Choosing the right phytase to improve sodium pump function, reduce the catabolism of amino acids and increase protein and glucose uptake

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PRF

Enhancing poultry performance

PhD chapter : Effect of phytase on starch and protein utilisation in broiler chickens

Three studies and (so far) two published papers in collaboration with Danisco Animal Nutrition

Truong HH, Yu S, Peron A, Cadogan DJ, Khoddami A, Roberts TH, Liu SY, Selle PH (2014) **Phytase supplementation of maize-, sorghum- and wheat-based broiler diets with identified starch pasting properties influences phytate (IP6) and sodium jejunal and ileal digestibility**

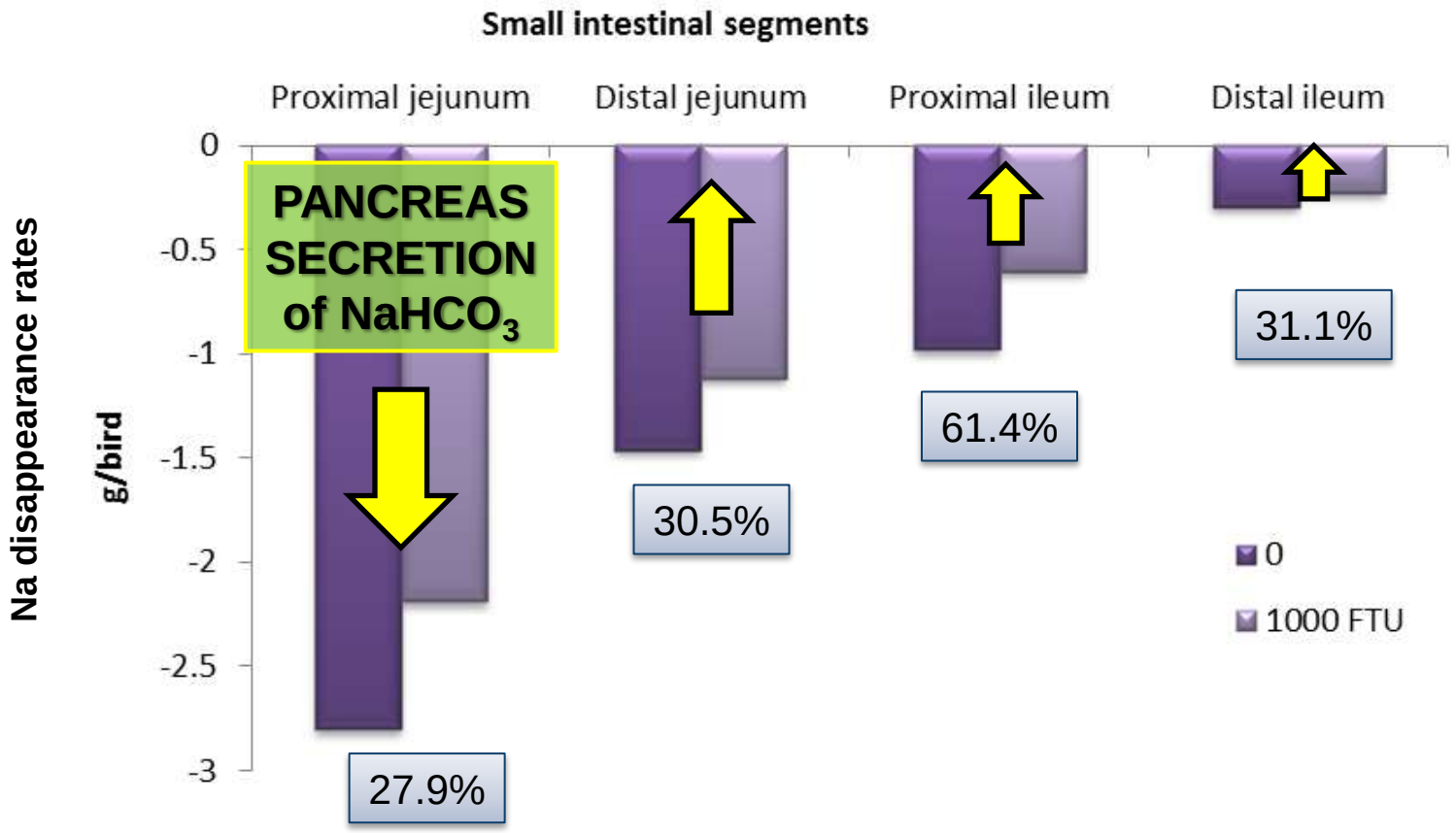
Animal Feed Science and Technology, 198**,** 248-256.

Truong HH, Bold RM, Liu SY, PH Selle (2015) **Standard phytase inclusion in maize-based broiler diets enhances digestibility coefficients of starch, amino acids and sodium in four small intestinal segments and digestive dynamics of starch and protein.**

Animal Feed Science and Technology (accepted for publication).

STUDY 1: Truong et al. (2014)

Buttiauxella phytase(1000 FTU) in maize, wheat and sorghum diets had a Na effect

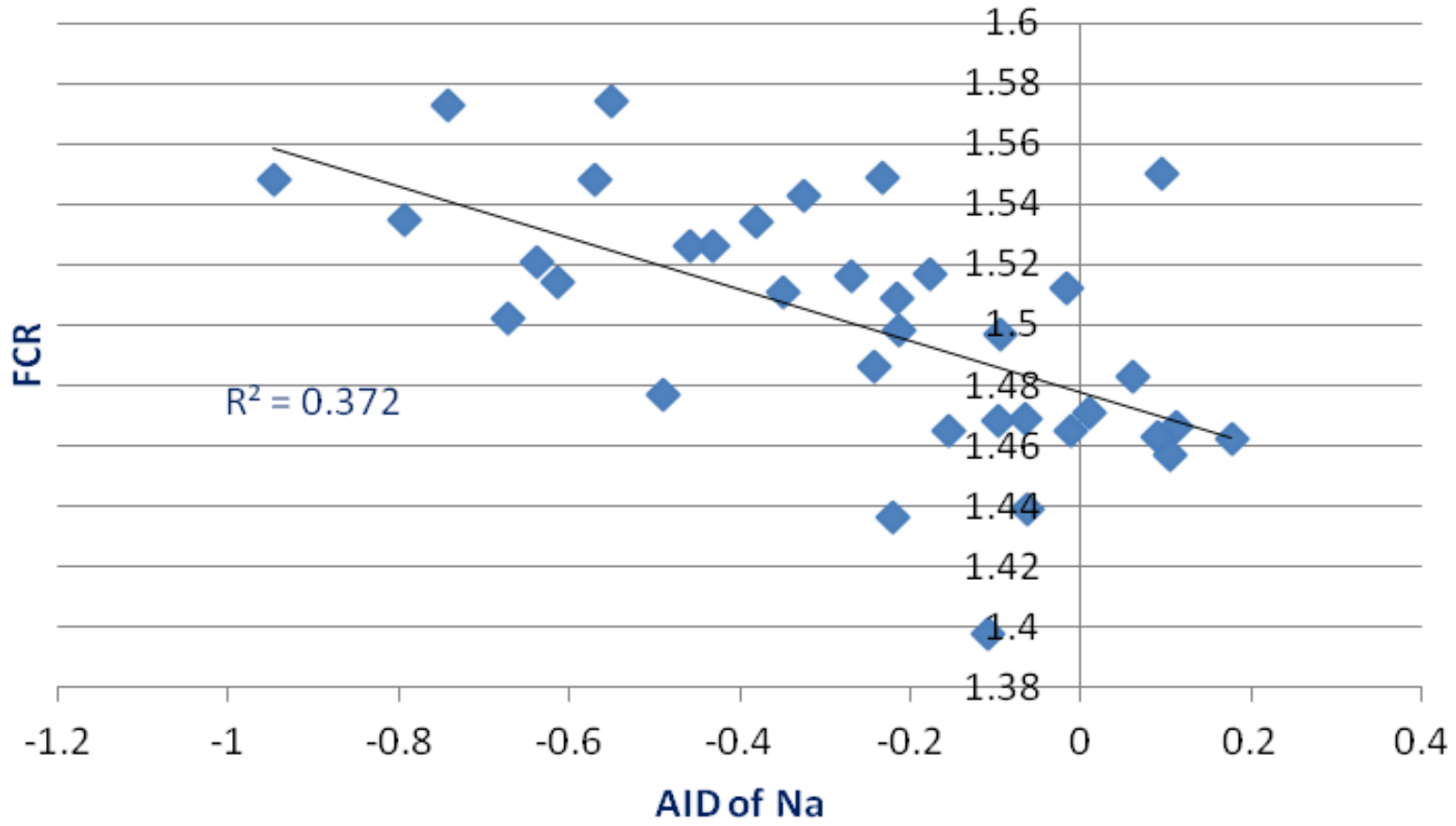


Phytase addition significantly increased sodium disappearance!

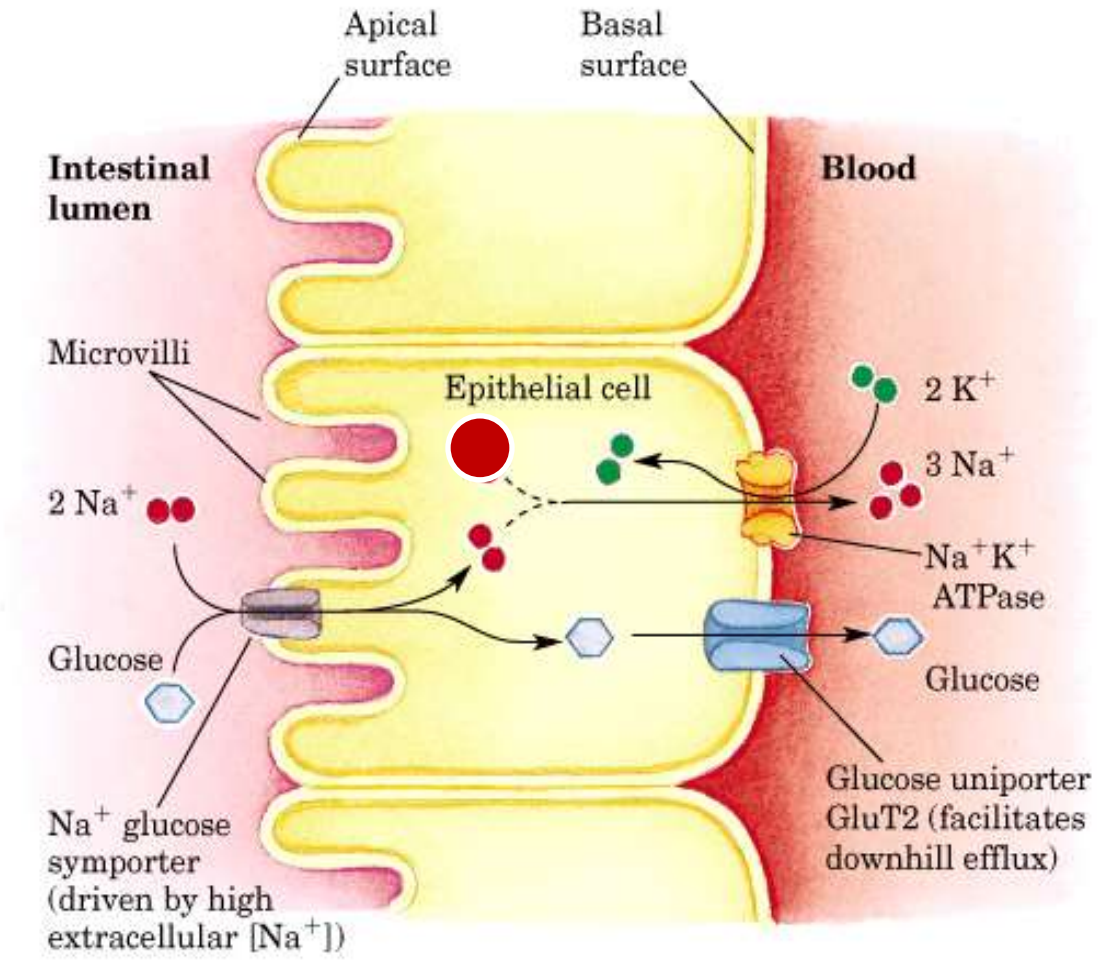
STUDY 1: Truong et al. (2014)

Increasing Na digestibility in the distal ileum improves FCR

(r = −0.610; P < 0.001)



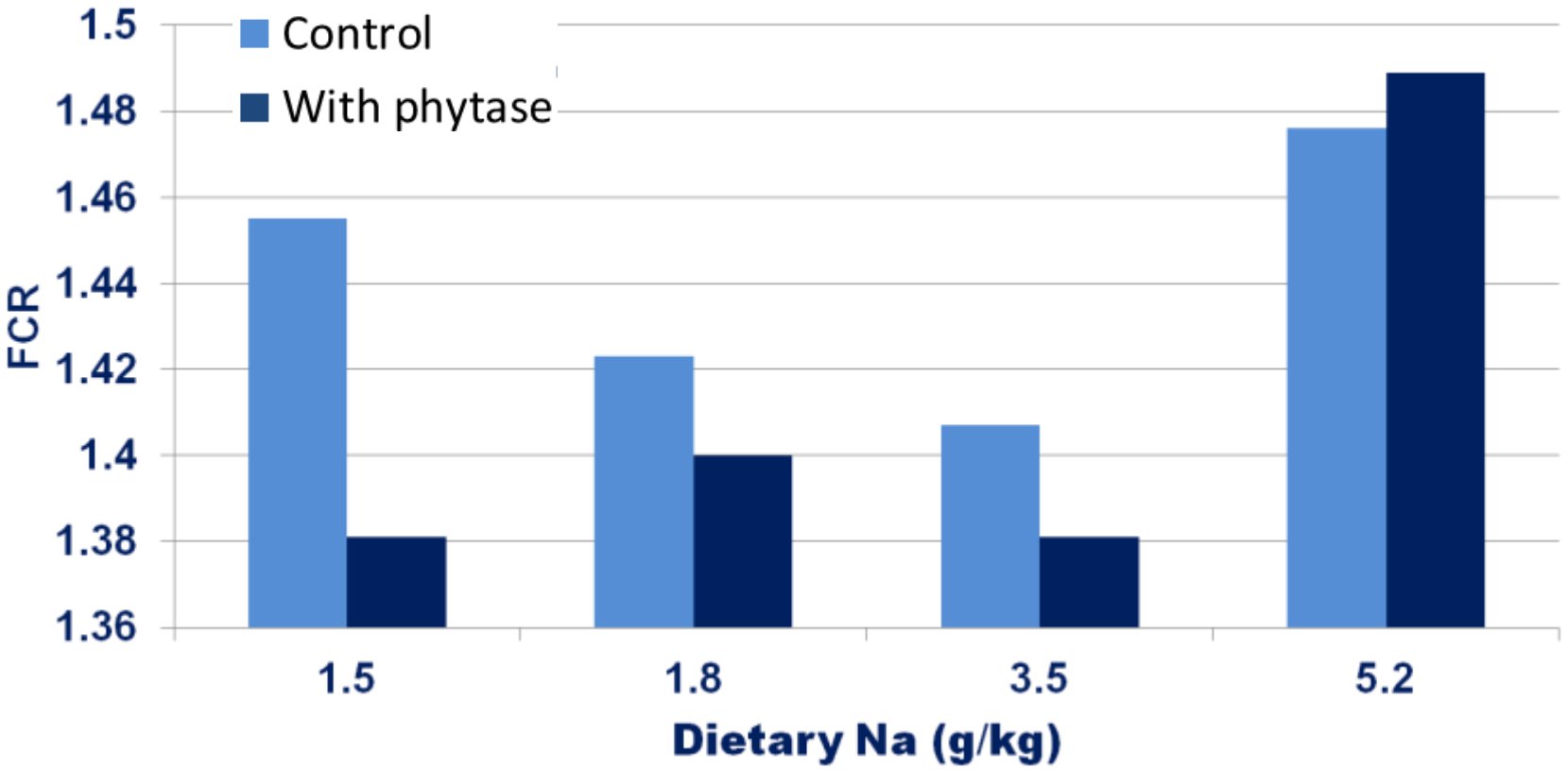
The Sodium pump
(Na$^+$, K$^+$-ATPase)



The sodium pump needs available sodium to function

Ravindran et al. (2009)

FCR responses to exogenous phytase as influenced by dietary Na levels
where 1.8 g/kg was their recommended standard

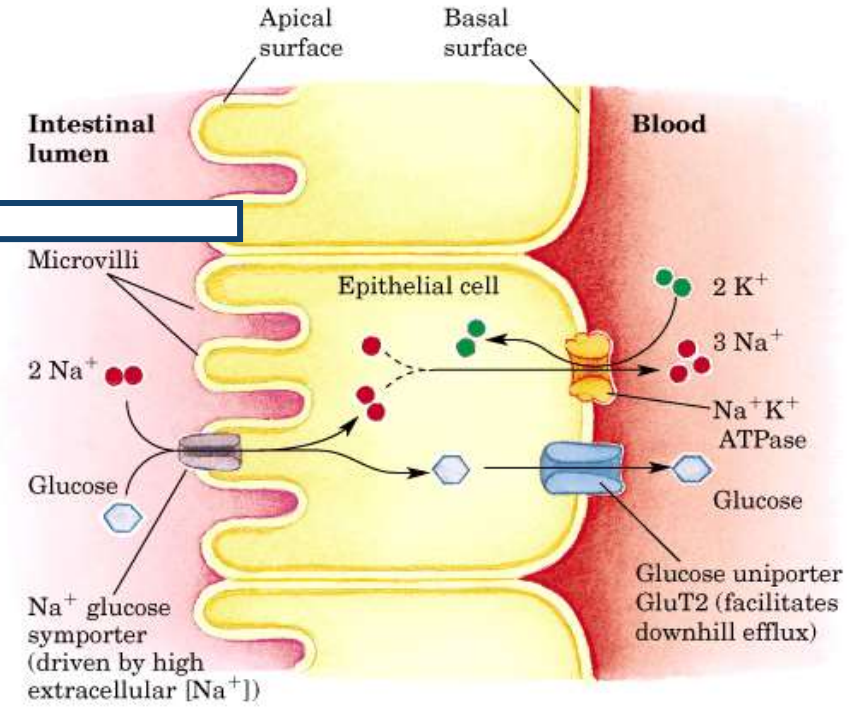


Phytase primes the sodium pump

› By decreasing release of Na as sodium bicarbonate ($NaHCO_3$) into the duodenum thereby countering the depletion of Na in enterocytes

$NaHCO_3$

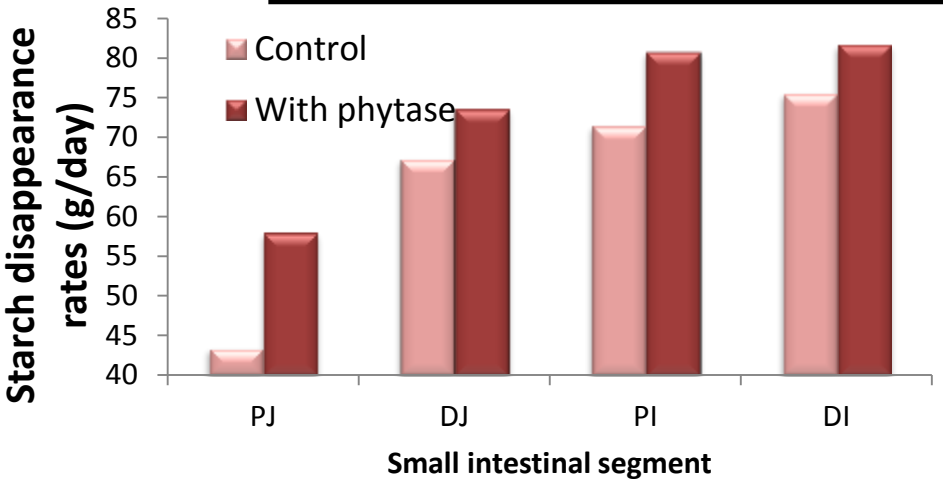
Na is being drawn out, into the lumen via
Pancreas
Liver
Gut lining

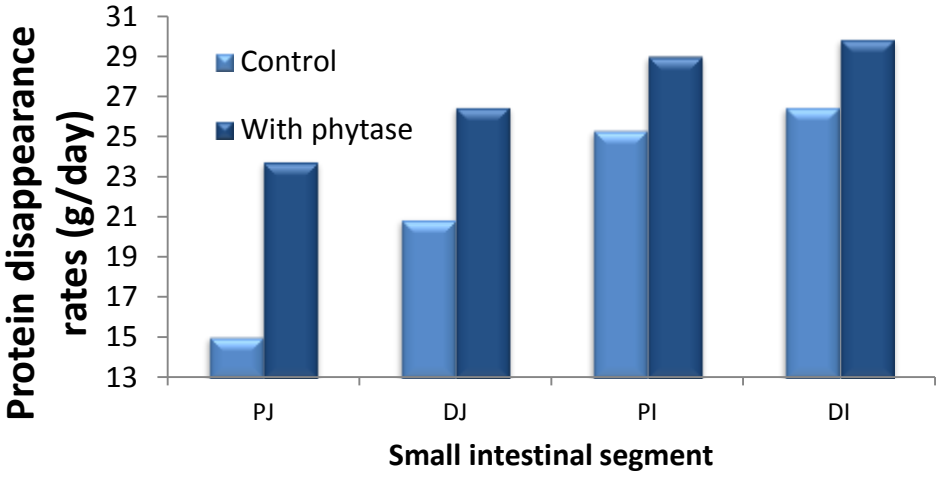


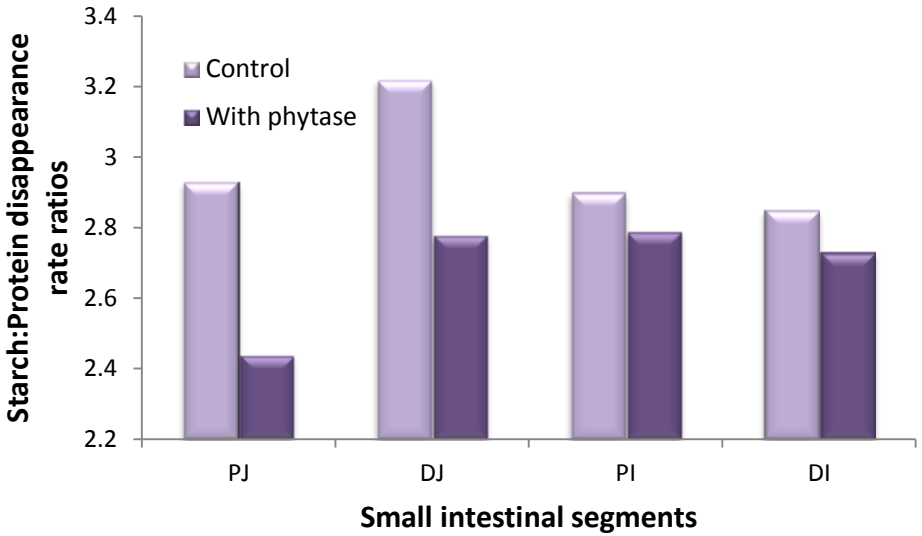
› With 1000 FTU phytase, lowering dietary Na levels can increase phytase responses, i.e its Na effect

STUDY 2: Truong et al. (2015)

Phytase increased the amount of starch and protein absorbed: Where protein was increased to a higher extent than starch (hence phytase lowered S:N disappearance ratios)



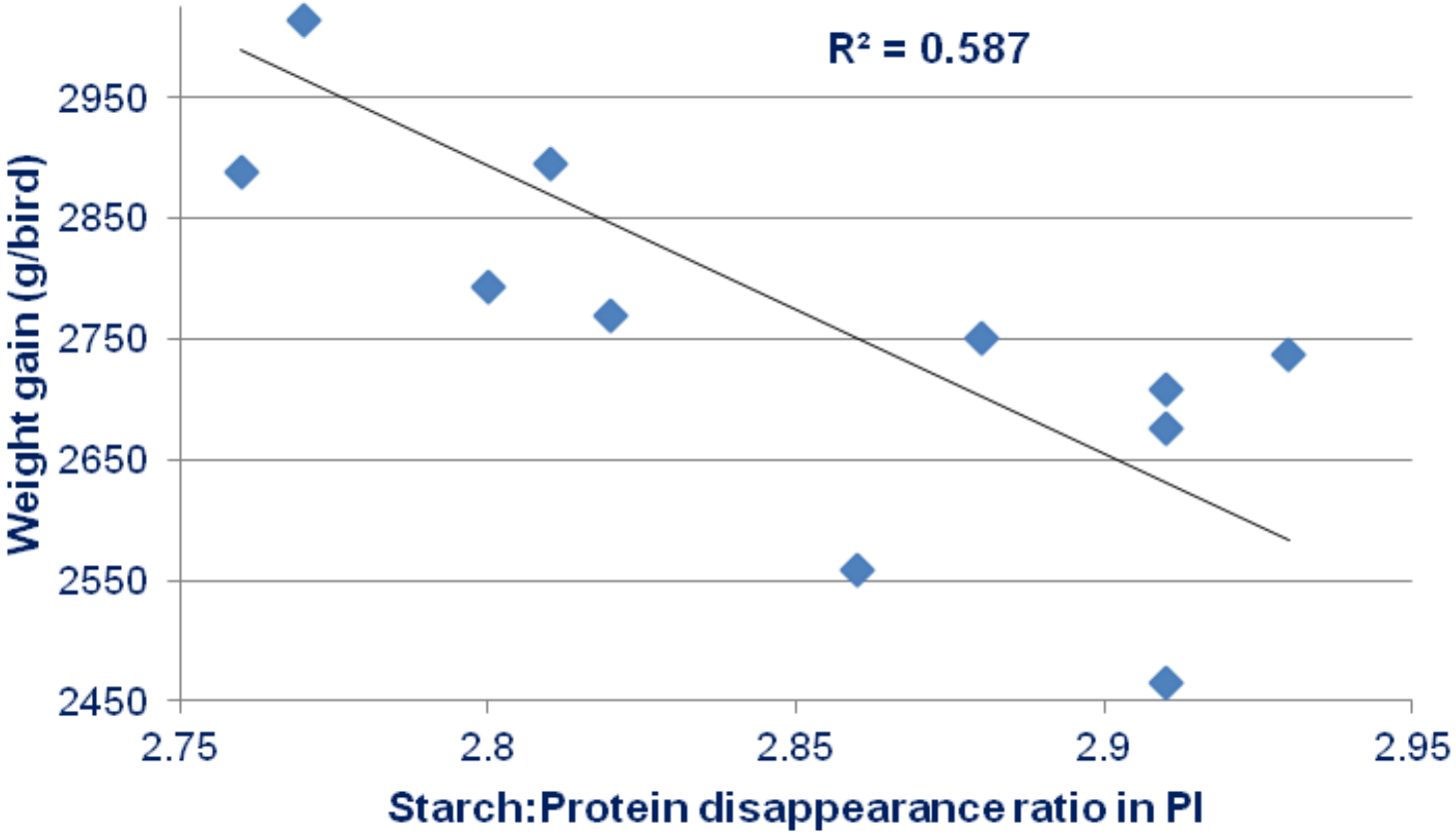




STUDY 2: Truong et al. (2015)

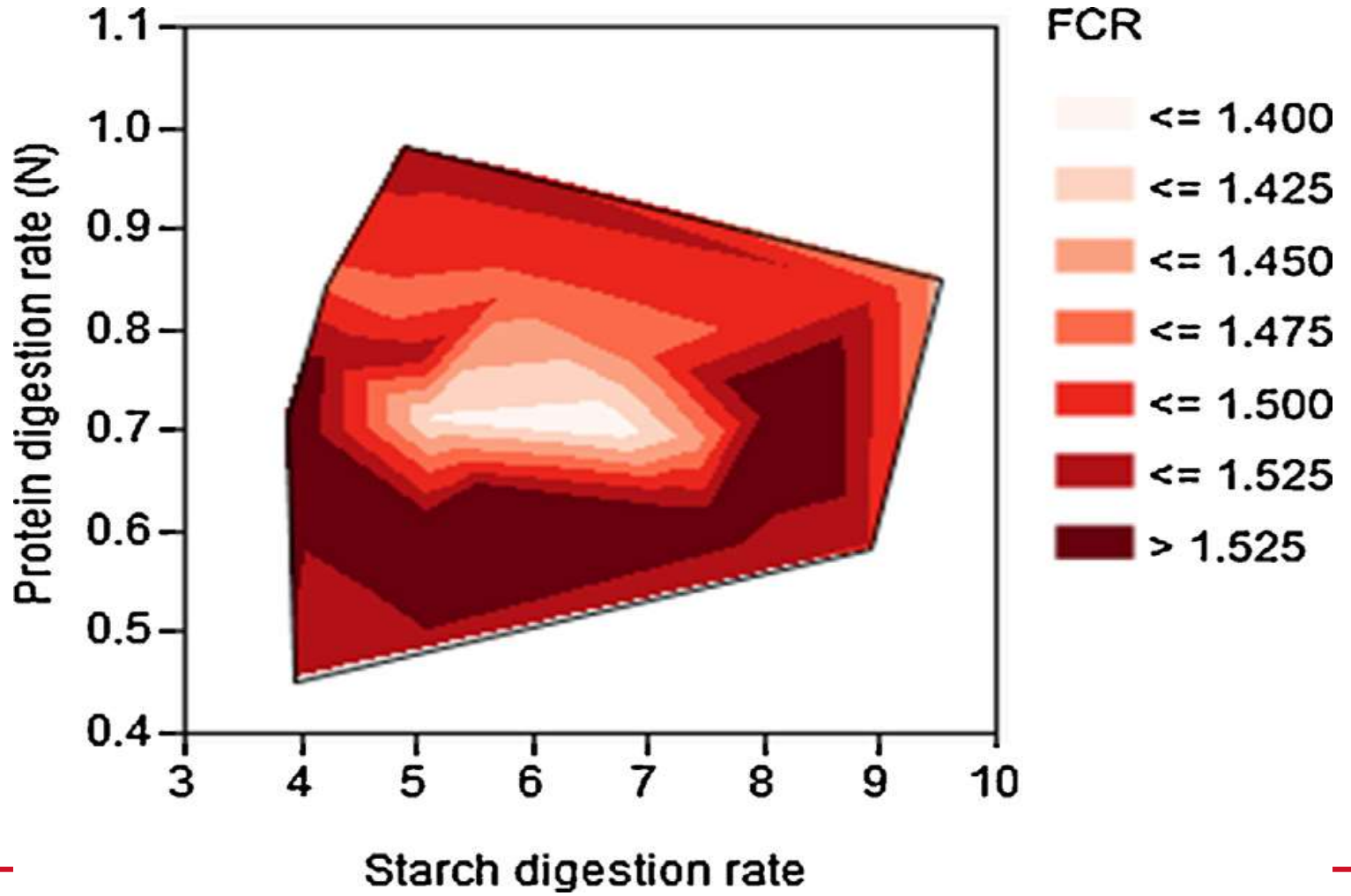
Narrow ratios of starch and protein disappearance rates increases weight gain

(r = -0.766; P = 0.003)



Liu et al. (2014)

Starch and protein digestion rates influence feed conversion



STUDY 2: Truong et al. (2015)

Phytase influences starch and protein digestion dynamics

Treatment	Starch:protein disappearance rate ratios in small intestine			
	Proximal jejunum	Distal jejunum	Proximal ileum	Distal ileum
0	2.93	3.22	2.90	2.85
Phytase	2.44	2.78	2.79	2.73
Response	**20.1%**	**15.8%**	**3.94%**	**4.40%**
SEM	0.2090	0.1041	0.0129	0.0289
Significance (P =)	0.132	0.013	< 0.001	0.015

Phytase condensed or narrowed starch:protein disappearance rate ratios

Truong et al. (2015)

Conclusions

Phytase accelerates digestion and absorption rates of protein/amino acids to a greater extent than that of starch/glucose.

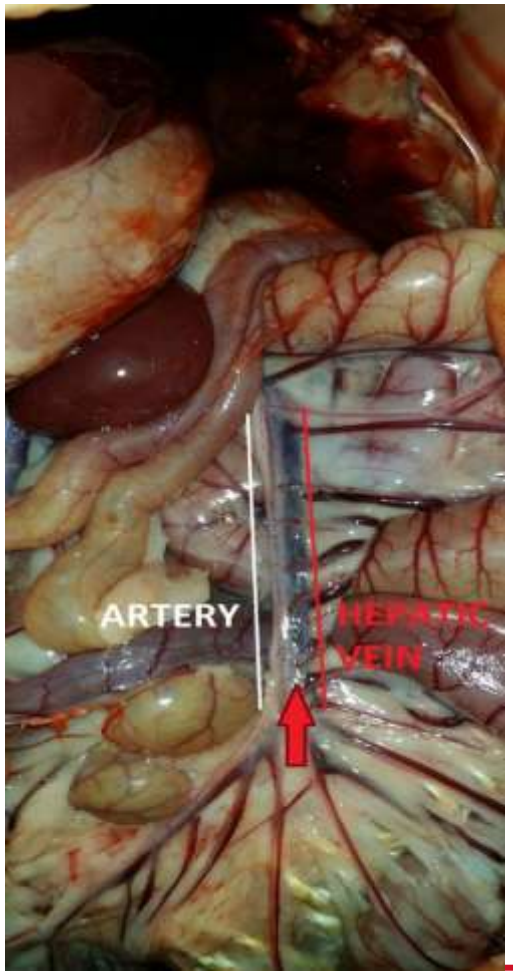
The balance between starch and protein digestive dynamics is improved.

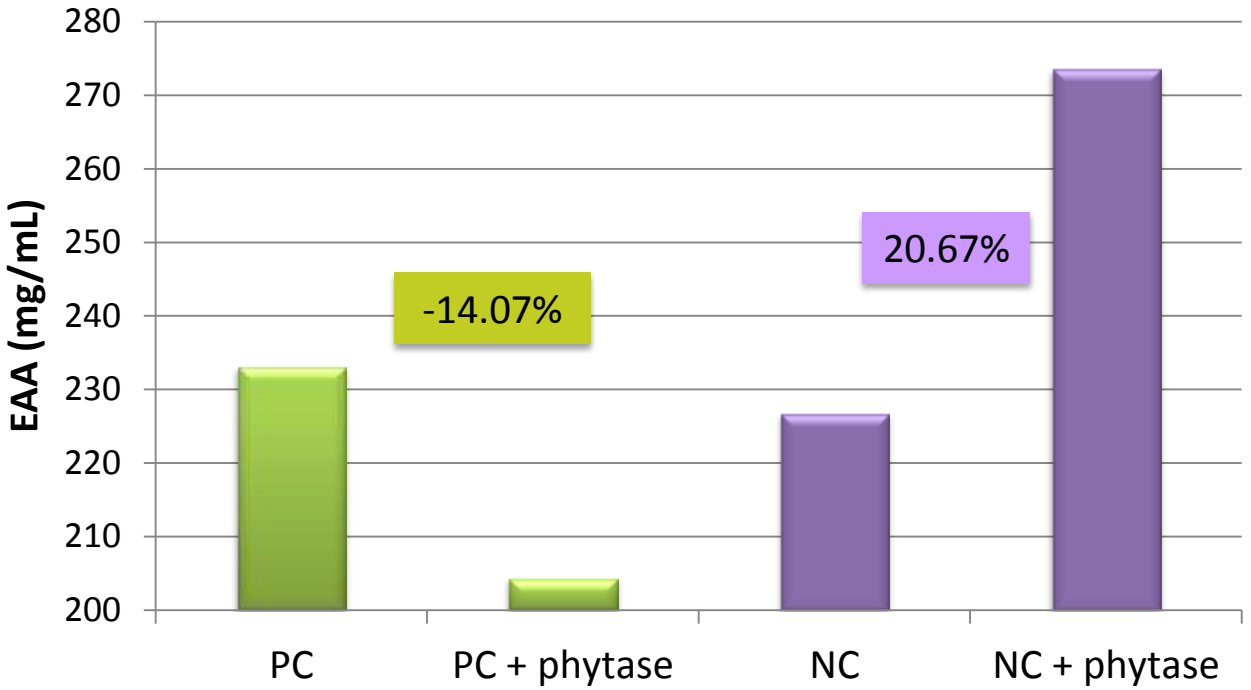
Possible mechanism?

Reduction of amino acid catabolism

STUDY 3: 2015 collaboration with Danisco, UK and APAF, Macquarie University, Sydney – AxtraPhy

Preliminary findings investigating portal 'flux' of essential amino acids in plasma collected from the anterior mesenteric vein



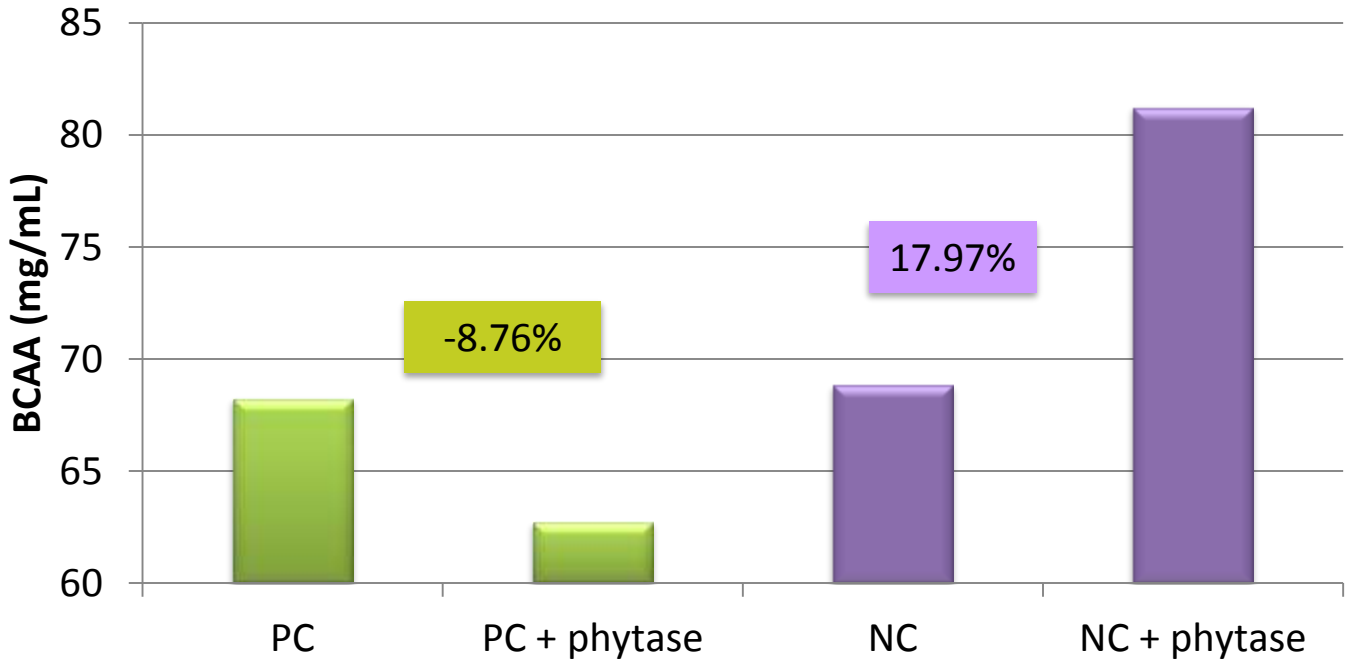


In the negative control diet:

Phytase (1000 FTU) increased the level of EAA in the 'systemic circulation'

STUDY 3: 2015 collaboration with Danisco, UK and APAF, Macquarie University, Sydney – AxtraPhy

Effect of phytase (1000 FTU) on branched-chain AA levels in plasma collected from the anterior mesenteric vein



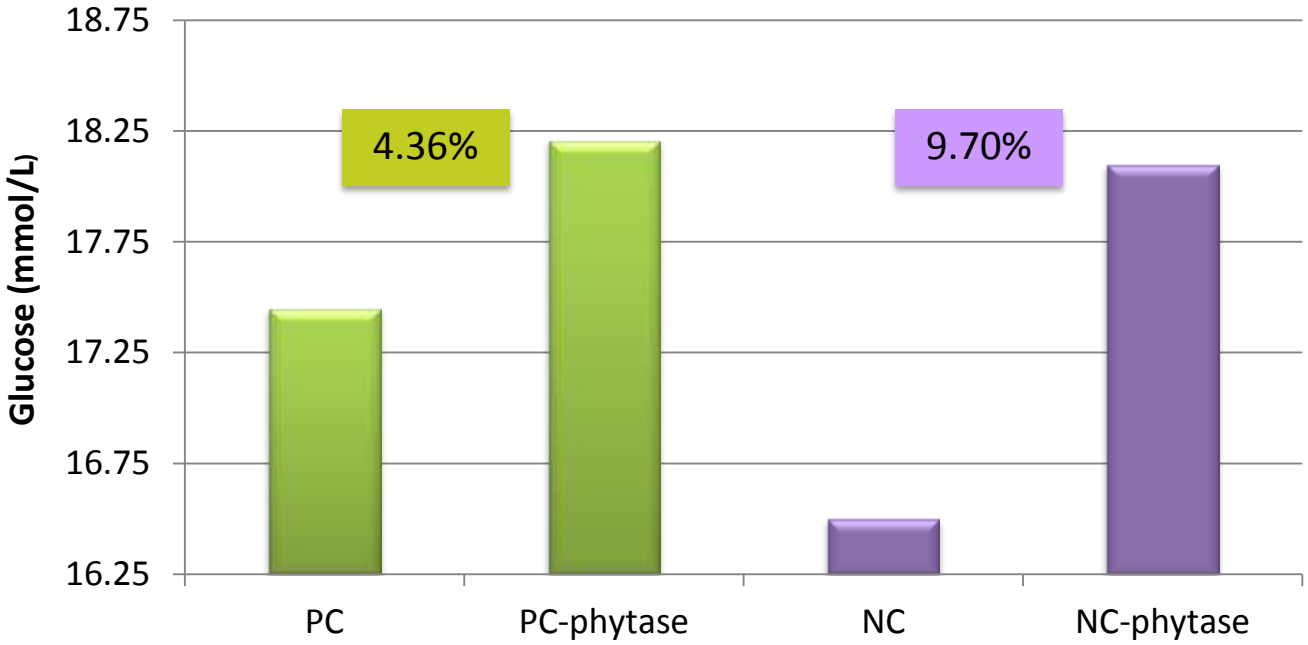
In the negative control diet: Phytase increased the level of BCAA in the 'systemic circulation'.

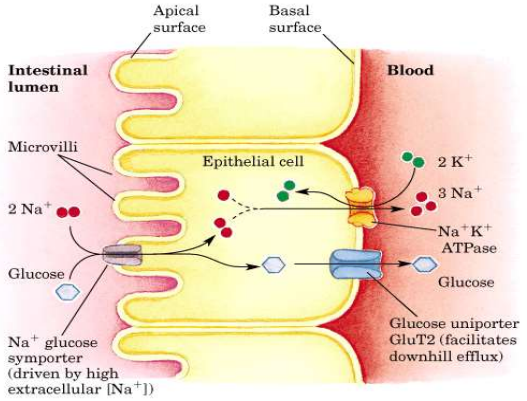
Branched-chain amino acids are especially suscpetible to catabolism in the gut mucosa in pigs (CHEN et al., 2007).

Phytase appears to have reduced the catabolism of these amino acids by the gut!

STUDY 3: 2015 collaboration with Danisco, UK and APAF, Macquarie University, Sydney – AxtraPhy

Effect of phytase (1000 FTU) on glucose levels in plasma collected from the anterior mesenteric vein





Phytase addition increased glucose levels in the portal blood stream – improved Na-pump function?

Thank you