Animal Feed Science and Technology 221 (2016) 62–69

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Ileal amino acid digestibility in high protein sunflower meal and pea protein isolate fed to growing pigs with or without multi-carbohydrase supplementation

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ARTICLE INFO

Article history:
Received 3 May 2016
Received in revised form 7 August 2016
Accepted 20 August 2016

Keywords:
Enzyme
High protein sunflower meal
Ileal digestibility
Pea protein isolate
Pig

ABSTRACT

Amino acids are the second most expensive nutrients in practical pig and poultry diets after energy. High protein sunflower meal (HiPSF) and pea protein isolate (PPI) are potential alternative protein sources for soybean meal and there is a great interest to explore their utilization as dietary ingredients for swine. Thus, eight ileal-cannulated barrows (initial BW = 23.5 ± 0.9 kg) were used to determine the apparent (AID) and standardized (SID) ileal amino acid (AA) digestibilities in HiPSF and PPI with or without multi-carbohydrase enzyme (MC) supplementation. Pigs were randomly assigned to 1 of 5 treatments in a replicated 4 × 5 incomplete Latin square design to give 8 observations per treatment. The experimental diets consisted of HiPSF or PPI as the sole source of protein with or without MC and a low-protein diet (5% casein) used to quantify endogenous AA losses. All diets contained titanium dioxide (0.3%) as an indigestible marker. Pigs were given their daily feed allowance at a rate of 4.5% of BW determined at the beginning of each experimental period. Each experimental period lasted for 7 d and the ileal digesta were collected on d 6 and 7. In general, AA digestibilities were higher in PPI than in HiPSF, with the exception of Met and Cys. There was no effect of MC on AA digestibility except for Lys, Ala, Cys and Pro in PPI. The AID and SID of essential AA in HiPSF and PPI (without MC) were, respectively: Arg, 0.86, 0.90 and 0.92, 0.95; His, 0.45, 0.54 and 0.58, 0.67; Ile, 0.78, 0.83 and 0.86, 0.90; Leu, 0.77, 0.81 and 0.86, 0.90; Lys, 0.71, 0.77 and 0.89, 0.92; Met, 0.85, 0.88 and 0.84, 0.87; Phe, 0.79, 0.82 and 0.86, 0.88; Thr, 0.68, 0.77 and 0.77, 0.85; Val, 0.75, 0.80 and 0.82, 0.87. The MC increased ($P < 0.05$) the AID of Lys (0.89 vs 0.91), Cys (0.59 vs 0.62) and Pro (0.79 vs 0.85) and SID of Lys (0.92 vs 0.94), Ala (0.88 vs 0.91) and Pro (0.89 vs 0.95) in PPI. Compared to HiPSF, PPI had better digestible AA profile for growing pigs. However, no differences were detected for the digestibility of most AA when diets were supplemented with MC.

Abbreviations: AA, amino acids; AID, apparent ileal digestibility; SID, standardized ileal digestibility; HiPSF, high protein sunflower meal; PPI, pea protein isolate; SBM, soybean meal; SFM, sunflower meal; BW, body weight; MC, multi-carbohydrase enzyme.

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http://dx.doi.org/10.1016/j.anifeedsci.2016.08.015
0377-8401/

Table 1
Composition of experimental diets (g/kg diet)[a].

Item	HiPSF[b] (−)	HiPSF(+)	PPI[c] (−)	PPI (+)	LND[d]
Cornstarch	534.5	534.5	525.7	525.7	594.0
Dextrose	50.0	50.0	50.0	50.0	252.0
Pea protein isolate	–	–	320	320	–
High protein sunflower meal	320	320	–	–	–
Casein	–	–	–	–	50.0
Solka-flok	40.0	40.0	40.0	40.0	40.0
Canola oil	25.0	25.0	25.0	25.0	20.0
Limestone	11.0	11.0	7.8	7.8	4.0
Monocalcium phosphate	2.5	2.5	14.5	14.5	23.0
Salt	4.0	4.0	4.0	4.0	4.0
Vit-min premix[e]	10.0	10.0	10.0	10.0	10.0

[a] As fed basis.
[b] HiPSF = high protein sunflower meal; +/− represents presence or absence, respectively, of 0.05% multi-carbohydrase enzyme (MC).
[c] PPI = pea protein isolate; +/− represents presence or absence, respectively, of 0.05% MC. The MC used in the present study was a mixture of carbohydrases (Superzyme OM, Canadian Bio-System Inc., Calgary, Alberta, Canada. Enzyme complex supplied 1700 units of cellulose, 1100 units of pectinase, 240 units of mannanase, 30 units of galactanase, 1200 units of xylanase, 360 units of glucanase and 1500 units of amylase. The rate of inclusion of MC was according to the recommendations of the manufacturer.
[d] Low N diet.
[e] Supplied the following per kg of finished feed: vitamin A, 2000 IU; vitamin D, 200 IU; vitamin E, 40 IU; vitamin K, 2 mg; choline, 350 mg; pantothenic acid, 14 mg; riboflavin, 7 mg; folic acid, 1 mg; niacin, 21 mg; thiamin, 1.5 mg; vitamin B6, 2.5 mg; biotin, 70 mg; vitamin B12, 20 mg, Cu, 25 mg; Zn, 150 mg; Fe, 100 mg; Mn, 50 mg; I, 0.4 mg; Se, 0.3 mg.

1. Introduction

Many protein sources are currently used in animal nutrition. Peas are a good source of crude protein (Bandegan et al., 2011; NRC, 2012), however, AA digestibility in peas for non-ruminants is limited by antinutritional factors such as fiber, trypsin inhibitors, and tannins (Gabriel et al., 2008). According to Valencia et al. (2008), the use of raw pea protein concentrates high in trypsin inhibitors should be restricted in diets for young pigs. To make pea proteins more acceptable for use in non-ruminants, pea protein isolates (PPI) are almost devoid of antinutritional factors (Fredrikson et al., 2001). According to Le Guen et al. (1995), diets containing PPI, showed a higher digestibility of nutrients when compared to diets with field pea.

Sunflower meal (SFM) is an important co-product obtained after the extraction of oil from sunflower seeds and has been used as a protein source in animal nutrition (Sredanović et al., 2012). Sunflower meal with 44% of crude protein can be fully compared to soybean meal (SBM) by its protein content. But, it contains considerably smaller amounts of Lys, Leu and Tyr than soybean meal (NRC, 2012). The concentrations of Met, Cys and Arg are higher in SFM compared to SBM, while those of Trp and Val are comparable (Delic et al., 1992; Fredrikson et al., 2001). According to González-Vega and Stein (2012) AID and SID of most AA in sunflower seeds were not different from those in SBM. However, similar to peas, these ingredients contain a variety of antinutritional and antiphysiological factors promoting a negative effect on AA digestibility (Gilani et al., 2005). The sunflower protein isolates from hydrolytic treatments have shown to improved functional and nutritional properties (Villanueva et al., 1999).

The main antinutritional factor in sunflower and pea affecting piglet diets are the high content of mucilaginous non-starch polysaccharide (NSP), which could increase digesta viscosity and thus impair nutrient utilization (Bhatty, 1993). However, supplemental carbohydrase enzymes, which have long been recognized as effective in hydrolyzing NSP in feedstuffs for swine (Kim et al., 2003; Omogbenigun et al., 2004), may allow inclusion of sunflower and pea in piglet diets. Furthermore, Vahjen et al. (1998) has suggested that carbohydrase enzymes may partially hydrolyze NSP in the intestinal tract to yield substrates capable of modulating microbial activity.

Therefore, the objective of the current experiment was to determine the apparent (AID) and standardized (SID) ileal digestibility of CP, AA, DM, GE, P, Ca and fat in high protein sunflower meal (HiPSF) and PPI with or without multi-carbohydrase enzyme (MC) supplementation in growing pigs.

2. Materials and methods

All experimental procedures were reviewed and approved by the University of Manitoba Animal Care Committee, and pigs were cared for according to the guidelines of the Canadian Council on Animal Care (CCAC, 2009).

2.1. Protein sources and diets

The HiPSF sample used for the current study was obtained from Bunge Global Innovation, Spain and the PPI from Parrheim Foods, Saskatoon, Saskatchewan, Canada. Each test ingredient was included (32%) in a cornstarch-based diet (Table 1) as the sole source of protein with or without 0.05% multi-carbohydrase enzyme (MC) and a low-protein diet (5% casein) used to quantify endogenous AA losses (Yang et al., 2010; Heo et al., 2012). Diets were formulated to meet or exceed NRC (2012)