Feeding hulled or hull-less barley differing in fermentable starch and fibre to weaned pigs

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Take Home Message

Hulled and hull-less barley are cereal energy sources that may replace wheat grain in feed for weaned pigs to increase profit. They also provide fermentable starch and fibre that can serve as prebiotics to improve gut health in young pigs. We have shown that hulled barley can fully replace wheat grain in nursery feeds without affecting feed intake, growth performance and feed conversion in weaned pigs. But feeding too much fermentable starch and fibre to weaned pigs should be avoided to prevent excess hindgut fermentation that reduces both feed intake and faeces consistency. Because high fermentable starch and fibre reduce energy value, feeds including hulled or hull-less barley should be formulated based on net energy and digestible amino acids to achieve predictable pig growth.

Introduction

Hulled and hull-less barley grain are cereal energy sources for swine. Chemical composition varies among barley grain samples causing changes in nutritional value that may affect pig growth. Among chemical components, fermentable carbohydrates can shift digestion from the small intestine to the large intestine, thereby increasing hindgut fermentation by microbes. Increasing dietary amylose, a less digestible component of starch, or gummy type soluble fibre instead of woody type insoluble fibre (cereal hulls or bran) may alter intestinal and immune function, thereby improving gut health in weaned pigs. But overfeeding amylose or soluble fibre could increase the softness of faeces. Cereal β-glucans, another type of soluble fibre, increases digesta viscosity (water holding capacity) and may also increase softness of faeces in weaned pigs. New cultivars of hull-less barley with increased amylose or β-glucan have been developed. We needed to confirm nutrient digestibility, growth performance and faeces consistency of weaned pigs fed cereal grains differing in these fermentable carbohydrates.

Chemical profile of hull-less, hulled barley and wheat grain

We selected one wheat, one hulled barley and three hull-less barley samples. They differed in chemical composition, especially in fermentable carbohydrates. The moderate fermentable hull-less barley contained moderate amylose (21 per cent of starch) and β-glucan, the high fermentable, high amylose hull-less barley contained the most amylose and elevated levels of β-glucans, whereas the high-fermentable, high-β-glucan hull-less barley contained little amylose but more β-glucan. Compared with hulled and hull-less barley, wheat grain was low in β-glucan and moderate in amylose.

Weaned pig trial set up

We conducted the nursery pig trial over two phases (day 0–14 and 15–35) at the Swine Research and Technology Centre, University of Alberta (Edmonton, Alberta). In total,

240 pigs (Duroc × Large White/Landrace F1; Hypor, Regina, Saskatchewan, weaned at 21 days in three groups) were housed in 60 pens, with four pigs per pen balanced by sex. One week after weaning, pigs (~7.6 kg) were fed the five diets randomized to five pens within area block to achieve 12 pen-replicates per feedstuff. Diets were formulated to include one of five cereal grains (~64 per cent for Phase 1; ~70 per cent for Phase 2): low-fermentable, hard red spring wheat (CDC Utmost), low-fermentable hulled barley (CDC Champion) and three hull-less barley cultivars, namely: 1) CDC Fibar, high-fermentable, high-β-glucan; 2) CDC Hilose, high-fermentable, high-amylose and 3) CDC McGwire, moderate-fermentable. Diets were formulated without antimicrobials or growth promoters to provide equal net energy and digestible amino acids for Phases 1 and 2. Diets were mixed and steam-pelleted at 70°C. Pigs had free access to feed and water. Faeces consistency was evaluated twice daily.

What we found

Protein digestibility of barley diets was 5-8%-units lower than the wheat diet, indicating that fibre in barley grain reduced protein digestion. Energy digestibility was lowest for the hulled barley diet (80-83%), intermediate for highly-fermentable hull-less barley (80-85%), and highest for wheat and moderately-fermentable hull-less barley (83-87%). As such, moderately-fermentable hull-less barley and wheat provided more energy to pigs than hulled barley or highly-fermentable hull-less barley. We found that lower energy digestibility was associated with high fibre content, e.g. woody type hull fibre, indicating that fibre in barley is less-digestible.

For the entire trial (day 0–35), there were no differences in feed conversion for pigs fed the 5 diets (Figure 1). Pigs fed the low-fermentable hulled barley or wheat grain had the greatest feed intake, followed by moderate-fermentable hull-less barley, and lowest for highly-fermentable hull-less barley, indicating that fermentation characteristics rather than fibre content had more influence on feed intake. Weight gain of pigs was similar to the order of feed intake, but the gain difference between pigs fed hulled barley or high-amylose hull-less barley was smaller at 43 g/day. As such, pigs fed hulled barley had the greatest final trial weight at 27 kg, followed by wheat grain, moderate-fermentable hull-less barley, and highly-fermentable hull-less barley the lowest at 25.7 kg.

We found pigs fed wheat grain or hulled barley had the best faeces consistency, followed by moderate-fermentable hull-less barley, and the lowest ranking was for highly-fermentable hull-less barley, likely due to excess hindgut fermentation of starch or increased digesta viscosity by abundant β-glucan, and thus increased chance to develop soft faeces.

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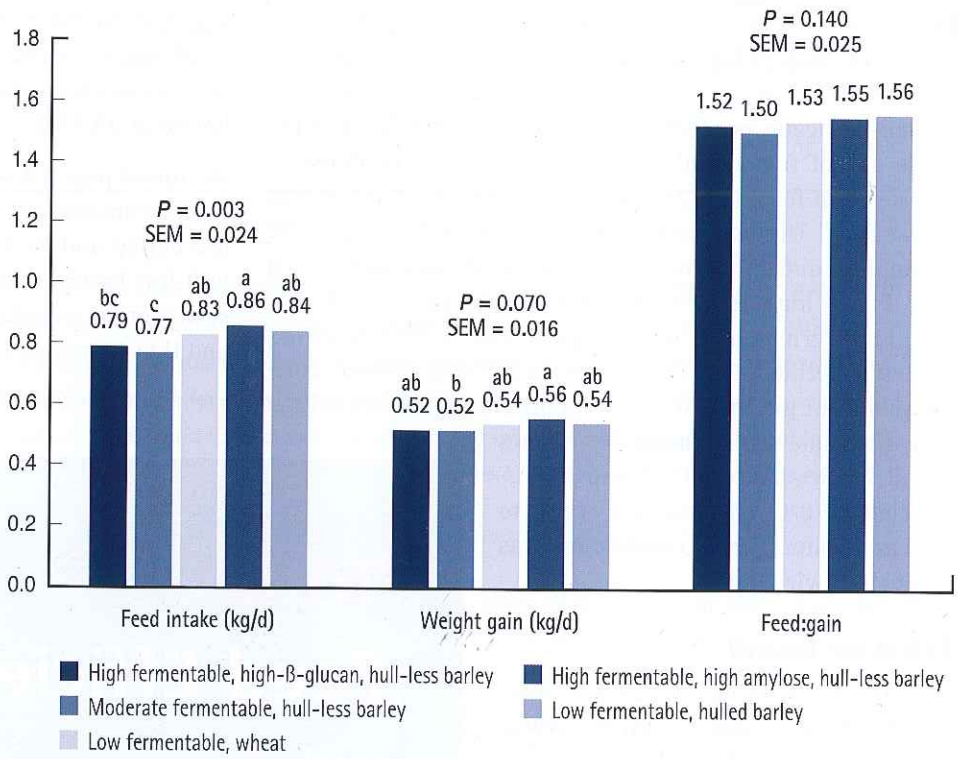
Figure 1. Growth performance of weaned pigs fed hulled or hull-less barley replacing wheat grain



a, b, c Bars within each growth performance trait without a common lower-case letter differ ($P < 0.05$)

A,B Bars within each growth performance trait without a common upper-case letter tended to differ ($P < 0.10$)

Cost vs. benefit

The following prices were assumed ($ per MT): barley grain (hulled or hull-less), $240; wheat grain, $305; canola oil, $1,100; limestone, $113; mono/di-calcium phosphate, $900; L-lysine HCl, $2,050; L-threonine, $2,630; DL-methionine, $4,050; L-tryptophan, $24,000. Dietary inclusion of hull-less barley or hulled barley to replace wheat reduced feed cost per MT by $36 and $18 for Phase 1, and by $37 and $21 for Phase 2, respectively. Combined, in 2 phases, feeding hull-less barley or hulled barley to replace wheat reduced feed cost per kg of BW gain by 6.58-7.66 cents and 3.57 cents, respectively.

What these results mean?

Considering lower protein digestibility for barley and lower energy digestibility for hulled barley and lower energy utilisation for high fermentable hull-less barley, feed should be formulated based on net energy and digestible amino acids to reach predictable growth performance. We observed reduced feed intake and poor faeces consistency for pigs fed highly fermentable hull-less barley, thus challenging inclusion of highly fermentable hull-less barley in feed for weaned pigs should be avoided. Finally, these results demonstrated that hulled barley is an excellent source of cereal energy for weaned pigs as reflected in both feed intake and growth performance. However, its economic benefit can be influenced by cost of vegetable oil to adjust the energy level in feed.

Thank you

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