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Effect of sire type and a by-product based diet on performance and meat quality in growing-finishing pigs

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ABSTRACT

For many years, pig production has focused on maximizing performance by selecting for maximal muscle growth and feeding diets that allow the animals to express their genetic potential. However, it is unclear whether this selection for muscle deposition has affected the capacity of pigs to cope with by-product-based diets, which rely on fat as the primary energy source instead of starches and sugars. Therefore, an experiment was set up to investigate if different types of boars affect how their progeny cope with alternative ingredients in the diet, with a possible need for adapted breeding schemes. Two types of boars within the Piétrain sire line were used based on either a high or low estimated breeding value for daily feed intake (**HFI**: high feed intake, low feed intake). When their progeny reached 14 weeks of age, two dietary strategies were compared: a control (**CON**) vs a by-product-based diet high in fat and fiber (**HFF**). The CON diet was mainly based on cereals (corn, wheat, barley) and soybean meal. The HFF diet was formulated to contain the same net energy, CP and digestible amino acid levels without any cereals or soybean meal. In total 192 animals were included in the experiment (48 animals/type of boar/diet) and performance, digestibility, carcass and meat quality were compared. None of the parameters showed a significant interaction ($P < 0.05$) between the type of boar and diet, suggesting that shifting to diets that are less prone to feed-food competition is equally feasible in different types of pigs. Type of boar did affect performance, carcass quality and intramuscular fat content. HFI pigs showed higher daily feed intake (**DFI**) and daily gain ($P < 0.001$), with no significant difference in feed conversion ratio ($P = 0.205$), lower carcass quality ($P < 0.001$) and higher intramuscular fat content ($P = 0.030$). For both boar types, pigs fed the CON diet performed better, with a higher daily gain ($P = 0.028$), DFI ($P = 0.011$) and dressing yield ($P = 0.009$) and better digestibility ($P < 0.001$), but without differences in feed conversion ratio or meat quality. In conclusion, there was no indication that pigs differing in feed intake capacity cope differently with a high-fat, high-fiber diet based on by-products. Different types of pigs may cope well with diets that are less prone to feed-food competition.

Implications

One of the challenges in animal production is food-feed competition, as feeds contain ingredients that can also be directly consumed by humans. Although a significant proportion of current diets already consist of human-inedible by-products, the shift to a more circular agriculture will eventually require exclusive feeding of by-products. By-products are often characterized by higher fiber levels and are less nutrient-dense, resulting in diets characterized by more fiber and fat. There were no indications that pigs with different breeding values for feed intake cope differently. Feeding with more sustainable diets does not appear to require any change in breeding goals.

Introduction

Intensive monogastric animal production is criticized in part because feeds contain a considerable proportion of ingredients that can also be consumed by humans (Déru et al., 2020). In Belgium, the edible protein efficiency of pig production is close to 1, which means that per gram of human-edible protein used, one gram of pork protein is obtained (De Cuyper et al., 2022). This relatively low number is related to the significant proportion of current pig diets already comprised of human-inedible by-products of the food

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and drink industry. However, according to the principles of circular agriculture, animal feed should consist almost exclusively of by-products (Van Zanten et al., 2019). Pigs are able to convert by-products from the food system into valuable food and manure and can therefore contribute to the human food supply while reducing the environmental impact of the entire food system (Van Zanten et al., 2019). By-products originating from industries such as milling, starch/sugar extraction or fermentation contain higher levels of fiber and are less dense in nutrients (Le Goff and Noblet, 2001). As a result, by-product-based diets may contain more fiber and are usually supplemented with fat to maintain dietary energy levels (Paternostre et al., 2021a). The energy source of the diet therefore (partially) shifts from starch and sugars to fat. Studies show that diets with higher inclusion of fiber and fat could limit the nutrient digestibility and feed intake of growing pigs. By-products vary in nutrient content as well as in availability over time, which can lead to increased variation in ingredient composition (Len et al., 2008; Jarrett and Ashworth, 2018; Manalaysay et al., 2019; Paternostre et al., 2021b). Moreover, the question can be raised whether the lower carbohydrate and higher fat level in the diet has an effect on postmortem muscle metabolism and eventually meat quality.

For several decades, pig production has focused on maximizing performance by selecting for maximal muscle growth and feeding diets that allow the animals to express their genetic potential. However, it is unclear whether the selection for muscle deposition has affected the capacity of pigs to cope with diets based on by-products, as reports in the literature are very limited (Déru et al., 2020). Research is needed to determine whether breeding goals require adaptation if alternative ingredients are used in the pig diet. To gain more insight into the effect of type of boar and the response of their progeny to diets rich in by-products, we designed an experiment to test the following hypothesis: crossbred slaughter pigs from Piétrain sires differentially selected for feed intake cope differently with high-fiber, high-fat diets based on by-products versus control diets and this has potentially an effect on their meat quality.

Material and methods

This experiment was approved by the Ethics Committee of Flanders Research Institute for Agriculture, Fisheries and Food (Melle, Belgium) (2021-401). The experiment was designed as a 2 × 2 factorial trial with genetic background and diet as factors.

Animals and management

Animals

The animals used in this experiment were born at the Flanders Research Institute for Agriculture, Fisheries and Food experimental farm. All piglets were a cross of a Piétrain sire line and a hybrid sow line (TN70, Topigs Norsvin). All hybrid sows used in this experiment were homozygous stress negative (*ryanodine receptor 1*), and the Piétrain sires were homozygous stress positive, resulting in heterozygous animals for the *ryanodine receptor 1 gene.* To obtain two genetically different groups, two types of boar were used within the Piétrain sire line: they had either a high feed intake (**HFI**) or low feed intake (**LFI**) estimated breeding value for daily feed intake **(DFI)** capacity (HFI: 149 ± 11; LFI: 82 ± 11). This choice of sire also implied differences in average estimated breeding value for growth rate (HFI:188 ± 10; LFI: 84 ± 24) and carcass quality (HFI: 107 ± 10, LFI: 141 ± 8) but not for feed conversion ratio **(FCR)** (HFI: 123 ± 6, LFI: 127 ± 12). For each type of sire, four boars were used (2 per round). Sows were inseminated twice with the semen of the same boar. The random assignment of the type of sire to the sows was stratified by parity.

The male piglets were castrated at birth after administration of 0.2 mL Metacam® (Meloxicam, 5 mg/mL) 15 min before castration for pain relief. Piglets were weaned at 4 weeks of age. In total, 192 animals were selected over two batches with a 3-week interval. For every individual boar (n = 4/round), four pens with six animals were set up (2 with barrows and 2 with gilts) from the offspring of three sows (Fig. 1).

Assignments of pens and housing

The average start pen weight of the selected animals was similar for the four pens, reflecting the average weight of this boars' progeny per sex. Before start of the experiment, from 4 to 9 weeks of age, the animals were housed in the nursery barn. They were divided over 32 pens with four pen replicates per type of sire, diet, and sex combination. The animals were housed in single-sex groups with six animals per pen. At 9 weeks of age, the animals were moved to the fattening barn, where the animals were kept with the same animals per pen. The experiment started in the fattening barn (9 weeks – slaughter). Each pen was assigned one of the two dietary treatments in a randomized complete block design: control diet **(CON)** vs high-fiber and high-fat by-product-based diet **(HFF).**

The fattening barn contained compartments of eight pens (2.0 m × 2.5 m), with thus in each compartment one pen per genotype × diet × sex combination. The animals had free access to water by a drinking nipple attached to the wall in the back of the pen and were fed *ad libitum* via fixed feeders located in front of the pen. At 15 weeks, 1 week after starting the grower diet of the test group (HFF), one animal per pen was removed from the experiment for euthanasia and tissue sampling (data not shown).

After 15 weeks, the animals were housed in groups of five animals per pen. The animals were slaughtered at 23 weeks if the average pen weight reached 108 kg one week before slaughter. The animals of the remaining pens were slaughtered at 26 weeks. In total, the pigs were slaughtered on three separate days and per pen: batch 1 (n = 52 animals): pigs from round 1 that reached the target weight at 23 weeks, batch 2 (n = 79 animals): other pigs from round 1 (n = 25) and pigs of round 2 (n = 54) that reached the target weight at 23 weeks, batch 3 (n = 23 animals): other pigs of round 2. The animals were fasted on average for 26 h (24:55–29:38 h) before slaughter. The average transport and lairage time were 02:16 h (01:30–03:50 h) and 02:16 h (01:30–02:40 h), respectively. The animals were slaughtered in a commercial

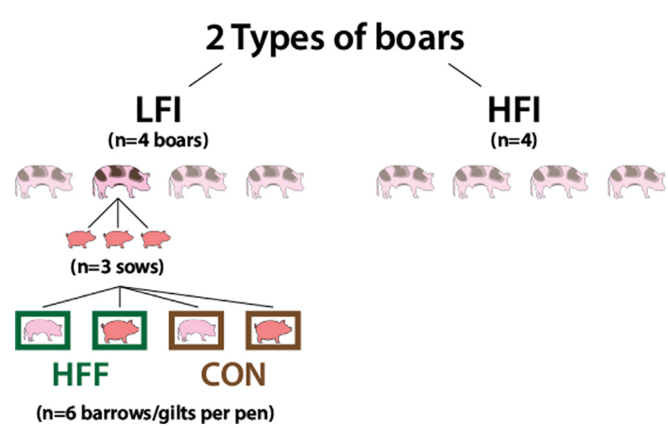

Fig. 1. Overview of the experimental setup of the selection of the fattening pigs. LFI = Low estimating breeding value feed intake; HFI = High estimating breeding value feed intake; HFF = High fat and fiber diet; CON = Control diet.

slaughterhouse (Covameat, Wijtschate, Belgium) by exsanguination after carbon dioxide stunning.

Diets

The animals were fed a three-phase diet. All the pigs received the same starter diet until 14 weeks of age. The HFF group received a grower diet between 14 and 20 weeks of age and a finisher diet between 20 weeks of age and slaughter. The CON group received a grower diet between 15 and 20 weeks of age, and a finisher diet between 20 weeks of age and slaughter. The CON diet was formulated in accordance with centraal Veevoeder Bureau (**CVB**) guidelines (CVB, 2007) and local standards (Tables 1 and 2). Main ingredients were cereals (corn, wheat, barley) and soybean meal. The HFF diet was formulated with the same nutrient constraints (same net energy, CP and digestible amino acid levels) but without using cereals or soybean meal. Analyzed values were in line with formulated values. To compensate for the higher fiber level in the HFF diet, the fat level was increased by increasing the proportion of bakery and cookie meal and animal fat. This resulted in a HFF diet with higher n-3 and n-6 polyunsaturated fatty acids and lower saturated and monounsaturated fatty acids compared to the CON diet (Table 3). To resemble the variation in feed ingredient composition, ingredients between grower and finisher varied more in the HFF than in the CON diet. Acid-insoluble ash (silicon dioxide, 10 g/kg) was added as a digestibility marker.

Performance

During the fattening period, the animals were weighed individually every week from the start of the experiment (9 weeks of age) until slaughter. At these time points, feed leftovers were weighed to calculate feed consumption, average daily gain (**DG**), DFI, gain-to-feed ratio (**G:F**) and FCR. The animals were also weighed just before slaughter and before transport to the slaughterhouse to calculate the fasting losses and carcass yield. Carcass gain to feed (g/g) was calculated according to the following formula (Chantziaras et al., 2020):

$$Carcass\ gain\ to\ feed = \frac{(cold\ carcass\ weight) - (starting\ weight\ x\ 0.72)}{feed\ intake}$$

Evaluation of digestibility

In the starter, grower and finisher period, 3 weeks after the switch to the HFF diet, fecal samples were collected from the rectum of at least two animals per pen during four consecutive days. The samples from the four days were pooled per pen, homogenized, frozen, and stored at −20 °C until analysis. The analyses for digestibility were performed at Flanders Research Institute for Agriculture, Fisheries and Food (Melle, Belgium). After freeze-drying using a CHRIST Beta 1–8 LSCplus freeze dryer (Martin Christ

Table 1
Ingredient composition of the diets (%) distributed to pigs during their finishing period, expressed on fed basis.

Ingredient	Starter (9–14/15 weeks)[1]	Grower (14/15–20 weeks)[2]		Finisher (20 weeks- slaughter)	
		CON	HFF	CON	HFF
Wheat	20.0	20.0	–	20.0	–
Maize	20.0	19.2	–	20.0	–
Barley	15.0	15.0	–	17.4	–
Corn germ meal	–	–	15.0	–	6.0
Soybean meal	10.0	8.0	–	6.0	–
Malt sprouts	–	–	9.5	–	11.2
Crispbread meal	–	–	9.4	–	8.0
Wheat middlings	5.0	8.0	14.3	8.0	20.0
Wheat gluten feed	5.0	5.0	5.0	5.0	9.3
Bakery and cookie meal	5.0	4.0	25.0	3.1	25.0
Proticorn	–	–	5.0	–	4.2
Sugar beet pulp	4.0	4.0	6.0	3.4	6.0
Sunflower meal	–	3.0	–	3.0	–
Beet molasses	3.0	3.0	3.0	4.0	4.0
Palm kernels	3.0	2.0	0.9	2.0	–
Rapeseed meal	2.3	1.3	0.7	3.0	0.4
Animal fat	1.5	1.0	1.6	1.0	1.9
Soybeans	0.6	–	–	–	–
Limestone	1.1	0.9	1.0	–	0.8
Premix*	1.0	1.0	1.0	1.0	1.0
Celite	1.0	1.0	1.0	1.0	1.0
Toasted soybeans	0.6	2.3	–	–	–
L-lysine HCL	0.6	0.4	0.6	0.4	0.5
Mono calcium phosphate	0.4	0.1	0.2	0.04	0.02
Salt	0.3	–	0.1	0.4	0.2
L-threonine	0.2	–	0.2	0.1	0.2
DI-methionine	0.2	0.1	0.2	0.08	0.1
Isoleucine/valine 50/50	–	–	0.1	–	0.1
L-valine	0.06	–	0.01	–	–
Ronozyme	0.01	0.1	0.1	0.1	0.1
L-tryptophan	0.05	0.02	0.05	0.02	0.03
Leucine/Valine 90/10	0.01	0.01	0.04	–	0.05

CON = control diet, HFF = high fat and fiber diet.
* The premix contained the following quantities of vitamins, amino acids and minerals per kilogram of diet: 12 000 IU vitamin A, 2 000 IU vitamin D3, 100 mg vitamin E, 3 mg vitamin K3, 2 mg vitamin B1, 8 mg vitamin B2, 5 mg vitamin B6, 25 mg calcium-D-pantothenate, 0.04 mg vitamin B12, 30 mg niacin, 550 mg choline, 4 mg folic acid, 0.50 mg biotin, 150 mg Fe, 15 mg Cu, 50 mg Mn, 70 mg Zn, 2 mg I, 0.4 mg Se, 18.3 mg lysine, 9.80 mg methionine, 18.3 mg threonine, 7.89 tryptophan, 3.31 mg BHT, 0.28 mg propyl gallate, 0.50 mg citric acid, 2 250 mg calcium carbonate, 273 mg magnesium oxide.
[1] HFF diet: 9–14 weeks, CON diet: 9–15 weeks.
[2] HFF diet: 14–20 weeks, CON diet: 15–20 weeks.

Table 2
Calculated[1] (analysed) nutrient composition of the diets (g/kg unless otherwise mentioned) distributed to pigs during their finishing period, expressed on fed basis.

Nutrient	Starter (9–14/15 weeks)[2]	Grower (14/15–20 weeks)[3]		Finisher (20 weeks- slaughter)	
		CON	HFF	CON	HFF
DM	885 (888)	884 (897)	896 (904)	879 (890)	893 (903)
CP	160 (157)	160 (159)	160 (160)	146 (143)	148 (151)
Crude fat	48.9 (50.7)	45.8 (45.3)	74.6 (73.0)	40.0 (37.3)	69.1 (66.5)
Crude ash	61.4 (58.7)	59.8 (57.5)	61.3 (58.2)	60.3 (57.6)	62.6 (61.4)
Crude fiber	40.0 (42.2)	45.0 (49.6)	60.0 (60.3)	45.0 (48.6)	67.3 (65.4)
Starch	353 (376)	349 (375)	246 (233)	371 (377)	241 (227)
Sugars	52.6 (54.1)	51.7 (54.6)	81.6 (93.3)	53.2 (55.4)	94.9 (104.3)
NSP[3]	210 (191)	221 (206)	295 (287)	207 (220)	289 (293)
ADF	54.9 (53.3)	58.6 (60.6)	75.9 (73.6)	59.0 (60.3)	82.9 (80.9)
ADL	10.9 (11.6)	11.9 (12.3)	15.8 (12.8)	12.9 (13.1)	16.6 (15.9)
NDF	137 (121)	148 (142)	209 (194)	152 (136)	214 (208)
Na	1.69 (2.01)	2.03 (2.32)	2.50 (2.11)	2.04 (2.27)	2.50 (2.51)
K	7.71 (7.91)	8.06 (8.35)	6.86 (7.11)	7.94 (8.16)	8.28 (8.57)
Cl	4.39	4.72	4.78	4.80	5.27
Ca	7.70 (7.57)	6.50 (6.54)	7.00 (6.73)	6.80 (6.82)	6.20 (6.00)
P	4.40 (4.89)	4.26 (4.67)	4.50 (4.86)	4.12 (4.39)	4.50 (4.91)
dP	2.90	2.50	2.50	2.30	2.30
SID LYS	9.60	8.50	8.50	7.50	7.50
SID M + C/LYS	0.60	0.61	0.61	0.61	0.61
SID THR/LYS	0.66	0.68	0.68	0.68	0.68
SID TRP/LYS	0.20	0.20	0.20	0.20	0.20
SID ILE/LYS	0.53	0.57	0.53	0.56	0.53
SID LEU/LYS	1.00	1.11	1.00	1.13	1.00
SID VAL/LYS	0.67	0.67	0.67	0.67	0.67
SID HIS/LYS	0.31	0.35	0.31	0.36	0.32
Gross energy	(14.9)	(16.7)	(17.5)	(15.7)	(17.2)
Nev (MJ/kg)	9.60	9.40	9.40	9.25	9.25

CON = control, HFF = high fat and fiber diet; NSPs = Non-Starch Polysaccharides; dP = Apparent fecal digestible phosphorus, SID = Standardized ileal digestible; LYS = lysine; M + C = methionine + cysteine; THR = threonine; TRP = tryptophan; ILE = isoleucine; LEU = leucine; VAL = valine; HIS = histidine; Nev = net energy value.
[1] According to (CVB, 2007).
[2] HFF diet: 9 – 14 weeks, CON diet: 9 – 15 weeks.
[3] HFF diet: 14 – 20 weeks, CON diet: 15 – 20 weeks.

Gefriertrocknungsanlagen GmbH, Germany), the samples were ground through a 1 mm screen using a knife mill (Brabender, Duisburg, Germany). First, the residual moisture was determined by drying at 103 °C and then analyses for CP, fat and acid-insoluble ash were performed. The CP was analyzed according to Kjeldahl (ISO 5983-2, 2005), and crude fat was extracted with petroleum ether after hydrolysis with HCL (ISO 6492, 1999). The acid-insoluble ash was determined according to McCarthy et al. (1974). The validity of using silicon dioxide is described in Supplementary Material S1.

The apparent total tract digestibility (**ATTD**) of the nutrients was calculated from the concentration of the nutrient in the feed and in the feces and the concentration of acid-insoluble ash in the feed and in the feces with the following formula (Wang et al., 2017):

$$ATTD = 1 - \left(\frac{\text{concentration of the nutrient in the feces}}{\text{concentration of the nutrient in the feed}}\right) * \left(\frac{\text{acid} - \text{insoluble ash feed}}{\text{acid} - \text{insoluble ash feces}}\right)$$

The standard digestibility coefficient (**STTD**) was calculated to correct the ATTD for endogenous losses which were considered as constant, namely 12.5 g/kg DM for CP and 5 g/kg DM for fat (Paternostre et al., 2021b).

$$STTD = \frac{\text{ATTD} * \text{concentration of the nutrient in the feces} + \text{endogenous losses}}{\text{concentration of the nutrient in the feed}}$$

Digestible energy was calculated as gross energy × the digestibility coefficient of gross energy. The net energy value of the diet was estimated according to the Dutch system using the formula (CVB, 2023):

net energy value (kJ/kg) = 11.70 × digestible CP + 35.74 × digestible crude fat + 14.14 × (starch + 0.90 × sugar) + 9.74 × digestibility of non-starch polysaccharides with digestible CP, crude fat and non-starch polysaccharides in g/kg, respectively, and the content in starch and sugars in g/kg, respectively. The digestible content of each component was calculated as its ATTD multiplied by its concentration.

Slaughter and carcass traits

At slaughter, the carcasses were weighed and quality parameters (e.g., lean meat percentage) were registered using the 'AutoFOM III' system (Frontmatec, Denmark). Dressing yield was calculated as the ratio of cold carcass weight over fasted live weight before transport to the slaughterhouse. Lean tissue gain (kg/day) was calculated according to the following formula:

$$\textit{Lean tissue gain} = \frac{(\textit{cold carcass weight} \times \textit{lean meat\%} \times 0.01) - (\textit{starting weight} \times 0.45)}{\textit{days in the fattening barn}}$$

Meat quality

Instrumental meat quality

At slaughter, the initial pH of the *m. longissimus thoracis et lumborum* was measured 35 min postmortem by puncturing the *m. longissimus thoracis et lumborum* around the 13th rib (3rd or 4th last rib) of the right carcass side with a pH sensor (type HI98163 pH meter, Hannah Instruments, electrode FC2323). One day later (24 h postmortem), the *m. longissimus thoracis et lumborum* of the right side of the selected carcasses was collected at the slaughterhouse and the ultimate pH was measured in triplicate. For one animal, the *m. longissimus thoracis et lumborum* could not be collected

Table 3
Analyzed fatty acid profile of the diets (g/100 g fatty acids) distributed to pigs during their finishing period on fed basis.

Fatty acid	Starter (9–14/15 weeks)[1]	Grower (14/15–20 weeks)[2] CON	Grower (14/15–20 weeks)[2] HFF	Finisher (20 weeks- slaughter) CON	Finisher (20 weeks- slaughter) HFF
C10:0	0.22	0.22	0.20	0.25	0.25
C12:0	2.76	1.97	0.86	2.40	0.68
C14:0	1.56	1.17	0.96	1.35	1.28
C15:0	0.07	0.08	0.09	0.11	0.13
C16:0	18.28	16.93	18.36	18.59	22.95
C17:0	0.17	0.16	0.17	0.19	0.19
C18:0	5.67	4.70	6.35	4.74	7.27
C20:0	0.29	0.15	0.32	0.26	0.34
C22:0	0.30	N.D.	0.16	0.04	0.04
SFA	29.32	25.38	27.46	27.93	33.14
C14:1	0.03	N.D.	0.06	0.01	0.08
C16:1	1.13	0.73	0.81	0.88	1.00
C17:1	0.14	0.14	0.11	0.12	0.12
c9C18:1	30.32	27.24	38.19	26.09	32.72
c11C18:1	2.01	1.93	1.82	2.17	1.92
C20:1	0.59	0.51	0.52	0.49	0.53
C22:1	N.D.	N.D.	N.D.	N.D.	N.D.
MUFA	34.23	30.56	41.52	29.76	36.36
C18:2n-6	32.02	39.93	27.53	38.24	26.02
C18:3n-6	N.D.	0.14	0.06	0.06	0.01
C20:2n-6	0.27	0.06	0.12	0.13	0.22
C20:3n-6	N.D.	N.D.	0.17	N.D.	0.18
C20:4n-6	0.13	0.06	0.08	0.07	0.10
C22:4n-6	0.04	N.D.	N.D.	N.D.	N.D.
C22:5n-6	N.D.	N.D.	N.D.	N.D.	N.D.
n-6 PUFA	32.46	40.20	27.96	38.50	26.53
C18:3n-3	2.29	2.88	1.84	2.54	2.26
C20:3n-3	0.07	0.02	0.02	0.03	0.03
C20:4n-3	N.D.	N.D.	N.D.	N.D.	N.D.
C20:5n-3	N.D.	N.D.	N.D.	N.D.	N.D.
C22:5n-3	0.02	N.D.	N.D.	N.D.	N.D.
C22:6n-3	N.D.	N.D.	N.D.	N.D.	N.D.
n-3 PUFA	2.39	2.90	1.86	2.57	2.29
Ratio UFA/SFA	2.36	2.90	2.60	2.54	1.97

CON = control, HFF = high fat and fiber diet, SFAs = lower saturated fatty acids, MUFAs = monounsaturated fatty acids, n-6 PUFAs = n-6 polyunsaturated fatty acids, n-3 PUFAs = n-3 polyunsaturated fatty acids, UFAs/SFAs unsaturated fatty acids /saturated fatty acids.
ND: not detected: < 1 mg/100 g feed.
[1] HFF diet: 9–14 weeks, CON diet: 9–15 weeks.
[2] HFF diet: 14–20 weeks, CON diet: 15–20 weeks.

in the slaughterhouse. Next, the *m. longissimus thoracis et lumborum* was trimmed for subcutaneous and intermuscular fat and sliced (2.0 cm thickness). The slices were sorted per measurement in the same order for each animal so that each measurement was carried out at the same anatomical location of the *m. longissimus thoracis et lumborum*. Drip loss was evaluated in triplicate according to the gravimetric EZ-drip loss method of Christensen (2003). Slices were stored vacuum-packed at −20 °C until analysis of cooking loss, Warner-Bratzler shear force (Boccard et al., 1981), carnosine (Barbaresi et al., 2019) and intramuscular fat content. Intramuscular fat content was analyzed using an in-house developed method using NIRS DS2500 (Foss Benelux) described in detail in the study of Kowalski et al. (2021). The Commission Internationale de l'Eclairage (**CIE**)-L*a*b* color determinants were measured by three repeated measurements with reflection spectroscopy (Hunterlab Miniscan, Reston, VA) after 30 min of blooming at 9 °C. The color measurements were repeated on days 3, 5, 7, and 8 to measure the color stability. To avoid dehydration of the meat, the samples were first wrapped in transparent kitchen plastic wrap and stored at 6 °C. On day 8, the meat slices were stored and vacuum-packed at −20 °C until the analysis of lipid oxidation through the determination of thiobarbituric acid reactive substances method using the method of Salih, Smith, Price, & Dawson (1987). In addition to the lipid oxidation, the color stability of the samples between days 3 and 8 was also assessed using the directional coefficient of the CIE a*-value. The validation of the intramuscular fat content method and the quality assurance of pH and color measurements are described in Supplementary Material S1.

Sensory evaluation

Sensory evaluation was performed by six out of 12 experts, all of whom had received the same training according to the method of Arildsen Jakobsen et al. (2014). Pork chops (± 2 cm) were heated on an electric grill (model GC3060, Tefal, Rumilly, France) to a core temperature of 72 °C. No fat, salt, or herbs were added. Each slice was evaluated for eight attributes on a visual analog scale from 0 to 100. The odor attributes were fried odor or piggy odor, and the taste attributes were juiciness first bite, juiciness third bite, tenderness, fried taste, piggy taste, and acid taste. Between samples, the experts cleansed their mouths with water and a cracker. In each session, nine pork samples were evaluated. The first sample was a test sample to avoid the first-order carryover effect and was followed by eight samples (1/treatment/sex). The meat was served in the same order to all panelists. To balance the effect of presentation and first-order carryover effects, a Williams design was used (Williams, 1949).

Statistical analysis

All statistical analyses were performed with R 4.0.2 (R Team, 2018). For all parameters, first a linear mixed model with both diet, sire type and their interaction and diet, sex and their interaction was analyzed; however, the diet/sex interaction was not significant for all parameters, thus, it was removed from the final models. Pen was considered as the experimental unit. For performance traits, the statistical analyses were executed for the whole period (9 weeks before slaughter) and the two feeding phases (before and after start of the dietary treatment): phase 1 (9–14 weeks) and phase 2 (14 - slaughter). Performance and digestibility traits were analyzed by a linear mixed effect model (lmer function in R) with sire type, diet, sex and the interaction between sire type and diet as fixed effects and round as a random effect. For carcass measurements, instrumental and sensory meat quality traits, a similar model was used with sire type, diet, sex, carcass weight and the interaction between sire type and diet as fixed effects. The unique pen ID was included as a random effect to account for repeated measurements within a pen. Slaughter date was also included as a random effect. For sensory meat quality traits, session numbers were also included as a random factor. Differences were considered as significant if $P < 0.05$ and as a trend when p was between 0.05 and 0.1 based on the Type III ANOVA table of the fixed effects. If the interaction term was not significant, the fixed factors diet and sire type were interpreted based on Tukey's posthoc test for the main effects. For the most economic important parameters (DG, digestible energy, DFI, FCR, G:F, dressing yield and lean meat content), a posthoc contrast and 95% confidence interval were used to evaluate how the two sire types cope differently with the two diets. The difference between the effect of diet in one sire type was compared with the effect of diet type in the other sire type. First, the estimated difference for each parameter for each sire type was calculated when the animals were fed the HFF diet compared to the CON diet. Subsequently, the difference between the above-calculated differences within a sire type was used to estimate the difference to cope with diet changes between the sire type, namely HFI vs LFI. The data were assumed to be sufficiently normally distributed based on the graphical examination (QQ plots and histograms) of the residuals of the models.

Results

Performance

Six animals were removed from the experiment due to illness. No significant sire type × diet interaction was observed for the performance traits (weight, DFI, DG, FCR, and G:F) (all $P > 0.307$). The weight at 9 weeks of age did not differ significantly (diet: $P = 0.948$, sire type $P = 0.205$) between the treatments. The offspring of the HFI sire type had a significantly higher ($P < 0.001$) DFI and DG for the whole period and the separated phases compared to the offspring of the LFI sire type (Table 4). The estimated differences between sire types for DG and DFI when fed different diets were 19.7 [−53.9;93.3, $P = 0.587$) and −13.1 [−153;127, $P = 0.849$), respectively. No significant difference in FCR and G:F between the offspring of HFI and LFI sire types was observed ($P > 0.05$). The estimated differences between sire types for FCR and G:F when fed different diets were −0.06 [−0.22;0.10, $P = 0.434$) and 0.01 [−0.02;0.04, $P = 0.403$), respectively. Pigs fed the CON diet had a significantly higher DFI and DG compared to the pigs fed the HFF diet in phase 2 (14 weeks - slaughter). Over the entire period (9 weeks - slaughter), DFI was significantly higher on the CON diet ($P < 0.05$) and a tendency to faster growth was observed in CON vs HFF pigs ($P = 0.066$). The final weight of the HFI pigs was significantly higher ($P < 0.001$) compared to the LFI pigs. Pigs fed the CON diet tended toward a higher final weight ($P = 0.075$) compared to pigs fed the HFF diet.

Digestibility and dietary energy content

No significant diet × sire type interaction ($P > 0.1$) and no effect of sire type ($P > 0.1$) on nutrient digestibility was observed (Table 5). During the grower period (14–20 weeks), a tendency to interaction was observed for both ATTD and STTD of crude fat ($P = 0.076$). A higher ATTD was observed for HFI pigs fed the HFF diet compared to the CON diet, but not for the LFI pigs. The STTD was higher for CON vs HFF for LFI pigs, but not for HFI pigs. In general, clear differences between diets on nutrient digestibility were observed. In both phases, the ATTD of organic matter, CP and gross energy and STTD of crude fat were lower in the HFF compared to the CON diet. The ATTD of crude fat was higher in the HFF vs CON diet during the grower phase. In the finisher phase, no difference in ATTD of crude fat was noted ($P = 0.951$). Digestibility of Non-Starch Polysaccharides (**NSP**) was higher in the HFF diet between 14 and 20 weeks, but lower between 20 weeks and slaughter. Between 14 and 20 weeks, digestible energy was higher in HFF than CON diet, while no significant difference in digestible energy level was observed between 20 weeks and slaughter. When estimating net energy based on the CVB formula (CVB, 2023), a slightly lower energy value was estimated in the HFF vs the CON diet. In the finishing period, this difference was higher.

Slaughter and carcass traits

No significant interactions between sire type and diet were observed for all carcass traits ($P > 0.564$) (Table 6). The fasted and cold carcass weights were significantly higher ($P < 0.05$) for the offspring of HFI sire type and for pigs fed with the CON diet compared to the other treatments. The fasting and dressing yield were significantly higher for the LFI pigs ($P < 0.001$) compared to the HFI pigs. Pigs fed the CON diet had a significantly higher dressing yield ($P < 0.05$) compared to those fed the HFF diet, but no effect on fasting yield was noted ($P > 0.1$). The lean meat content was significantly higher ($P < 0.001$) for the LFI compared to HFI pigs, but no effect on the lean tissue gain was noted. Neither lean meat content nor lean tissue gain were significantly influenced by diet ($P > 0.1$). The estimated differences between sire types for dressing yield and lean meat content when fed different diets were 0.18 [−0.72;1.07, $P = 0.687$) and 0.36 [−2.18;1.46, $P = 0.687$), respectively.

Meat quality

Due to the mechanical failure of the refrigerator in which the drip loss samples from slaughter day 2 were stored, data from these samples differed greatly from the other data. Drip loss data from slaughter day 2 were therefore removed from the dataset. The b*value at days 0 and 7 was significantly higher ($P < 0.05$) for LFI pigs compared to HFI pigs. The intramuscular fat content was significantly higher ($P < 0.05$) for HFI pigs compared to LFI pigs. For the other parameters (Table 7), no significant effect of sire type and diet or their interaction on meat quality traits of the loin (e.g. pH, color, water-holding capacity, thiobarbituric acid reactive substances, intramuscular fat, shear force, and carnosine) was observed, except the b*value at day 0 and day 7 and intramuscular fat level for sire type. In general, no significant effects were observed for sire type and diet and their interaction for any of the attributes of the sensorial evaluation (Table 7).

Discussion

Since their domestication, pigs have been used to valorize swill and temporarily store surpluses from the harvest (Leen, 2017). Since the 20th century, the role of pigs in the agricultural ecosys-

Table 4
Effect of sire type and diet on growth performance of pigs during fattening (mean values, expressed on fed basis).

	Sire Type		Diet			*P*-value*	
Traits	LFI	HFI	CON	HFF	RMSE	Sire[1]	Diet[1]
Number of pens	16	16	16	16			
BW, kg							
At 9 weeks	19.9	21.1	20.5	20.4	2.43	0.205	0.948
At slaughter, before fasting	121.0	128.0	126.0	122.8	5.43	<0.001	*0.075*
Daily feed intake, g/day							
9–14 weeks	1 537	1 770	1 660	1 647	111	<0.001	0.747
14 weeks - slaughter	2 548	3 000	2 845	2 702	148	<0.001	0.011
9 weeks - slaughter	2 219	2 559	2 439	2 340	96.1	<0.001	0.007
Daily gain, g/day							
9–14 weeks	864	1 002	929	937	68.4	<0.001	0.755
14 weeks - slaughter	963	1 144	1 081	1 025	67.5	<0.001	0.028
9 weeks - slaughter	930	1 093	1 029	995	50.6	<0.001	*0.066*
Feed conversion ratio, g/g							
9–14 weeks	1.79	1.77	1.79	1.77	0.08	0.543	0.429
14 weeks - slaughter	2.65	2.62	2.63	2.64	0.13	0.493	0.914
9 weeks - slaughter	2.39	2.34	2.37	2.36	0.11	0.205	0.664
Carcass gain: feed ratio, g/g	0.33	0.33	0.33	0.33	0.02	0.912	0.402

LFI = low feed intake; HFI = high feed intake, CON = control, HFF = high fat and fiber diet.
* Interaction between sire type and diet was not significant ($P > 0.307$).

Table 5
Effect of sire type and diet on nutrient digestibility of pigs during fattening and estimated energy content of the diets (mean values, expressed on fed basis).

	Sire Type		Diet			*P*-value		
Traits	LFI	HFI	CON	HFF	RMSE	Sire[1]	Diet[1]	S*D
Number of pens	16	16	16	16				
Apparent total tract digestibility coefficient - organic matter, %								
Phase 1	84.7	84.7	–	–	0.665	0.991	–	–
Phase 2	80.9	80.8	82.0	79.7	0.630	0.750	<0.001	0.260
Phase 3	80.1	80.1	83.8	76.3	0.678	0.959	<0.001	0.827
Apparent total tract digestibility coefficient - CP, %								
Phase 1	75.2	74.9	–	–	1.98	0.613	–	–
Phase 2	72.8	72.6	75.0	70.5	1.950	0.790	<0.001	0.313
Phase 3	73.8	74.3	77.6	70.5	1.944	0.498	<0.001	0.462
Apparent total tract digestibility coefficient - crude fat, %								
Phase 1	79.4	79.5	–	–	1.13	0.841	–	–
Phase 2	76.3	76.6	75.4	77.5	1.310	0.784	<0.001	0.076
Phase 3	74.2	73.9	74.1	74.0	1.904	0.614	0.951	0.433
Standardized total tract digestibility coefficient - CP, %								
Phase 2	80.7	80.4	82.9	78.3	1.950	0.790	<0.001	0.313
Phase 3	82.3	82.8	86.3	78.8	1.944	0.498	<0.001	0.462
Standardized total tract digestibility coefficient - crude fat, %								
Phase 2	85.2	85.4	86.4	84.3	1.310	0.784	<0.001	0.076
Phase 3	84.7	84.3	87.5	81.6	1.904	0.614	<0.001	0.433
Apparent total tract digestibility coefficient - gross energy, %								
Phase 1	81.2	81.3	–	–	0.786	0.690	–	–
Phase 2	79.6	79.5	80.6	78.5	0.665	0.978	<0.001	0.428
Phase 3	77.8	77.8	81.3	74.3	0.810	0.883	<0.001	0.838
Apparent total tract digestibility coefficient - non-starch polysaccharides, %								
Phase 1	59.5	60.0	–	–	1.510	0.393	–	–
Phase 2	56.7	57.1	51.2	62.2	1.146	0.861	<0.001	0.121
Phase 3	55.5	55.4	57.8	53.1	1.131	0.693	<0.001	0.514
Digestible energy, MJ								
Phase 1	12.1	12.2	–	–	0.115	0.690	–	–
Phase 2	13.6	13.6	13.5	13.8	0.115	0.956	<0.001	0.436
Phase 3	12.8	12.8	12.8	12.8	0.135	0.877	0.176	0.835
Net energy, MJ								
Phase 1	9.9	9.9	–	–	0.059	0.868	–	–
Phase 2	9.6	9.6	9.6	9.6	0.067	0.931	0.003	0.703
Phase 3	9.3	9.3	9.6	9.1	0.077	0.875	<0.001	0.606

LFI = low feed intake; HFI = high feed intake, CON = control, HFF = high fat and fiber diet, S*D = sire line × diet interaction
[1] *P*-values of Tukey's posthoc test for the main effect in case of a non-significant interaction between sire type and diet.

Table 6
Effect of sire type and diet on carcass traits of pigs (mean values).

Traits	Sire Type		Diet		RMSE	P-value*	
	LFI	HFI	CON	HFF		Sire[1]	Diet[1]
Number of animals	76	78	78	76			
Fasted weight (kg)	118.1	124.8	123.7	119.0	9.53	<0.001	0.004
Cold carcass weight (kg)	93.6	98.2	98.3	93.6	7.78	<0.001	<0.001
Fasting yield (%)	97.90	96.90	97.50	97.20	0.83	<0.001	0.280
Dressing yield (%)	79.30	78.60	79.40	78.50	1.02	<0.001	0.009
Lean meat content (%)	64.40	62.20	62.90	63.70	1.87	<0.001	0.585
Lean tissue gain (kg/day)	0.468	0.519	0.503	0.484	0.02	0.100	0.601

LFI = low feed intake; HFI = high feed intake, CON = control, HFF = high fat and fiber diet.
* Interaction between sire type and diet was not significant ($P > 0.564$).
[1] P-values of Tukey's posthoc test for the main effect in case of a non-significant interaction between sire-type and diet.

Table 7
Effect of sire type and diet on instrumental meat quality traits of pigs (mean values).

Traits	Sire Type		Diet		RMSE	P-value*	
	LFI	HFI	CON	HFF		Sire[1]	Diet[1]
Number of animals	75	78	77	76			
Instrumental meat quality							
Initial pH	6.55	6.56	6.55	6.56	0.21	0.887	0.961
Ultimate pH	5.49	5.51	5.50	5.49	0.08	0.432	0.869
Drip loss (%)[2]	8.71	8.71	8.46	9.04	1.63	0.969	0.716
Lightness (L*) day 0	55.0	54.2	54.9	54.3	2.25	0.210	0.101
Redness (a*) day 0	7.23	7.33	7.16	7.40	0.85	0.782	0.487
Yellowness (b*) day 0	15.7	15.5	15.6	15.6	0.65	0.009	0.712
Lightness (L*) day 3	58.7	58.9	59.1	58.5	2.08	0.873	0.201
Redness (a*) day 3	9.62	9.56	9.41	9.78	0.95	0.899	0.182
Yellowness (b*) day 3	16.7	16.6	16.6	16.8	0.48	0.186	0.660
Lightness (L*) day 5	58.3	58.4	58.7	58.0	2.16	0.792	0.238
Redness (a*) day 5	8.56	8.70	8.45	8.82	0.92	0.482	0.117
Yellowness (b*) day 5	16.3	16.2	16.2	16.3	0.44	0.433	0.313
Lightness (L*) day 7	58.6	58.8	59.1	58.4	2.06	0.559	0.193
Redness (a*) day 7	8.08	8.00	7.95	8.13	0.82	0.932	0.288
Yellowness (b*) day 7	16.1	15.8	16.0	16.0	0.39	0.014	0.993
Lightness (L*) day 8	59.4	59.5	59.8	59.1	1.99	0.939	0.172
Redness (a*) day 8	7.34	7.50	7.34	7.50	0.78	0.867	0.256
Yellowness (b*) day 8	15.5	15.8	15.6	15.7	0.43	0.342	0.295
Color stability	−2.50	−2.83	−2.79	−2.54	0.78	0.424	0.743
Thiobarbituric acid reactive substances (µg malondialdehyde/ g)	0.96	0.917	0.96	0.92	0.59	0.722	0.765
Cooking loss (%)	33.0	33.1	32.9	33.2	1.88	0.370	0.192
Shear force (N)	39.2	43.1	41.2	41.1	9.84	0.741	0.441
Intramuscular fat (%)	2.01	2.25	2.17	2.09	0.44	0.030	0.169
Carnosine (mg/100 g)	268	291	256	302	102	0.645	0.161
Sensory evaluation[3]							
Fried odor	35	30	30	34	16.0	0.115	0.327
'Piggy' odor	19	20	20	20	7.58	0.670	0.876
Juiciness 1st bite	45	46	46	45	10.7	0.493	0.476
Juiciness 3rd bite	42	44	43	43	10.7	0.674	0.775
Tenderness	43	45	45	43	9.59	0.669	0.903
Fried taste	25	23	23	25	12.6	0.649	0.476
'Piggy' taste	24	23	23	23	5.55	0.607	0.857
Acid taste	15	14	14	15	5.41	0.475	0.818

LFI = low feed intake; HFI = high feed intake, CON = control, HFF = high fat and fiber diet.
* Interaction between sire type and diet was not significant ($P > 0.288$),
[1] P-values of Tukey's posthoc test for the main effect in case of a non-significant interaction between sire-type and diet.
[2] only samples of slaughter days 1 and 3 (number of samples: LFI = 41; HFI = 34; CON = 33; HFF = 42).
[3] on a visual analog scale from 0 to 100.

tem has changed dramatically. Falling cereal prices sparked an increase in pig production. After a decrease in the added value of cereal production, specialized pig husbandry emerged in order to create more added value (Leen, 2017). The current framework of circular food production cycles back to the pigs' original role as a converter of by-products of food production into valuable food and manure (Van Zanten et al., 2019). Within a modern context, the question arises whether genetic selection for maximal performance has affected the pigs' capacity to cope with by-products. The Belgian Piétrain is known for its extreme leanness, in part because of its limited feed intake and therefore reduced fat deposition. Selection is traditionally done by testing the progeny of sires under standardized conditions with a high-quality feed to allow them to express their genetic potential. In this trial, we compared sires differing in estimating breeding values for feed intake, gain and carcass quality. This was reflected in the performance of their progeny: the HFI pigs ate >300 g/day more and grew 100 g/day faster, with no difference in FCR. This is in accordance with previous observations (Kowalski et al., 2021). However, no interaction was observed in the way the animals coped with their diets. Therefore, the hypothesis that pigs differentially selected for feed intake cope differently with fiber-rich by-product- based diets was not confirmed in this trial.

For both phenotypes, the switch to the high-fiber, high-fat HFF diet resulted in a lower DFI and DG compared to the CON diet, with no apparent difference in FCR and (carcass)G:F. In this study, the inclusion of fat compensated for the lower energy content of fibrous feedstuffs, whereas in other studies, mostly one aspect was investigated (Len et al., 2008; Liu et al., 2018; Déru et al., 2020; Pu et al., 2022). In general, it is assumed that pigs eat to fulfill their energy requirements (Henry, 1985) and therefore increasing dietary fat levels often leads to decreased feed intake (Liu et al., 2018). In the present paper, however, diets were formulated to be iso-energetic. Based on the calculated net energy values, we were fairly successful in reaching this in the second phase (14–20 weeks), but in the last phase (20 weeks of slaughter), the estimated energy content of the HFF diet was clearly lower than anticipated. Theoretically, this should lead to higher feed intake (and lower FCR), but the opposite happened.

An explanation for the lower feed intake in the HFF may be that both fat and fiber may affect satiation and satiety. Satiation refers to physiological responses during feed consumption that leads to a cessation of eating, whereas satiety refers to physiological responses that delay taking the next meal (Benelam, 2009). The bulking and textural properties of fiber may affect preabsorptive factors, such as gastric distention and the work and time required for chewing. As such, they may enhance satiation (Slavin and Green, 2007). Lipids arriving in the distal part of the small intestine may trigger the ileal brake, a negative feedback mechanism with inhibition of proximal gastrointestinal motility and secretion, eventually leading to increased feelings of satiety and reduced *ad libitum* food intake (Maljaars et al., 2008). In general, digestibility of nutrients is lower in high-fiber diets (Paternostre et al., 2021b). It is therefore quite possible that the higher fiber and fat levels may have caused higher fat levels at the end of the small intestine, triggering these feedback mechanisms and contradicting the generally accepted assumption (Henry, 1985) that energy content is the driving factor for feed consumption. Similarly, Déru et al. (2020) observed that animals receiving a high-fiber diet did not compensate for the energy content reduction by increasing their voluntary feed intake.

The digestibility of most nutrients was higher for pigs fed the CON diet compared to the HFF diet; this is in accordance with other studies of Jarrett and Ashworth (2018), Len et al. (2008) and Pu et al. (2022). Jarrett and Ashworth (2018) noted that when pigs are fed diets rich in dietary fibers, the associated reduction in protein digestibility can be explained by the bulking capacity of dietary fibers. This bulking capacity leads to a reduction in the transit time of the feed in the small and large intestines and consequently reduces the duration of the exposure of the diet to the intestinal digestive enzymes. Another reason may be that an increase in the dietary fiber content leads to increased ileal losses of both endogenous and exogenous protein (Schulze et al., 1994). In contrast to the lower digestibility of protein in the HFF diet, a higher apparent fecal fat digestibility was observed for the HFF diet in phase 2 for the HFI animals but not for LFI animals. One reason may be that the higher fat levels lead to relatively lower endogenous losses. Paternostre, De Boever et al. (2021b) observed that standardized total tract fat digestibility was lower in a high-fiber diet, but when extra fat was added, the standardized digestibility did not differ. This was confirmed in our study, as the STTD of crude fat was higher for the pigs fed with the CON diet vs HFF, but only for the LFI and not for the HFI animals.

Dietary energy levels calculated based on digestible nutrient contents were higher than those formulated (9.9, 9.6, and 9.3 vs 9.6, 9.4 and 9.25 for the first, second and third phases). The feed formulation software was running on the feeding tables from 2007 (CVB) and in the meantime, the formula for estimating net energy has been changed (Blok et al., 2015), generally leading to slightly higher values. Especially in the last phase, the estimated energy level in the HFF diet was lower than anticipated, which is somewhat unexpected. Dietary nutrient levels were in line with formulated values. In contrast to the second phase, however, measured NSP digestibility was lower in the HFF than in the CON diet, while an important part of the energy comes from large intestinal fermentation (9.74 MJ per g of fermentable NSP). While in the second phase, net energy from NSP fermentation was deduced to be 1.7 in the HFF vs 1.0 in the CON diet, in the third phase, this was 1.5 for HFF vs 1.2 in the CON diet. This may be a result of the choice of ingredients. Still, one should be careful in interpreting these results, since the carcass gain per kg feed was similar in the two groups, indicating fairly similar energy levels and energy efficiency in both diets.

The offspring of LFI sires had higher fasting and dressing percentage and higher lean meat content compared to HFI offspring. This seems to be a logical consequence of the difference in feed intake. Higher daily feed intake leads to more gut fill as well as a heavier digestive tract (Gispert et al., 2010, Latorre, Medel, Fuentetaja, Lázaro, & Mateos, 2003), although this contradicts the findings of our previous study (Kowalski et al., 2021). In contrast, despite the lower feed intake on the HFF diet, there was no difference in fasting yield, but the dressing percentage was higher for CON vs HFF. The latter is likely a result of a higher fiber level, as fiber digestion affects the structure and function of the intestine and consequently the size and weight of the visceral organs and gastrointestinal tract (Jarrett and Ashworth, 2018), as also observed by Déru et al. (2020), Jaturasitha, Kamopas, Suppadit, Khiaosa-ard, & Kreuzer (2006) and Li et al. (2021). Jarrett and Ashworth (2018), Len et al. (2008) and Millet et al. (2012) stated that this effect of high fiber diets on carcass yield may mask the lower feed efficiency. Indeed, the feed conversion ratio was similar between the two dietary treatments, despite the lower feed intake.

The lean meat content of the offspring of LFI sires was higher compared to HFI but lean tissue gain was similar for both types of boars. Therefore, the increased feed intake led to a higher fat deposition and thus a lower lean meat content. The intramuscular fat level was higher for HFI compared to LFI pigs, which coincides with the overall higher fat deposition. This was the only significant difference found between both type of boars. In general, only a few studies have investigated the effect of feed ingredient composition on the technological and sensorial quality of meat (Li et al., 2021). In our study, the effects of both sire types differentially selected for feed intake and dietary ingredient composition on meat quality were very limited despite large differences in phenotype and type of diet.

Conclusion

In general, there was no indication that pigs differing in feed intake capacity cope differently with a high-fat, high-fiber diet based on by-products. This suggests that even different types of pigs may cope well with diets that are less prone to feed-food competition. Type of boar affected the performance and fatness of the animals, while diet affected nutrient digestibility and carcass yield, with limited effects on growth performance. Meat quality was only slightly affected by the type of boar and not by the type of diet.

Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.animal.2024.101106.

Ethics approval

This experiment was approved by the Ethics Committee of Flanders Research Institute for Agriculture, Fisheries and Food (Melle, Belgium) (2021-401).

Data and model availability statement

The model was not deposited in an official repository. The data that support the study findings are available from the authors upon request.

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 declare that there is no conflict of interest for this manuscript.

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