Effect of starch content and rumen-protected amino acid supplementation on milk performance and persistency in dairy cows

Jean-Charles Anger, Christelle Loncke, R. Bidaux, P. Piantoni, K. Dieho, Sophie Lemosquet

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J.C. Anger[a,c], C. Loncke[b], R. Bidaux[c], P. Piantoni[d], K. Dieho[e], S. Lemosquet[a]

[a]PEGASE, INRAE, Institut Agro, Saint Gilles, France
[b]Université Paris-Saclay, INRAE, AgroParisTech, UMR Modélisation Systémique Appliquée aux Ruminants, 75005 Paris, France
[c]Provimi France, Cargill Animal Nutrition and Health, Crevin, France
[d]Cargill Animal Nutrition, Elk River, USA
[e]Cargill Animal Nutrition, Velddriel, Netherlands

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Introduction

Reducing metabolizable protein (**MP**) supply increased protein efficiency but reduced milk yield (**MY**) and milk protein yield (**MPY**) in dairy cows. However, increasing dietary starch content or balancing Lys, Met and His could mitigate performance loss (Cantalapiedra-Hijaret al., 2014, Gialllongo et al., 2017). The aim of the experiment was to evaluate the effects of diets varying in starch content and amino acid (**AA**: Lys, Met, His) supply on MY, MPY, and glucose and AA concentrations in a 18-wk study in dairy cows.

Material and methods

Forty Holstein dairy cows were used in a randomized complete block design experiment with a 2-wk covariate (22 – 35 DIM) and a 18-wk treatment (55 – 180 DIM) period. A factorial arrangement of treatments was used with two levels of starch (high and low starch: HS and LS) and two levels of AA supplies (through rumen-protected AA; RPAA; AA− or AA+). Cows were blocked by parity, calving date and MY. Diets were formulated to be iso-nitrogenous and iso-energetic. The LS diet was based on maize and grass silages, whereas HS was based on maize silage and alfalfa hay. The LS and HS diets contained 37% of concentrate (wheat, barley, sugar beet pulp, molasses vs. corn grain, respectively), and experimentally provided (in g/kg DM): 182 vs. 265 of starch, 384 vs. 380 of NDF, 138 vs. 142 of CP, 90.9 vs. 94.4 of MP (i.e. PDI for Protein Digestible in the Intestine; INRA, 2018) and 6.53 vs. 6.19 MJ/kg DM of NEL, respectively. The AA− vs. AA+ diets were formulated to provide [in % of MP]: 6.5 vs. 7.2% of Lys, 2.0 vs. 2.4% of Met, and 2.2 vs. 2.4% of His, respectively. Persistency was estimated as the slope of the declining phase of lactation. Plasma were sampled once a month and milk twice a week. Data were analyzed by ANCOVA using the MIXED procedure of SAS with week as the repeated measurement, cows as the random effect and orthogonal contrasts. Milk protein efficiency was calculated as proposed by INRA (2018).

Results and Discussion

The HS diets increased MY (+ 3.0 kg/day; Table 1) and MPY (+ 100 g/day) despite decreased NEL intake (151 vs. 158 MJ/day; $P < 0.01$) compared with LS. Supplementation of RPAA increased MPY (+ 36 g/day) and tended to increase DMI (+ 0.7 kg/day), consistent with Gialllongo et al. (2017). Overall, MP efficiency was not affected by treatment (71.0%) because HS and AA+ increased MP supply compared with LS and AA− (+ 97 g/day and + 83 g/day, respectively; both $P < 0.05$). Milk persistency was higher with HS vs. LS (+ 0.28 kg/wk) or RPAA supplementation (+ 0.11 kg/wk). Plasma glucose concentration did not differ among treatments (3.9 mM). Plasma Lys and Met concentrations were higher in AA+ vs. AA−. Histidine metabolism was modified by starch (carnosine, 1-methylhistidine) and RPAA (1-methylhistidine) or by starch × AA (tendency of interaction), and plasma His and 3-methylhistidine were lower in treatment LSAA− vs. other treatments. A higher mobilization of muscular His, indicated by higher carnosine and 3-methylhistidine concentrations, could at least partially explain the lack of effect of RPAA supplementation on plasma His concentration in the HS diet compared with LS.

Conclusion and implications

In conclusion, dietary starch content and RPAA supplementation increased both MPY but with different mechanisms: dietary starch content through MY and RPAA supplementation through DMI. We hypothesized that the changes in His metabolism could contribute to the greater persistency observed both when increasing starch content or RPAA supplies.

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Table 1. Effect of two levels of dietary starch or Lys, Met, His supplementation on cow performances and plasma metabolites

	LSAA-[1]	LSAA+[1]	HSAA-[1]	HSAA+[1]	*Pooled SE*	*P* value[4]		
						Starch	AA	Starch × AA
Dry matter intake, kg /d	24.1	24.4	23.9	25.0	0.37	NS	†	NS
Milk								
Yield, kg/d	32.3	32.8	35.3	35.8	0.54	***	NS	NS
Persistency, kg/week	-0.50	-0.31	-0.14	-0.11	0.031	***	**	NS
Protein yield, g/d	986	1023	1087	1122	18.4	***	*	NS
Protein, g/kg	30.8	31.5	31.0	31.6	0.42	NS	NS	NS
Plasma concentration, µM								
Lys	61.4	71.2	65.5	74.0	3.68	NS	**	NS
Met	20.7	29.9	22.1	29.2	1.33	NS	***	NS
His	23.9	34.0	42.7	40.7	3.24	***	NS	†
Carnosine	14.7	14.2	19.6	19.2	1.02	***	NS	NS
1-methylhistidine[2]	5.56	5.23	6.37	5.90	0.222	**	†	NS
3-methylhistidine[3]	4.22	4.50	5.39	4.50	0.251	*	NS	*

[1]LS: Low starch; HS: High starch; AA- vs AA+: without and with RPAA (Lys, Met, His) supplementation, CAS number: [2]332-80-9; [3]368-16-1
[4]*P* value: † : < 0.1, * : < 0.5, ** : < 0.01, *** : < 0.001