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Data paper

Data paper: Early and late immunocastrated and entire male pigs' data from production, carcass and meat quality, including bones, histology and sensory analysis

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ABSTRACT

Data from 11 entire male pigs, 14 late immunocastrated-**LIC** pigs (vaccines at 8 (**V1**) and 4 (**V2**) weeks before slaughter) and 12 early immunocastrated-**EIC** pigs (vaccines at 13 (V1) and 8 (V2) weeks before slaughter) are provided. Daily feed consumption by pen (two pigs of the same treatment per pen) and individual weight and body characteristics measured at the farm are provided globally and by period (Period 1: From beginning to V1_EIC; Period 2: From V1_EIC to V2_EIC and V1_LIC; Period 3: From V2_EIC and V1_LIC to V2_LIC; and Period 4: From V2_LIC to slaughter). Carcass fat thickness and muscle depth measures at the ham level (ZP method) and the loin (with ruler in the midline and with Fat-O-Meat'er II device at 6 cm of the midline) from the slaughtered animals are provided. Left half carcasses were computed tomography scanned and from the axial images, complementary information of the carcass characteristics was obtained, e.g. several areas and thicknesses. Additionally, the radius bone was measured and its cortical and medullar areas were determined. From all the images, the volume and proportion of bones in global or divided by density classes were also obtained considering the volume associated with different Hounsfield values. Reproductive organs (testes and bulbourethral glands) weight, length and colour (only testes) data are reported. Meat quality parameters (e.g. pH, electrical conductivity, drip loss, and colour) and histological characteristics of *longissimus* muscle (slow-twitch oxidative, fast-twitch oxidative and fast-twitch glycolytic fibre diameter and proportion) are reported. Additionally, proximate analysis and fatty acid composition of the subcutaneous fat and the *longissimus* muscle are also available. Finally, the standardized sensorial properties of the meat determined by 10 panellists are also included. These data have been reused in two scientific publications and can be included in other data sets to increase the number of animals and/or treatments, to perform a meta-analysis or to be re-analysed in a different way considering different parameters or effects in the model.

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Specification table

Subject	Quality of Animal Products
Specific subject area	Immunocastration effects on production parameters, reproductive organs, carcass and meat quality, sensory quality and histological properties of the *longissimus* muscle.

(*continued on next page*)

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Type of data	Table (Excel file)
How data were acquired	Productive data were obtained from scales used to weigh pigs and feed. An ultrasound device was used to determine fat and muscle thickness. Consumption was determined by pen, while weight and ultrasound data were obtained individually for each pig.At the slaughter plant, carcass weight was obtained with an aerial scale. A ruler and a tape were used for carcass and fat measurements, as well as the hand-held reflectance equipment (Fat-O-Meat'er II). Carcasses were also evaluated with a computed tomography (**CT**) device, and Digital Imaging and Communication in Medicine (**DICOM**) images were analysed with the Matlab R2008b and VisualPork softwares. Reproductive organs were measured with a ruler and a scale. pH-meter, conductimeter, and colorimeter were used for meat quality determination, and an official pattern was used for marbling evaluation and tubs and scales for drip losses. For histology analysis, standard reagents, cryostat and light microscope were used. ImageJ software was used for image analysis. Chemical analysis was carried out with several laboratory devices (Soxtherm Multistat, Keltec System 1026, chromatographs).
Data format	Raw and pretreated data. DICOM images.
Parameters for data collection	The dataset contains data obtained from live pigs. Also, data from warm and cooled carcasses, and from warm and cooled specific muscles. All the data were obtained: at the farm, in a research CT unit, in an experimental slaughter plant with a refrigerated dissection room, chemical and physical laboratory.
Description of data collection	Data from live pigs were collected via standard protocols at the farm level for productive information acquisition and at the slaughter plant level for carcass and meat quality data acquisition, including CT scanning. When possible, the devices used were calibrated or verified before their use. Chemical and histological information was obtained using standard methodologies used in the laboratory. Sensory analysis was performed, controlling the temperature and time of cooking, and the evaluated room conditions were also optimal for the analysis. CT images of the whole carcasses taken helically are also provided.
Data source location	Institution: **IRTA**-Institute of AgriFood Research and Technology City/Town/Region: Monells, Girona, CataloniaCountry: SpainLatitude and longitude (and GPS coordinates, if possible) for collected samples/data: 41.97602343210449, 2.997687195885855
Data accessibility	Repository name: *CORA. Repositori de Dades de Recerca* Data identification number: https://doi.org/10.34810/data2871 Open access: https://dataverse.csuc.cat/dataset.xhtml?persistentId=https://doi.org/10.34810/data2871
Related research article	Božičković, I., Savić, R., Panella-Riera, N., Radojković, D., Brun, A., Font-i-Furnols, M., 2025. Pork quality and histological properties of longissimus muscle from boars and early and late immunocastrated pigs. Meat Science, 219, 109688. Moreover, some of the data have been used in the following article: Božičković, I., Radojković, D., Savić, R., Popovac, M., Brun, A., Soler, J., Lizardo, R., Font-i-Furnols, M., 2026. Bones, reproductive organs and carcass characteristics of entire, early and late immunocastrated male pigs. Animal, 20, 101726.

Value of the data

- Productive, carcass, and meat quality characteristics of entire male pigs and immunocastrated pigs following two different immunocastration protocols are useful for better understanding of the effects of immunocastration on these traits.
- Histological data provided are relevant because there is very few information about the effect of immunocastration on muscle histology characteristics.
- The data can be combined with other datasets and complement its information by providing different types of animals or immunocastration strategies, thereby increasing variability or enabling other types of analysis, such as a meta-analysis.
- All the data provided can be used by researchers or by research and development departments in pig-related industries to conduct their own analyses according to their needs, avoiding the experimental phase and promoting the 3Rs principles.
- The data provided can be re-analysed using statistical models better suited to the objectives of the analysis or to generate different insights from those already published.
- The images provided can be used to measure different carcass characteristics (e.g., fat thickness and muscle areas at various anatomical locations) that help characterize the carcasses. In addition, alternative thresholds for determining lean, fat, and bone content can also be applied.

Data description

The dataset consists of three data files (.tab) along with their respective three metadata files (.tab) and one image file (.zip). Additionally, a readme file is included to explain the contents of the different files.

The three data files are described below, given that the columns follow alphabetical ordering:

(1) Productive data by pen (IRTA_PENPRODUCTIVE_TNASERBIA_DATA.tab):
Column A: Pen number.
Column B: Treatment.
Columns C-G: Average weight of the two pigs within each pen at different moments.
Columns H-R: Average feed intake, daily gain per pen and period.
Columns S-Z: Average feed intake, daily gain per pig and period (pen/2).
Columns AA-AD: Feed conversion ratio per pig and period.
Columns AE-AF: Total average daily gain and feed intake per pig within pen.
Columns AG-AJ: Average of the initial and the final weight per period by pen.

(2) Individual productive data and quality data (IRTA_PRODUCTIVEQUALITY_TNASERBIA_DATA.tab file):
Column A-B: Identification of the pig and treatment.
Column C: Initial weight.
Column D: Pen.
Columns E-N: Weight of the pigs at different moments, fat thickness and muscle depth measured with ultrasound.
Column O: Live weight at slaughter.
Column P: Slaughter day.
Columns Q-T: Warm carcass weight and yield.
Columns U-AA: Carcass fat and muscle thickness at different levels and carcass lean meat percentage.
Column AB: Flare fat weight.
Column AC: Loin pH at 45 min postmortem.
Column AD-AM: Reproductive organs characteristics.
Column AN: Boar taint classification by human nose.
Columns AO-AP: Warm carcass weight and length.
Columns AQ-AZ: *Longissimus* muscle quality characteristics.
Columns BA-BY: Fatty acid composition of the subcutaneous fat.
Columns BZ-CC: Proximate composition of the subcutaneous fat.
Columns CD-CU: Fatty acid composition of the loin relative to its total fatty acids.
Columns CY: Proximate composition of the loin.
Column CZ: Total fat of the loin.
Columns DA-DR: Quantitative fatty acid composition of the loin.
Columns DS-EB: Areas and thicknesses measured in the carcasses from computed tomography images.
Columns EC-EL: Bones characteristics: volume, density and proportion of each density type.
Columns EM-EP: Characteristics of the radius bone.
Columns EQ-EX: Histological characteristics of the *longissimus* muscle.

(3) Sensory data (IRTA_SENSORY_TNASERBIA_DATA.tab):
Column A-B: Identification of the sample and session.
Column C: Day of the sensory panel evaluation.
Column D: Identification of the panellist.
Columns E-F: Order of evaluation of the sample and identification code of the sample.
Column G: Treatment.
Columns H-K: Standardized scores of the odour attributes.
Columns L-Q: Standardized scores of the in-mouth texture attributes.
Columns S-X: Standardized scores of the flavour attributes.

The image dataset (IRTA_CARCASSDICOM_TNASERBIA_IMAGES.zip) contains 37 folders, one for each carcass (CAN 1 to CAN 37). Within each folder, there are two folders:

- The smaller sub-folder contains scout (survey) images in DICOM format of the whole carcass.
- The larger sub-folder contains axial DICOM images of the whole carcass, acquired helically every 3 mm from the caudal to the cranial direction.

Experimental design, materials and methods

Experimental design and productive data

Initially, a total of 40 entire male pigs from the crossbreed (LargeWhite × Landrace) × Pietrain were acquired from a commercial farm and randomly distributed into three treatment groups, trying to have similar BW per treatment. Twelve pigs were kept entire (**EM**), 14 pigs were early immunocastrated (**EIC**), and 14 pigs were late immunocastrated (**LIC**). Immunocastration was performed with two doses of the vaccine Improvac® (Zoetis, Madrid, Spain). The EIC pigs received the first dose (**V1**) 13 weeks before slaughter (V1_EIC) and the second one (**V2**) at 8 weeks before slaughter (V2_EIC). The LIC pigs received V1 at 8 weeks before slaughter (V1_LIC) (the same time that EIC received V2, i.e. V2_EIC) and V2 at 4 weeks before slaughter (V2_LIC). Pigs were in two rooms with 12 pens each, separated with metal bars, distributed in two rows, with a central corridor. In each room, there were two empty pens. The room temperature was kept around 27 °C by means of a cooling system and mechanical ventilation. In each pen, two pigs of the same treatment were included. Pens had 1.25 × 2.7 m^2, fully slatted concrete floor, one drinking bowl and one 50 kg feed hopper. All pigs were fed the same diet in two phases, growing and finishing, with 159.4 g/kg and 158.2 g/kg of CP, 2 445 and 2 440 kcal/kg of net energy, 34.0 and 29.7 g/kg of crude fibre, respectively. The full ingredient and chemical composition are detailed in Božičković et al. (2026). Feed consumption was determined by pen. One EM and two EIC pigs from different pens were withdrawn from the experiment at an early stage, due to health problems. Feed consumption of the pig that remained alone in the pen was not included in the database, as well as information from one pen where one of the pigs did not grow normally. Pigs were weighed individually at each vaccination, and the average weight per pen, together with the consumption, was used to determine the feed intake, daily gain and feed conversion ratio. Additionally, fat thickness and muscle depth at 4–6 cm left from the midline at the level of the last rib were determined with the Piglog (Frontmatec A/S, Denmark) ultrasound device. Feed and weight control was carried out at each vaccination; thus, four periods were defined: From beginning to V1_EIC (Period 1), from V1_EIC to V2_EIC and V1_LIC (Period 2), from V2_EIC and V1_LIC to V2_LIC (Period 3) and from V2_LIC to slaughter (Period 4). The periods lasted, approximately, 12, 35, 31 and 28 days, respectively.

Carcass and meat quality

Slaughtering was carried out in two days, the last week of November 2022, and once pigs arrived at the slaughter plant, placed approximately 500 m from the farm, they were weighed

and live weight was recorded. Stunning was performed with CO_2 at 90% concentration. Viscera, bristles, tongue, diaphragm, kidneys, flare fat, hooves and reproductive organs were removed and the carcass weight was measured using an aerial scale previously calibrated, and used to determine carcass yield. Flare fat was weighed with a calibrated scale of precision 1 g. Reproductive organs (testes and bulbourethal glands) were weighed with the same scale, and their length was measured with a metallic ruler. For the testes, length with and without epididymus was determined using the same ruler. Colour luminosity (**L***), redness (**a***) and yellowness (**b***) were determined after cutting each testicle in halves with the spectrophotometer CM-600d (Konica Minolta Inc., Tokyo, Japan), using D65 illuminant and 10° observer. Chroma ($\sqrt[2]{a^2 + b^2}$) and Hue ($arctangent(b^*/a^*)$) were calculated. For all the measures, the average between the right and left testicle and bulbouretral gland was obtained and included in the data set. From the left, warm carcass fat and muscle thickness was determined between the 3rd and 4th last ribs with the Fat-O-Meat'er II device (Frontmatec A/S, Denmark). Based on these two parameters, the lean meat percentage was calculated by applying the Spanish official equation ($\text{lean meat percentage} = 69.592 - (0.741 \times \text{mm of fat}) + (0.066 \times \text{mm of muscle})$; Commission Implementing Decision EU 2020/113, 2020). Fat thickness over the left *gluteus medius* and perpendicular to the skin was measured with a ruler, as well as the distance between the dorsal edge of the vertebral channel and the cranial edge of the *gluteus medius* muscle (ZP method). Additionally, pH of the left *longissimus* muscle at the last rib level was determined 45 min after slaughter with the Crison pH-meter and a Xerolyte electrode (Crison instruments, Spain) previously calibrated using buffer solutions with pH 4.0 and pH 7.0 and adjusting the temperature. Less than 30 min after slaughter, a *longissimus* muscle sample from the right half of the carcass was removed for histological analysis (see below).

At 24 h postmortem, the left half carcasses were CT scanned (see below). The left carcass length was measured with a tape, as the distance between the anterior edge of the symphysis pubis and the notch of the first rib. Additionally, the ultimate pH was determined with the same pH-meter at the same place as the previous day. Electrical conductivity was obtained with the Pork Quality Meter (PQM-Kombi, Germany) at the same place as ultimate pH. The colour of the loin (L*, a* and b*) was obtained with the Minolta C-600d colorimeter (Konica Minolta Inc., Japan), after 15 min blooming. Furthermore, three operators determined the marbling using a scale from 1 (no marbling) to 10 (heavy marbling) (NPPC, 1999). The median was calculated and included in the database. Drip losses were obtained by weighing the exudate collected in a tube after 24 h at 4 °C from a muscle sample of around 11 g (Rasmussen and Andersson, 1996).

A piece of loin sample and subcutaneous fat were collected and frozen for the chemical analysis and another piece for the sensory evaluation (see below).

Computed tomography scanning and image analysis

The left half carcasses without heat but with check and without feet were scanned 24 h postmortem with the Philips Brilliance16 CT device (Koninklijke Philips N.V., Spain). Carcasses were placed with their interior part over the CT table. The front shank was removed and placed longitudinally over the carcass with an X-ray transparent piece in between to facilitate its separation. Scanning protocol was 120 kV, 200 mA, collimation 16 × 1.5 mm, 500 mm of field of view and using a matrix of 512 × 512. Images are provided in the dataset.

The VisualPork software (Bardera et al., 2012) was used to obtain measures from specific individual axial images. Images were measured manually by a trained technician. Thus, from the shoulder image, where the scapula bone is visible from the centre showing the inverted T-shape, the subcutaneous fat area was determined, as well as the fat thickness at the dorsal edge (Fig. 1). From the axial image at the last rib level and the axial image between the 3rd and 4th last rib levels, the *longissimus* area and perimeter and the fat thickness perpendicular to the skin at the ventral extreme of the area were measured (Fig. 2). Finally, from the axial image of the ham, at the level of the joint between the femur and pelvic bones, the subcutaneous fat area and the fat thickness at the central point were measured (Fig. 3). Furthermore, from the coronal image of the front radius, its length was measured in triplicate by a trained technician and

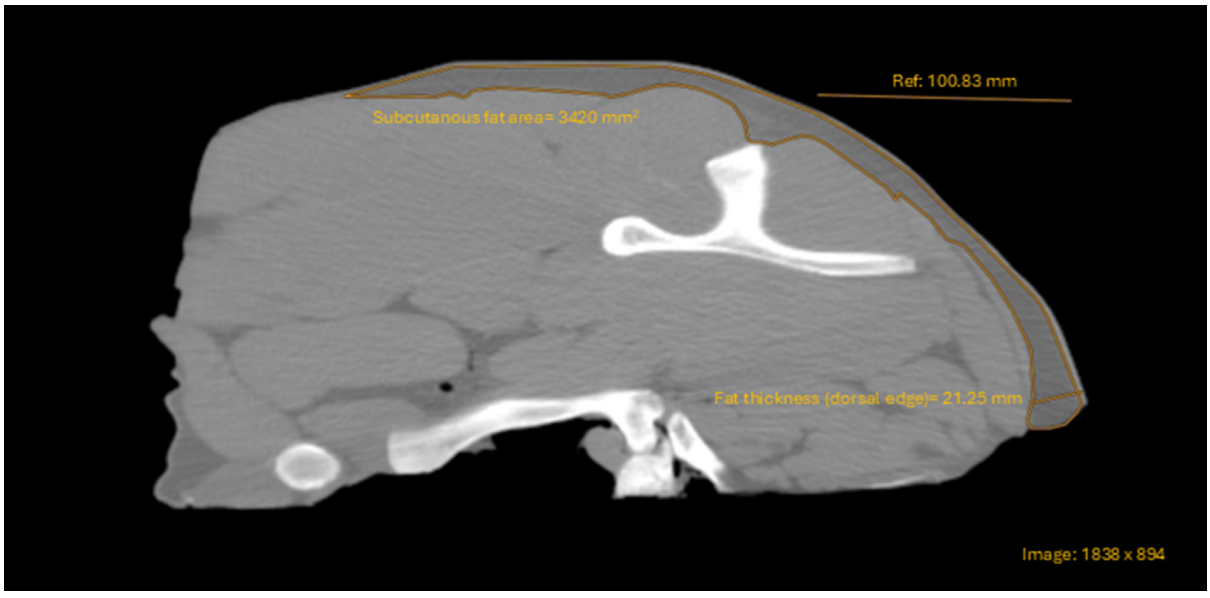


Fig. 1. Fat measurements taken at the shoulder level from computed tomography images of a pig carcass.

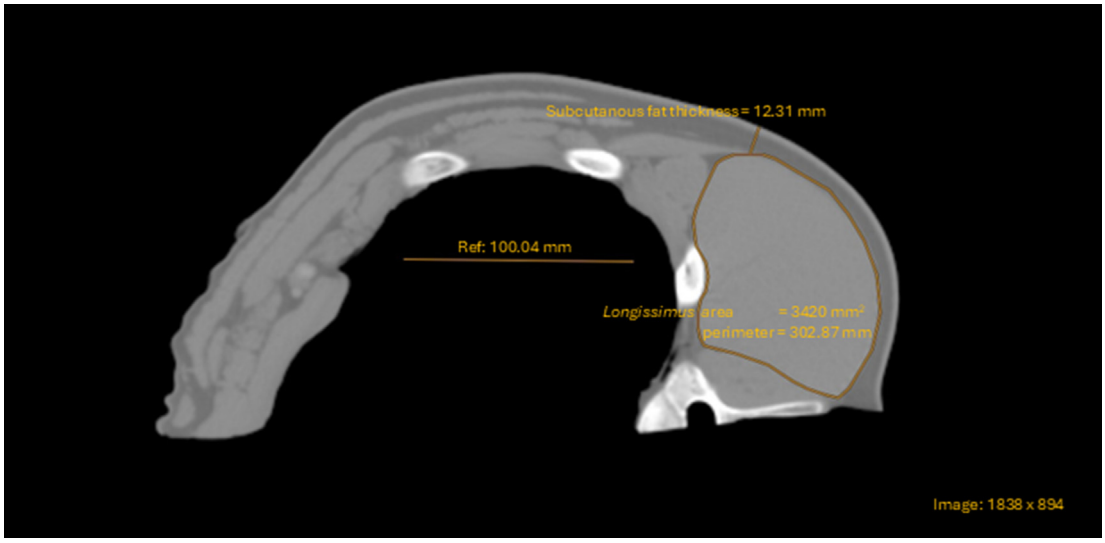


Fig. 2. Fat and loin measurements taken between the 3rd and 4th last ribs level from computed tomography images of a pig carcass.

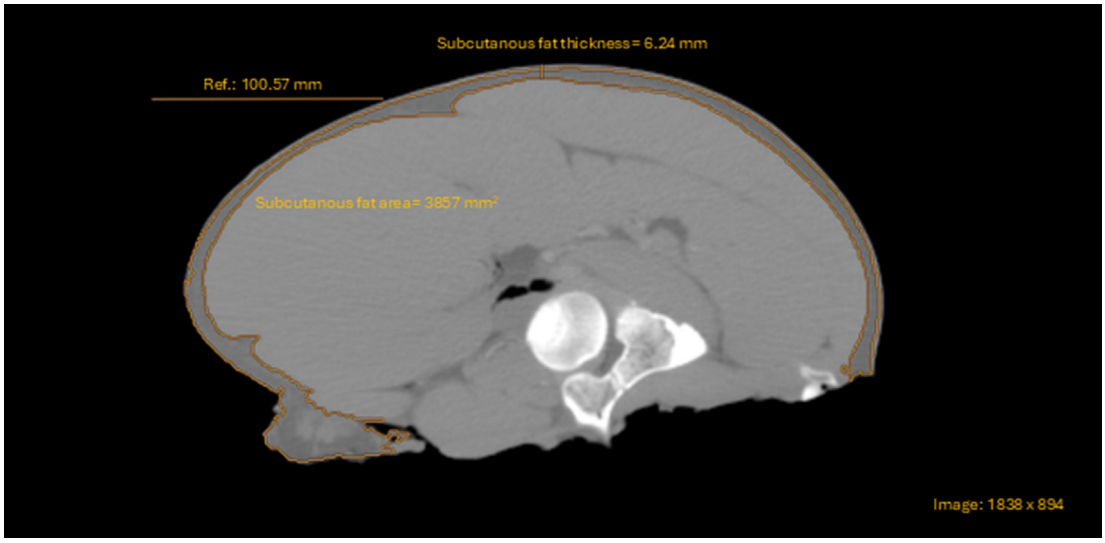


Fig. 3. Fat measurements taken at the ham level from computed tomography images of a pig carcass.

averaged (Fig. 4 left). From an axial image of the centre of the radius, the diameters of the external and internal cortical bone were measured in anterior-posterior and latero-medial directions (Fig. 4 right). These measures were used to calculate the total, medullar and cortical diaphyseal cross-sectional areas (Vitorović et al., 2023 and supplementary material of Božičković et al., 2026).

From obtained images, the volume associated with each Hounsfield value (**HU**) was determined using a home-made program for the Matlab software (R2008b © The Matworks Inc.). Volume of voxels with HU values higher than +140 were considered bone, and it was divided into four densities: low (between +141 and +499 HU), medium (between +500 and +999), high (between +1 000 and +1 499) and very high (≥ +1 500). The proportion of bone of each density type with respect to the total bone was calculated. Additionally, the bone density was determined. For this purpose, the density to each HU value (from –150 HU to +1 700 HU) was first calculated as $\text{Density}(g/cm^3) = 0.9997649 + \text{HU} \times 0.001413$), according to Picouet et al. (2010). Each of these values was then multiplied by its associated volume. The sum of all these weighted densities was divided by the total volume (from –150 to +1 700 HU) to obtain the density of the whole carcass.

Histological analysis

For the histological analysis, the sample from the right *longissimus* muscle at the level of the last rib obtained 30 min after slaughter was used. A piece of approximately 1 cm^3 was cut parallel to the direction of muscle fibres, snap frozen in isopentane cooled in liquid nitrogen and stored at –80 °C until being processed. For the staining of muscle fibre types, 12 µm thick cross sections of the sample were cut at –20 °C in a cryostat (Leica

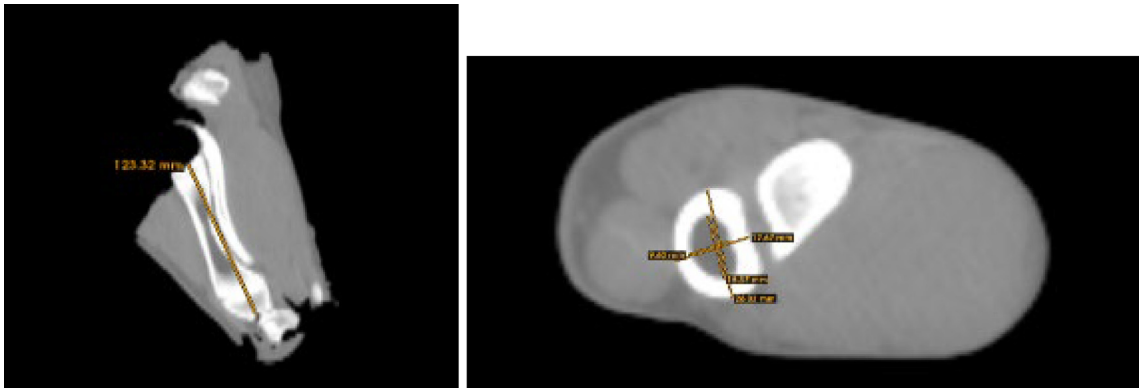


Fig. 4. Evaluation of the radius length (left) and measures in the centre of the radius to determine the area of the cortical and medullar regions (right) of the pig forelimb.

CM1860 UV), and combined reaction for NADH–tetrazolium reductase (NADH-TR; Novikoff, Shin, & Drucker, 1961) and acid preincubated ATPase at pH 4.2 (Guth & Samaha, 1970) was applied to differentiate slow-twitch oxidative fibres, fast-twitch oxidative fibres and fast-twitch glycolytic fibres. For each animal, five microscopic views/images were taken randomly, as shown as an example inn Fig. 5 (from a to d) for animal 23, aiming to gather approximately 200 muscle fibres on which all the measurements would be taken. The images were processed using the ImageJ software (Rasband, 1997). On each microscopic image, the total number of fibres and the respective number of slow-twitch oxidative fibres, fast-twitch oxidative fibres and fast-twitch glycolytic fibres fibres were recorded, and each fibre was outlined to measure its circumference. The diameter of each fibre was calculated from its circumference, while from the total number of fibres and the number of respective fibre types, the percentage of the respective fibre types was calculated. Due to problems with freezing, one sample from the LIC group was omitted from histological analysis. On the left half of the carcass, the muscle cross-sectional area (MCSA) was determined from the image of the loin at the last rib level, obtained with a Computed Tomography device (Philips Brilliance 16, using 120 kV, 200 mA, field of view 500 mm and 512 × 512 matrix as scanning protocol) and using the VisualPork software (Bardera et al., 2012). The total number of fibres on the cross-sectional area was estimated based on the number of fibres per unit area and the muscle surface determined by Computed Tomography.

Chemical analysis

From the loin muscle and subcutaneous fat, moisture content was obtained with the SRPS ISO144 (1998), free fat content with the method described at SRPS ISO 1444 (1998) using the Soxtherm Multistat (Gerhardt, Germany), nitrogen content with the Kjendahl method (SRPS ISO 937, 1992) using the Kjeltec System 1026 (Foss Tecator, Denmark), and total ash content using the SRPS ISO 936 (1999) method.

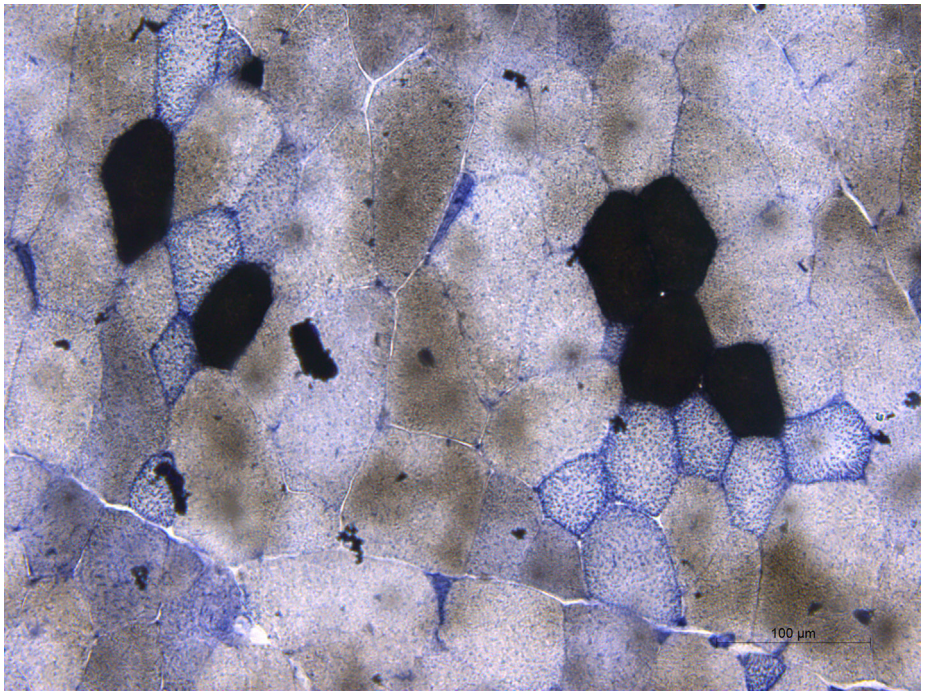


Fig. 5. Five microscopic images (from a to e) of the *longissimus* muscle cross-section of pig 23 used to calculate its histological properties.

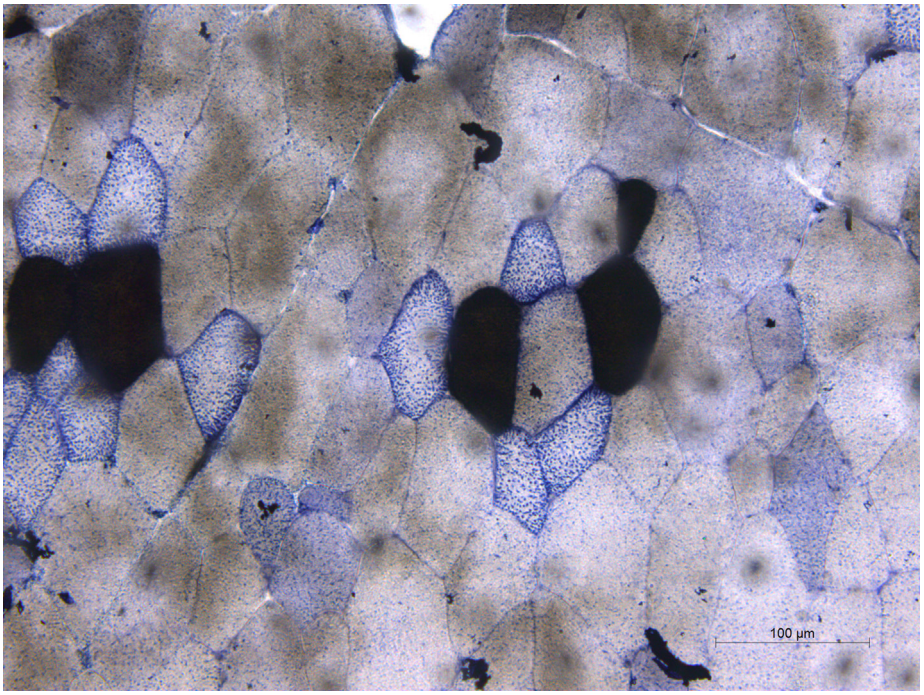


Fig. 5 (*continued*)

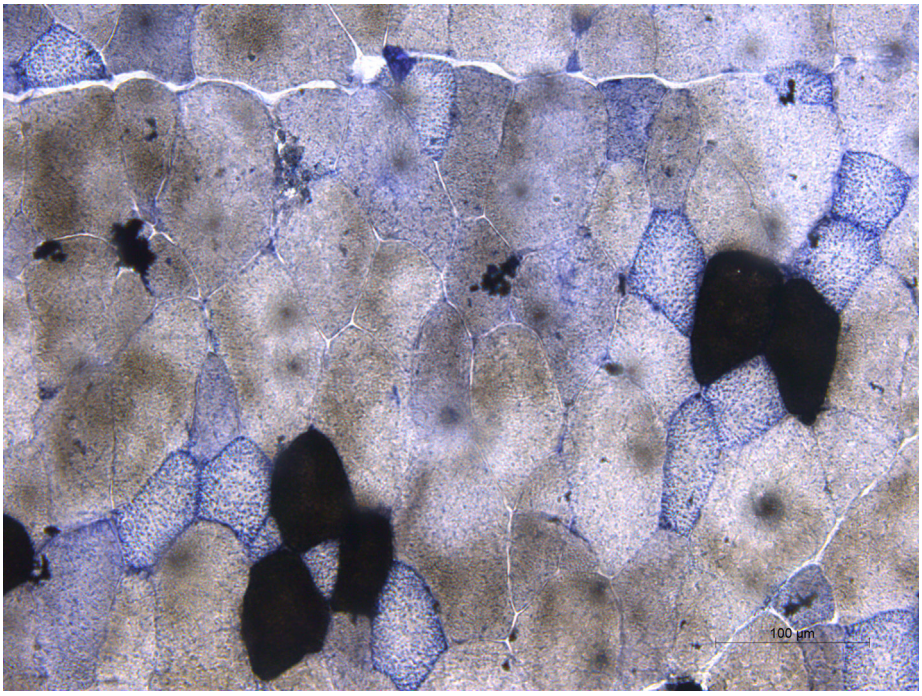
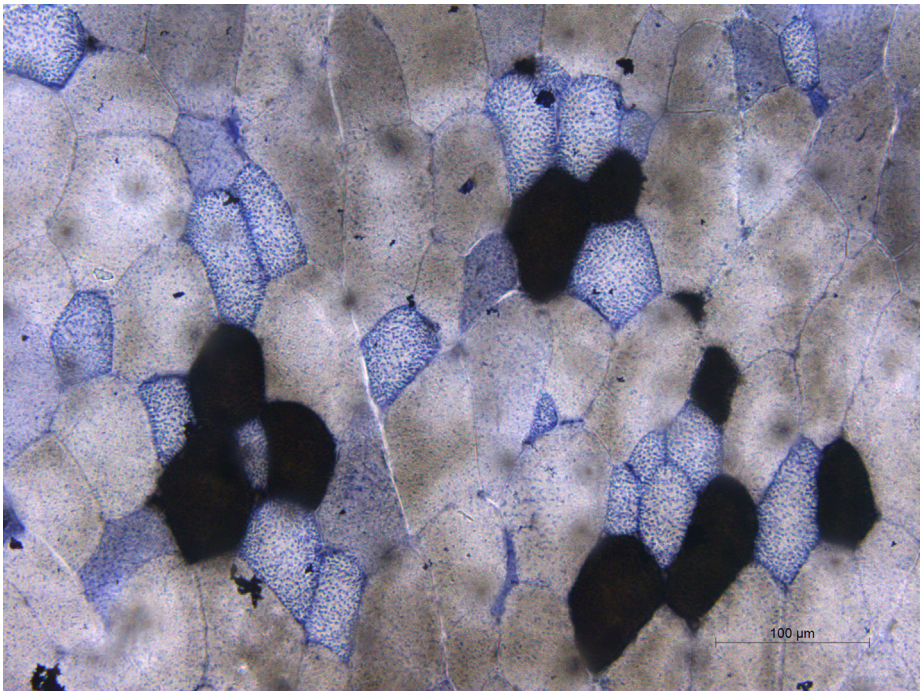


Fig. 5 (*continued*)

The fatty acid methyl esters were prepared according to O'Fallon et al. (2007) from 2 g of meat or 40 mg of adipose tissue using C13:0 as an internal standard. For this purpose, the meat or fat was placed in a 15 mL tube where 1.0 mL CH_3OH, 0.7 mL 10 N KOH in water and 5.3 mL MeOH were added. After incubation for 1.5 h in a 55 °C water bath, the tube was manually shaken vigorously for 5 s every 20 min. A solution of 0.58 mL of 24 N H_2SO_4 was added to the previously cooled tube in a tap water bath. Thereafter, the tube was inverted in order to mix and incubated for 1.5 h in a 55 °C water bath, in the presence of precipitated K_2SO_4 and tub was shaken manually for 5 s every 20 min. Once the fatty acid methyl esters were synthesized, the tube was cooled in a cold



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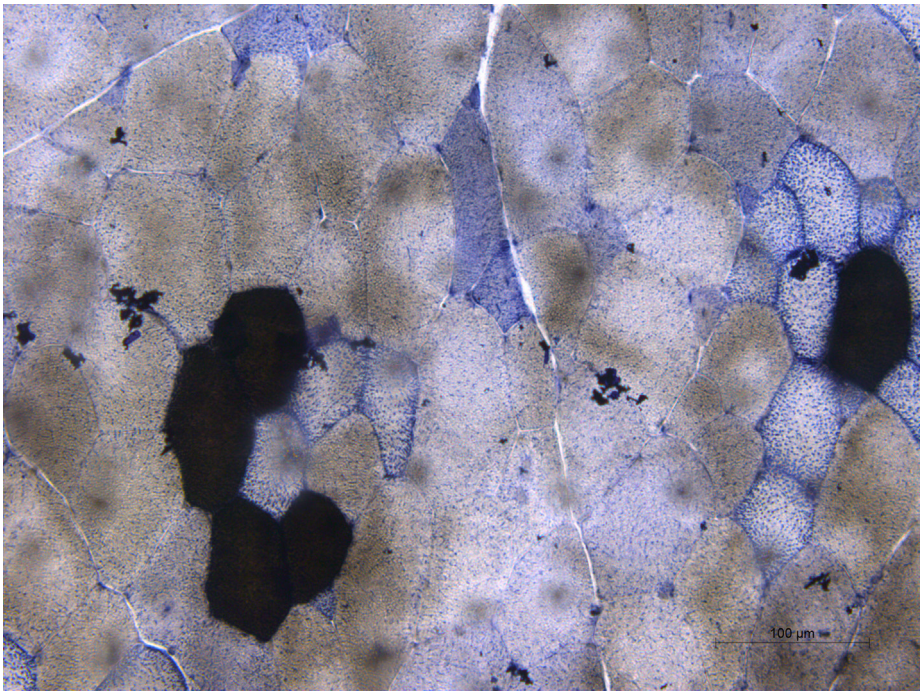

Fig. 5 (*continued*)

tap water bath, and 3 mL of hexane was added. The tube was shaken, and the separated organic phase, including the fatty acid methyl esters, was analysed. For this purpose, the Shimadzu 2014 GC instrument (Kyoto, Japan) was used as described in Božičković et al. (2025). Fatty acid data in the subcutaneous fat are provided as mg/g of adipose tissue, and those of the loin are provided as mg/g of total fatty acids and as mg/g of loin muscle after conversion considering the fat content and the conversion factor of 0.91 (Greenfield and Southgate, 2003).

Sensory analysis

Boar taint was determined in triplicate by two trained panellists by smelling the subcutaneous fat heated using a soldering iron (Soldering iron station Analogue 58 W, 150–450 °C, Basetech, Austria) (Mathur et al., 2012; Burgeon et al., 2023). First, the panellists evaluated the presence or absence of the boar taint odour. If present, the level (low, medium, high) was also determined. The most frequent score was considered as the final classification of the fat.

Moreover, a panel of 10 trained panellists, in individual booths and using red light, scored the loin samples in seven sessions with three samples per session (1 per treatment), and four sessions with four samples per session (1 per treatment plus one of EIC or LIC). A 1.5 cm thick loin slice with 1 mm of subcutaneous fat was cut in 1 cm width pieces, which were wrapped individually with aluminium foil and coded. Then, they were cooked in a 200 °C preheated oven (Balay 3HB4131X2, BSH Electrodomésticos, Spain) for 10 min and kept warm until analysis, to ensure they reach the internal temperature of 72 °C. Panellists evaluated the samples, identified with a 3-digit code obtained randomly, in a designed order to avoid the first sample and carry-over effect (MacFie et al., 1989) using a scale from 0 (no or very low intensity) to 10 (high intensity). After two training sessions, the attributes were selected and adapted from those of a previous study (Font-i-Furnols et al., 2020). The odour attributes evaluated were boar taint, pig, pork and abnormal, the in-mouth texture attributes were hardness, initial juiciness, medium juiciness, crumbliness, fibrosity and chewiness and flavour attributes were boar taint, pig, pork, abnormal, sour, sweet and metallic. The average per sample was obtained. The individual values were standardized within the sample, and the average was added to the standardized value. Thus, the data provided are the individual standardized score by each panellist and sample, as well as the session, panellist identification and day of the evaluation.

Peer Review Summary

Peer Review Summary for this article (https://doi.org/10.1016/j.anopes.2026.100143) can be found at the foot of the online page, in Appendix A.

Ethics approval

The trial was approved by the Animal Ethical Commission of the Generalitat of Catalonia (CEA-OH/118221/1).

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) did not use any AI and AI-assisted technologies.

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Declaration of interest

The authors have no conflict of interest.

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