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Carcass quality and uniformity of heavy pigs fed restrictive diets with progressive reductions in crude protein and indispensable amino acids

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ABSTRACT

This study investigated the effects of four dietary treatments characterized by 0 to 20% progressive reduction of the dietary crude protein (CP) and indispensable amino acid (AA) contents on carcass quality and uniformity of pigs fed restrictively and slaughtered around 165 kg body weight (BW). Carcass data from 233 pigs from a feeding study that involved 3 batches of 80 crossbred pigs each were used. Pigs, offspring of 12 boars, were assigned to 1 of 4 dietary treatments (10 pigs per pen, gilts and barrows, and 2 pens per treatment in each batch) with diets formulated to contain 146 to 117 and 133 to 108 g/kg of CP and 7.3 to 5.8 and 5.7 to 4.7 g/kg of total Lys in early (90 to 130 kg BW) and late (130 to 165 kg BW) finishing, respectively. After slaughter, the carcasses were processed and the weight of the commercial lean (neck, loin, shoulder, and ham) and fat cuts (backfat, belly, and jowl) was recorded. The coefficient of variation was used to describe uniformity of the most important carcass traits, and the corresponding confidence intervals were computed to make comparisons across dietary treatments. Carcass weight and midline backfat thickness averaged 137 kg and 31 mm, respectively, and were not affected by diets. Diets did not influence the weight of commercial cuts and their proportion on carcass weight, with the sole exception of loins. Pigs fed diets containing the 2 lowest CP content had a slight lower proportion of loins in the carcass compared with pigs fed the conventional CP diet ($P < 0.05$). Most carcass traits were affected by sex and by sire effects, but interactions between diet and sex or sire was only episodic. Uniformity of carcass weight, backfat thickness, and weight of loins and dressed hams was not influenced by the dietary treatments. In conclusion, the content of CP, Lys, and other indispensable AA of conventional diets for finishing heavy pigs may be reduced by 20% without impairing the weight of carcass and primal cuts and the yields of dressed hams. This feeding strategy will contribute to the heavy pig industry by reducing feed costs (i.e., decreasing the dietary provision of soybean meal and crystalline AA) and minimizing the nitrogen excretion, without affecting carcass quality.

1. Introduction

The increasing cost of protein sources and the need of decrease the environmental impact of animal production are encouraging studies that evaluate the effect of low-protein diets on the production performance (Gallo et al., 2014),

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the quality of products (Wood et al., 2013), and the N excretion (Bunger et al., 2014). Under some conditions a decrease in the dietary crude protein (CP) level has been found to favorably affect feeding costs (Schiavon et al., 2013), slurry management costs (Schiavon et al., 2009) and the need of cropland for a proper slurry distribution (Smith et al., 2000).

Pigs fed diets with inadequate protein concentration had decreased growth rates, feed efficiency, and carcass lean percentage, and had increased carcass fat content (Kerr et al., 1995; Ruusunen et al., 2007). These traits were not affected when these diets were supplied with Lys and other indispensable amino acids (AA) according to the optimum dietary AA balance concept (Hernández et al., 2011; Hinson et al., 2009; NRC, 2012), even if some reports indicate that the fat deposition may be influenced (Kerr et al., 1995; Tuitoek et al., 1997; Wood et al., 2013).

The Italian pig industry deals with heavy pigs, slaughtered at 165 kg body weight (BW) and 9 months old, to yield fresh hams processed within the Protected Designation of Origin (PDO) dry-cured hams consortia, according to specific rules (EEC, 1992; EU, 2012). Feed restriction is applied to achieve a growth rate consistent with the production targets (Cesaro et al., 2013), and a further protein restriction may be required in current fast-growing pig lines (Bosi and Russo, 2004). The optimal protein and AA allowances for finishing heavy pigs according to the production goal have not been defined (Mordenti et al., 2003). Commercial feeds for heavy pigs from 90 to 165 kg BW commonly provide 150 to 130 g CP/kg and 7.0 to 6.5 g Lys/kg feed (European Commission, 2003). In previous studies investigating the effects of decreased dietary CP contents, the diets for heavy pigs were supplemented with crystalline AA to keep the concentration of indispensable AA per kilogram of feed comparable to that of conventional diets, and no change was observed in growth performance (Galassi et al., 2010; Prandini et al., 2013). Recently, Gallo et al. (2014) reported that diets containing only 117 or 108 g CP/kg and 5.8 or 4.6 g total Lys/kg were adequate to support the required growth performance of PDO heavy pigs in the ranges of 90 to 130 or 130 to 165 kg BW, respectively. However, effects on carcass quality of a concurrent restriction of protein and AA contents of the diets have not been explored yet. This study investigated the effect of decreasing dietary CP and indispensable AA content in comparison with current conventional diets on carcass quality and uniformity of fed-restricted heavy pigs aimed at the dry-cured ham PDO industry.

2. Materials and methods

2.1. Pigs, diets and experimental design

Readers are referred to Gallo et al. (2014) for details regarding the pigs and their diet characteristics, growth performance, estimated N and energy balance. All experimental procedures were reviewed and approved by the Ethical Committee for the Care and Use of Experimental Animals of the University of Padova (Italy).

Briefly, 3 batches of 80 crossbred pigs each (120 gilts and 120 barrows), representing the offspring of 12 boars (C21 Sire Line; Goland, Gorzagri, Fonzaso, BL, Italy) mated to 32 Large White-derived crossbred sows, were used. The 12 boars involved were partitioned across the batches as follows: 4 sires in the 1st batch, 4 different sires in the 2nd batch and 3 other sires in the 3rd batch, with the remaining 1 boar present in all batches as the sire of connection. In each batch, 20 pigs were allotted to 1 of 4 dietary treatments: conventional, CONV; medium-high-protein, MHP; medium-low-protein, MLP; and low-protein, LP. These were formulated by replacing soybean meal with wheat grain to yield 146 to 117 and 133 to 108 g CP/kg for the feeding of early finishing (90 to 130 kg BW) and late finishing (130 to 165 kg BW) pigs, respectively (Table 1). The main ingredients of the diets were corn grain, barley grain, wheat grain, soybean meal, and wheat bran, and all diets provided 13.1 MJ of ME/kg, according to NRC (2012). Small amounts of crystalline AA were added to provide the diets with the same amounts of indispensable AA per unit of CP within each period. The conventional diets provided an average of 6.5 g/kg feed in total Lys, whereas the dietary total Lys contents were 6.0, 5.7 and 5.2 g/kg in the MHP, MLP, and LP diets, respectively. Synthetic AA other than Lys were included in all diets in the same proportions relative to Lys content. Pigs were allotted to dietary treatments on the basis of individual BW, sex and sire of origin, so that the number of barrows and gilts, the

Table 1
Chemical composition and calculated ME, NE, and Lys content (g/kg as-fed, unless otherwise indicated) of early (90 to 130 kg BW) and late (over 130 kg BW) finishing diets[a].

Item	Early finishing diets[b]				Late finishing diets			
	CONV	MHP	MLP	LP	CONV	MHP	MLP	LP
Analyzed composition[c]								
DM	881	880	878	883	885	885	884	884
CP (N × 6.25)	146	135	127	117	133	121	112	108
Starch	426	434	451	455	436	454	470	476
Energy and Lys content[d]								
ME (MJ/kg)	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1
NE (MJ/kg)	9.8	9.9	9.9	10.0	9.9	10.0	10.0	10.0
Total Lys	7.3	6.8	6.4	5.8	5.7	5.2	5.0	4.7

[a] Ingredient, chemical, and nutrient composition of diets are detailed in Gallo et al. (2014).
[b] CONV, conventional diet, high-protein content; MHP, medium-high-protein diet; MLP, medium-low-protein diet; and LP, low-protein diet.
[c] Analytical results were obtained according to AOAC (2003) by averaging data from 3 independent replications.
[d] Computed from dietary ingredient composition according to NRC (2012).