Dietary energy density affects the preference for protein or carbohydrate solutions and piglet performance after weaning

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ABSTRACT: Physiological state or dietary nutrient content can be determinants of the sensory perception with consequences for feed preferences. The aim of the present study was to assess whether the preference for protein or carbohydrate of piglets is affected by dietary energy density. In total, 240 weanling piglets (28 d old; initial BW 7.2 ± 1.1 kg) were allocated to 24 pens (10 pigs/pen) according to BW. Piglets were split up into 2 groups and had ad libitum access to a high energy (HE; 3.90 Mcal DE/kg; crude fat 129 g/kg) or a low energy (LE; 3.35 Mcal DE/kg; crude fat 60 g/kg) diet with similar CP content (190 g/kg). Piglet performance and preference for protein [porcine digestible peptides (PDP; Palbio 62SP, Bioibérica, Palafolls, Spain) 20 g/L] or carbohydrate (sucrose 20 g/L) solutions were measured on days 14 and 21 after weaning using a double-choice test (DCHT). The LE diet promoted a higher (P < 0.05) ADFI and ADG than the HE diet. Final BW on day 21 was higher (P < 0.001) for piglets fed the LE diet than piglets fed the HE diet (12.8 vs. 11.5 kg). Preference (P > 0.05) was not observed for protein or carbohydrate solutions on day 14 or 21 in piglets fed the LE diet. On the other hand, piglets fed the HE diet had higher (75% on day 14 and 65% on day 21; P < 0.01) preference for the sucrose solution. Dietary energy level and consequent nutrient imbalances, such as dietary protein-to-energy ratio, may affect feed preference for protein or carbohydrate solutions in piglets.

Key words: carbohydrate, energy density, growth performance, pig, preference, protein source

INTRODUCTION

Pigs have a complex and sophisticated biological system that allow them to regulate their feed selection, intake, and self-nourishment in accordance to different nutritional or physiological states. This system is as an interconnected network that involves different organs and tissues of the body integrated by the central nervous system (Forbes, 2007; Black et al., 2009) and results in different actions of pigs towards feeds, ultimately expressed as preference or aversion. Thus, when a particular feed is consumed their postdigestive feedback may triggers metabolic signals to alter feeding behavior.

The ability of pigs to accurately select diets to satisfy their nutritional requirements has been documented by using diets differing in CP content (Kyriazakis et al., 1991) or dietary essential AA (Kirchgessner et al., 1999; Roth et al., 2006). In these situations pigs were able to perform sensible choices to avoid the nutrient deficiency. However, evidence does not exist that pigs are able to adapt these choices depending on current nutritional status, for example through imbalances in the dietary protein-to-energy ratio. The aim of the present study was to assess whether preference for protein or carbohydrate is affected by dietary energy density in piglets.

MATERIALS AND METHODS

All procedures described in this study were conducted at the animal research facilities of the Universitat Autònoma de Barcelona (UAB) and were approved by Ethical Committee on Animal Experimentation of the UAB (CEAAH 1406).

Diets and Feeding

Two prestarter diets differing in DE content, a high energy (HE; 3.90 Mcal DE/kg; crude fat 129 g/kg) and a low energy diet (LE; 3.35 Mcal DE/kg; crude fat 60 g/kg) with similar CP content (190 g/kg), were offered ad libitum to the piglets in mash form starting
at weaning and for 21 d. The HE diet was formulated to exceed the DE requirements of a diet containing soybean oil (Glycine max) (60 g/kg) to a diet containing maize (Zea mays), barley (Hordeum vulgare), wheat (Triticum aestivum), and extruded soybean (312, 100, 100, and 131 g/kg, respectively). The LE diet was formulated to contain a suboptimal DE content by adding sepiolite (29.3 g/kg; Myta, Zaragoza, Spain) to a diet containing maize, barley, wheat, and extruded soybean (105, 350, 120, and 90 g/kg, respectively). Sweet milk whey (150 g/kg), soybean meal (44% CP; 50 g/kg), synthetic AA, and a vitamin and mineral premix had the same inclusion in both diets. Diets resulted in different protein-to-energy ratios: 48.7 and 56.7 g CP/Mcal DE for the HE and LE diet, respectively. Total lysine:energy ratio, 4.1 g Lys/Mcal DE, was maintained in both diets, and Met, Met + Cys, Thr, and Trp were balanced to Lys. The AA to DE ratio was lower in the HE diet than in the LE diet for Ile (1.9 vs. 2.2 g Ile/Mcal DE, respectively) and Val (2.3 vs. 2.9 g Val/Mcal DE, respectively) and lower than requirements (2.1 g Ile and 2.7 g Val/Mcal DE) according to NRC (1998).

Animals, Facilities, and Experimental Design

In total, 240 piglets [Pietrain × (Landrace × Large White)] were weaned at 28 d of age with an average initial BW of 7.2 ± 1.1 kg (mixed sexes). Piglets were distributed just after weaning according to their BW block and allocated in a weaning room with 24 pens (10 piglets/pen). The weaning room had forced ventilation and completely slatted flooring. Each pen was equipped with one feeder and a commercial drinker. Pens were randomly assigned to the experimental treatments: either the HE or LE diet.

During the first 2 weeks after weaning, piglets were trained to the presence of 2 pans containing 800 mL of tap water for 30 min. On days 14 and 21 after weaning, the preference of 4 piglets per pen was assessed by using a 3 min double-choice test (DCHT) protocol (Solà-Oriol et al., 2009) in which protein and carbohydrate water-based solutions were tested [20 g/L porcine digestible peptides (PDP; Palbio 62SP, Bioibérica, Palafolls, Spain) vs. 20 g/L sucrose]. Solution position was rotated within pens. Feed disappearance and BW gain was monitored days 0 to 14 and days 15 to 21.

Calculations and Statistical Analyses

Preference for protein or carbohydrate solution was measured as the percentage of each solution of the total fluid intake and was compared to the neutral value of 50% by using a Student's t-test (SAS Inst. Inc., Cary, NC). Solution intake and the productive performance results were analyzed taking into account the dietary DE content, BW block, and their interaction with ANOVA by using the GLM procedure of SAS. Average values were compared by least square means with Tukey adjustment for multiple comparisons with an α-level of 0.05.

RESULTS

Pigs fed the LE diet had a higher (P < 0.05; Table 1) ADFI, ADG, and BW than pigs fed the HE diet during days 0 to 14 and days 14 to 21. Differences in energy intake and G:F were not observed between groups. Final BW on day 21 was 1.31 kg higher (P < 0.001) for pig fed the LE diet than the HE diet. Piglets fed the LE diet did not prefer (P > 0.05) PDP or sucrose (Figure 1). Piglets fed the HE diet preferred (P < 0.01) sucrose to PDP solution (75% on day 14 and 65% on day 21).

DISCUSSION

We designed the experimental diets to generate a clear difference in the dietary energy:protein balance between 2 groups of weanling piglets. Growth performance confirmed that a HE diet (low protein-to-energy ratio) decreased the growth rate of the animals as compared to those fed an AA-balanced but LE diet. The similar energy intake between diets confirmed that the animals regulated feed intake to obtain similar daily energy intake, with consequences, such as a daily protein restriction in the HE diet. Piglets fed LE diets may have the capacity to increase feed intake, and their performance is less likely to be impaired (Beaulieu et al., 2009).

The unexpected sucrose preference by piglets fed on the HE diet indicates that piglets were unable to express an innate preference for protein in the case of the protein deficient status. On the other hand, sucrose was preferred by pigs fed the HE (high fat) diet, likely reflecting changes in the perception of sweet taste by these pigs. Moreover, the absence of a learning process in this time framework

Table 1. Growth performance of postweaned piglets fed the experimental diets

<table>
<thead>
<tr>
<th>Item</th>
<th>HE 2 diet</th>
<th>LE 3 diet</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days 0 to 14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial BW, kg</td>
<td>7.17</td>
<td>7.18</td>
<td>0.005</td>
<td>0.42</td>
</tr>
<tr>
<td>ADG, g</td>
<td>155a</td>
<td>198b</td>
<td>9</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>ADFI, g</td>
<td>230c</td>
<td>282b</td>
<td>11</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>EI, Mcal DE/d</td>
<td>0.90</td>
<td>0.94</td>
<td>0.04</td>
<td>0.43</td>
</tr>
<tr>
<td>G:F</td>
<td>0.67</td>
<td>0.70</td>
<td>0.01</td>
<td>0.11</td>
</tr>
<tr>
<td>Final BW, kg</td>
<td>9.50a</td>
<td>10.14b</td>
<td>0.127</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Days 15 to 21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADG, g</td>
<td>335c</td>
<td>446b</td>
<td>13</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>ADFI, g</td>
<td>536c</td>
<td>636b</td>
<td>28</td>
<td>0.02</td>
</tr>
<tr>
<td>EI, Mcal DE/d</td>
<td>2.09</td>
<td>2.13</td>
<td>0.10</td>
<td>0.79</td>
</tr>
<tr>
<td>G:F</td>
<td>0.64</td>
<td>0.71</td>
<td>0.03</td>
<td>0.13</td>
</tr>
<tr>
<td>Final BW, kg</td>
<td>11.51a</td>
<td>12.82b</td>
<td>0.185</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

a,bWithin a row, means without a common superscript differ (P < 0.05).

1HE = high energy.
2LE = low energy.
3EI = energy intake.
(Kyriazakis et al., 1991), where an association could be made by pigs between the sensory properties of tested feeds and the physiological consequences of eating them, might have reduced the ability of the pigs to make sensible choices. This should be considered for future research on this topic.

**LITERATURE CITED**


