Effect of starch source on growth performance and intestinal health

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ABSTRACT – Three diets with raw wheat, boiled wheat and boiled rice as main source of starch were formulated. Forty two and 87 rabbits weanling rabbits of 25 days of age were blocked by litter and assigned to the three diets to determine faecal and ileal digestibility of DM and starch. Ninety nine rabbits weaned at 25 days of age were blocked by litter and assigned to the three diets. Animals were housed individually and fed with the experimental diets during a 14-d period after weaning. After that (at 39 days of age), all the animals received a commercial feed until 60 days of age. For mortality, an additional group of 284 rabbits weaned at 25 days of age were blocked by litter, caged in groups of four animals and assigned to the treatments. Heat processing of wheat increased starch ileal ($P < 0.05$) and faecal ($P = 0.090$) digestibility compared to raw wheat (by 1.9% and 0.9%, respectively). Boiled rice reduced ileal ($P < 0.05$) and faecal ($P = 0.090$) starch digestibility compared to boiled wheat (by 4.5 and 1.3%, respectively), but show a similar ileal and faecal digestibility than raw wheat. Rabbits fed boiled rice showed an intermediate value for villus height between suckling and wheat fed rabbits, but the high crypth depth observed for this treatment lead to a similar value of the ratio villus height/crypth depth. However, these effects did not affect growth performance or mortality. In conclusion, the use of heat processed wheat or boiled rice do not improve the results obtained with raw wheat.

Key words: Starch source, Heat processing, Growth performances, Intestinal morphology.

INTRODUCTION – Heat processing of starch sources or dietary enzymes inclusion improves growth performances and reduces ileal starch concentration and mortality in young rabbits (Gutierrez *et al.*, 2002). Recent research in piglets indicates that rice feeding improve the performance and digestibility with respect to other cereals and might protect pigs against diarrhea (Pluske *et al*., 2003, Vicente *et al*., 2008). However there is no information in rabbits. The aim of work was to study the effect of type of cereal (wheat *vs* rice) and heat processing on growth performances and intestinal health.

MATERIALS AND METHODS – Three diets with raw wheat, boiled wheat and boiled rice as main source of starch were formulated (Table 1). Diets were formulated to meet all the essential nutrient requirements of growing rabbits. In order to determine ileal digestibility, 5 g of DM/kg of alfalfa hay labeled with Yb_2O_3 was included in each diet. Rabbits had *ad libitum* access to feed and water, and were water medicated with a mixture of 100 ppm of apramicine sulphate and 120 ppm of tylosine tartrate to minimize the incidence of epizootic rabbit enteropathy. Forty two and 87 rabbits (14 and 29 per diet) weanling mixed-sex rabbits of 25 days of age were blocked by litter and

randomly assigned to the three experimental diets in order to determine faecal and ileal digestibility. Procedures for digestibility are described by Gómez-Conde *et al*. (2007). Animals for ileal digestibility were slaughtered at 35 d of age. Jejunal morphology was studied in eight animals per treatment coming from the ileal digestibility trial and in 19 suckling rabbits 35 d old (876 ± 17,0 g), and samples collected and processed according to Gómez-Conde *et al*. (2007). Ninety nine rabbits weaned at 25 days of age and weighting 482 ± 69,8 g BW were blocked by litter and assigned at random to the three experimental diets (33 animals per diet). Animals were housed individually and fed with the experimental diets during a 14-d period after weaning. After that (at 39 days of age), all the animals received a commercial feed until 60 days of age. For mortality study, an additional group of 284 rabbits were used. Chemical analyses were performed by procedures of the AOAC (2000). The results for ileal and faecal digestibility, mucosa morphology traits, and mortality rates were analyzed as a completely randomised block, with the type of diet used as the main source of variation and the litter as a block effect using the GLM procedure (SAS Inst. Inc., Cary, NC). Weaning weight was included as a linear covariate. Means were compared using a protected t-test.

Table 1 – Ingredient and chemical composition of experimental diets.

	Boiled rice	Boiled wheat	Raw wheat
Ingredients[1], g/kg			
Boiled wheat	162	323	
Non-boiled wheat			323
Rice	129		
Wheat bran	116	84	84
Analyzed composition, g/kg of Dry Matter			
Crude protein	190	200	193
Starch	230	207	215
Neutral detergent fibre	338	339	339
Acid detergent lignin	38	37	36
Neutral detergent soluble fibre	77	81	81

[1] Common ingredients: soybean meal (111), soybean meal concentrate (20), sunflower meal (71), alfalfa hay (144), oat hulls (147), sunflower hulls (44), lard (33), L-Lysine (4.5), DL-methinine (1), L-threonine (1.5), ClNa (5), CaO (6), Vit-min. premix (5).

RESULTS AND CONCLUSIONS – Heat processing of wheat increased starch ileal ($P < 0.05$) and faecal ($P = 0.090$) digestibility compared to raw wheat (by 1.7% and 0.9%, respectively) (Table 2).

Table 2 – Effect of starch source and heat processing on feed intake and ileal and faecal digestibility.

	Boiled rice	Boiled wheat	Raw wheat	SEM	P
ADFI 25 to 35, g/d	81.4	82.8	82.8	2.63	0.94
Faecal digestibility[1], %					
Dry matter	65.8	64.7	64.8	0.69	0.58
Starch	98.3	99.6	98.7	0.34	0.09
Ileal digestibility[2], %					
Dry matter	45.2	46.8	46.0	1.22	0.86
Starch	89.0a	93.2b	91.5a	0.56	0.02

[1] n = 14. [2] n = 7. Means denoted with different letters differ at P<0.05 level

However, heat processed wheat did not improve mucose morphology, growth rate or mortality (Table 3 and 4). Boiled rice reduced ileal ($P < 0.05$) and faecal ($P = 0.090$) starch digestibility compared to boiled wheat (by 4.5 and 1.3%, respectively), but show a similar ileal and faecal digestibility than raw wheat. Suckling rabbits showed the highest ratio villus height/crypth depth ($P = 0.001$). Rabbits fed boiled rice showed an intermediate value for villus height between suckling and wheat fed rabbits, but the high crypth depth observed for this treatment lead to a similar value of the ratio villus height/crypth depth. However, these effects did not affect growth performance or mortality. In conclusion, the use of heat processed wheat or boiled rice do not improve the results obtained with raw wheat.

Table 3 – Effect of starch source, heat processing and weaning upon the morphology of jejunal mucosa in 35-d-old rabbits.

	Weaned rabbits			Suckling rabbits	SEM[1]	P
	Boiled rice	Boiled wheat	Raw wheat			
Villous height, µm	513[ab]	493[b]	455[b]	566[a]	28.4	0.01
Crypt depth, µm	128[a]	113[c]	122[ac]	89.6[b]	4.66	0.0001
Villous height/ Crypt depth	4.04[a]	4.41[a]	3.75[a]	6.68[b]	0.37	0.0001

[1] n = 8 in all cases except for 35-d-old suckling rabbits (n=19)

Table 4 – Effect of starch source and heat processing on fattening performance.

	Boiled rice	Boiled wheat	Raw wheat	SEM[1]	*P*
From 25 (weaning) to 39 d of age					
Weight gain, g/d	42.9	43.5	44.4	2.05	0.88
Feed intake, g/d	71.2	77.5	78.9	3.07	0.23
Feed efficiency, g/g	0.59	0.57	0.56	0.015	0.53
Mortality rate, %	12.0	8.3	7.1	2.55	0.37
Whole fattening period (25-60 d)					
Weight gain, g/d	46.0	45.2	45.1	0.84	0.74
Feed intake, g/d	120	120	120	2.33	0.98
Feed efficiency, g/g	0.385	0.379	0.375	0.003	0.19
Mortality rate, %	16.0	12.1	11.8	2.99	0.55

[1] n = 33, except for mortality rate where n =128. Means denoted with different letters differ at P<0.05 level

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