Responses of dietary ileal amino acid digestibility to consumption of different cultivars of potatoes and conventional fibers in grower pigs fed a high-fat basal diet

Q. Wang,* X. Yang,* S. Leonard,* T. Archbold,* J. A. Sullivan,† A. M. Duncan,‡ D. W. L. Ma,‡ B. Bizimungu,§ A. Murphy,§ J. K. Htoo,# and M. Z. Fan*2

Departments of *Animal and Poultry Science, †Plant Agriculture, and ‡Human Health and Nutritional Sciences, University of Guelph, Guelph, Ontario, Canada N1G 2W; §Agriculture and Agri-Food Canada Potato Research Center, Fredericton, New Brunswick, Canada E3B 4Z7; and #Evonik Industries AG, Hanau-Wolfgang, Germany 463457

ABSTRACT: Whereas dietary fibers are well recognized for nutritional management of human health issues, fiber is also known to be one of the dietary factors potentially affecting digestive use of dietary proteins. As a staple food, potato (Solanum tuberosum) may be a significant dietary fiber source. The objective of this study was to examine effects of dietary supplementation of six potato cultivar–genotype samples that differ in soluble fiber content and two conventional fiber components (i.e., cellulose and guar gum) on the apparent ileal AA digestibility in pigs fed a high-fat basal diet. The basal diet was formulated as a zero-fiber negative control (NC) to contain 41.5% poultry meal, 4% casein, 15% animal fat–oil blend, 2.8% sucrose, 31% corn (Zea mays) starch, 0.50% salt, and 0.40% trace mineral–vitamin supplement with fat contributing to 47% of the dietary GE. The two fiber diets were formulated by respectively diluting the basal diet with 10% guar gum and 10% cellulose at the expense of corn starch. Six other test diets were formulated by including 8.5% guar gum and further diluting the basal diet with 25.1% one of the six cultivar–genotype samples of dehydrated potato tuber powder to contain about 10% total dietary fiber at the expense of corn starch. Eighty-one 25-kg barrows were fitted with a simple T-cannula at the distal ileum and fed the diets according to a completely randomized block design with each block lasting 28 d. Compared with the NC, the ileal digestibility of Ala, Gly, and Pro were decreased (P < 0.05) by 10% guar gum whereas the digestibility of Gly was reduced (P < 0.05) by 10% cellulose. The ileal digestibility of several AA was decreased (P < 0.05) by the test potatoes plus 8.5% guar gum compared with the NC. Our results suggest that dietary inclusion of fiber at 10% from guar gum and cellulose and contributed by potatoes may adversely affect digestive use of dietary protein.

Key words: amino acids, digestibility, grower pigs, potato, total dietary fiber


INTRODUCTION

There is growing human health concern regarding obesity that may be partially attributed to overconsumption of potatoes and potato products currently available on the market, which are characterized as being rich in their highly digestible starch but relatively low in fiber content (e.g., Mozaffarian et al., 2011). Development of new potato cultivars high in nonviscous soluble fiber (i.e., resistant starch) content provides a relatively inexpensive source of human dietary fiber. Meanwhile, potato resistant starch is supplemented as prebiotic in weanling pig nutrition (Bhandari et al., 2009) and as a modulator of hindgut fermentation to control odor and off-flavor of pork (Lösel et al., 2006). On the other hand, fiber is also known to be one of the dietary factors potentially affecting digestive use of dietary proteins (Mosenthin et al., 1994). Therefore, the objective of this study was to examine effects of dietary supplementation of six...
Table 1. Responses 1 in the apparent ileal AA digestibility values (%) in the experimental diets fed to the growing pigs

<table>
<thead>
<tr>
<th>Items</th>
<th>NC (no fiber)</th>
<th>PC (guar gum)</th>
<th>Cellulose</th>
<th>Potato 1 (FV12272-3)</th>
<th>Potato 2 (F05035)</th>
<th>Potato 3 (CV96044-3)</th>
<th>Potato 4 (WV5475-1)</th>
<th>Potato 5 (Atlantic)</th>
<th>Potato 6 (F03031)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leu</td>
<td>86.3 ± 8.5</td>
<td>55.5 ± 7.3</td>
<td>58.8 ± 7.3</td>
<td>51.3 ± 6.5</td>
<td>55.3 ± 6.9</td>
<td>49.0 ± 6.5</td>
<td>63.5 ± 7.3</td>
<td>46.5 ± 6.5*</td>
<td>52.1 ± 8.5</td>
</tr>
<tr>
<td>Lys</td>
<td>90.2 ± 8.3</td>
<td>76.8 ± 7.3ab</td>
<td>82.9 ± 7.3</td>
<td>66.9 ± 6.7*</td>
<td>75.4 ± 7.0*</td>
<td>77.0 ± 6.7*</td>
<td>74.5 ± 7.3*</td>
<td>70.8 ± 6.7a</td>
<td>78.5 ± 8.0a</td>
</tr>
<tr>
<td>Ile</td>
<td>80.3 ± 5.6</td>
<td>73.1 ± 4.8</td>
<td>80.2 ± 4.8</td>
<td>74.3 ± 4.3</td>
<td>72.5 ± 4.5</td>
<td>73.2 ± 4.3</td>
<td>82.2 ± 4.8</td>
<td>79.0 ± 4.3</td>
<td>84.0 ± 5.6</td>
</tr>
<tr>
<td>Phe</td>
<td>89.4 ± 9.4</td>
<td>56.9 ± 5.8ab</td>
<td>77.9 ± 8.5</td>
<td>51.3 ± 8.0*</td>
<td>58.5 ± 8.2a</td>
<td>52.8 ± 8.0*</td>
<td>63.9 ± 8.5*</td>
<td>48.9 ± 8.0a</td>
<td>51.1 ± 9.4*</td>
</tr>
<tr>
<td>Val</td>
<td>81.5 ± 5.7</td>
<td>72.6 ± 5.0</td>
<td>78.8 ± 5.0</td>
<td>77.7 ± 4.5</td>
<td>67.7 ± 4.6</td>
<td>74.6 ± 4.5</td>
<td>81.3 ± 5.0</td>
<td>76.2 ± 4.5</td>
<td>81.6 ± 5.7</td>
</tr>
<tr>
<td>Ala</td>
<td>95.7 ± 1.9</td>
<td>90.2 ± 1.8a</td>
<td>92.4 ± 1.8</td>
<td>90.3 ± 1.7*</td>
<td>92.9 ± 1.7</td>
<td>91.4 ± 1.8</td>
<td>91.4 ± 1.8</td>
<td>90.5 ± 1.7*</td>
<td>90.1 ± 1.9*</td>
</tr>
<tr>
<td>Asp + Asn</td>
<td>85.5 ± 4.0</td>
<td>82.0 ± 3.6</td>
<td>84.7 ± 3.6</td>
<td>79.9 ± 3.3</td>
<td>84.3 ± 3.5</td>
<td>83.0 ± 3.3</td>
<td>83.7 ± 3.6</td>
<td>83.6 ± 3.3</td>
<td>83.8 ± 4.0</td>
</tr>
<tr>
<td>Gly + Glu</td>
<td>88.1 ± 7.0</td>
<td>75.07 ± 6.4a</td>
<td>80.7 ± 6.4</td>
<td>71.4 ± 6.0a</td>
<td>49.5 ± 6.1*</td>
<td>64.0 ± 6.0*</td>
<td>64.5 ± 6.4a</td>
<td>70.2 ± 6.0a</td>
<td>71.9 ± 7.0a</td>
</tr>
<tr>
<td>Gly</td>
<td>90.6 ± 6.2</td>
<td>62.1 ± 5.5ab</td>
<td>47.9 ± 5.5</td>
<td>76.7 ± 5.1*</td>
<td>55.9 ± 5.3a</td>
<td>83.1 ± 5.1*</td>
<td>83.9 ± 5.5*</td>
<td>75.3 ± 5.1a</td>
<td>73.4 ± 6.2ac</td>
</tr>
<tr>
<td>Pro</td>
<td>98.1 ± 5.9</td>
<td>73.31 ± 5.2a</td>
<td>82.1 ± 5.2</td>
<td>79.7 ± 4.9a</td>
<td>83.1 ± 5.0a</td>
<td>73.8 ± 4.9a</td>
<td>80.1 ± 5.2a</td>
<td>76.5 ± 4.9a</td>
<td>86.7 ± 5.1a</td>
</tr>
</tbody>
</table>

1Values are least square means ± SE of the estimates.
2NC = negative control.
3PC = positive control.
4Number of observations for the corresponding dietary treatments.

a,b,c,dMeans diets with different superscript letters differ (P < 0.05) as analyzed by the Tukey-Kramer’s tests.

p<0.05) as analyzed by the Dunnett-Hsu’s tests.

p<0.05) as analyzed by the indicator method (Rideout et al., 2008). Due to losing some test pigs and missing values, least square means were calculated for the major endpoints. All of the statistical analyses including ANOVA as well as Tukey-Kramer’s tests and the Dunnett-Hsu’s tests were conducted by using the mixed models of SAS (SAS Institute Inc., Cary, NC).

RESULTS AND DISCUSSIONS

As observed by Bregendahl et al. (2004), it is not possible to quantify several AA by GC-MS, resulting in an incomplete profiling of AA in this study (Table 1). Nevertheless, significant effects were observed for a number of AA. When compared with the NC, the ileal digestibility of Ala, Gly, and Pro were decreased...
(P < 0.05) by 10% guar gum (PC) and the digestibility of Gly was also reduced (P < 0.05) by 10% cellulose. Potato supplementations also decreased (P < 0.05) the ileal digestibility of several AA compared with the NC diet likely due to the combined effects of 8.5% guar gum supplementation and fiber contributed by the corresponding test potatoes. However, there were generally no significant differences in the ileal AA digestibility between each of the potato diets and the PC diet. This is in agreement with Lenis et al. (1996) with the addition of cellulose in diets in the pig. Mosenthin et al. (1994) observed negative effects of viscous fiber pectin on the apparent ileal AA digestibility in growing pigs. Lien et al. (1996) showed that exogenous pea (Pisum sativum) fiber affected the ileal AA digestibility in human subjects. In summary, our results suggest that dietary inclusion of fiber at 10% from guar gum and cellulose and contributed by potatoes may adversely affect digestive use of dietary protein.

LITERATURE CITED


