Intrauterine growth restriction defined by increased brain-to-liver weight ratio affects postnatal growth and protein efficiency in pigs

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Supplementary Table S1

Piglets selected for euthanasia.

Item	Total	Number of pigs Females	Males
Category[1]			
Category 1	10	4	6
Category 2	10	7	3
Category 3	10	5	6
BtW[2]			
Low-BtW	12	5	7
Norm-BtW	18	10	8
Head shape[3]			
Score 1	20	10	10
Score 2	2	1	1
Score 3	8	4	4

[1] Category: category 1: piglets with a birth weight (BtW) < 1.1 kg; category 2: piglets with a BtW ≥ 1.1 and < 1.8 kg; category 3: piglets with a BtW ≥ 1.8.

[2] BtW: low-BtW: piglets with a BtW < 1.1kg; normal-BtW: piglets with a BtW ≥ 1.1kg.

[3] Head shape based on the morphological characteristics of the head (Chevaux et al. 2010; Hales et al. 2013; Hansen et al. 2018): score 1: "normal" piglet, score 2: mild intrauterine growth restriction (IUGR); score 3: severe IUGR.

Supplementary Table S2

Piglets selected for fattening.

	Females	Males	BtW-range[1]
Number of pigs[2]	48	48	0.83 kg – 2.16 kg
Score 1	23	20	0.99 kg – 2.16 kg
Score 2	17	22	0.96 kg – 2.16 kg
Score 3	8	6	0.83 kg – 1.3 kg

[1] Range of birth weight (BtW).

[2] Selection of the piglets (N = 96) for the grower-finisher period.

Supplementary Table S3

Ingredients and gross chemical composition of the pre/early post-weaning, starter, grower, and finisher diet administered to the pigs.

	Pre/early post-weaning diet[1]	Starter diet[2]	Grower diet[3]	Finisher diet[4]
Ingredients (%)				
Wheat, ground	40.413	44.550	50.000	50.000
Corn, ground	14.185	1.570	-	-
Potato proteins	7.243	8.026	-	-
Oats, ground	6.162	10.000	-	-
Beet pulp	5.842	5.202	5.923	5.961
Soybean meal	5.361	3.746	11.555	6.104
Whey permeate	5.000	5.000	-	-
Barley, ground	3.636	3.470	26.584	32.418
Rapeseed oil	2.500	3.864	-	-
Rapeseed meal			0.711	1.371
Oats flakes	2.000	2.000	-	-

[1] Diet for the piglets from 15 days after birth to 14 days post-weaning, formulated and produced by Agroscope according to the Swiss feeding recommendations for pigs.

[2] Diet for the piglets from 14 days post-weaning to 20 kg BW, formulated and produced by Agroscope according to the Swiss feeding recommendations for pigs.

[3] Diet for pigs from 20kg to 60 kg of BW, formulated and produced by Agroscope according to the Swiss feeding recommendations for pigs.

[4] Diet for pigs from 60kg of BW to slaughter, formulated and produced by Agroscope according to the Swiss feeding recommendations for pigs.

Apple pomace, dried	2.000	8.560	-	-
Animal fat RS 65	-	-	1.530	1.353
Chestnut extract[5]	2.000	-	-	-
Calcium formate	0.800	1.000	-	-
Monocalcium phosphate	0.487	0.486	-	-
Dicalcium phosphate	-	-	1.417	0.913
Wheat barn	-	0.560	-	-
Wheat meal	0.400	-	-	-
Vitamin-mineral premix starter[6]	0.400	0.400	-	-
Vitamin-mineral premix fattening[7]	-		0.400	0.400
Lysine pure	0.392	0.394	-	-
L-Lysine HCL	-	-	0.397	0.275
Salt	0.391	0.544	0.307	0.254

[5] Chestnut extract (containing 54% of hydrolysable tannins) provided by Silvateam (Silvafeed Nutri P/ENC for Swine; Italy).

[6] Supplied per kg of diet: vitamin A, 8000 IU; vitamin D3, 1000 IU; vitamin E, 25 mg; menadione, 3 mg; thiamine, 2 mg; riboflavin, 5 mg; biotin, 0.1 mg; niacin, 20 mg; pantothenic acid, 15 mg; iron, 80 mg as iron sulphate monohydrate; iodine, 0.15 mg as calcium iodate; copper, 6 mg as copper sulphate; manganese, 10 mg as manganese oxide; zinc, 75 mg as zinc oxide; selenium, 0.2 mg as sodium selenite.

[7] Supplied per kg of diet: Vitamin A, 4000 IU; vitamin D3, 400 IU; vitamin E, 65 IU; choline, 200 mg; vitamin B6, 3 mg; folic acid 0.5 mg; menadione, 1 mg; thiamine, 2 mg; riboflavin, 3 mg; biotin, 50.4 μg; niacin, 15 mg; pantothenic acid, 15.1 mg; iron, 20.1 mg; iodine, 0.15 mg; copper, 4 mg; manganese, 10 mg; zinc, 55.1 mg; selenium, 0.15 mg.

Pellan[8]	0.300	0.300	0.300	0.300
Greencab-70-C[9]	0.200	0.200	-	-
Calcium carbonate	0.165	-	0.725	0.588
Threonine pure	0.087	0.088	-	-
L-Threonine	-	-	0.103	0.057
Methionine 98%	0.016	0.020	-	-
DL-Methionine	-	-	0.047	0.005
Luctarom[10]	0.010	0.010	-	-
Natuphos 5000 G[11]	0.010	0.010	-	-
Gross chemical composition analysed (g/kg as fed)				
DM	45	46	54	45
CP	170	170	158	140
Fat	46	58	31	30
Crude fibre	50	50	40	40
Digestible energy (MJ/kg)	14	14.0	13.7	13.7
Lysine	11	11.5	9.7	7.6
Methionine	3.1	3.1	2.8	2.2

[8] Pellet binding aid: Pellan, Mikro-Technik, Bürgstadt, Germany.

[9] Coated calcium butyrate: Greencab 70-c, Brenntag; Denmark.

[10] Luctarom, Lucta; Montornès del Vallès, Spain.

[11] Phytase; 500 units of aspergillus niger phytase/kg diet; 1 phytase unit corresponds to the amount of enzyme that releases 1 µmol P from 5 mM phytate/min at pH 5.5 and 37˚C.

Threonine	7.5	7.5	6.2	5.1
Tryptophan	1.9	2.0	1.8	1.6
Calcium	5.8	5.8	8	6.1
Phosphorus	4.5	4.4	6.4	5.4
Sodium	1.9	2.5	1.3	1.1
Vitamin A (IE/kg)	8000	8000	4000	4000
Vitamin D3 (IE/kg)	1000	1000	400	400
Vitamin E	25	25	65	65
Iodine (mg/kg)	0.15	0.15	0.15	0.15
Manganese (mg/kg)	10	10	10	10
Copper (mg/kg)	6	6	4	4
Zinc (mg/kg)	75	75	55	55
Selenium (mg/kg)	0.20	0.20	0.15	0.15

Supplementary Table S4

Effect of classifying the pigs based on the brain-to-liver weight ratio (BrW/LW) and sex on the energy and nutrient content of the carcass and meat quality traits of the *longissimus thoracis* muscles.

Item[3]	BrW/LW[1]		Sex		SEM[4]	P-value[2]	
	IUGR	NORM	Female	Castrate		BrW/LW	Sex
Number of carcasses[5]	19	69	47	41			
Carcass weight, kg	87.5	88.1	86.9	88.8	0.74	0.45	< 0.01
Gross energy, MJ	1113	1107	1053	1167	22.3	0.77	< 0.001
Water, kg	49.4	49.9	50.1	49.1	0.59	0.37	0.03
Ash, kg	3.06	3.10	3.13	3.02	0.050	0.38	< 0.001
CP, kg	14.9	15.1	15.2	14.9	0.19	0.39	0.03
Lipids, kg	20.3	20.1	18.7	21.8	0.61	0.74	< 0.001

[1] BrW/LW: IUGR: piglets with a BrW/LW ≥ 0.78; NORM: piglets with BrW/LW < 0.78.

[2] P-value for the main effect of the BrW/LW and sex.

[3] pH 1: muscle pH at 45 min *postmortem*; pH 24: muscle pH at 24 h *postmortem*; temperature 1: muscle temperature at 45 min *postmortem*; temperature 24: muscle temperature at 24 h *postmortem*; drip loss: drip loss 24 h *postmortem*; purge loss: purge loss during maturation.

[4] Pooled SEM.

[5] After slaughter, the Dual-energy X-ray absorptiometry (DXA) scan was not available for five of the 93 carcass halves. The content of single nutrients was determined for the 88 carcasses scanned with DXA after slaughter.

Number of *longissimus thoracis* samples[6]	21	70	47	44			
pH 1	6.75	6.78	6.73	6.81	0.080	0.72	0.30
pH 24	5.57	5.56	5.57	5.56	0.034	0.69	0.55
Temperature 1	33.9	33.9	33.6	34.2	0.309	0.97	0.02
Temperature 24	3.45	3.36	3.33	3.48	0.116	0.32	0.04
Meat colour							
Lightness	56.8	57.8	56.6	57.9	0.644	0.01	< 0.001
Redness	2.56	2.60	2.29	2.87	0.244	0.84	< 0.01
Yellowness	12.4	12.6	12.1	12.9	0.301	0.27	< 0.001
Water holding capacity							
Drip loss, %	2.26	2.51	0.03	0.04	0.189	0.17	0.25
Purge loss, %	3.43	3.48	3.40	3.51	0.213	0.75	0.41
Cooking loss, %	20.90	21.70	21.90	20.80	0.894	0.18	0.03
Shear force, N	54.8	48.2	53.0	50.0	2.32	< 0.01	0.08

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[6] For two of the 93 pigs, it was not possible to perform the meat quality analysis.

Supplementary Figure caption
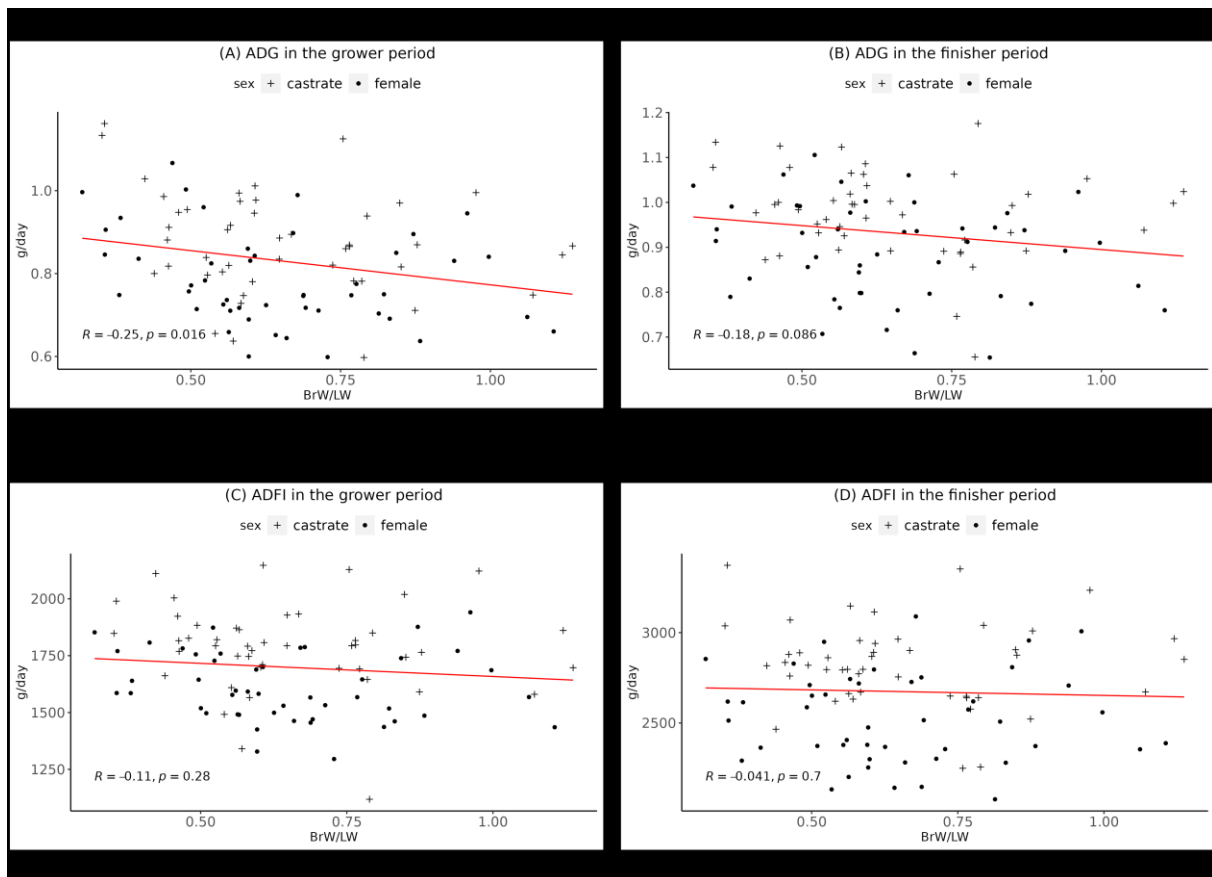
Supplementary Fig. S1. Effect of the brain-to-liver weight ratio (BrW/LW) and sex on the average daily gain (ADG, g/day) and average daily feed intake (ADFI, kg/day) of the pigs in the grower-finisher period. X-axis: BrW/LW; y-axis: ADFI in the grower (A) and finisher period (B); average daily gain (ADG) in the grower (C) and finisher period (D). R: Pearson correlation coefficient of the linear correlation; p: P-value of the linear correlation. Regression equations: ADG grower = (BrW/LW * (-0.17)) + 0.94; ADG finisher = (BrW/LW * (-0.11) + 1; ADFI grower = (BrW/LW * (-115.5) + 1773.9; ADFI finisher = (BrW/LW * (-61.1)) + 2713.
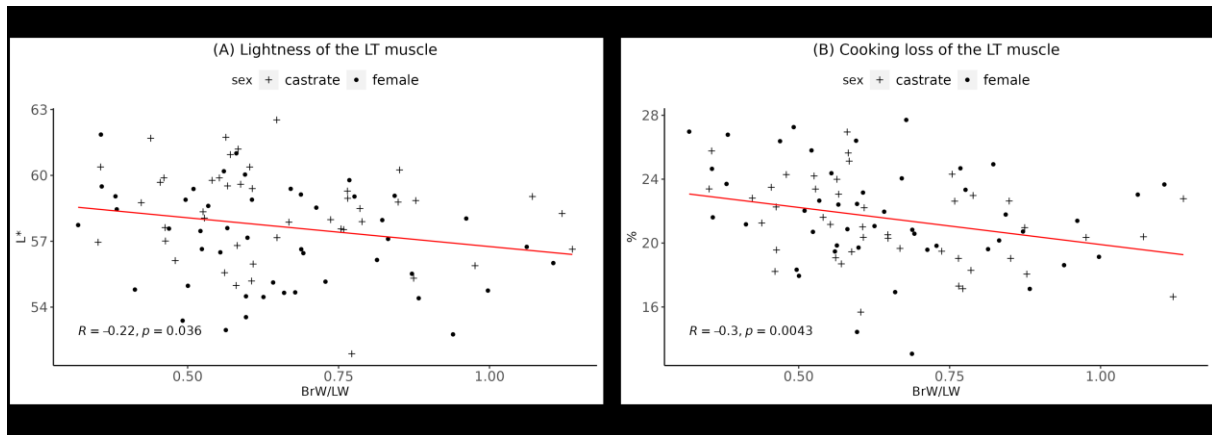
Supplementary Fig. S2. Effect of the brain-to-liver weight ratio (BrW/LW) and sex on meat quality of the pigs. X-axis: BrW/LW; y-axis: lightness (L*) value of the *longissimus thoracis* (LT) muscle (A); cooking loss (%) determined in the LT muscle (B); R: Pearson correlation coefficient; p: P-value of the linear correlation. Regression equations: L* = (BrW/LW × (-2.62)) + 59.4; cooking loss = (BrW/LW × (-0.05)) + 0.25.