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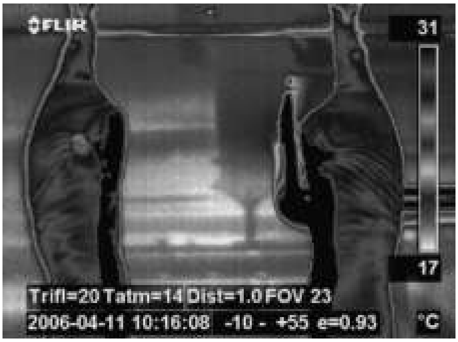
ABSTRACT: The left and right hams of forty heavy pig carcasses were thermographed to evaluate whether surface temperature differences were related to meat and ham quality. Thermal imaging analysis showed no differences in average surface temperature among classes of pH or of L* colour co-ordinate nor among classes of ham defects such as veining and red skin. However, hams with a lower fat cover displayed a significantly warmer average temperature surface. Infrared thermography seems to be a practical and non-invasive method to detect hams with a fat cover below the minimum requested to be submitted to the dry-curing process.

Key words: Pig, Thermography, Slaughter-line, Ham quality.

INTRODUCTION - Infrared thermography (IRT) uses thermal radiation emitted by objects to visualize and measure their surface temperature. The temperature is detected over wide areas, at a distance and measuring time is fast. It does not require physical contact and, therefore, it is entirely non-invasive. The colours of the images represent different temperatures, highlighting hot and cold spots and showing the map of the thermal distribution of an object or a body surface. Thermal imaging cameras can produce very sharp images of the distribution of body surface temperatures to a precision of 0.08°C. These characteristics allow the IRT to be applied where the temperature of live animals or carcases is difficult to measure under housing conditions or in the situation occurring during commercial slaughter. Several studies have been carried out to measure the surface temperature of pigs to evaluate the effects of environmental conditions (Loughmiller *et al*., 2001; Warriss *et al*., 2006) and to predict the pork quality of pigs immediately before they are slaughtered (Gariepy *et al*., 1989, Schaeffer *et al*., 1989). The aim of this preliminary study was to examine the possibility of applying the IRT directly on the slaughter-line for the evaluation of pork quality and ham suitability to be processed as dry-cured ham.

MATERIAL AND METHODS - Thermographic images were collected on 40 carcasses of heavy pigs at 20 min after stunning. The Infrared Thermal Camera (ITC) (Model ThermaCam P25, Flir System, Italy) was placed after carcass splitting, thus left and right caudal and dorsal surface images were kept for each half carcass (Fig. 1). The settings of the camera were as follows: emissivity of pig's skin 0.98; reflected air temperature 22°C; distance between camera and skin surface m 2.5. Temperatures were recovered by processing the thermographic images of a squared area located in the centre of the caudal side of ham using the ThermaCam Researcher Basic Software (Flir System, Italy). The pigs, consisting of commercial hybrids, were supplied from one farm located 35 km from the slaughter plant and were stunned by electronarcosis (250 V, 1.25 A) after a lairage that lasted 2 hours. At 90 min post mortem the pH (pH_1) was measured on the semimembranous (SM) muscle of each left ham. After 24 hours of chilling at a temperature of 0-4°C, the measure of pH (pH_u) was repeated together with the objective colour assessment (CIE Lab system, Minolta

Figure 1. A thermographic image.



Colorimeter Cr300) after 30 min of bloom time. Moreover, a subjective evaluation of some characteristics of ham such as the veining defect (4-point scale, 1=none, 4= serious), the red skin defect (3-point scale, 1=none, 3=serious) and the fat cover (3-point scale, 1=insufficient, 3=excessive) was carried out on the trimmed left thighs destined to be processed as Parma dry-cured-ham (Tassone *et al*., 2006). The temperature range frequencies (% of 0.25°C ranges from 27°C to 30°C) and the means of the obtained distributions were calculated. In order to evaluate the possible relationship between the surface temperature of ham and the meat quality, pH and L* colour values were arranged in the following classes (pH_1, < 5.80, 5.80 < 6.00, 6.00; L*, < 45, ≥45 < 50, 50). The difference of surface temperature among classes of meat and ham quality traits were analyzed using a one-way ANOVA.

RESULTS AND CONCLUSIONS – The means and the measures of variability of the surface temperatures and meat and ham quality traits are reported in Table 1. The distributions of the average surface temperatures on left and right hams showed a total range from 27.3°C to 29.2°C with mean values of 28.3°C and 28.1°C, respectively. Although all carcasses were processed in the same way along the slaughter chain, a variation of 1.8°C for the left hams and of 1.5°C for the right hams were found. The widest ranges of surface temperatures using ITC were found on live pigs before stunning at the level of the back by Schaeffer *et al*. (1989) (from 17°C to 34°C) and by Gariepy *et al*. (1989) (from 21°C to 29°C), and after sticking at the level of the ears by Warriss *et al*. (2006) (from 27°C to 35°C). A largest range of surface temperatures, from 16°C to 21°C, was also found on pig carcasses (Schaeffer *et al*., 1989). The pigs used in the present study produced meat characterized by a large variability in terms of glycolysis speed, as demonstrated by the range of pH_1 values, but also a similar extent of acidification, as confirmed by the narrow range of the ultimate pH values (Table 1). The L* colour co-ordinate values showed that final meat colour of the examined pigs was included from normal to slightly pale.
Least-squares means of surface temperature in the classes of meat and ham quality are presented in Table 2. In both hams, the differences of surface temperature among pH_1 classes were extremely small and non significant. The temperature of both hams were also very similar and not significantly different in the L* colour co-ordinate classes. These

Table 1. Means and measures of variability of the surface temperatures and meat and ham quality.

	Mean	Standard deviation	Min.	Max.
Average left ham surface T°	28.3	0.43	27.40	29.20
Average right ham surface T°	28.1	0.36	27.30	28.80
pH1	6.13	0.26	5.56	6.63
pHu	5.42	0.05	5.33	5.57
L*	48.2	2.90	40.7	55.6
Veining defect score	2.14	0.80	1	4
Red skin defect score	2.25	0.60	1	3
Fat cover score	2.11	0.57	1	3

results are consistent with previous findings of Schaeffer *et al*. (1989) showing an absence of relationship between these meat quality traits and the skin surface temperature. The veining and the red skin defect classes were not significantly related to a variation of the skin surface temperature; although, in both hams there was a tendency for the latter defect to decrease with an increase in the surface temperature. Significant differences of temperature in both hams according to the fat cover score were found. An increase of temperature was found in hams with a decreasing of fat cover, particularly in the right hams. It is suggested that a lower thermal insulation due to a thinner subcutaneous adipose tissue might be responsible to the higher skin surface temperature. The relationship between the fat cover score of ham and the surface temperature suggests that infrared thermography could be a valuable, fast and non-invasive method to estimate its fatness. Thus, the preliminary results achieved here showed a possible application of this technique to better select the raw hams destined to the successive dry-cured processing.

Table 2. Least squares means and standard errors of surface temperature in the classes of meat and ham quality.

	Left ham	Right ham
pH1		
< 5.80	28.40 ± 0.09	28.12 ± 0.09
≥ 5.80 < 6.00	28.40 ± 0.19	28.26 ± 0.18
≥ 6.00	28.32 ± 0.22	28.08 ± 0.21
L*		
< 45	28.41 ± 0.18	27.99 ± 0.18
≥ 45 < 50	28.32 ± 0.10	28.19 ± 0.10
≥ 50	28.54 ± 0.15	28.12 ± 0.15
Veining defect score		
1	28.32 ± 0.17	28.14 ± 0.17
2	28.53 ± 0.11	28.19 ± 0.11
3+4	28.24 ± 0.13	28.05 ± 0.13
Red skin defect score		
1	28.77 ± 0.27	28.57 ± 0.26
2	28.44 ± 0.10	28.19 ± 0.09
3	28.23 ± 0.13	27.96 ± 0.12
Fat cover score		
1	28.82 ± 0.19 ^{a}	28.75 ± 0.16 ^{A}
2	28.35 ± 0.09 ^{b}	28.08 ± 0.08 ^{B}
3	28.22 ± 0.15 ^{b}	27.90 ± 0.13 ^{B}

^{a,b}= *P<0.05.* ^{A,B}= *P<0.01.*

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REFERENCES - Gariepy, C., Amiot, J., Nadai, S., 1989. Ante-mortem detection of PSE and DFD by infrared thermography of pigs before stunning. Meat Sci. 25:3-41. **Loughmiller**, J. A., Spire, M. F., Dritz, S. S., Fenwick, B.W., Hosni, M. H., Hogge, S. B., 2001. Relationship between mean body surface temperature measured by use of infrared thermography and ambient temperature in clinically normal pigs and pigs inoculated with *Actinobacillus pleuropneumoniae.* Am. J. Vet. Res. 62:676-681. **Schaeffer**, A.L., Jones, S.D.M., Murray, A.C., Sather, A.P., Tong, A.K.W., 1989. Infrared thermography of pigs with known genotypes for stress susceptibility in relation to pork quality. Can. J. Anim. Sci. 69:491-495. **Tassone**, F., Ielo, M.C., Bertolini, D., Lo Fiego, D.P., Nanni Costa, L., Russo, V., 2006. Caratterizzazione morfologica di prosciutti freschi colpiti dal difetto di venatura in tre impianti di macellazione. Atti Soc. Ital. Sci. Vet. 60:495-496. **Warriss**, P.D., Pope, S J., Brown, S.N., Wilkins, L.J., Knowles, T.G., 2006. Estimating the body temperature of groups of pigs by thermal imaging. Vet. Rec. 158:331-334.