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Effect of coarse ground corn, sugar beet pulp and wheat bran on the voluntary intake and physicochemical characteristics of digesta of growing pigs

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Abstract

The aim of this work was to evaluate the influence of a coarse ground cereal and two fibrous ingredients incorporated in the diet on the physicochemical properties of digesta and productive parameters of pigs during the first stage of the growing period. A total of 96 pigs (initial body weight, BW, 15 kg) were distributed into four experimental treatments: the control diet (CT) consisted of corn, barley and soybean meal milled to pass through a 2.5 mm screen; the coarse corn diet (CC) was prepared by milling the corn to a coarser particle size (4.0 mm screen); the sugar beet pulp diet (SBP) and the wheat bran diet (WB) were prepared by replacing some of the corn for sugar beet pulp (80 g/kg) or wheat bran (100 g/kg) respectively, in order to contain a higher amount of non-starch polysaccharides (NSP). Three experimental periods were considered (7, 21 and 42 days) during which body weight (BW) and voluntary feed intake were assessed. At the end of each period eight animals per diet were slaughtered. Weight of the gastrointestinal tract and its compartments (full and empty) was recorded and the contents were sampled. Digesta samples were analysed for water concentration, water retention capacity (WRC), ammonia and short-chain fatty acids concentration (SCFA). Histological study of the proximal colon tissues was also performed. In general, the different parameters evaluated showed differences between the experimental periods, but few interactions were recorded. Animals fed CC, SBP and WB diets presented a lower feed intake ($P \leq 0.009$) compared to CT fed animals. Compared to the control diet, coarse grinding of corn provoked an increase in the colonic digesta content ($P = 0.032$). Similarly, animals fed the SBP diet compared to CT animals, showed an increase in the contents ($P = 0.009$) of hindgut, and in the concentration of water in the digesta ($P \leq 0.011$). Compared to CT diet the SBP diet lowered the ammonia concentration in the hindgut contents ($P \leq 0.045$) and increased the concentration of SCFA in the distal colon ($P \leq 0.025$). Animals fed the SBP diet also showed a lower number of lymphoid nodes in the colonic mucosa compared to the other diets ($P \leq 0.043$). Minor modifications were observed associated with the incorporation of wheat bran in the diet, but colonic water from WB fed animals showed a tendency to increase cytolytic capacity. The results confirm major changes in the voluntary intake and physicochemical properties of digesta as affected by the incorporation in the diet of a fibrous ingredient or coarse grinding of cereals.

Keywords: Growing pigs; Dietary fibre; Physicochemical properties; Cytolysis

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1. Introduction

The incorporation of fibrous or coarse ground ingredients may result in a reduction of the energy value of the diets fed to pigs (Graham et al., 1986; Bach Knudsen and Hansen, 1991; Wondra et al., 1995; Noblet and Le Goff, 2001), due to the shift of the site of energy digestion from foregut to hindgut. These modifications in the diets may also cause decreases in the voluntary intake of the animals as a consequence of the gut filling, compromising the energy intake of pigs during the growing stage (Giles and Black, 1998). For pigs between 12 and 40 kg the capacity for dealing with the digesta bulk is directly proportional to the body weight of the animals (Kyriazakis and Emmans, 1995). Thus, the adaptation to bulky foods with increasing animal body weight has been related to increases in the gut size and thus in gut capacity (Whittemore et al., 2003).

The content of dietary fibre and the feed particle size influence to some extent the digestive processes in the gastrointestinal tract (GIT, Cummings and Englyst, 1995), the physicochemical characteristics of digesta (Canibe and Bach Knudsen, 2001; Mikkelsen et al., 2004), gut morphology (Jorgensen et al., 1996), and mucosal maturation and integrity (Goodlad et al., 1995; Stark et al., 1995; Brunsgaard, 1998). The effects of dietary fibre and feed form on the gastrointestinal tract physiology can be direct or indirect. Direct effects such as modification of viscosity, water retention capacity or rate of digesta passage, are important throughout the GIT but are especially relevant in the stomach and small intestine (Ellis et al., 1995; Glitso et al., 1998; Mikkelsen et al., 2004). Indirect effects gain relevance in the hindgut where most of the fermentation process takes place, and releases short-chain fatty acids (SCFA, mainly acetate, propionate and butyrate), organic acids (formate, lactate) and gases. In the hindgut, concentration of undigested residues, water, and fermentation products may settle the environment to which colonic mucosa is exposed, leading to different responses in the colonic mucosa integrity (Brunsgaard, 1998).

The use of fibrous ingredients in pig nutrition is supported by the low price and also by some beneficial effects reported on animal health (Tabeling et al., 2003) and welfare (de Leeuw et al., 2004). However, a general assumption on the DF effects on the animals may not be valid, due to the complex composition of the carbohydrate fraction in the fibrous ingredients.

The present study evaluates the effects caused by the coarse grinding of corn and the incorporation of sugar beet pulp or wheat bran, on the composition and the physicochemical properties of digesta, and its relationship to physiological responses in pigs during the first stage of the growing period.

2. Material and methods

2.1. Animals and feeding

A total of ninety-six male and female pigs ([Large White × Landrace] × Pietrain) of 15 ± 0.2 kg initial body weight (BW) were allocated in the experimental farm of the Universitat Autònoma de Barcelona, which is equipped with four rooms with eight pens each (1.0 m × 1.8 m). Pigs were distributed into the rooms according to their BW and received the experimental diets from the first day, resulting in a total of eight replicates per treatment (three animals per pen and two diet replicates per room). Each pen had a feeder and a water nipple to ensure *ad libitum* feeding and free water access.

Dietary treatments consisted of four dry mash diets (Table 1) formulated according to the nutritive value of ingredients and to the requirements of growing pigs as described by NRC (1998). Diets were balanced for ME (13.47 MJ/kg feed) and lysine (1.11%). The control diet (CT) consisted of corn, barley and soybean meal milled to pass through a 2.5 mm screen diameter. The control diet was modified to obtain the three experimental diets: the coarse corn diet (CC) was prepared by grinding the corn to a coarser particle size (4.0 mm screen diameter); the sugar beet pulp diet (SBP) was prepared by replacing some of the corn with sugar beet pulp (8%), and the wheat bran diet (WB) was prepared by replacing corn with wheat bran (10%). Mean particle size of experimental diets, determined as stated by Pfost and Headley (1976), was 472 μm in CT, 557 in CC, 528 in SBP and 578 in WB. Diets contained 0.15% of Cr_2O_3 as a digestibility marker.

2.2. Experimental procedures

The experiment lasted 42 days, and three experimental periods were considered (up to days 7, 21 and 42) to evaluate the time course adaptation of growing pigs. On the last day of each experimental period, body weight, feed intake and feed efficiency were assessed, and the heaviest animal from each pen was killed, resulting in eight animals slaughtered per diet and experimental period. Before slaughtering, the animals were submitted to a controlled feed intake pattern, which permitted the standardization of gastrointestinal tract contents. The intake protocol consisted of