A TECHNICAL UPDATE ON THE USE OF ENZYMES IN ANIMAL FEED

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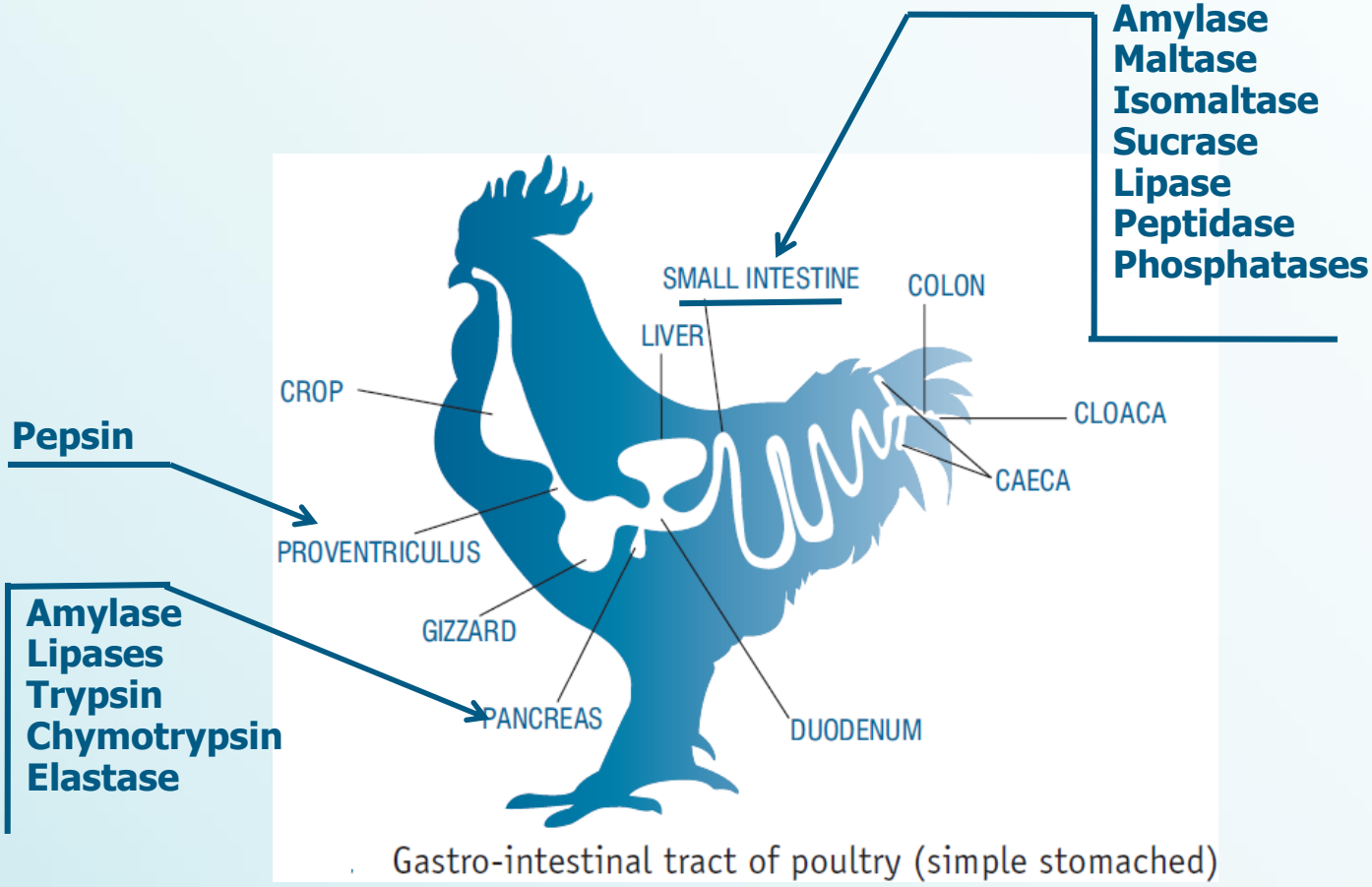
MONOGASTRICS DO NOT PRODUCE FIBRE-DEGRADING ENZYMES OR SUFFICIENT PHOSPHATASES/PHYTASES



FEED ENZYME HISTORY

1. Dr Rőhm started 1st commercial enzyme company in 1907
2. Positive effects of feed enzymes known by the 1920's
3. Breakthrough research in Washington State in 1950-60's
4. 1984 – launch of ß–glucanase supplemented barley-based feeds in Finland
5. 1989 – xylanase introduced in commercial UK wheat-based broiler feeds
6. 1991 – first commercial phytases used in Europe, to reduce P pollution

WHAT FIBRE-DEGRADING ENZYMES DO – PIG ENZYME TRIAL

- ~22 kg pigs fitted with ileal cannula
- Diet based on barley (533 kg/t), wheat middlings (330 kg/t) and SBM (86 kg/t)
- Fed with or without enzyme product contributing 2,600 U/kg xylanase and 32 U/kg glucanase

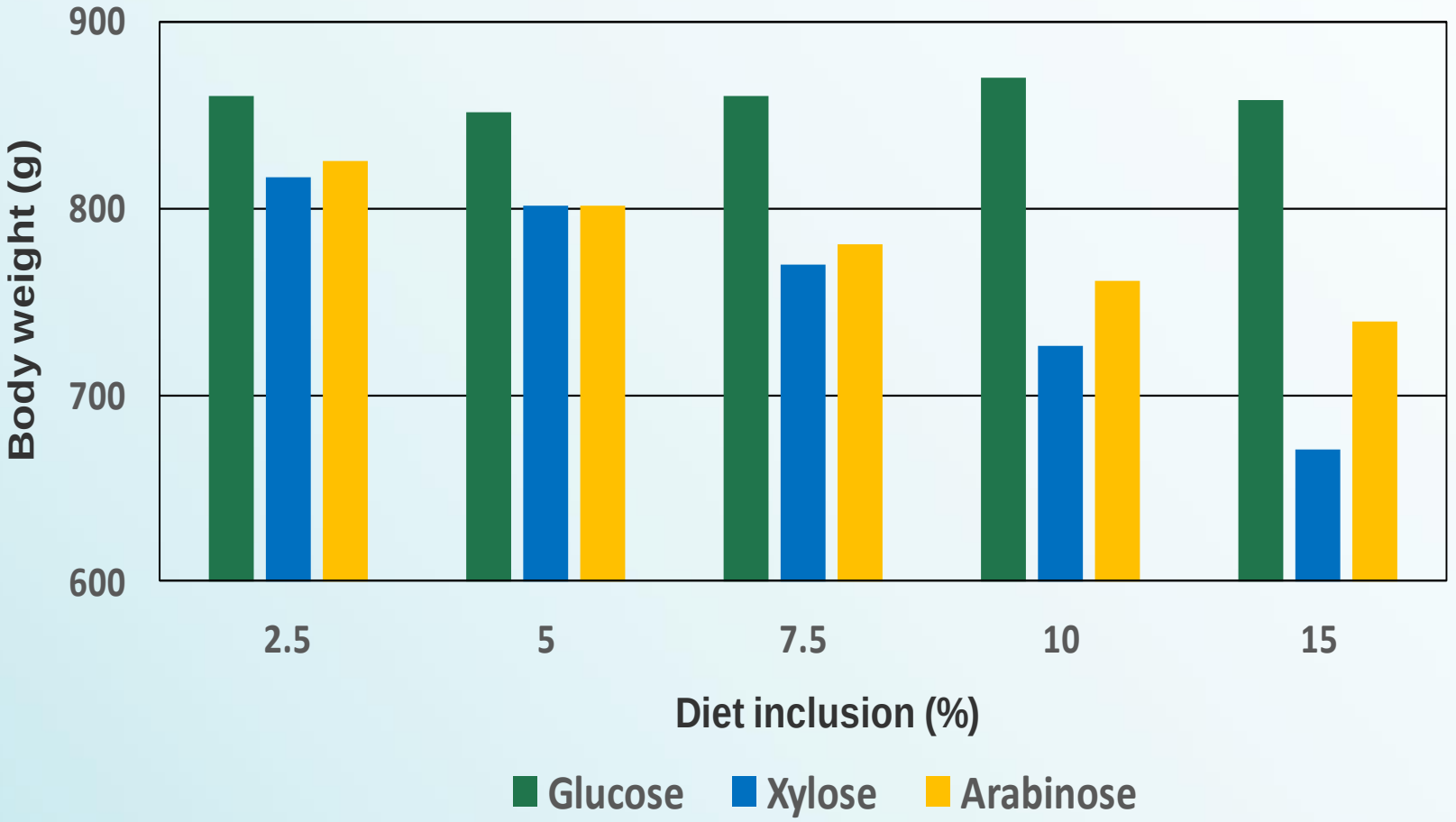
Graham, Löwgren, Pettersson & Åman, 1988

PIG ENZYME TRIAL - RESULTS

	Ileal apparent digestibility (%)		Faecal apparent digestibility (%)	
	Control	+Enzyme	Control	+Enzyme
Crude protein	64.5	70.1*	79.4	81.2
Crude fat	60.0	65.5*	56.9	58.8
Starch	92.0	94.9*	99.2	99.6
Total NSP	12.2	13.2	52.4	55.6
Arabinoxylan	1.7	2.1	47.4	50.3
Cellulose	9.6	5.5	34.3	37.8
Mixed-linked-ß -glucan	40.1	58.6*	99.5	99.7
Xylan solubility %	15.9	22.2*	<1	<1

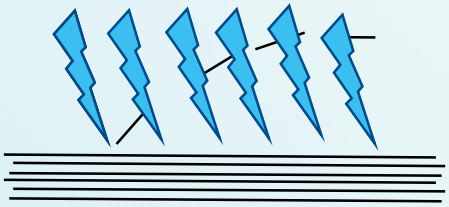
*P<0.05; Graham *et al*, 1988

MONOSACCHARIDES PRODUCED BY ENZYME ACTION ON FIBRE CAN REDUCE ANIMAL PERFORMANCE



(Schutte, 1990)

FIBRE DEGRADING ENZYMES CAN MAXIMISE DIGESTIBILITY AND FEED CONVERSION



1. Opening of feedstuff cell walls (insoluble fibre)

2. Reduction in intestinal viscosity (soluble fibre)

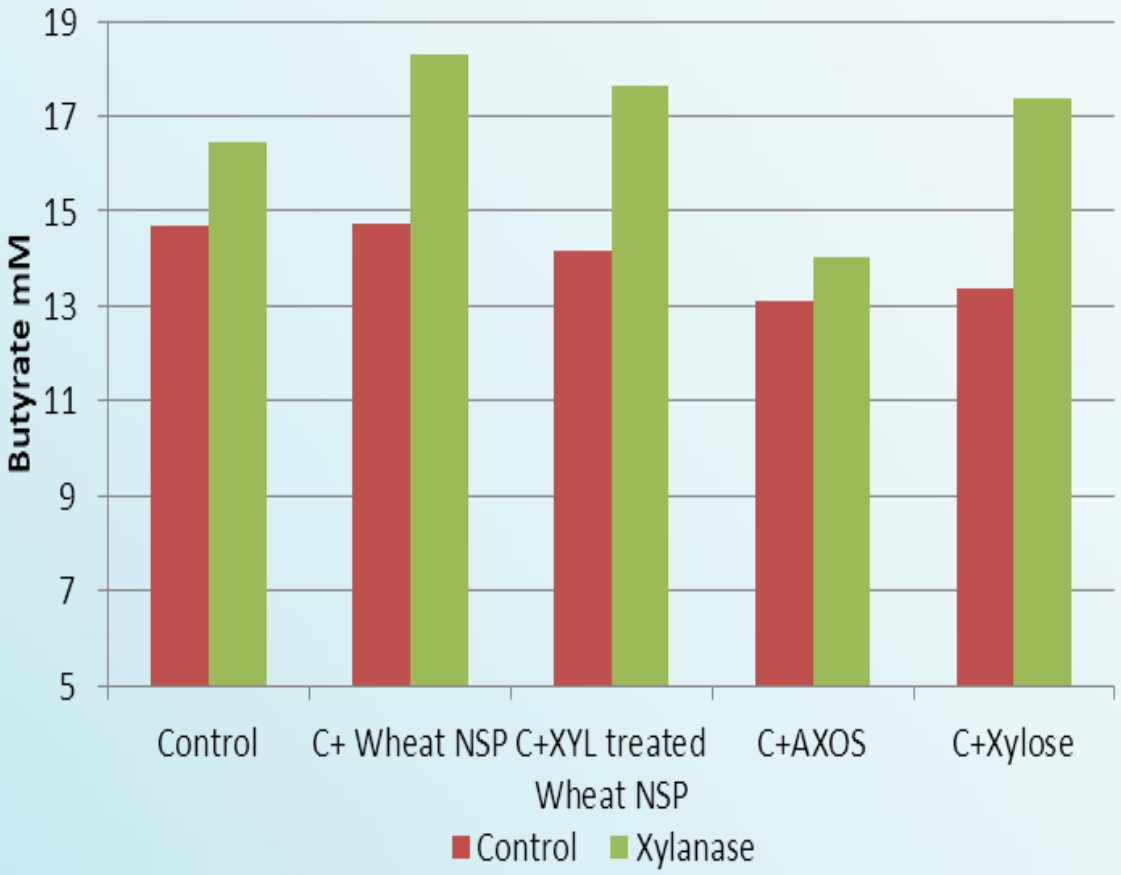
3. Production of prebiotic oligosaccharides

Better digestion of nutrients such as starch, protein & fat

Encourage establishment of a healthy gut microflora

Fibre-degrading enzymes are not designed to release extra sugars from fibre, to be absorbed directly and used by the animal!

XYLANASES POTENTIATE GUT MICROFLORA



Butyrate production by caecal inocula from birds fed Control or Xylanase supplemented diets, incubated *in vitro* with ileal digest from control birds with various substrates added.

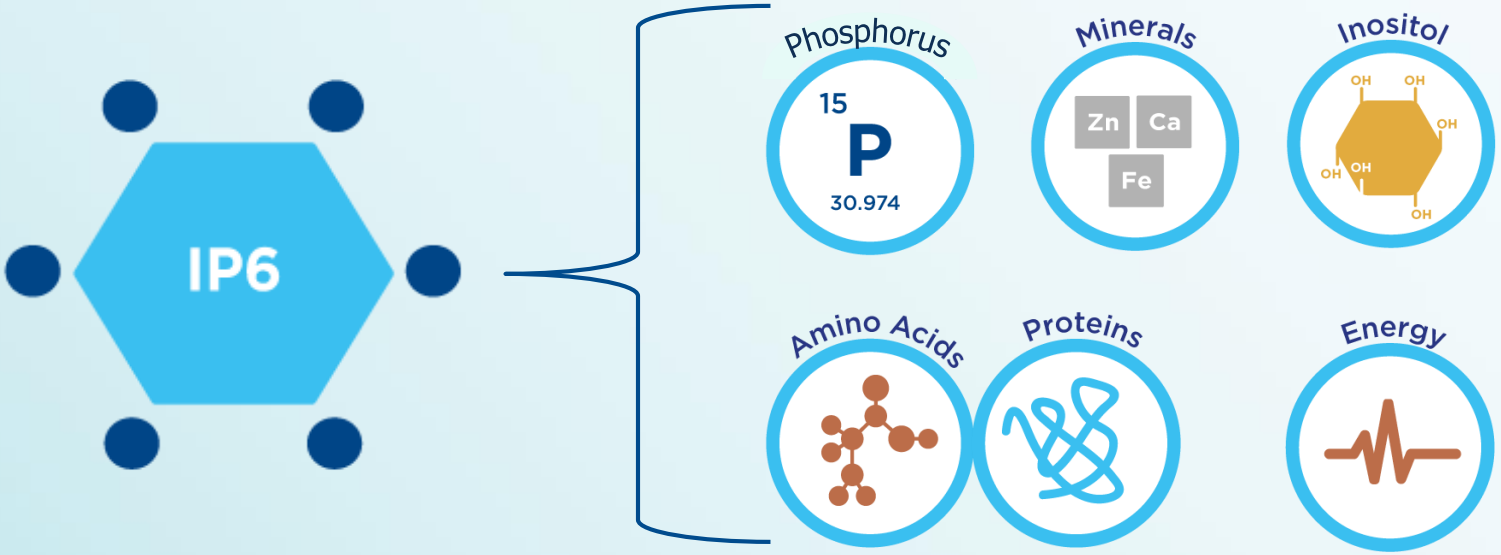
The caecal microbiome in birds fed xylanase-supplemented diets were more effective at degrading fibre and producing butyrate

Bedford & Apajalahti, 2018

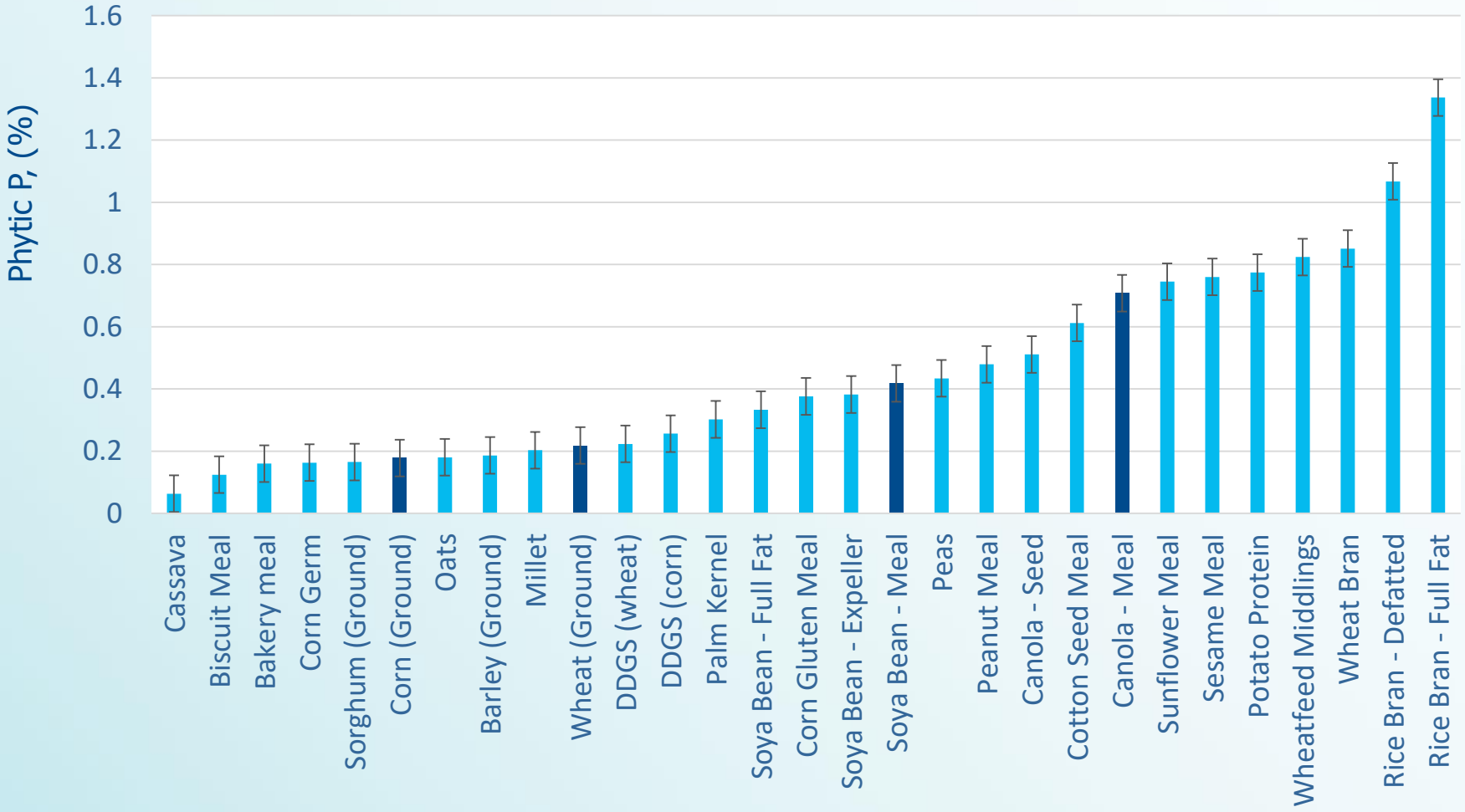
PHYTATE REDUCES NUTRIENT DIGESTIBILITY IN FEED – ITS MORE THAN JUST PHOSPHORUS

- Phytate is the primary source of phosphorus in plant-derived feedstuffs. Phytate can also binds to important minerals, amino acids and proteins.

- As monogastrics do not break down phytate efficiently, many of the vital nutrients contained within and bound to the molecule are under-utilised or excreted as waste.



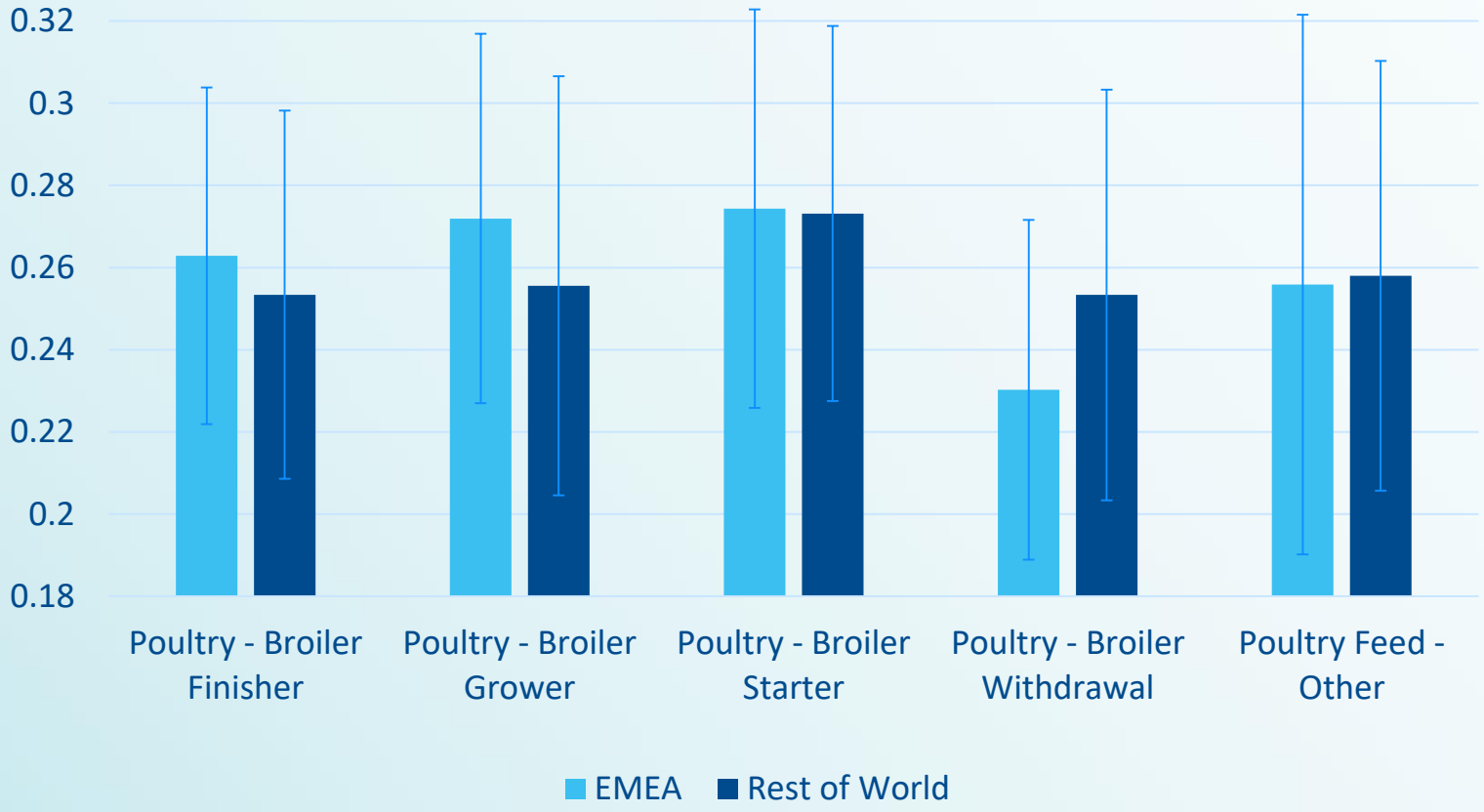
THERE IS VARIATION IN PHYTATE LEVELS BETWEEN AND WITHIN INGREDIENTS



> 100,000 samples tested

Source: AB Vista

THERE IS VARIATION IN PHYTATE LEVELS BETWEEN AND WITHIN FEEDS



MINIMISING PRODUCTION COSTS AND WASTE THROUGH MAXIMISING ENZYME MATRIX APPLICATION

Basal diet	Mineral matrix	AA matrix	AME matrix kcal/kg	Phytase FTU/kg	Xylanase BXU/kg
Positive control (PC)	-	-	-	-	-
Industry control (IC)	0.15% avP 0.165% Ca 0.035% Na	-	50	500	9,600
Negative control (NC)	0.20% avP 0.22% Ca 0.045% Na	Lysine 0.050% Threonine 0.050% TSAA 0.050% Methionine 0.010% Cysteine 0.040% Valine 0.040% Tryptophan 0.020% Isoleucine 0.036% Arginine 0.026%	120	- 2,000	- 9,600

0-42 days, 12 pens of 19 males broilers per diet, corn-based diets

MINIMISING PRODUCTION COSTS AND WASTE THROUGH MAXIMISING ENZYME MATRIX APPLICATION

Diet	PC	IC	NC	NC+P+X
Phytase, FTU/kg	-	500	-	2,000
Xylanase, BXU/kg	-	9,600	-	9,600
	0-42 days			
Weight Gain, g/bird	3,539^{a}	3,549^{a}	2,868^{b}	3,509^{a}
BW-corrected FCR, g:g*	1.43^{c}	1.44^{bc}	1.74^{a}	1.48^{b}
EPEF	576^{a}	567^{a}	409^{b}	564^{a}
P efficiency, g/bird*	30.7^{a}	22.8^{b}	22.5^{b}	21.5^{c}
Lys efficiency, g/bird*	59.9^{b}	60.6^{b}	61.6^{a}	59.0^{c}
Feed cost/bird, %	**100.0^{a}**	**97.6^{b}**	**98.4^{ab}**	**94.3^{c}**

*standardised for a 3.58 kg bird

ADDING PROTEASE TO LOW NUTRIENT DIETS SUPPLEMENTED WITH PHYTASE AND XYLANASE

Diet		Phytase (U/kg)	Xylanase (U/kg)	Protease (U/kg)
Positive control	Std corn/SBM diets	-	-	-
-Ca/P control	-0.18% avP -0.20% Ca	-	-	-
-Ca/P +Phy		1,500	-	-
-Ca/P/ME control	-0.18% avP -0.20% Ca -80 kcal/kg	-	-	-
-Ca/P/ME +Phy+Xyl		1,500	16,000	-
-Ca/P/ME/AA control	-0.18% avP -0.20% Ca -80 kcal/kg -5% digAA	-	-	-
-Ca/P/ME/AA +Phy+Xyl		1,500	16,000	-
-Ca/P/ME/AA +Phy+Xyl+Pro		1,500	16,000	15,000

As-hatched broilers, 1-35 days, 9 pens of 66 birds per diet
Walk & Poernama, 2018

Phytase, Xylanase & Protease supplementation - 35 day mFCR

Walk & Poernama, 2018

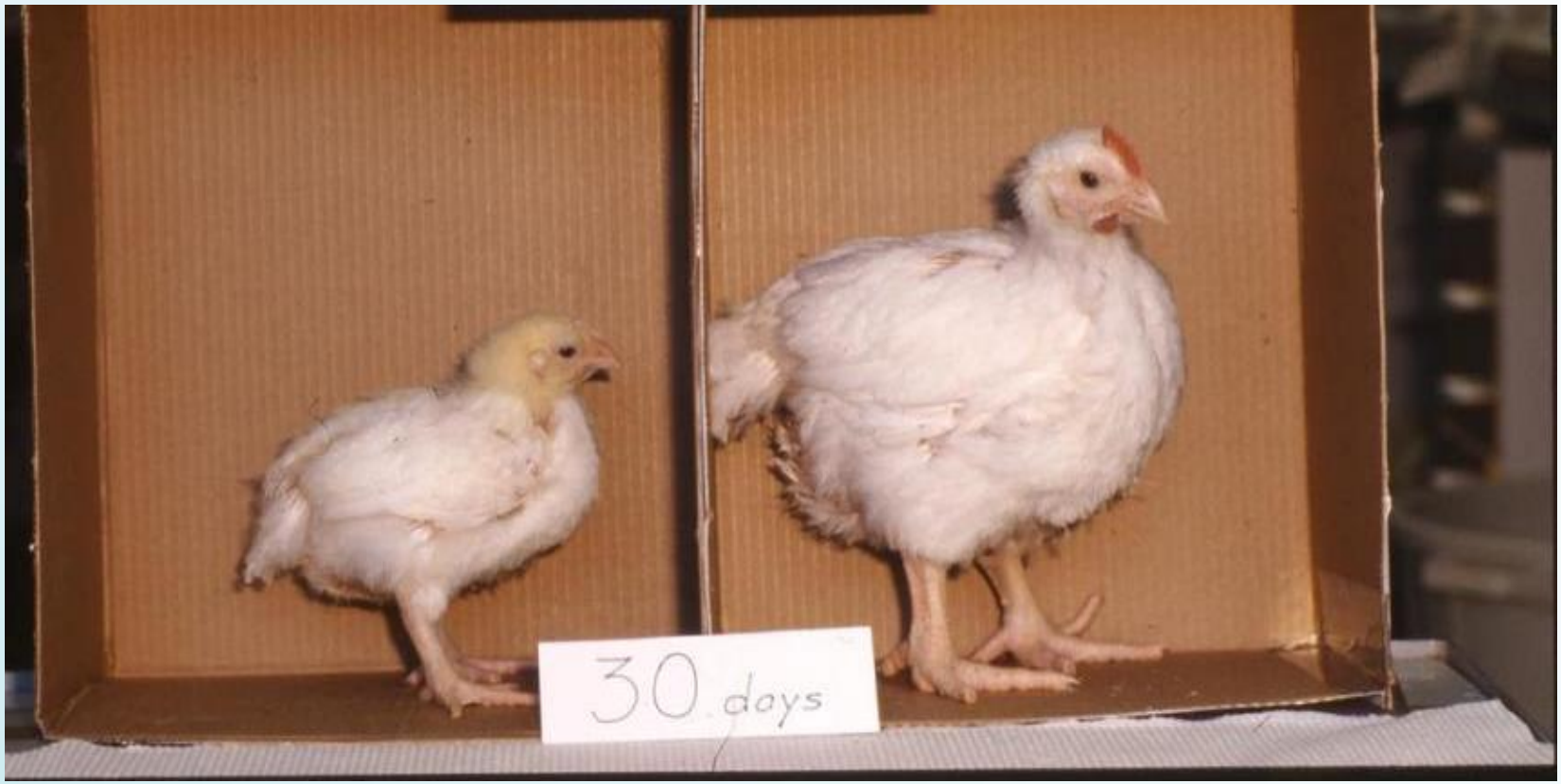
CURRENT GLOBAL ENZYME MARKET

- Market penetration (2017):
  - Poultry >95%
  - Swine >90%

- Annual Phytase Market ~€450 million
- Annual Xylanase Market ~€500 million
- Annual Protease Market ~€100 million

- **Current savings to the feed industry >€4 billion**

ENZYMES MAKE A DIFFERENCE!



UNTREATED CEREALS

FIBRE-DEGRADING ENZYME ADDED

Improved feed intake
Improved feed conversion ratio
Improved growth
Less sticky droppings

QUESTIONS?