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# Chemical composition and standardized ileal amino acid digestibility in rapeseed meals sourced from German oil mills for growing pigs

U. Messerschmidt[a], M. Eklund[a], N. Sauer[a], V.T.S. Rist[a], P. Rosenfelder[a], H.K. Spindler[a], J.K. Htoo[b], F. Schöne[c], R. Mosenthin[a,*]

[a] Institute of Animal Nutrition, University of Hohenheim, Emil-Wolff-Strasse 10, 70599 Stuttgart, Germany
[b] Evonik Industries AG, Rodenbacher Chaussee 4, 63457 Hanau, Germany
[c] Thuringian State Institute of Agriculture, Naumburger Strasse 98, 07743 Jena, Germany

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ABSTRACT

The study was conducted to determine chemical composition and standardized ileal digestibility (SID) of amino acids (AA) in rapeseed meals (RSM) differing in glucosinolate (GSL) content for growing pigs. The selected RSM ($n = 5$) represent the actual range in GSL content (15–5 μmol GSL/g dry matter) of commercial prepress-solvent extracted RSM among German oil mills, and were sourced from 5 different locations. In total, 5 RSM-cornstarch-based diets were formulated to contain the selected RSM as the sole protein source. The experiment was conducted according to a $5 \times 5$ Latin square design using 5 barrows with an initial body weight of $22 \pm 0.7$ kg, which were fitted with a T-cannula at the distal ileum. The contents of neutral detergent fiber, acid detergent fiber, acid detergent lignin and neutral detergent fiber bound crude protein (CP) increased and contents of reactive lysine (rLys) and CP, as well as ratios of lysine:CP and rLys:CP, in RSM decreased linearly as the content of GSL in RSM decreased ($P<0.05$). Lower GSL contents in combination with lower ratios of lysine:CP and rLys:CP indicate that over-toasting during processing of RSM may be an issue in German oil mills. There was no effect of GSL or rLys contents on SID of CP and AA ($P>0.05$), which is in line with the observation that the SID of AA differed not more than 7 percentage units between the 5 assay RSM. However, when taking the differences in total Lys content between assay RSM into account, standardized ileal lysine content decreased linearly from 14.2 to 11.5 g/kg DM, as the GSL content decreased from 15 to 5 μmol/g DM ($P<0.05$). Overall, SID of CP and AA in all 5 assay RSM was rather low compared with average table values for canola meal and RSM, eventually due to their relatively high contents of fiber and sinapic acid, a phenolic compound, which is associated with higher tannin contents.



*Abbreviations:* AA, amino acids; ADF, acid detergent fiber expressed inclusive of residual ash; ADL, acid detergent lignin; ADL (sa), acid detergent lignin determined by solubilization of cellulose with sulphuric acid; AID, apparent ileal digestibility coefficient; aNDF, neutral detergent fiber assayed with a heat stable amylase and expressed inclusive of residual ash; BW, body weight; CP, crude protein; DM, dry matter; DMI, dry matter intake; GSL, glucosinolate; HPLC, high-performance liquid chromatography; Lys, lysine; Lys:CP ratio, lysine:crude protein ratio; ME, metabolizable energy; NDF, neutral detergent fiber; NDF-CP, neutral detergent fiber bound crude protein; rLys, reactive lysine; rLys:CP ratio, reactive lysine:crude protein ratio; rLys:Lys, reactive lysine:lysine ratio; RS, rapeseed; RSM, rapeseed meal; SID, standardized ileal digestibility coefficient.

* Corresponding author. Tel.: +49 711 459 23938; fax: +49 711 459 22421.
*E-mail address:* rainer.mosenthin@uni-hohenheim.de (R. Mosenthin).

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## 1. Introduction

During the last decade, European rapeseed (RS) production increased sharply from 12 million tons in 2000 to 20 million tons in 2010 (FAO, 2012), mainly due to higher demands for biofuel. Rapeseed meal (RSM), as a co-product of RS processing for edible oil and biofuel, is frequently used as protein-rich feed ingredient for livestock due to its relatively high content of indispensable amino acids (AA), particularly sulphur AA, in comparison to other protein ingredients including soybean meal (Mansour et al., 1993; Woyengo et al., 2010). However, the use of RSM in diets for monogastric animals such as pigs is often limited due to its high fiber content (Grala et al., 1994; Pastuszewska et al., 2003; Mailer et al., 2008), and the presence of several anti-nutritional factors including different glucosinolates (GSL) and phenolic compounds (Fan et al., 1996; de Lange et al., 1998; Tripathi and Mishra, 2007). Although GSL can be destroyed to a certain extent through hydrothermal treatment during processing of RS, excessive heat treatment of RSM may reduce digestibility of AA (Grala et al., 1994; Newkirk and Classen, 2002). Current feed tables on standardized ileal digestibility coefficients (SID) of AA for pigs include mainly SID values for canola meal (*e.g.* NRC, 2012). Canola seeds, which are mainly produced in Canada, Australia and the US, represent double 00-spring varieties such as *Brassica napus* L., *Brassica campestris* L. and *Brassica Rapa* var., and are characterized by low levels of erucic acid (<20 g/kg in the oil fraction) and low levels of GSL (<30 μmol/g in toasted oil free meal; Canola Council of Canada, 2009). In comparison, contents of erucic acid and total GSL in double 00-winter RS varieties grown in Europe must not exceed 20 g/kg in the oil fraction and 27 μmol/g dry matter (DM) in the RS (Commission Regulation, 1999), respectively. However, there is a scarcity of information on SID of AA in RSM manufactured from European varieties of double 00-winter RS crops, which are known to contain higher contents of GSL, neutral detergent fiber (NDF) and acid detergent fiber (ADF) compared with canola meals (Gomes et al., 1993; Canola Council of Canada, 2009).

Therefore, this study with growing pigs was conducted to determine the chemical composition and SID of AA in 5 RSM, representing the actual range in GSL content of commercial prepress-solvent extracted RSM among German oil mills.

## 2. Materials and methods

### 2.1. Animals, housing and surgical procedures

Five barrows (German Landrace × Piétrain) were obtained from the University of Hohenheim Research Station. The average initial and final body weight (BW) of the experimental animals was 22 ± 0.7 and 32 ± 0.6 kg, respectively. They were housed individually in stainless steel metabolic crates (0.8 m × 1.5 m). Each metabolic crate was equipped with an infrared heating lamp and a low pressure drinking nipple, which allowed free access to water. The research unit was equipped with an automated temperature control system kept at 20 °C. Until the beginning of the experiment, the pigs were fed a commercial starter diet at a daily level of 50 g (as-fed)/kg BW (Porcigold®SMA 134, Raiffeisen Kraftfutterwerke Süd GmbH, Würzburg, Germany; 175 g crude protein (CP), and 13.4 MJ metabolizable energy (ME)/kg, as-fed). On day 7 and 14 after arrival at the research unit, 3 and 2 pigs, respectively, were surgically fitted with a simple T-cannula at the distal ileum as described by Li et al. (1993). The cannulas were prepared from high molecular weight polyethylene. The internal diameter of the barrel of the cannulas was 17 mm, the length of the barrel was 80 mm and each of the 2 curved flanges was 55 mm in length. The washer had 70 mm in diameter and screw caps were used to seal the cannulas. During the experiment, the skin around the cannula was cleaned with lukewarm water several times daily, dried and provided with a skin protecting paste (Stomahesive® Paste, Convatec, Princeton, USA). Additionally, a sterile compress (Rondopad®, DEWECO Dr. Wüsthoff & Co., Wermelskirchen, Germany) was put between the retaining ring and the skin to absorb leaking digesta to prevent erythema. The pigs were allowed a recovery period of at least 7 days. During this period, the feed allowance was gradually increased, starting from 50 g/day the day after surgery until 1000 g/day (as-fed) were consumed. The research protocol was approved by the German Ethical Commission for Animal Welfare. Care of the animals used in this experiment was in accordance with the corresponding Council Directive (1986).

### 2.2. Experimental design, diets and procedures

Based on a survey on GSL contents of RSM manufactured in different German oil mills (Weber, 2011), 5 RSM batches in total were selected from 5 German oil mills representing a wide range in GSL contents from 15 to 5 μmol GSL/g DM (Table 1). According to their GSL content, the assay RSM were referred to as RSM 15, RSM 14, RSM 10, RSM 6, and RSM 5. The experiment was arranged as a 5 × 5 Latin square design with 5 pigs and 5 experimental periods. An additional period (period 6) was conducted with 2 pigs to repeat dropouts of the experiment. One of the 5 assay RSM each was added to a cornstarch-based basal diet as the sole protein source at a level of 565 g/kg (as-fed) diet (Table 2). Each diet was formulated to meet or exceed the dietary threshold levels for CP and AA according to Fan et al. (1994) and NRC (1998) nutrient recommendations for pigs from 20 to 50 kg BW (Table 3). Titanium dioxide (5 g/kg) was used as digestibility marker. The pigs received their assay diets at a daily level of 26 g/kg (as-fed) of their average BW, which corresponded twice the ME requirement for maintenance (0.72 MJ ME/day × $BW^{0.63}$) according to GfE (2005, 2006) standards.

The assay diets were fed twice daily (07:00 and 19:00 h) in a mash form mixed with water (1/1, w/v). During each of the 5 experimental periods, the pigs were allowed to adapt to their assay diets for 5 days before ileal digesta were collected for