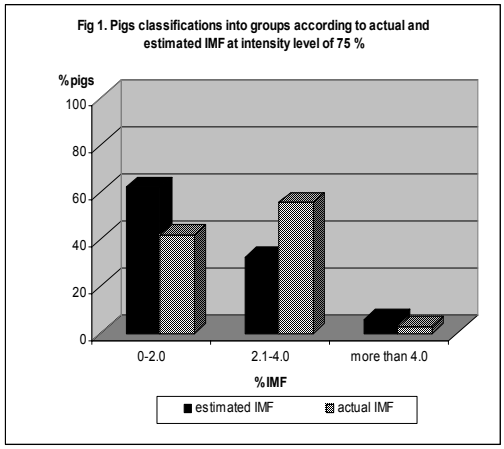
Table 3. Correlations between actual and estimated IMF using probe type 5.0 MHz

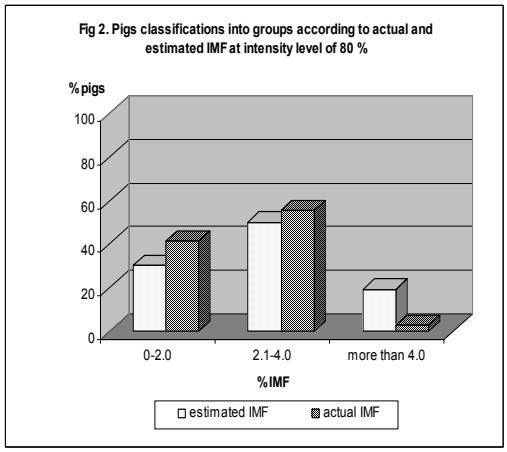
Trait	SONO_65	SONO_70	IMF
SONO_60	0.57***	0.43***	0.09
SONO_65	-	0.31***	0.14
SONO_70		-	0.18

Several studies often report higher correlation between estimated and predicted intramuscular fat content, e.g. *Ragland et al.* (2002), r = 0.68, *Newcom et al.* (2002), r = 0.57, *Faucitano et al.* (2004), r = 0.86. Lower values in our study could be caused by various factors such as using the different ultrasound device, different methods of proccessing and evaluation of sonographic pictures, using different pig genotypes. Also, it can be due to fewer number of observations since the presented data are the first results of our experiments.

Figure 1 shows the clasification of predicted and analysed IMF values using probe 3.5 MHz and intensity of 75 %. Almost 62 % of pigs were classified in group 0 – 2.0 % IMF by ultrasound prediction whereas according to actual IMF content it was 42 % only. Similar difference between analysed and estimated IMF was determined in group 2.1 – 4.0 %. This indicates that majority of pigs had estimated IMF content lower than that analysed in laboratory.

The comparison of pig classification into single groups according to actual and estimated IMF using the same probe 3.5 MHz but intensity of 80 % is illustrated in figure 2. In this case was found more distinct overevaluation of IMF content in group over 4.0 % for ultrasound predicted values.





However, 50 % of pigs were classified correctly in group 2.1 – 4.0 % IMF. *Ragland et al.* (1997) reported differences about 20 % in classification of pigs in groups 0-2.0 % and/or 2.1-4.0 % between true and estimated IMF content.

Conclusion

The results of this experiment indicate that using ultrasound for intramuscular fat prediction in live pigs is perspective. It seems that using the ultrasound probe 3.5 MHz and intensity level of 80 % (and/or of 70 %) is more suitable than probe 5.0 MHz. However, it is needed to increase the number of observations and mainly to improve the accuracy of data proccesing and evaluation (sonographic pictures). Other way is to search another suitable levels of total ultrasound intensity.

UTICAJ TIPA SONDE I INTENZITETA ULTRAZVUKA NA TAČNOST PROCENE INTRAMUSKULARNE MASTI U MIŠIĆU Longissimus dorsi KOD SVINJA

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Rezime

Pojačana selekcija na sadržaj mesa je izazvala značajno smanjenje sadržaja potkožne masti, čak možda i sadržaja intramuskularne masti. Ova osobina ima veoma važnu ulogu u ispoljavanju tipičnih osobina svinjskog mesa kao što su ukus, sočnost, mekoća, itd. Odgajivački programi u svinjarstvu koji su fokusirani na poboljšanje kvaliteta svinjskog mesa zahtevaju podatke o svinjama koji se dobijaju u klanicama. Zbog toga su ovi programi bazirani na progenom testiranju. Alternativa tim konvencionalnim odgajivačkim strategijama je korišćenje ultrazvučne metode kod živih životinja.

Cilj ovog ispitivanja je bio ocena izvodljivosti predviđanja intramuskularne masti u mišiću longissimus dorsi živih svinja korišćenjem dve ultrazvučne sonde različitiih frekvencija, i nalaženje optimalnog nivoa ukupnog intenziteta ultrazvuka.

Stočetrdesetšest svinja su izmerene i skenirane jedan do tri dana pre klanja pomoću ultrazvučnog aparata ALOKA SSD 500 korišćenjem dve sonde različite frekvencije (3.5 i/ili 5.0 MHz). Tačka merenja je bila na desnoj strani tela svinje u predelu poslednjeg rebra. Svaka svinja je skenirana sa obe sonde ali sa tri različita nivoa ukupnog intenziteta

ultrazvuka. Sonografske slike poprečnog preseka mišića longisimus dorsi su digitalizovane i prebačene u kompjutersku bazu za kasniju evaluaciju. Kompjuterska analiza video prikaza/slika procene sadržaja intramuskularne masti (IMF) je korišćena. Drugog dana nakon klanja urađena je disekcija desne polutke i uzet uzorak mišića longisimus dorsi (100 g) iz predela poslednjeg rebra i rađena je laboratorisjka analiza sadržaja intramuskularne masti. Za izračunavanje koeficijenata korelacije između analiziranih i procenjenih vrednosti sadržaja intramuskularne masti korišćen je SAS/STAT.Koeficijent korelacije između vrednosti analiziranog i procenjenog sadržaja IMF/IMM korišćenjem sonde 3.5 MHz i različitih nivoa ukupnog intenziteta ultrazvuka je bio statistički visoko signifikantno različit pri intenzitetu od 80 % (r = 0.31), i manje signifikantan pri intenzitetu od 75 % (r = 0.20). Međutim, korelacije između analiziranih IMF/IMM i procena korišćenjem sonde od 5.0 MHz su bile niske i statistički nesignifikantne na sva tri nivoa ukupnog intenziteta ultrazvuka.

Rezultati istraživanja ukazuju da korišćenje ultrazvuka za procenu sadržaja intramuskularne masti živih svinja predstavlja perspektivu. Ova činjenica će omogućiti identifikaciju životinja sa poželjnim većim sadržajem intramuskularne masti i njihovo korišćenje u strategijama i programima selekcije. Čini se da je korišćenje sonde od 3.5 MHz i ukupnog nivoa intenziteta od 80 % (i/ili od 70 %) pogodnije nego sonda od 5.0 MHz. Povećanje broja opservacija i poboljšanje načina sakupljanja i prerade sonografskih slika je neophodno za postizanje veće tačnosti IMF/IMM predviđanja.

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