International Egg Commission
TECHNICAL SEMINAR INDIA

Increasing production efficiency through improved feed management

Kostas Stamatopoulos
Global Speciality Solutions Manager – Enzymes, DSM Animal Nutrition & Health

International Egg Commission

TECHNICAL SEMINAR

INDIA

Profitable Egg Production

Agenda

- Enzymes – Action & Benefits
- Feed cost reduction
- Alternative RMs & maximizing utilization by layers
- Environmental impact

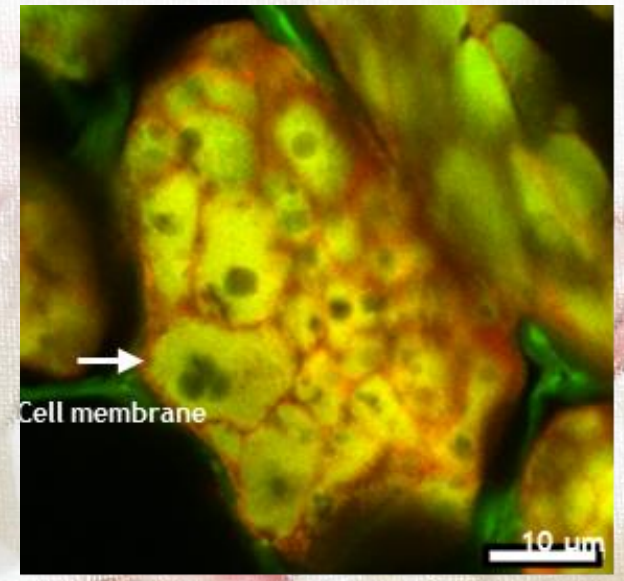
- Layer efficiency improvement
- Waste reduction

for increasing both productivity & profitability within layer business.

Feed enzymes

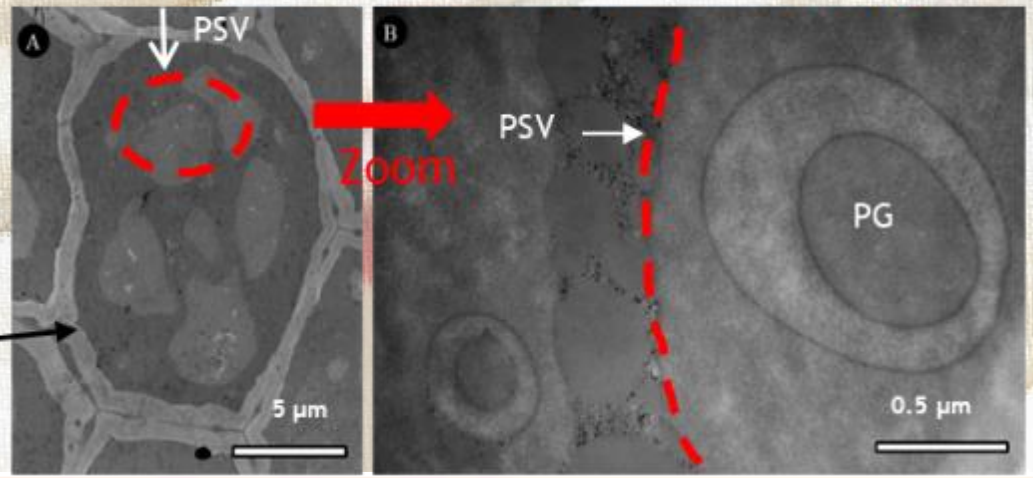
Enzyme	Substrate	Final products
Phytase	Phytate	Phosphorus & *MYO*-inositol
Xylanase	Arabinoxylan	Xylan Oligomers
β-glucanase	β-glucans	Glucan Oligomers
Cellulase	Cellulose	Cellulose Oligomers
Xyloglucanase	Xyloglucans	Xyloglucan Oligomers
Pectinases	Pectins	Pectic Oligomers
Amylase	Starch	Maltose & Glucose
Protease	Undigestible protein	Peptides

Why do we need feed enzymes ? - The substrate

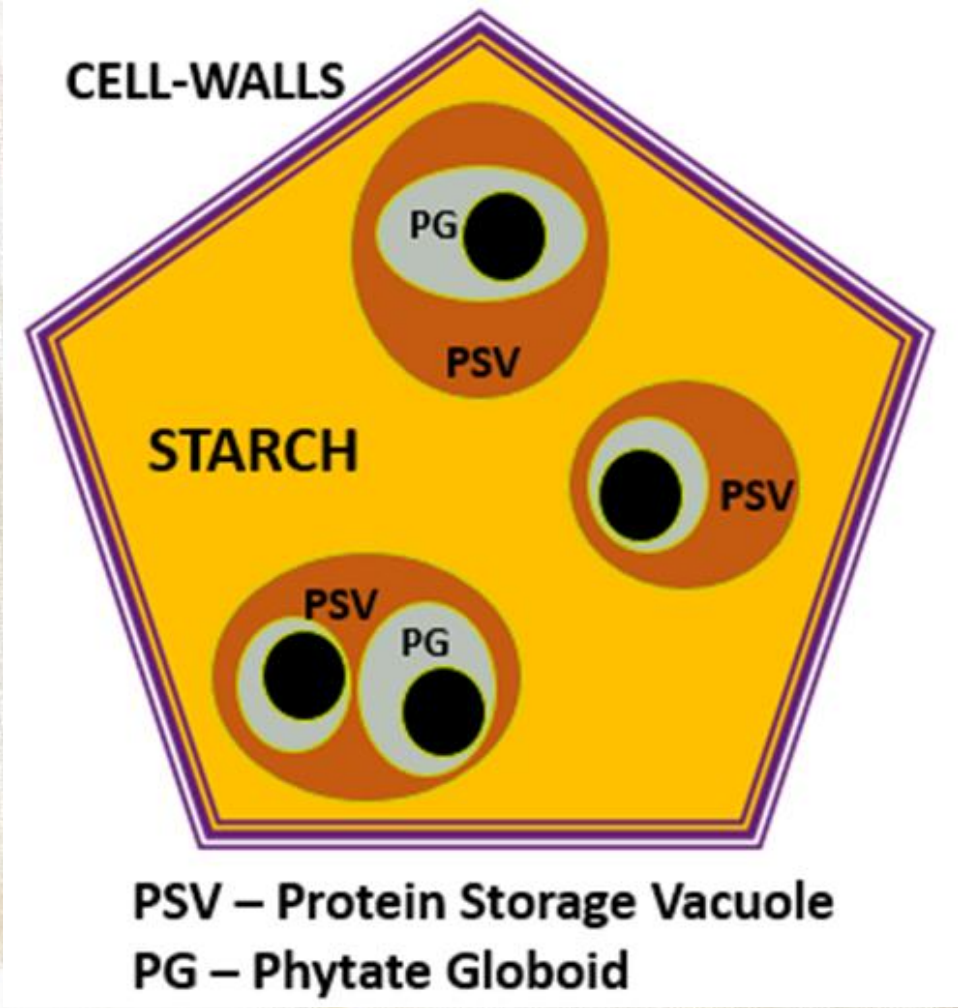


Layers do not have Phytases and NSP-enzymes to hydrolyze Phytate and NSPs respectively.

Transmission electron microscopy



Cell-Wall



Feed Waste Reduction (or better feed utilisation)

FEED	DIGESTION	NUTRIENT ABSORPTION	WASTE	PROFITABILITY
Without enzymes	Average	Average	Average	Average
With feed enzymes	**Better**	**Better**	**Minimum**	**Better**

Some factors affecting Feed Utilization:

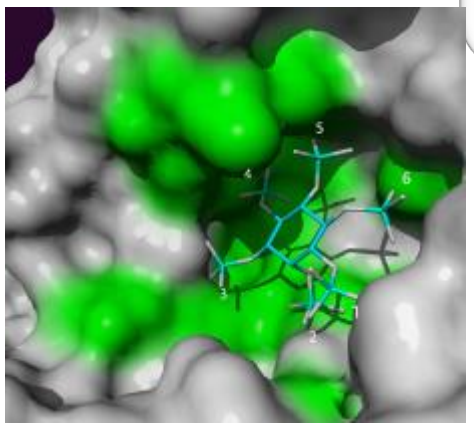
- Feed quality
- Gizzard function
- Gut Health & Integrity

Feed Enzymes could affect these factors via :

- Feed digestibility improvement
- Coarsely ground feed is welcome
- Better protein utilization, viscosity reduction, prebiotic NSP-oligomers

Feed Enzyme Benefits

- Phosphorus release (phytases)
- Cage effect & energy release (Carbohydrases)
- Amino Acid Digestibility improvement (proteases)



- Viscosity reduction
- Prebiotic effects of NSP-oligomers
- Less nutrients for pathogenic bacteria
- Less endogenous heat production for starch digestion (Heat Stress)

Feed cost reduction

Layer welfare & health

Less Dirty Eggs
Strong Egg-Shell

Animal Performance

Environmental Sustainability

- Nutrient digestibility improvement
- *MYO*-inositol release
- Anti-antinutritional effects (phytate-NSPs-Trypsin Inhibitors)

Use of alternative RMs

- Nitrogen & Phosphorus emission reduction
- Green House Gas emission reduction (CO_2e)

Feed cost reduction
with feed enzymes

- Indian layer Diet formulated with Hy-Line, Phase-1 nutrient specs.
- It contains ~12% “alternative” & local RMs.
- MBM is also considered as “alternative” RM, for which its quality needs attention.
- “Other Additives” are Vitamins, Minerals, Tryptophan, Salt, Toxin Binder, Choline, Soda.
- Multi NSP enzyme contains xylanase, de-branching activities, xyloglucanase, cellulase, B-glucanase.

Raw Material	Rs/Kg	No Enzymes
Broken Rice	13	200.00
Maize	17	433.90
Soyabean Meal	70	119.44
Rice Bran De-oiled	12	2.68
Rice DDGS	45	15.00
Rapeseed Meal	29	30.00
Groundnut Meal	50	30.00
Sunflower Meal	30	25.00
Meat & Bone Meal-LP	65	20.00
Shell Grit	2	100.67
DCP	36	11.28
DL-Methionine	270	1.84
Lysine-HCl	200	1.65
Threonine	209	0.45
Other Additives	78	8.08
Phytase (standard dose)	*620*	
Protease	*1,650*	
Multi NSP enzyme	*1,150*	
Total		1,000

Nutrient	Unit	
C Protein	%	16.0
C Fiber	%	3.3
C Fat	%	2.5
ME	Kcal/Kg	2,700
Calcium	%	4.30
Av Phosphorus	%	0.38
Sodium	%	0.17
Chloride	%	0.23
Dig Lysine	%	0.72
Dig Methionine	%	0.42
Dig M + C	%	0.64
Dig Arginine	%	1.00
Dig Tryptophan	%	0.16
Dig Threonine	%	0.50
Dig Valine	%	0.65
Dig Leucine	%	1.13
Dig IsoLeucine	%	0.53

Feed cost reduction

with phytase

- The first diet was optimized with Av.P, Ca & Na contribution from a standard phytase dose.
- The second diet was optimized with Av.P, Ca, Na matrix, together with 50% of the recommended matrix for CP, AA & Energy (standard phytase dose).

- Alternative RMs = ~ 17%
- Desktop enzyme ROI = from 1:13 to 1:26

- Conditions for achieving these substantial diet cost savings:
  - Good phytase (at least 3G – stability)
  - Sufficient substrate (phytate-P)

Raw Material	Rs/Kg	No Enzymes	Phytase with Av.P/Ca/Na	Phytase with full matrix
Broken Rice	13	200.00	200.00	200.00
Maize	17	433.90	428.27	406.18
Soyabean Meal	70	119.44	115.00	110.00
Rice Bran De-oiled	12	2.68	20.71	48.46
Rice DDGS	45	15.00	15.00	15.00
Rapeseed Meal	29	30.00	30.00	30.00
Groundnut Meal	50	30.00	30.00	30.00
Sunflower Meal	30	25.00	25.00	25.00
Meat & Bone Meal-LP	65	20.00	20.00	20.00
Shell Grit	2	100.67	101.30	101.45
DCP		11.28	2.77	2.47
DL-Methionine	270	1.84	1.83	1.69
Lysine-HCl	200	1.65	1.68	1.52
Threonine	209	0.45	0.45	0.27
Other Additives	78	8.08	7.93	7.90
Phytase (standard dose)	*620*		*0.06*	*0.06*
Protease	*1,650*			
Multi NSP enzyme	*1,150*			
Total		1,000	1,000	1,000
	Rs/MT	**25,624**	**25,156**	**24,644**
SUBSTANTIAL DIET COST SAVINGS			**(468)**	**(981)**
	$/MT		**(6.2)**	**(13.1)**

For a 10,000 layer flock, 358,000 Rs or $4,800 p.a.

Feed cost reduction
with phytase & protease

- Protease diet was optimized with a specific AA/ME matrix.
- Phytase effect on AA was already discounted by 50%.

- Alternative RMs = ~ 19%
- Desktop enzyme ROI = 1:7.

- **Additional protease benefits:**
  - Gut health – more clean eggs
  - Trypsin Inhibitors' degradation
  - Flexibility on diet optimization
  - Feed protein variability reduction
  - Less Nitrogen emissions

Raw Material	Rs/Kg	No Enzymes	Phytase with Av.P/Ca/Na	Phytase with full matrix	Phytase & Protease
Broken Rice	13	200.00	200.00	200.00	200.00
Maize	17	433.90	428.27	406.18	396.75
Soyabean Meal	70	119.44	115.00	110.00	100.00
Rice Bran De-oiled	12	2.68	20.71	48.46	68.35
Rice DDGS	45	15.00	15.00	15.00	15.00
Rapeseed Meal	29	30.00	30.00	30.00	30.00
Groundnut Meal	50	30.00	30.00	30.00	30.00
Sunflower Meal	30	25.00	25.00	25.00	25.00
Meat & Bone Meal-LP	65	20.00	20.00	20.00	20.00
Shell Grit	2	100.67	101.30	101.45	101.59
DCP	36	11.28	2.77	2.47	2.31
DL-Methionine	270	1.84	1.83	1.69	1.40
Lysine-HCl	200	1.65	1.68	1.52	1.42
Threonine	209	0.45	0.45	0.27	0.09
Other Additives	78	8.08	7.93	7.90	7.89
Phytase (standard dose)	*620*		*0.06*	*0.06*	*0.06*
Protease	*1,650*				*0.15*
Multi NSP enzyme	*1,150*				
Total		1,000	1,000	1,000	1,000
	Rs/MT	**25,624**	**25,156**	**24,644**	**24,127**
			(468)	**(981)**	**(1,497)**
	$/MT		**(6.2)**	**(13.1)**	**(20.0)**

SUBSTANTIAL DIET COST SAVINGS

For a 10,000 layer flock, 546,000 Rs or $7,300 p.a.

Feed cost reduction
with phytase & NSP multi-enzyme

- The Multi-NSP-enzyme diet was optimized with a calculated ME contribution of 60 kcal/Kg.
- Together with the Phytase ME effect, the enzymes were contributed a total of **102 kcal/Kg.** Enzyme energy contribution was managed by the addition of Rice Bran.
- Alternative RMs = ~ 20%
- Desktop enzyme ROI = 1:9.
- **Additional benefits:**

  - Lower Starch diets are less thermogenic, which is good for birds under Heat Stress.
  - Gut health from viscosity reduction & prebiotic effects of NSP-oligomers.
  - Feed energy variability reduction.
  - Flexibility on diet optimization.

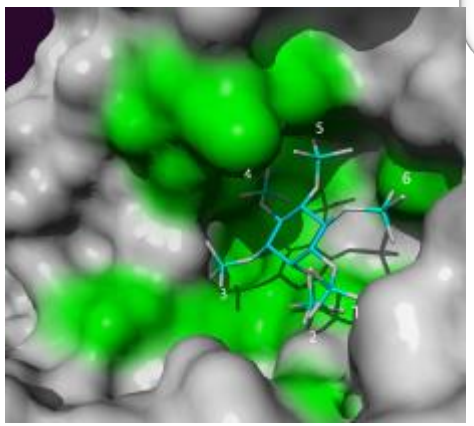
For a 10,000 layer flock, 410,000 Rs or $ 5,500 p.a.

Raw Material	Rs/Kg	No Enzymes	Phytase with Av.P/Ca/Na	Phytase with full matrix	Phytase & NSP-enzyme
Broken Rice	13	200.00	200.00	200.00	200.00
Maize	17	433.90	428.27	406.18	371.97
Soyabean Meal	70	119.44	115.00	110.00	110.00
Rice Bran De-oiled	12	2.68	20.71	48.46	83.14
Rice DDGS	45	15.00	15.00	15.00	15.00
Rapeseed Meal	29	30.00	30.00	30.00	30.00
Groundnut Meal	50	30.00	30.00	30.00	30.00
Sunflower Meal	30	25.00	25.00	25.00	25.00
Meat & Bone Meal-LP	65	20.00	20.00	20.00	20.00
Shell Grit	2	100.67	101.30	101.45	101.63
DCP	36	11.28	2.77	2.47	2.04
DL-Methionine	270	1.84	1.83	1.69	1.65
Lysine-HCl	200	1.65	1.68	1.52	1.37
Threonine	209	0.45	0.45	0.27	0.21
Other Additives	78	8.08	7.93	7.90	7.86
Phytase (standard dose)	*620*		*0.06*	*0.06*	*0.06*
Protease	*1,650*				
Multi NSP enzyme	*1,150*				*0.08*
Total		1,000	1,000	1,000	1,000
	Rs/MT	**25,624**	**25,156**	**24,644**	**24,500**
			(468)	**(981)**	**(1,125)**
	$/MT		**(6.2)**	**(13.1)**	**(15.0)**

SUBSTANTIAL DIET COST SAVINGS

Feed Enzyme Benefits

- Phosphorus release (phytases)
- Cage effect & energy release (Carbohydrases)
- Amino Acid Digestibility improvement (proteases)



- Viscosity reduction
- Prebiotic effects of NSP-oligomers
- Less nutrients for pathogenic bacteria
- Less endogenous heat production for starch digestion (Heat Stress)

Feed cost reduction

Layer welfare & health

Less Dirty Eggs
Strong Egg-Shell

Animal Performance

Environmental Sustainability

- Nutrient digestibility improvement
- *MYO*-inositol release
- Anti-antinutritional effects (phytate-NSPs-Trypsin Inhibitors)

Use of alternative RMs

- Nitrogen & Phosphorus emission reduction
- Green House Gas emission reduction (CO_2e)

Which Feed Raw Materials are considered as “Alternative” for layer feed?

…question with different answers…

Europe-Australia-Canada

- Wheat
- Barley
- Corn
- SBM

- Oats
- Triticale
- Rye
- Lupins-Peas-Faba Beans
- Cereal By-products
- Canola / Rapeseed Meal
- Sunflower Meal

USA - Latin America - Asia

- Corn
- SBM

- Wheat-Barley
- Sorghum-Millet
- Lupins-Peas-Faba Beans
- Cereal By-products
- Canola / Rapeseed Meal
- Sunflower Meal
- Cottonseed Meal
- Groundnut meal
- Palm Kernel Meal
- Sesame Meal

Mexico

- Sorghum
- Corn
- SBM

- Wheat
- Cereal By-products
- Canola Meal
- Sunflower Meal
- Palm Kernel Meal
- Cottonseed Meal
- Groundnut Meal

Characteristics of Alternative Raw Materials

- Locally produced
- Lower price
- Low inclusion rate
- Variable quality
- Inconsistent availability
- Anti-Nutritional factors

Today we will focus on :

- Wheat
- Pearl Millet
- Corn DDGS
- Rice Bran
- Canola / Rapeseed Meal
- Sunflower Meal
- Palm Kernel Meal

Cereals & by-products

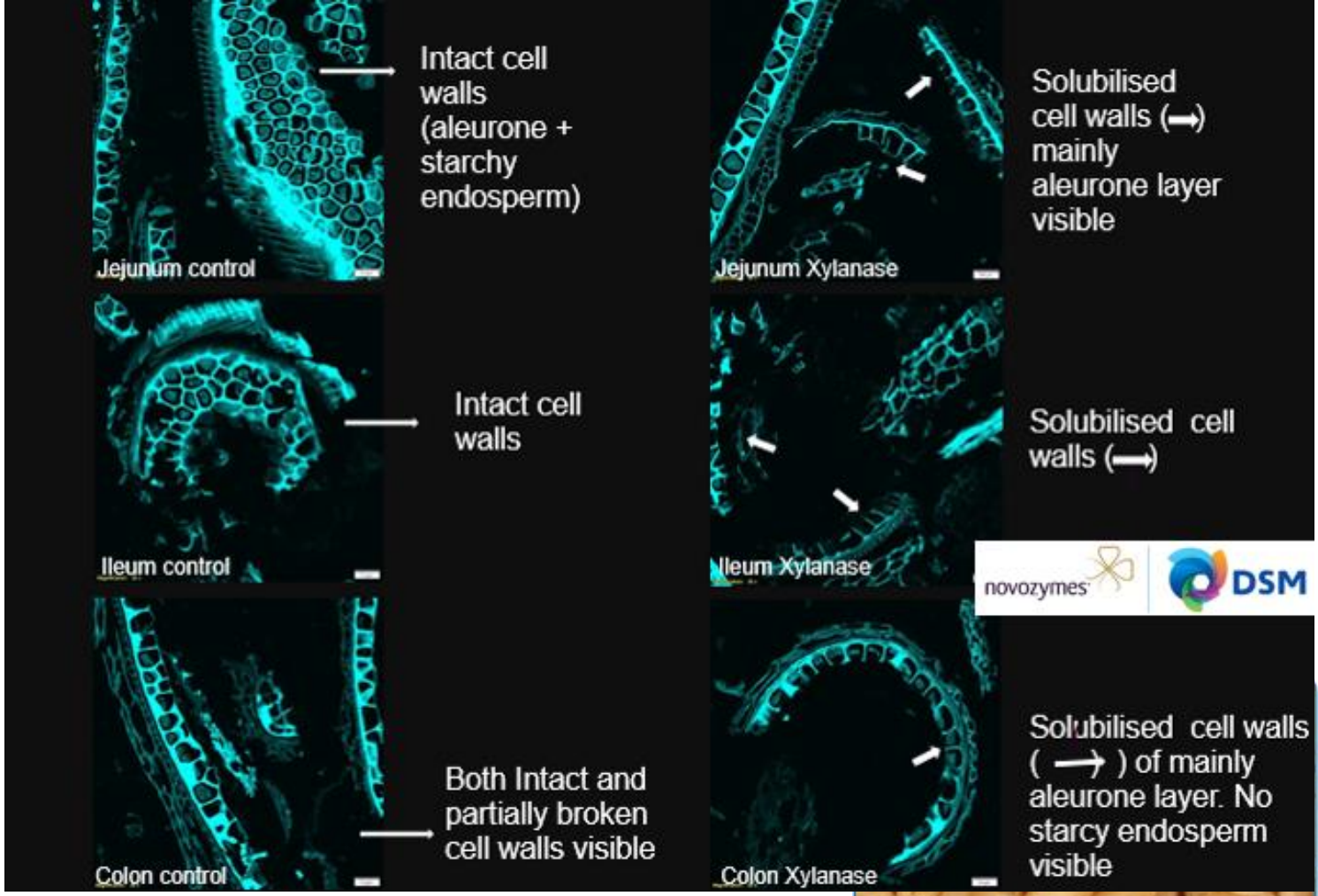
(from mono-cotyledonous plants)

Non-Starch Polysaccharides in cereals and their by-products:

- Cellulose
- Hemicelluloses
  - β-glucans
  - Xylans (Arabinoxylans)
  - Xyloglucans

Wheat

- Each endosperm cell is surrounded by a cell-wall unique for wheat, consisting of 70% arabinoxylans
- Wheat contains both soluble and insoluble arabinoxylan in the endosperm cells
- Starch is stored as granules in starchy endosperm cells
- If both entrapped nutrients are released and gut viscosity is reduced, this will maximize the energy value of wheat-based diets

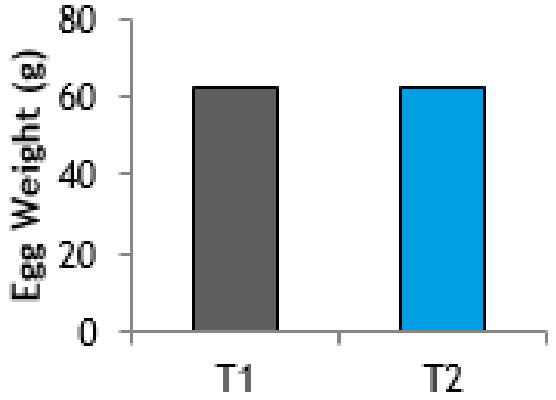


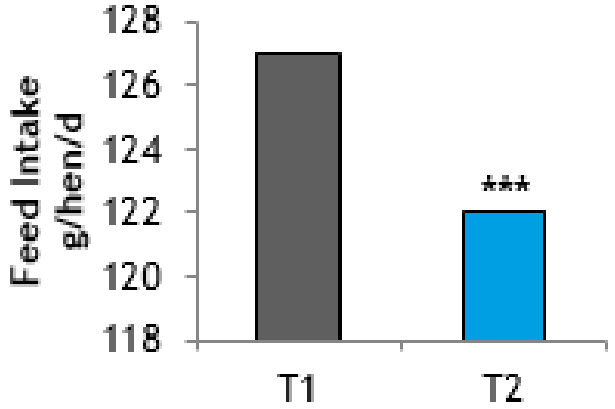
ATTENTION TO CAROTENOID SUPLEMENTATION

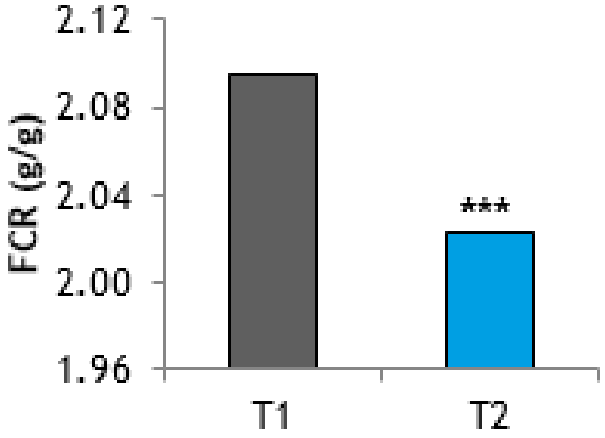
Wheat - Xylanase effect

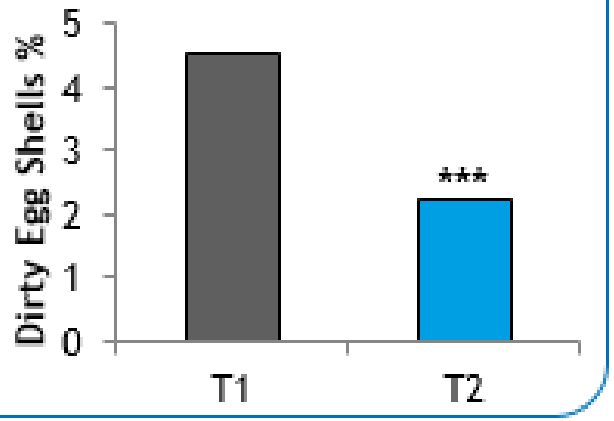
Results

*** P<0.001









- New Zealand trial, Massey University, 2015
- HyLine brown-egg, 26 wks of age
- Wheat-based diet (~55%)
- T1 - Control, T2 - T1+Xylanase

Pearl Millet (Bajra)

- In Pearl Millet, the endosperm cell-walls consist mainly of highly substituted arabinoxylans and cellulose.

- To successfully breakdown the cell-walls of Pearl Millet, a combination of xylanase, de-branching activities (e.g. arabinofuranosidase) & cellulase is needed, in order to **release the trapped energy** and reduce the intestinal viscosity.

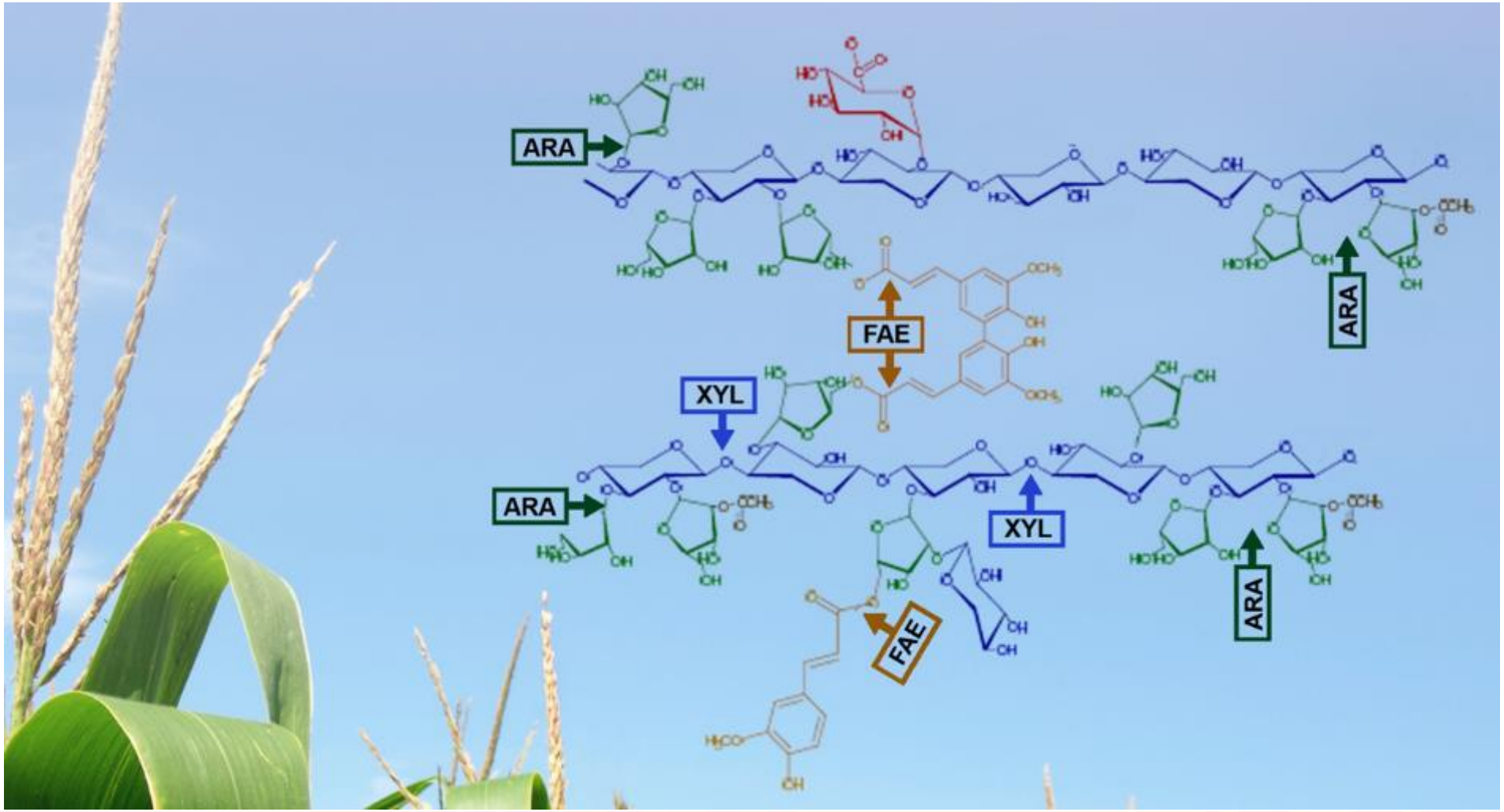
- Pearl Millet – based layer diets performed the same as corn-based diets. Both diets were supplemented with Soya Oil. *Muramatsu et al.*, 2005.

ATTENTION TO CAROTENOID SUPLEMENTATION

- Whole (unground) Pearl Millet can replace corn up to 15%, in a layer corn-SBM based diet. *Garcia et al.*, 2006.

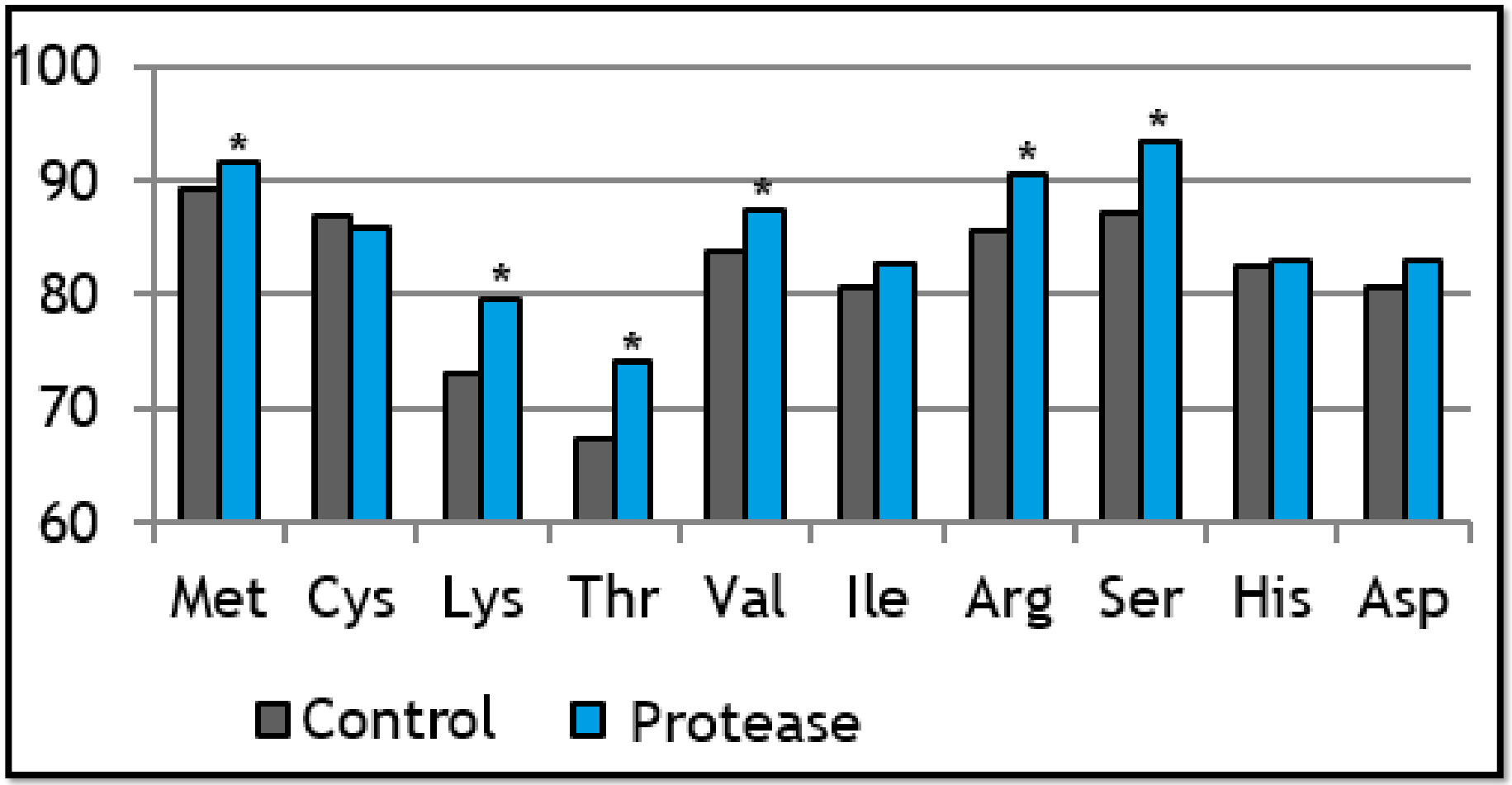
Corn DDGS

Arabinoxylan needs de-branching enzymes & xylanases for solubilization



- Arabinoxylan de-branching activities (arabinofuranosidase) are needed.
- If only a xylanase is available, it is difficult to work on a such highly substituted arabinoxylan structure.

Corn DDGS - Protease effect



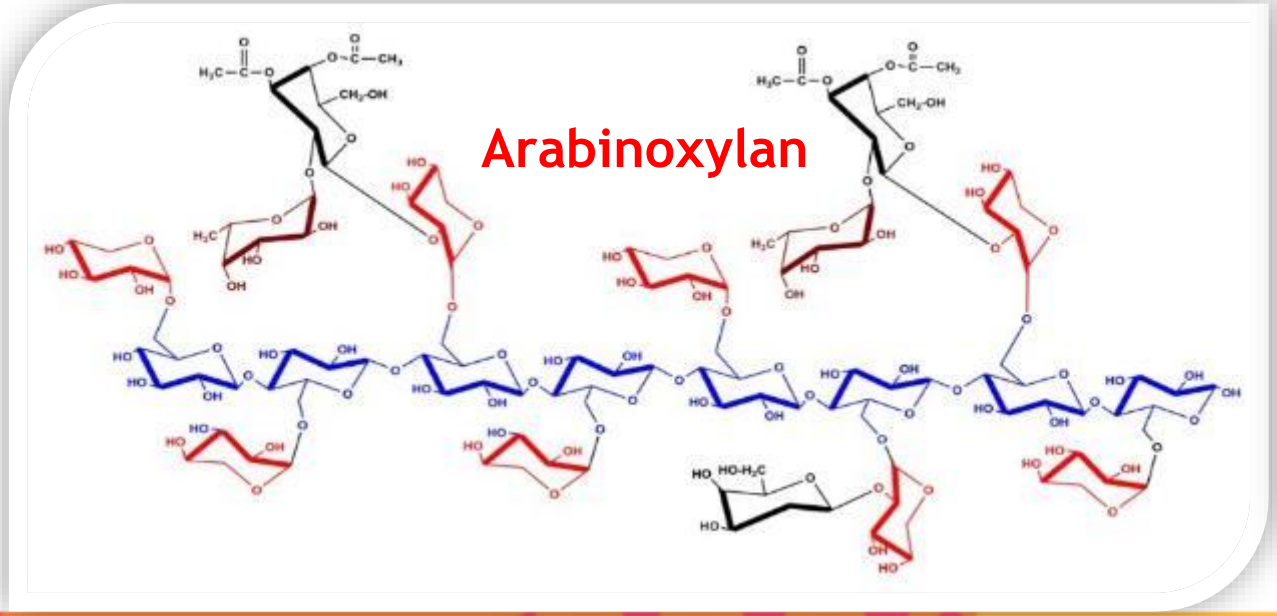
- USA trial
- HyLine W36 white layers,
- 56 wks of age

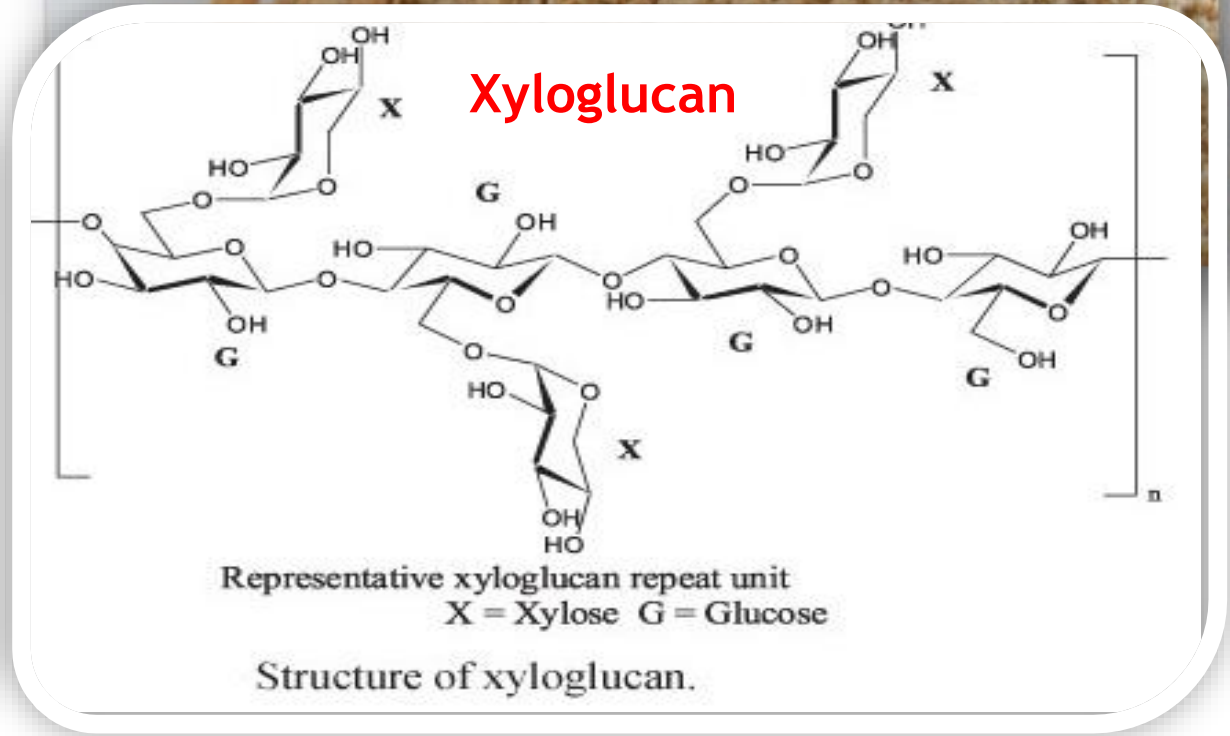
Source: *Angel, R. et al.* "Effects of a mono-component protease on true ileal amino acid digestibility of selected ingredients for commercial laying hens."
Abstract 508 – Poster - PSA 2011

Rice Bran (& rice polish)

A great and low-cost source of :

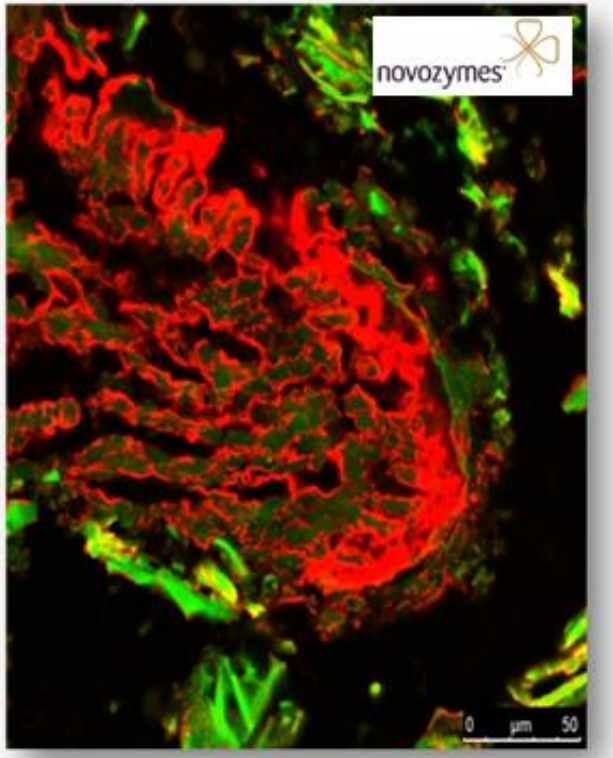
- Protein
- Energy (full-fat rice-bran)
- Phosphorus

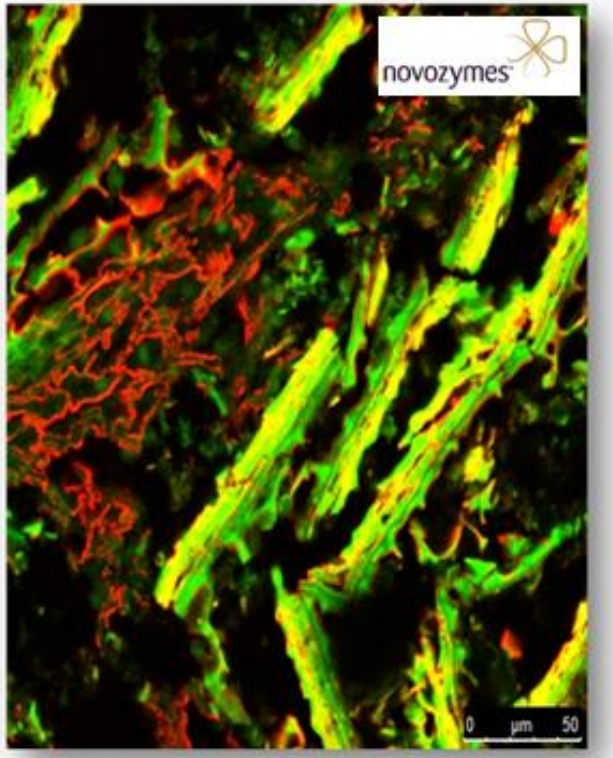




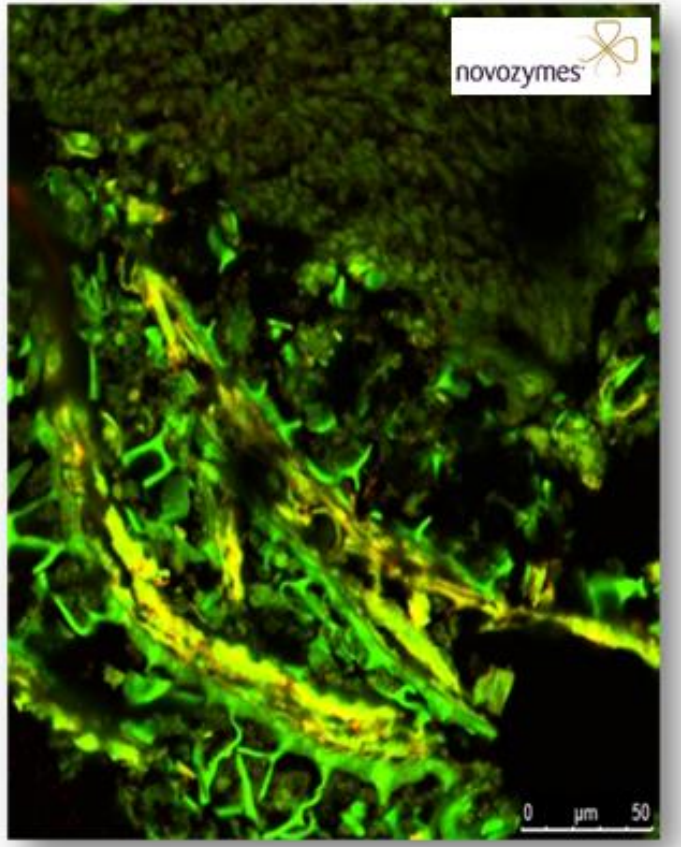
Rice Bran

Xylanase alone, is not sufficient to "unlock" the nutrients from rice brans.





Xyloglucan (red signal) in 2 areas of sample.
Other cell components visualised as yellow green



Incubation with
XYLOGLUCANASE
containing feed enzyme

Oil Seeds & Tubers
(from di-cotyledonous plants)

Non-Starch Polysaccharides in oil seeds, tubers and their by-products:

- Cellulose
- Hemicelluloses
  - Xyloglucans
- Pectins
  - Mannans (Galactomannans
  - Galactans (Arabinogalactans)
  - Arabinans
  - Homogalacturonan
  - Rhamnogalacturonans
  - Xylogalacturonan

Canola Meal or Rapeseed Meal (RSM) or Mustard De-Oiled Cake

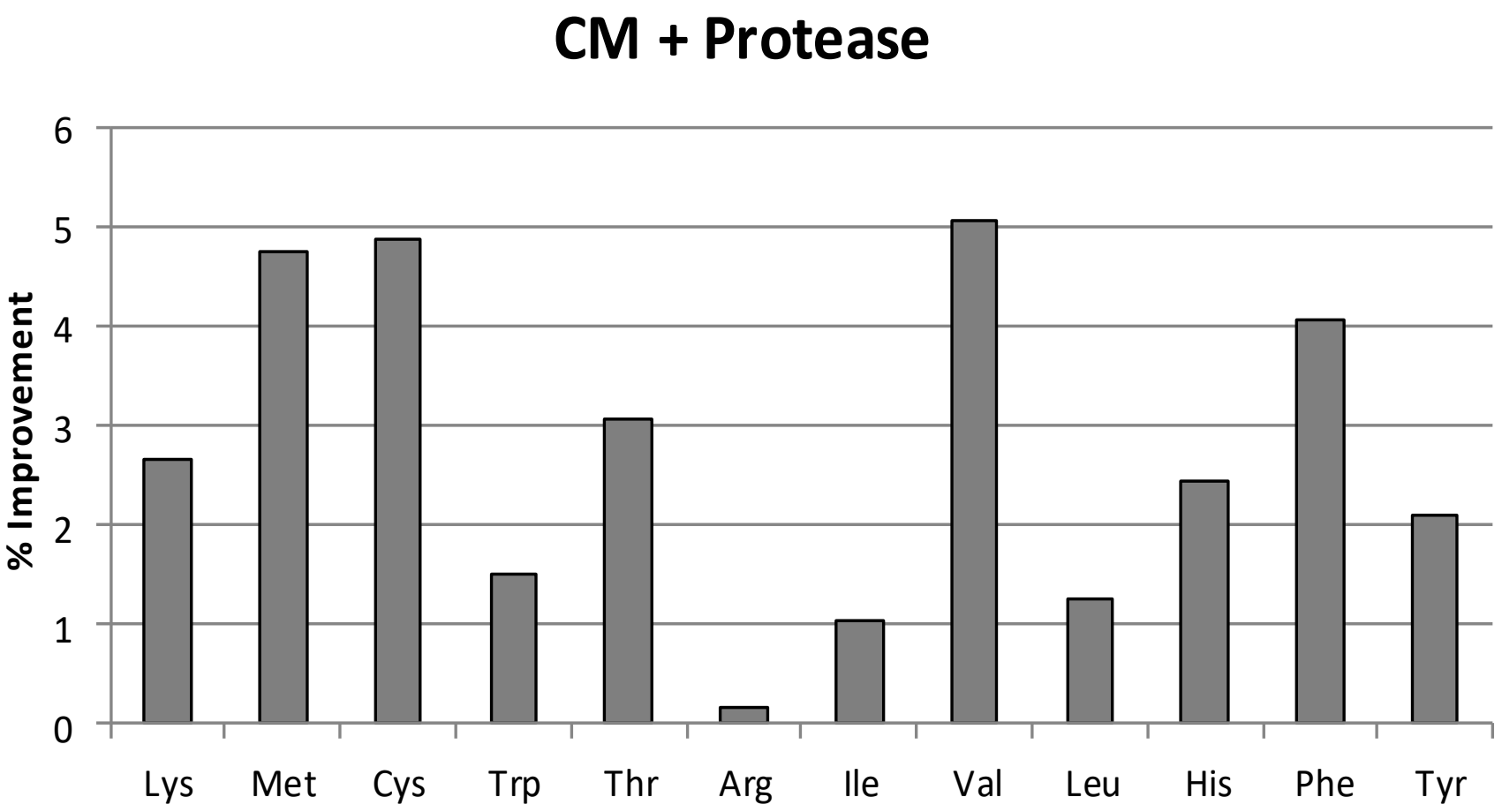
- Solvent extracted rapeseed meal (RSM) could safely be included up to 15%, replacing part of soybean meal in maize or maize & pearl-millet based broiler chicken diets.

(*Tyagi et al.*, 2004, *Jayanti et al.*, 2006)

- '00'RSM (canola meal) having total glucosinolate content of 32.1 µmol/g, can be included up to 30% in the broiler finisher diet. Supplementation of enzyme mixture containing xylanase, pectinase and cellulase can improve performance.

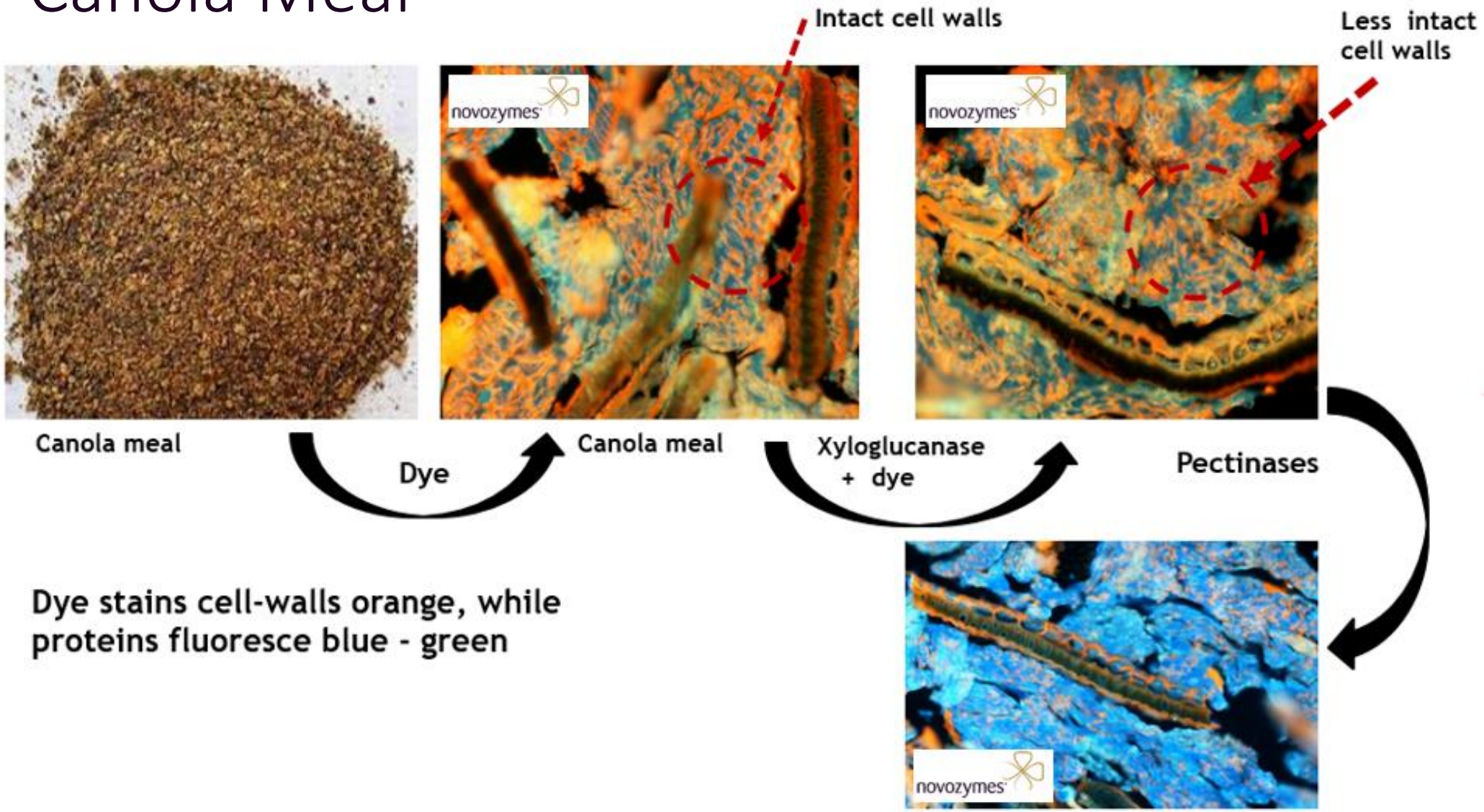
(*Ramesh et al.*, 2006)

Canola Meal (CM) - Protease effect on AID of AA



Source: Gomez et al., 2011

Canola Meal

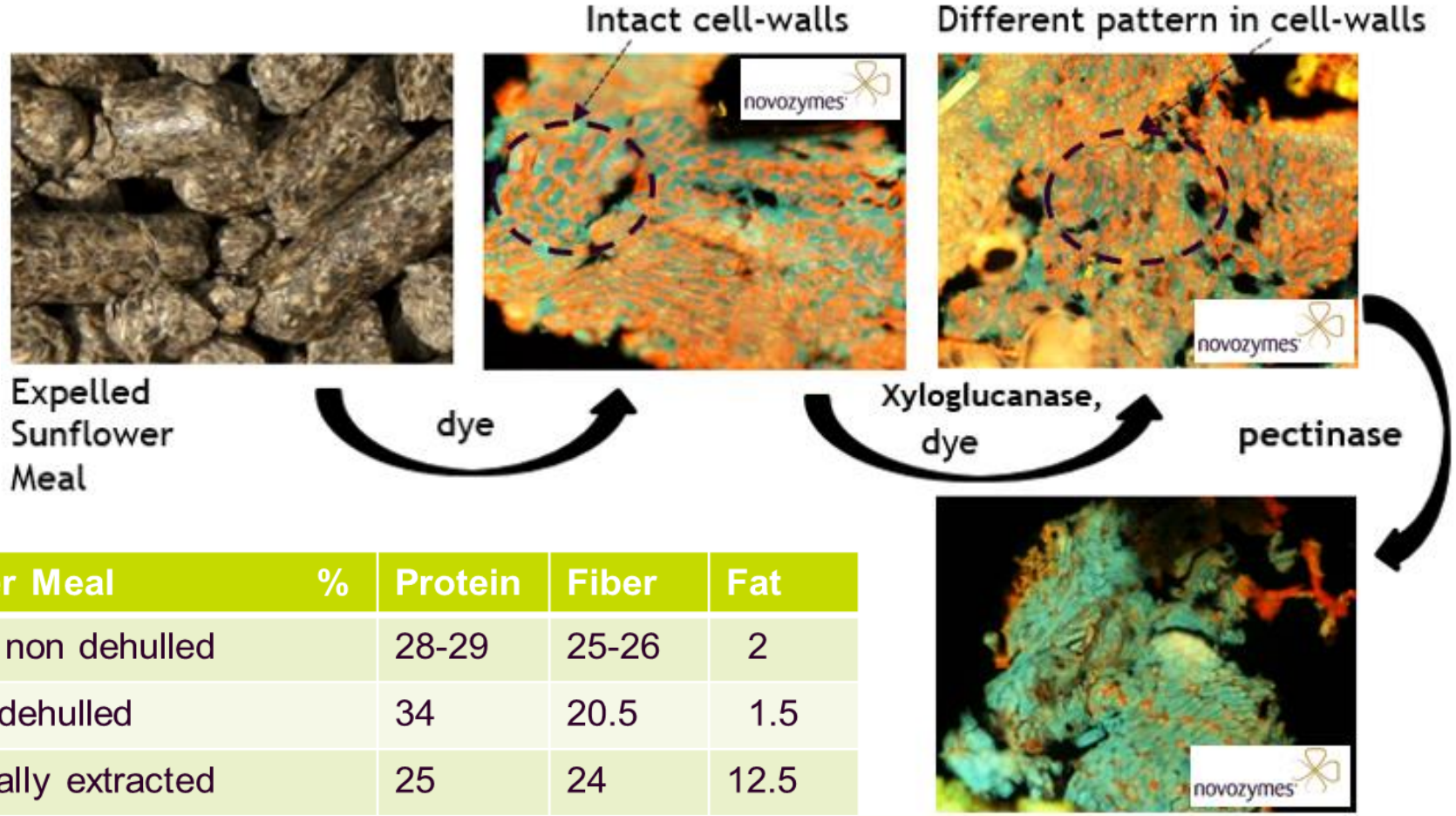


Degradation of Canola Meal cell-walls by xyloglucanases & pectinases

Sunflower Meal

A good protein source, high in fiber

- Low in lysine
- High in insoluble fiber
- Bulky raw material, issue for mash feeds
- In pelleted feed the bulky factor is not an issue, higher inclusions
- Promotes gizzard function
- 13-20 % of protein is not digestible (protease)



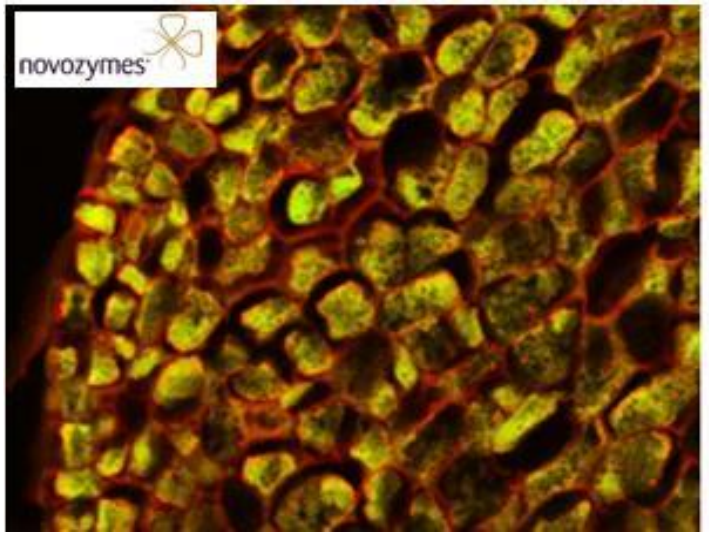
Sunflower Meal %	Protein	Fiber	Fat
Solvent – non dehulled	28-29	25-26	2
Solvent - dehulled	34	20.5	1.5
Mechanically extracted	25	24	12.5

Palm Kernel Meal

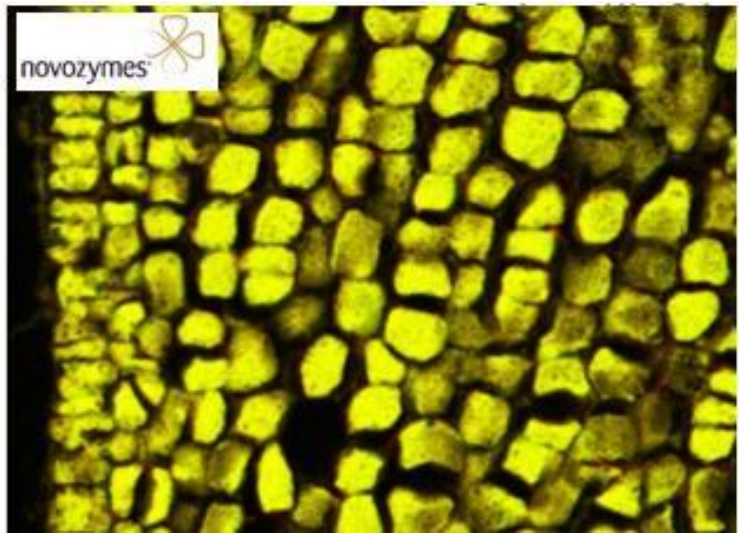
Only for ruminants ?

- Good quantities are available in South-East Asia (Malaysia – Indonesia).
- A low-cost alternative protein source.
- High in lignin (10-18%), which is reducing feed intake.
- Sometimes is causing wet droppings, if the right enzymes are not used.
- It could be used up to 15% in layer diets.
- It contains 62-66% NSP:
  - 50% mannans
  - 11% cellulose
  - 3% arabinoxylan

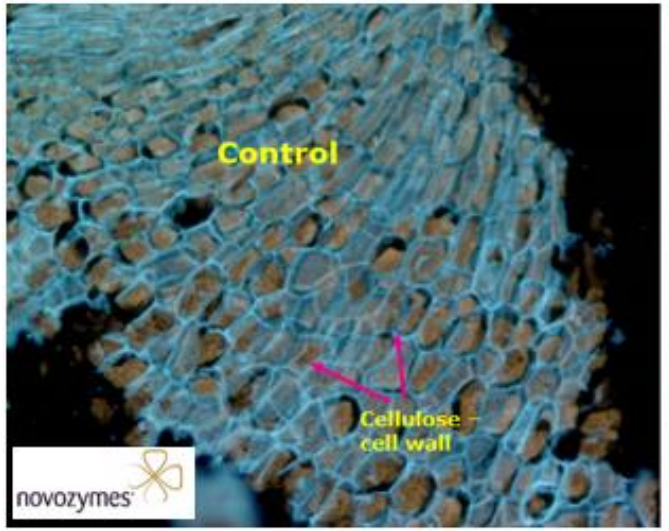
PKM %	Protein	Fiber	Fat
Expelled-extracted	15	18	8.5
Solvent	17	18.5	2.5

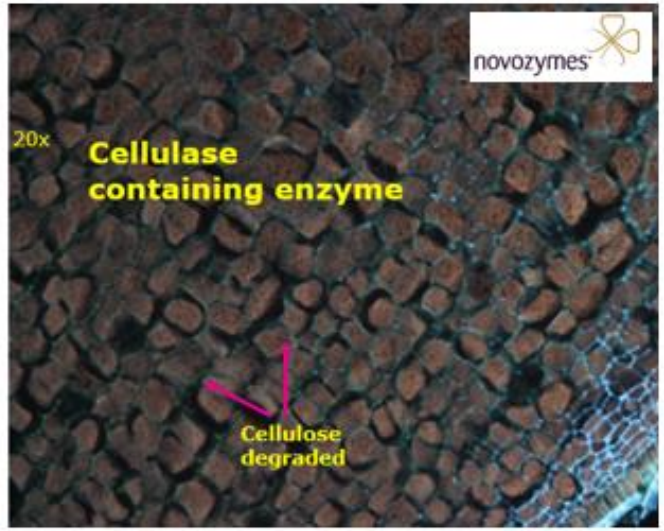


Red Mannan signal in cell-walls.



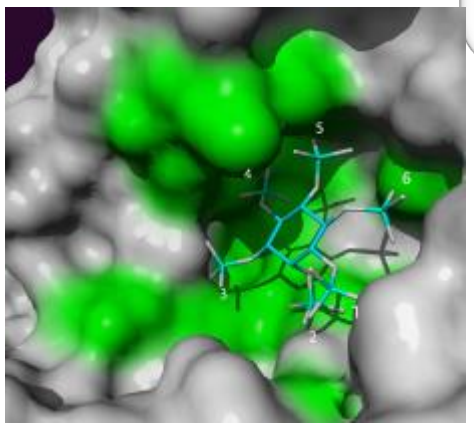
Mannanase containing enzyme removed the red Mannan signal.





Feed Enzyme Benefits

- Phosphorus release (phytases)
- Cage effect & energy release (Carbohydrases)
- Amino Acid Digestibility improvement (proteases)



- Viscosity reduction
- Prebiotic effects of NSP-oligomers
- Less nutrients for pathogenic bacteria
- Less endogenous heat production for starch digestion (Heat Stress)

Feed cost reduction

Layer welfare & health

Less Dirty Eggs
Strong Egg-Shell

Animal Performance

Environmental Sustainability

- Nutrient digestibility improvement
- *MYO*-inositol release
- Anti-antinutritional effects (phytate-NSPs-Trypsin Inhibitors)

Use of alternative RMs

- Nitrogen & Phosphorus emission reduction
- Green House Gas emission reduction (CO_2e)

Reducing our reliance on soybean in feed

Low protein diets

Proteases

Synthetic amino acids

Other feed enzymes

Advanced and readily available technology

Other sources of protein and non-edible materials

Corn & rice byproducts

Sunflower Meal

More digestibility with feed enzymes

- Greater adoption of feed additive technology is key in reducing the layers industry footprint – for feed efficiency, reducing waste, and reducing reliance on soybean.
- If the entire layer industry will apply *feed enzyme* technology to its 149million MT layer feed, Green House Gas emission reduction is estimated at 12.4 million tons (CO_2e), amount equivalent to:

Impact: 12million ton CO2 reduction = ~ 7% of layer industry emission

Conclusion

- Feed enzymes could contribute to more profitable and sustainable layer farming
- They are improving nutrient utilization, reducing nutrients which are escaping digestion
- Right selection of enzyme activities could “unlock” the potential of many alternative local raw materials
- Enzymes are also offering some strong side benefits related to bird performance, health & welfare.

International Egg Commission

TECHNICAL SEMINAR INDIA

Any Questions?