Amino acid digestibility and metabolizable energy in a heating double-low rapeseed meal fed to pigs

M.S.F. Oliveira[1], J.K. Htoo[2], M.K. Wiltafsky[2], J.C. González-Vega[2] and H.H. Stein[1]*
[1]University of Illinois at Urbana-Champaign, Urbana, IL, USA; [2]Evonik Nutrition & Care GmbH, Hanau-Wolfgang, Germany; msespere@illinois.edu

Abstract

Two experiments were conducted to test the hypothesis that both the degree and duration of heating that is applied will affect the concentration of metabolizable energy (ME) and the standardized ileal digestibility (SID) of amino acids (AA) in double-low rapeseed meal (RSM) fed to growing pigs. Nine treatments were prepared using a conventional RSM that was either not autoclaved or autoclaved following one of 8 treatments: 110 °C for 15 or 30 min or 150 °C for 3, 6, 9, 12, 15, or 18 min. In both experiments, 20 barrows were assigned to a replicated 10 treatment × 4 period Youden square design. There were no effects of autoclaving at 110 °C on ME or on SID of AA in RSM but both ME and SID of AA in RSM were less ($P<0.01$) if RSM was autoclaved at 150 °C compared with 110 °C. At 150 °C, there were decreases (quadratic, $P<0.05$) in both ME and SID of AA as heating time increased. In conclusion, autoclaving at 110 °C did not affect ME or SID of AA in double-low RSM, but autoclaving at 150 °C reduced both ME and SID of AA, and the negative effects increased as heating time increased.

Keywords: *metabolizable energy, Maillard reactions, standardized ileal digestibility*

Introduction

Double-low rapeseed meal (RSM) is currently used as a protein ingredient in animal diets. Heat treatment of RSM at varying processing conditions removes the residual hexane and efficiently reduces the glucosinolate content. However, variations in heat processing temperatures and duration of heat treatment may result in Maillard reactions, resulting in the formation of sugar-amino acid complexes (Eklund *et al.*, 2015). Maillard reaction products result in reduced standardized ileal digestibility (SID) of amino acids (AA), with Lys being the most sensitive AA (Almeida *et al.*, 2014; Eklund *et al.*, 2015). However, there is limited information about how heating affects the concentration of digestible energy (DE) and metabolizable energy (ME). Therefore, the objective of this experiment was to test the hypothesis that both the degree and duration of heating that is applied will affect the concentration of DE and ME and the SID of AA in double-low RSM fed to growing pigs.

Materials and methods

Nine sources of RSM were prepared using a conventional double-low RSM that was either not autoclaved or autoclaved following one of 8 treatments: 110 °C for 15 or 30 min or 150 °C for 3, 6, 9, 12, 15, or 18 min. The study consisted of 2 experiments. In Exp. 1, 20 barrows (21.2±1.2 kg) were assigned to a replicated 10 treatment × 4 period Youden square design. A corn based basal diet and 9 diets containing corn and one of each source of RSM were formulated. Urine and feces were collected for 5 d. In Exp. 2, 20 ileal-cannulated barrows (69.8±5.7 kg) were also allotted to a replicated 10×4 Youden square. The 10 diets included, a N-free diet and one diet containing each of the 9 sources of RSM as a sole source of AA. Ileal digesta were collected on d 6 and 7 of each 7-d period. Orthogonal contrasts were used to compare the effects of treatment temperatures (i.e. 0 vs 110 °C; 110 vs 150 °C) and to determine linear and quadratic effects of heating time at 110 or 150 °C.

DOI 10.3920/978-90-8686-891-9_80, ©Wageningen Academic Publishers 2019

Results and discussion

There were no effects of autoclaving at 110 °C on DE and ME of RSM or on SID of AA, regardless of the time of heating, but both DE and ME, and SID of AA were reduced ($P<0.01$) if RSM was autoclaved at 150 °C compared with 110 °C (Table 1). At 150 °C, there were decreases (quadratic, $P<0.05$) in both DE and ME, and SID of AA as heating time increased. Similar results for SID of AA have been reported (Almeida *et al.*, 2014; Eklund *et al.*, 2015). The negative effects of autoclaving on AA digestibility is because heat treatment results in Maillard reactions, which form insoluble complexes that cannot be digested by pigs. The observation that over-heating also reduces DE and ME of RSM has not been previously reported, but may be a result of sugars being bound in the Maillard reactions, and therefore, these sugars are not available for absorption. In conclusion, the DE and ME, and the SID of AA in RSM are not reduced by autoclaving at 110 °C for 15 or 30 min. However, if RSM is autoclaved at 150 °C, DE and ME and SID of AA are reduced and the longer the duration of autoclaving, the more the ME and SID of AA are reduced. These results indicate that if crushing plants can avoid heating RSM to more than 110 °C during processing, the risk of over-heating is greatly reduced.

Table 1. Digestible energy (DE) and metabolizable energy (ME) and standardized ileal digestibility (SID) of AA in double-low rapeseed meal.

Item	Control	Heating temperature							
		110 °C		150 °C					
Duration (min):		15	30	3	6	9	12	15	18
DE, kcal/kg[1,2]	3,161	3,239	3,220	2,919	3,147	2,731	2,788	2,793	2,737
ME, kcal/kg[1,2]	2,873	3,013	3,017	2,720	2,936	2,508	2,619	2,547	2,458
SID of AA, %									
Lys[1,2]	76.8	70.8	73.3	59.9	45.7	25.7	25.8	21.6	-0.49
Met[1,2]	50.3	44.7	50.3	36.5	23.3	10.5	9.4	9.5	-22.1
Thr[1,2]	69.9	66.2	69.1	59.6	54.9	46.6	47.9	47.0	30.1
Trp[1,2]	72.1	69.6	71.6	63.7	61.0	55.7	56.7	58.1	44.4
Ile[1,2]	73.8	73.1	73.4	65.5	60.1	51.9	52.9	51.7	35.1
Cys[1,2]	74.2	70.7	72.7	58.0	48.5	33.4	34.2	31.4	7.8

[1] 110 vs 150 °C; $P<0.001$.

[2] Quadratic effect of heating time at 150 °C; $P<0.05$.

References

Almeida, F.N., J.K. Htoo, J. Thomson and H.H. Stein, 2014. Effects of heat treatment on the apparent and standardized ileal digestibility of amino acids in canola meal fed to growing pigs. Animal Feed Science and Technology 187: 44-52. https://doi.org/10.1016/j.anifeedsci.2013.09.009

Eklund, M., N. Sauer, F. Schone, U. Messerschmidt, P. Rosenfelder, J.K. Htoo and R. Mosenthin, 2015. Effect of processing of rapeseed under defined conditions in a pilot plant on chemical composition and standardized ileal amino acid digestibility in rapeseed meal for pigs. Journal of Animal Science 93: 2813-2825. https://doi.org/10.2527/jas.2014-8210