Efforts to increase canola meal energy content for monogastrics: *Enzyme supplementation*

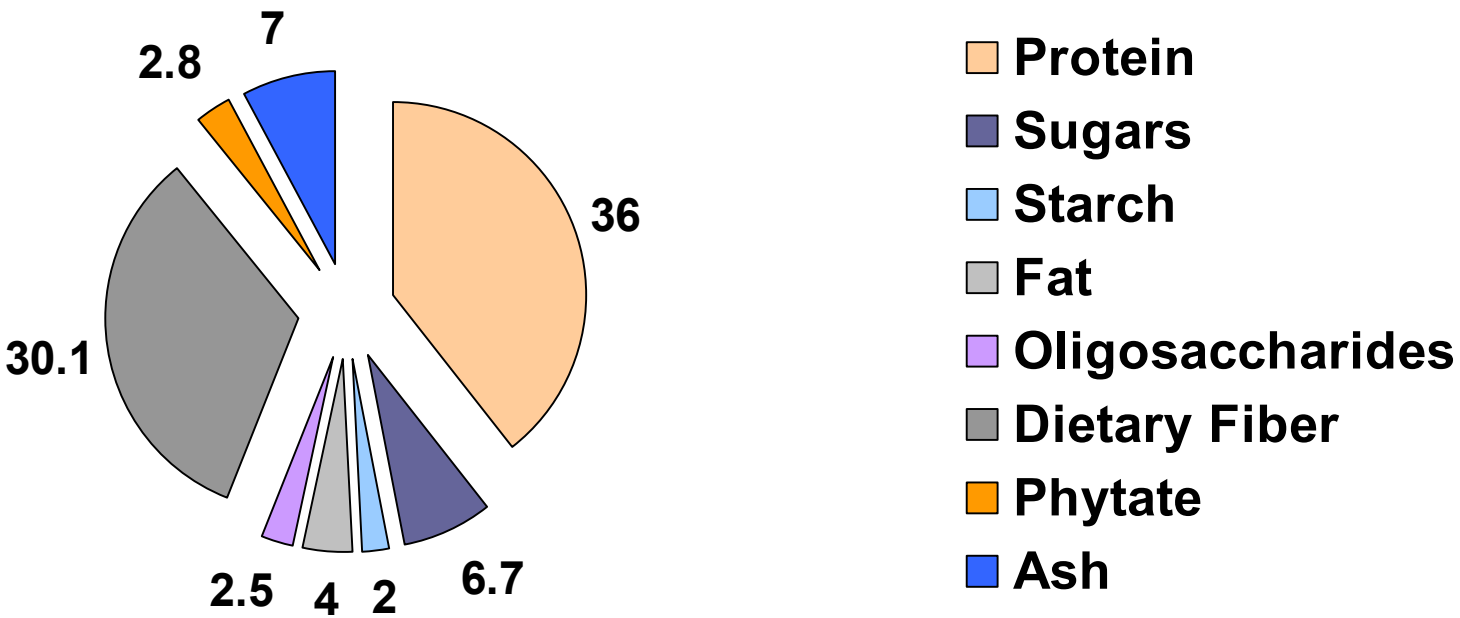
Bogdan A. Slominski

Department of Animal Science, University of Manitoba, Winnipeg, Canada R3T 2N2

UNIVERSITY OF MANITOBA

FACULTY OF AGRICULTURAL AND FOOD SCIENCES

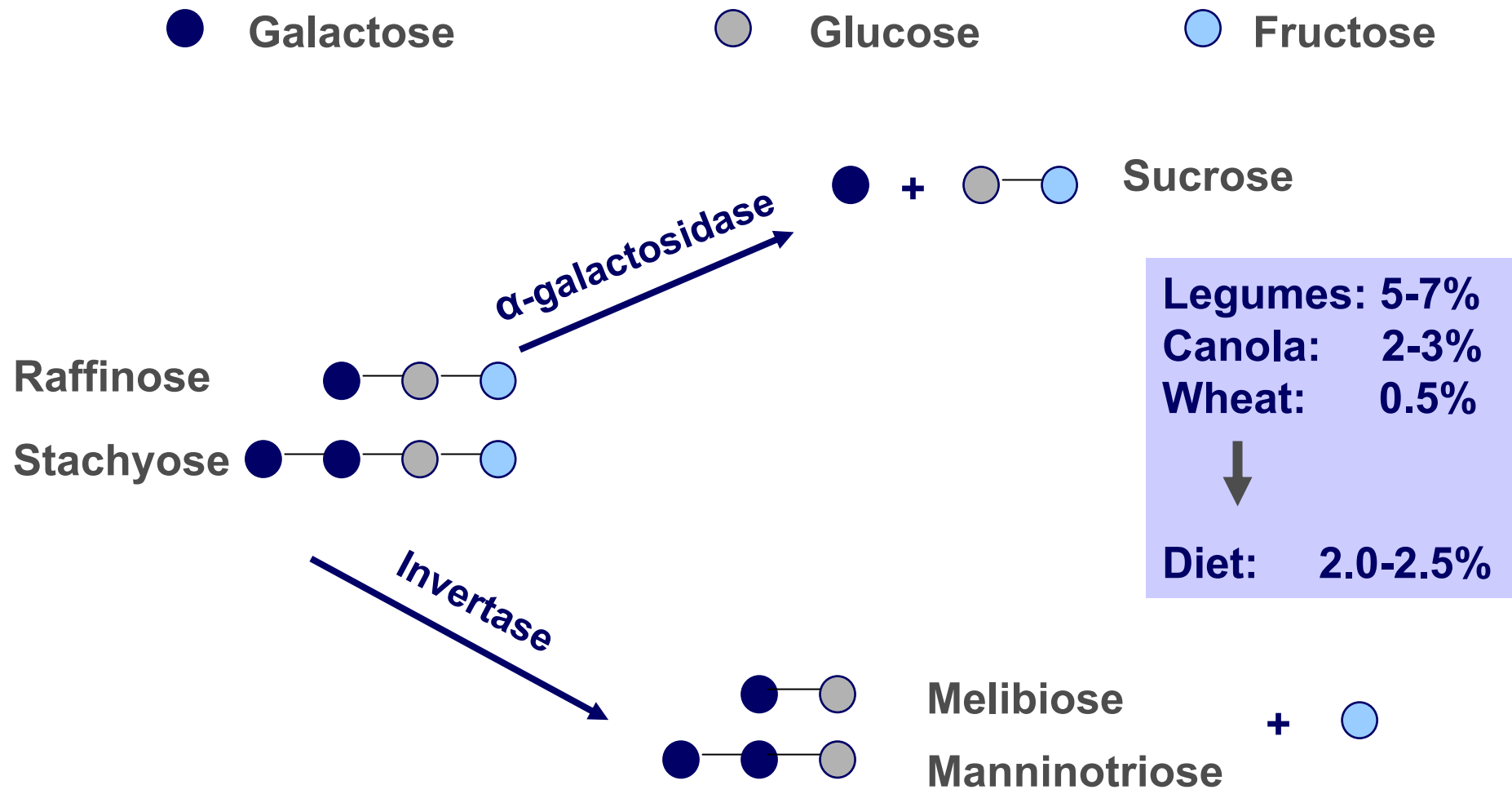
Chemical composition of canola meal (%)



Target Substrates for Enzyme Application

- Oligosaccharides
- Phytate
- Dietary Fiber Components

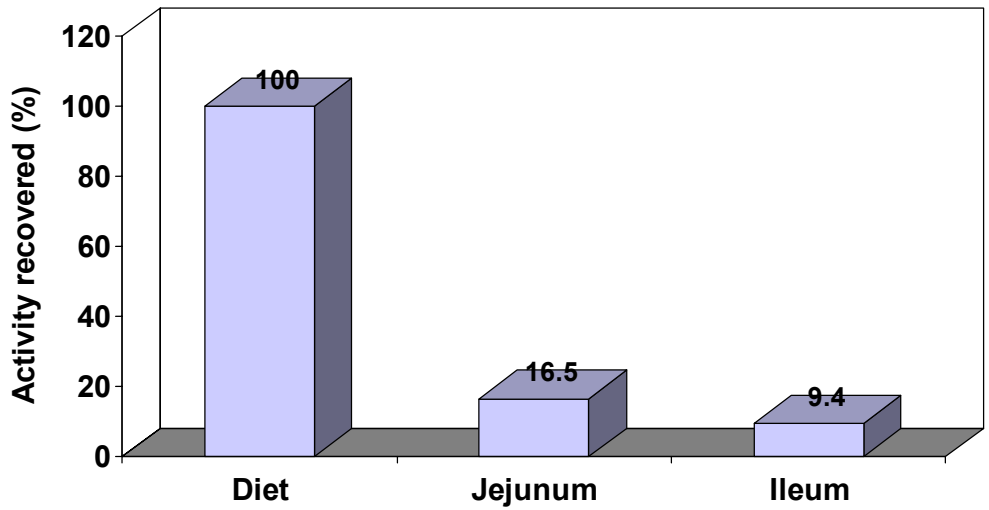
Enzymatic reactions involved in oligosaccharide hydrolysis



Alpha-galactosidase research

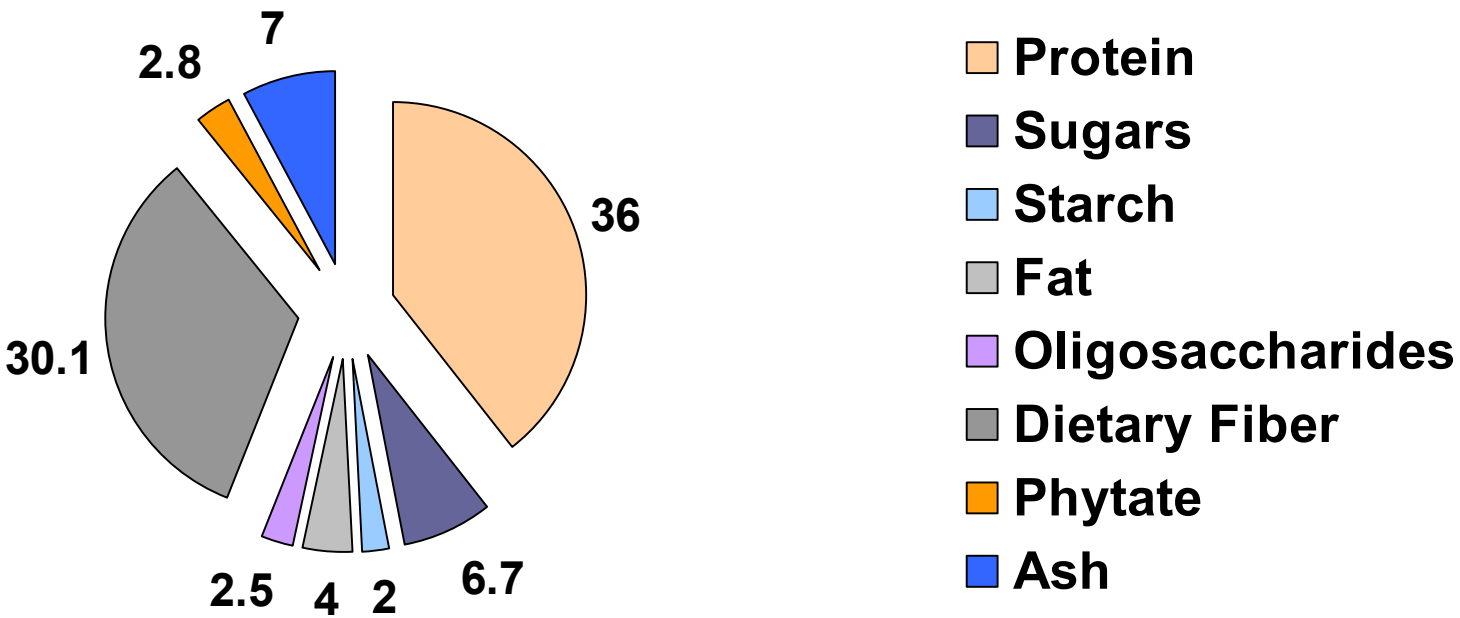
Conclusions

- Alpha-galactosidase is inactivated in the gut!!
  - Acidic environment
  - Dietary calcium



- The oligosaccharides do not pose a nutritional concern.

Chemical composition of canola meal (%)



Composition of dietary fibre

(% DM, fat free basis)

***B. napus* canola**

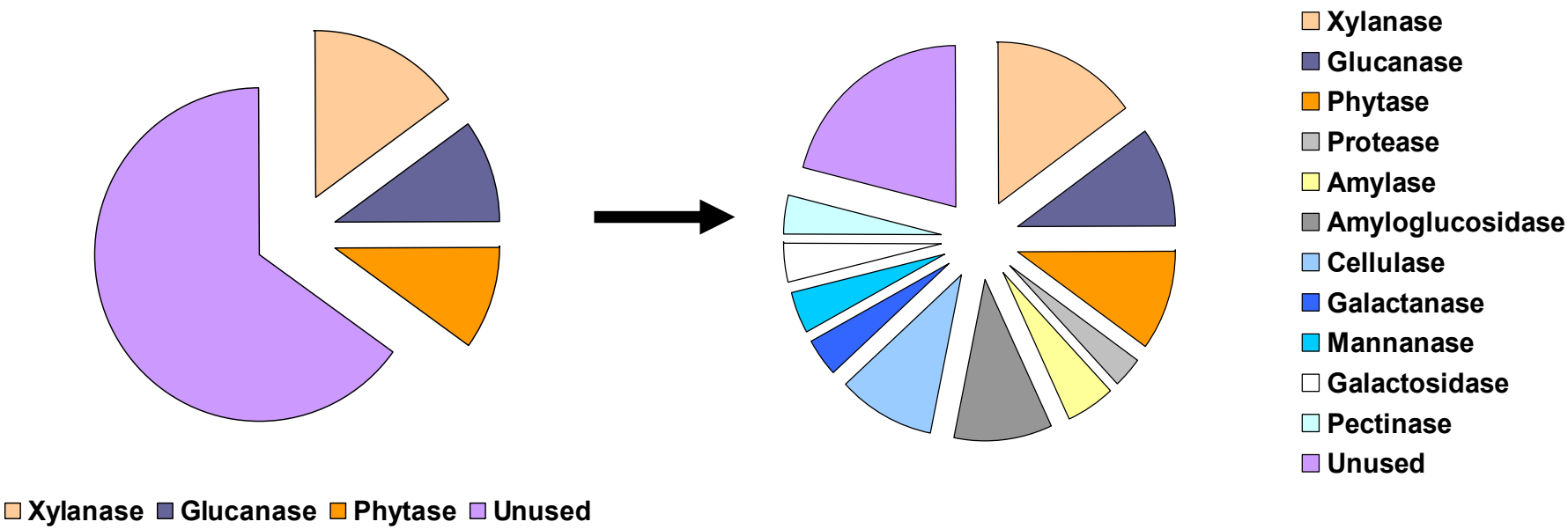
Seed type	NSP	Glycoprotein	Lignin & polyphenols	Total fiber
Black	16.7[b]	4.8	9.8[a]	32.1[a]
Yellow	17.5[a]	4.0	4.7[b]	26.4[b]

[ab] P<0.05

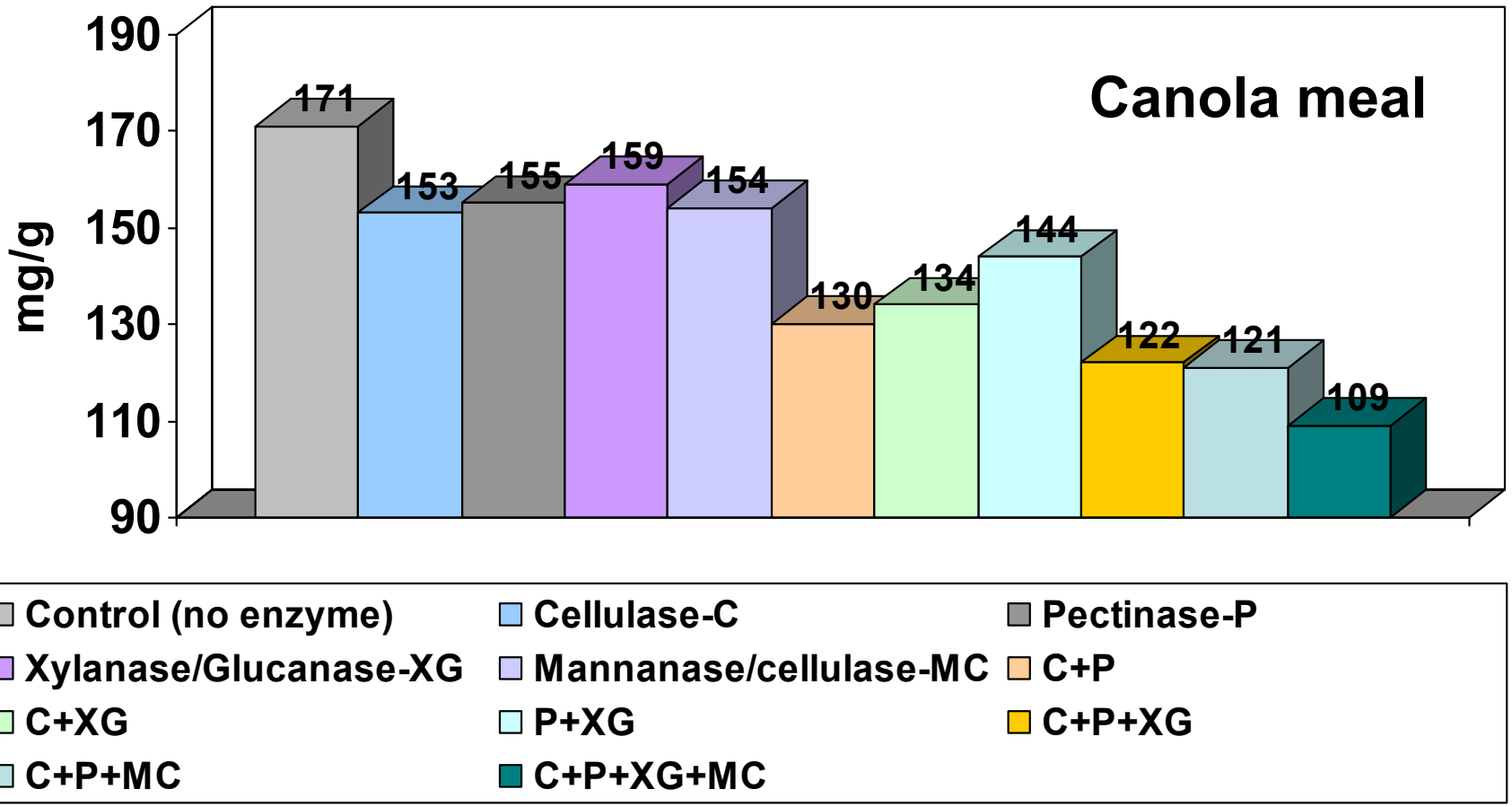
NSP of canola meal

- May encapsulate nutrients
  - more so in canola seed than meal.
- Do not pose the viscosity problem
- Poorly utilized
- Associated with enzyme resistant proteins

The Evolution from Conventional to New Generation Enzyme Supplements



NSP Depolymerization



Canola Seed

- Research using a new generation enzyme supplement has demonstrated:
  - Improvement in TME_n ↑ **32% (1154 kcal/kg seed)**
  - Improvement in growth performance of broiler chickens fed diets containing 15% of canola seed:
    - FCR ↑ **4%**
    - AME_n ↑ **7% (200 kcal/kg diet)**
  - Improvement in FCR of broilers fed diets containing 15% of black and yellow *B. napus* seeds:
    - Black ↑ **4%**
    - Yellow ↑ **3%**

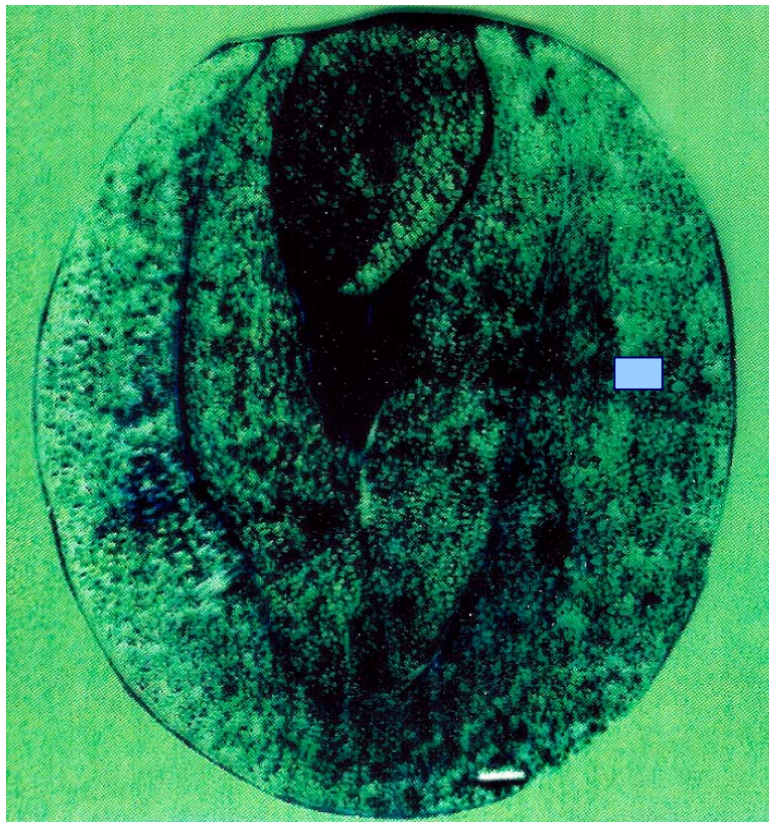
Meng et al., 2006; Slominski et al., 2007

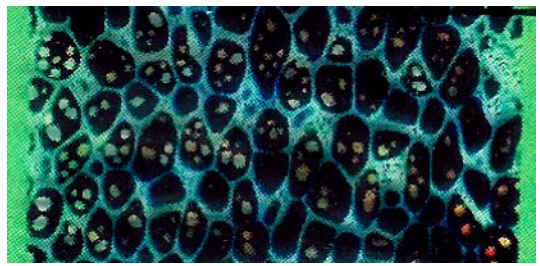
Canola Seed-rich Wheat Screenings

- Research using a new generation enzyme supplement has demonstrated:
  - Improvement in growth performance of broiler chickens fed diets containing CM and canola seed-rich wheat screenings:
    - BWG ↑ **3.5%**
    - FCR ↑ **6.0%**
    - AME_n ↑ **8.5% (241 kcal/kg diet)**
  - Improvement in growth performance of weaned pigs fed diets containing CM and canola seed-rich wheat screenings:
    - Average daily gain ↑ **4%**
    - Gain to feed ration ↑ **15%**
    - Ileal energy digestibility ↑ **14%**

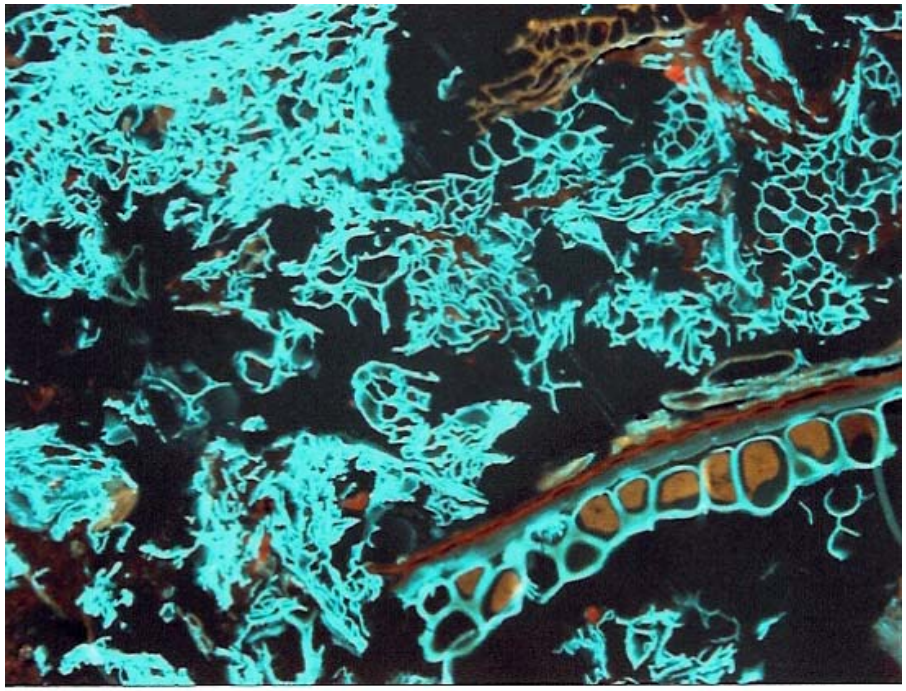
Boros et al., 2004; Omnibenigun et al., 2004

Microstructure of Canola Seed





Carbohydrase enzymes improve energy utilization from full fat canola seed by elimination of the nutrient encapsulating effect of cell walls

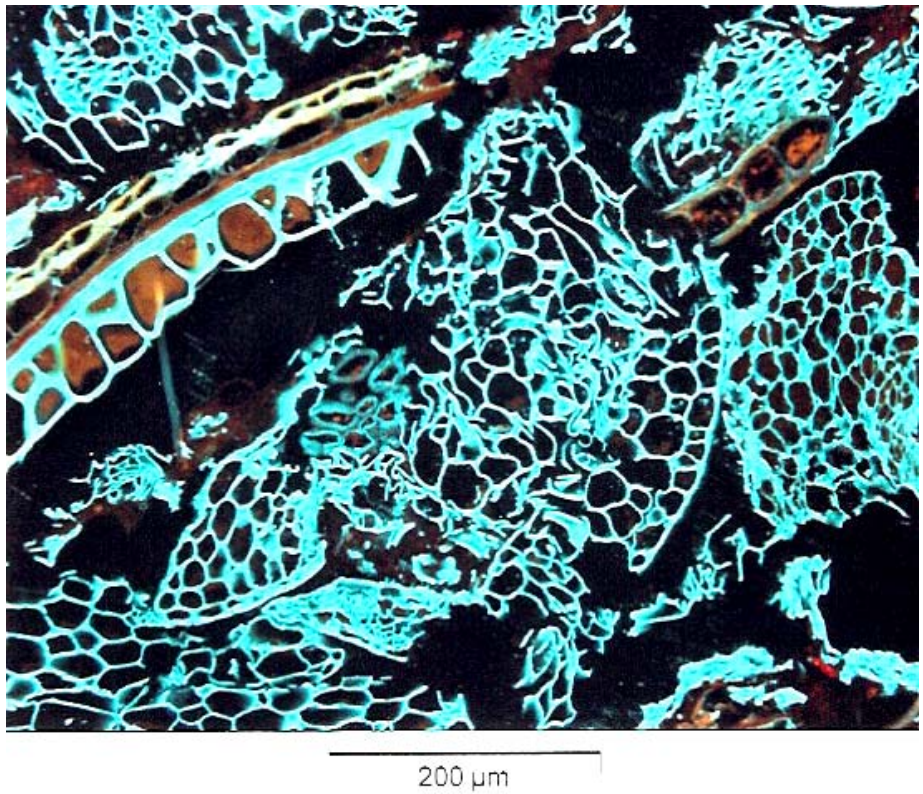


Terminal ileum digesta

Wheat/CM diet fed to broiler chickens

Protein bodies within the aleurone layer of wheat

Canola meal fragments

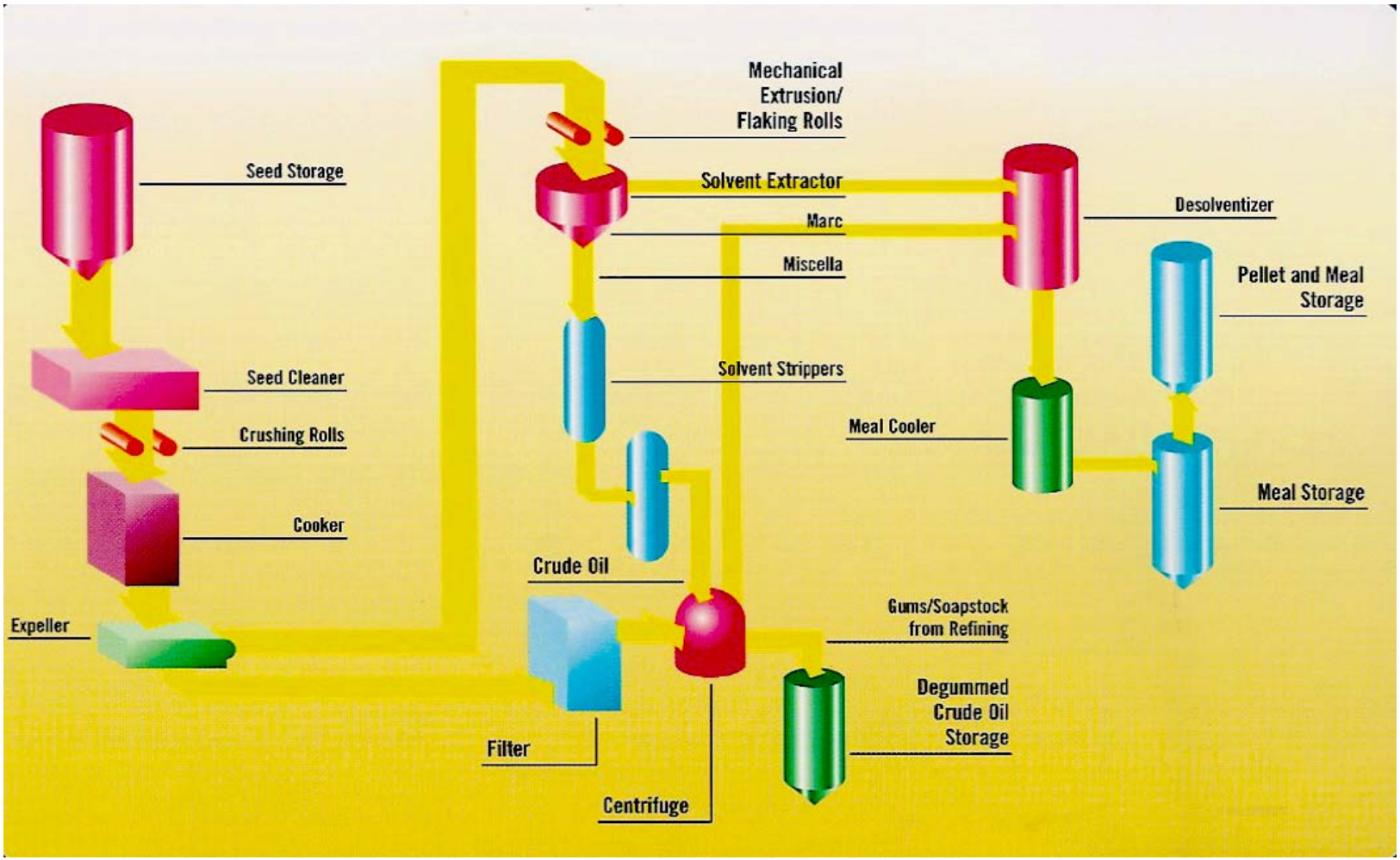


Canola Meal

- Research using a new generation enzyme supplement has demonstrated:
  - Some improvement in growth performance of broiler chickens fed diets containing 30% canola meal:
    - FCR ↑ **3.3%**
  - Lack of improvement in growth performance of broilers fed corn/canola meal (30%) diets.

Simbaya et al., 1996; Meng and Slominski, 2005

Prepress Solvent Extraction Process



Enzyme Pretreated Canola Meal

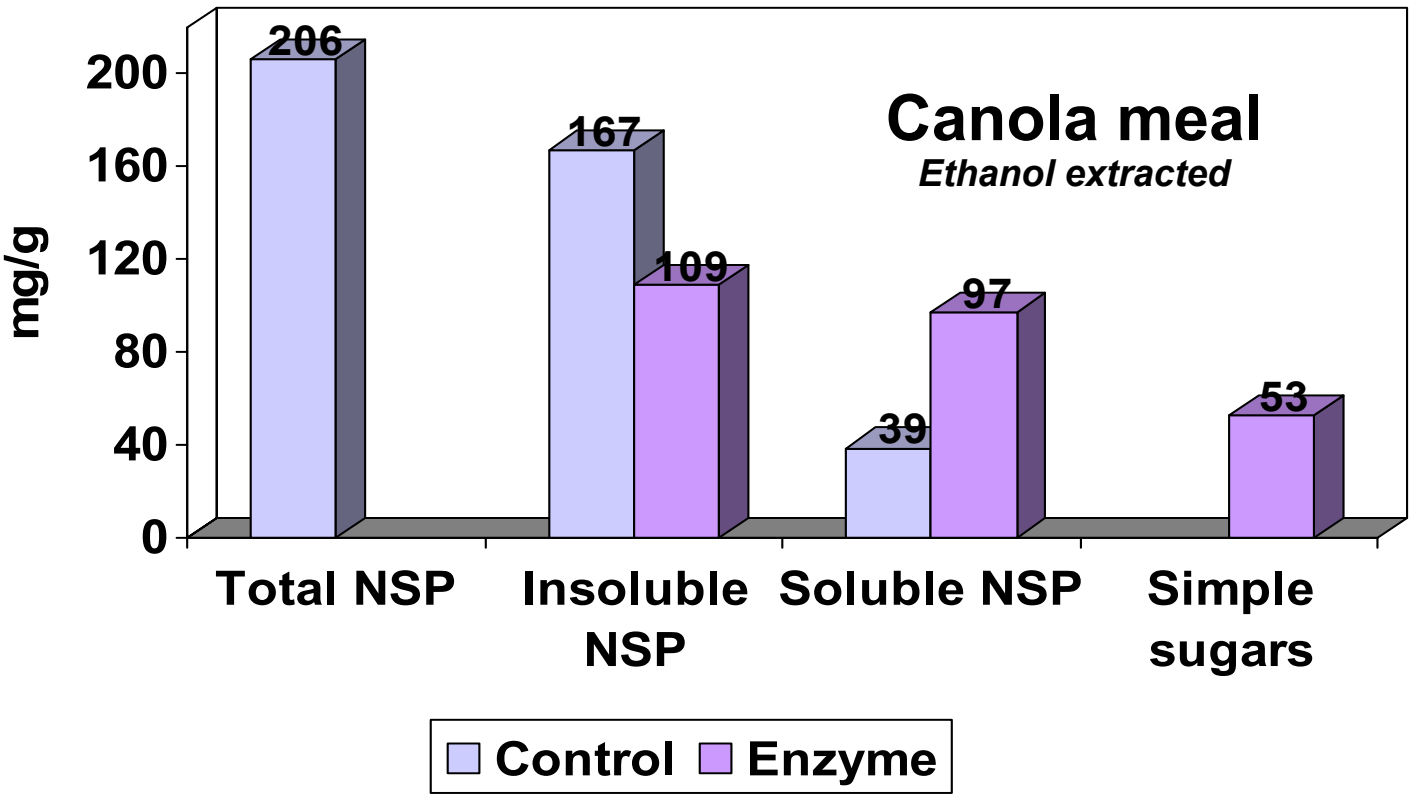
- Incubation of CM with enzyme at 20% moisture content

Enzyme	NSP	NSP-glucose	Oligosaccharides	Phytate
-	172.9[a]	66.4[a]	21.0[a]	28.8[a]
+	137.3[b]	35.8[b]	0.0[b]	1.1[b]

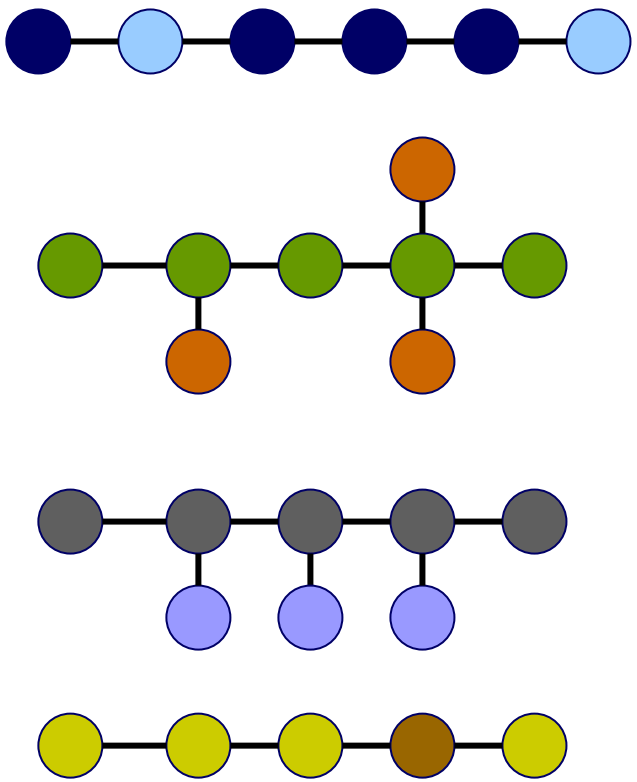
- Improvement in growth performance of broiler chickens fed enzyme pretreated meal (30%):
  - BWG ↑ **5.6%**
  - FCR ↑ **2.6%**
  - AME_n ↑ **5.2% (151 kcal/kg diet)**

NSP balance

In vitro enzyme incubation study



Carbohydrase enzymes may produce NSP hydrolysis products which are similar to those effective in minimizing proliferation of pathogenic bacteria



- 1,4-D-Glucose
- 1,3-D-Glucose
- D-Xylose
- L-Arabinose
- D-Galactose
- D-Mannose
- L-Rhamnose
- D-Galacturonic acid

Bacterial growth on EtOH-extracted CM

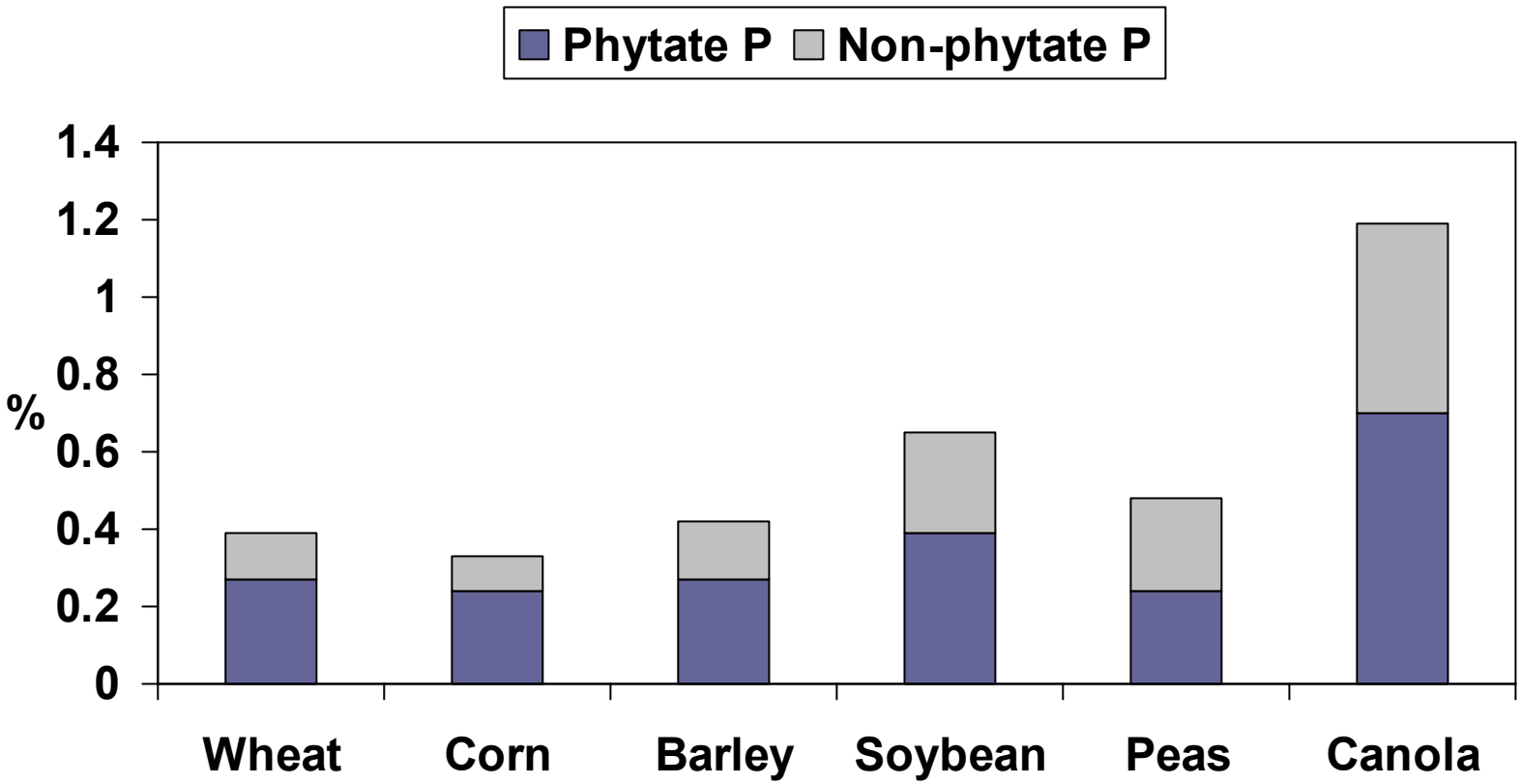
Represents difference in growth without and with enzyme addition

Bacteria	**Growth (log_{10}CFU/ml/6h)**
Escherichia coli	0.16
Salmonella Typhimurium	0.00
Clostridium perfringens	0.00
Campylobacter jejuni	0.31
Lactobacillus brevis	0.58
Bifidobacterium pullorum	0.53

Thank you!

Questions?

Phytate and non-phytate P contents of feed ingredients



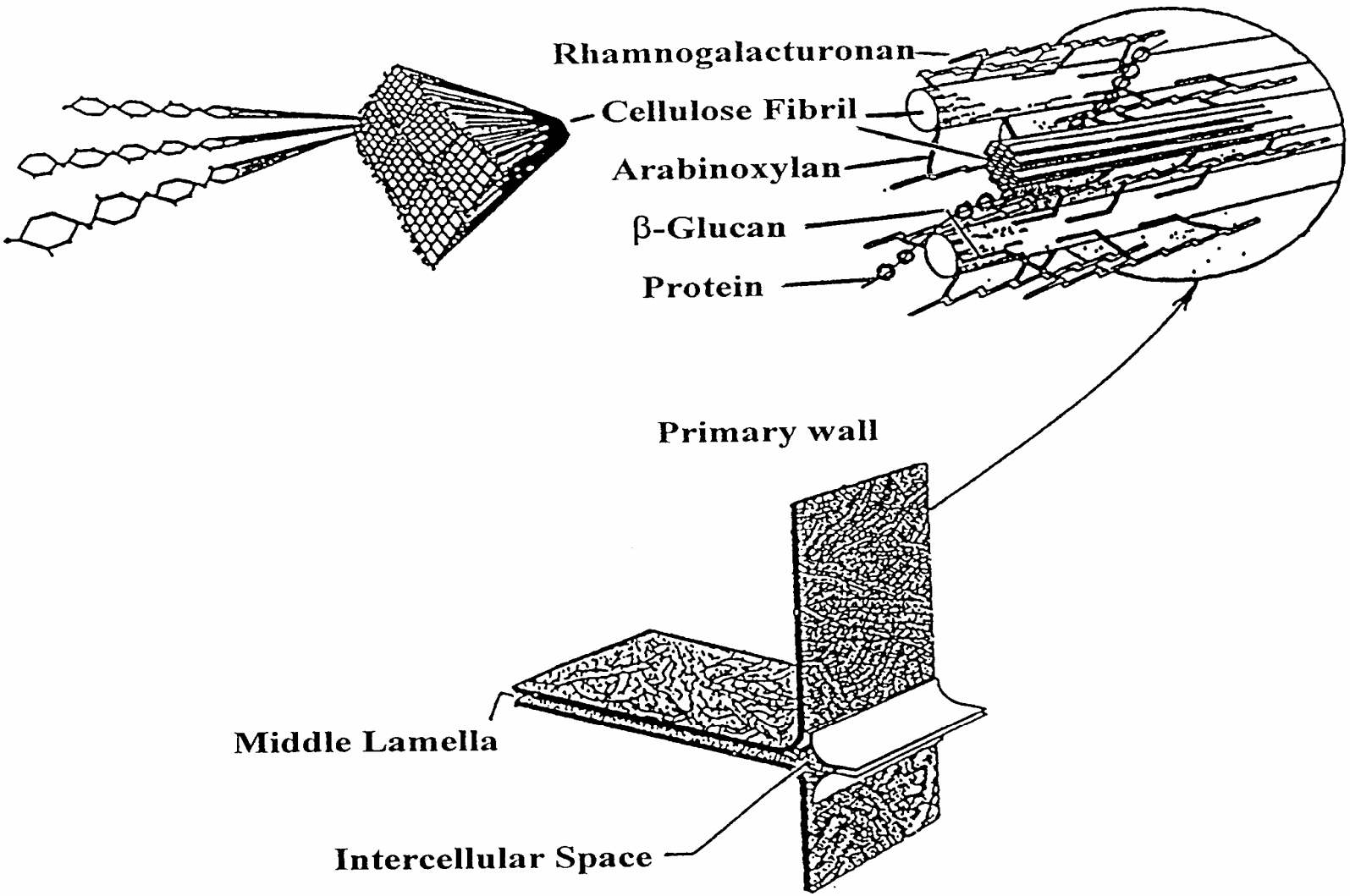
Future Research

- Further characterization of the carbohydrase enzyme hydrolysis products.
- Growth of *Cl. perfringens* strains on ileal digesta samples from broiler chickens fed different diets without and with enzyme supplementation: In vitro study (on going).
- The effect of enzyme supplementation on growth performance, Necrotic enteritis development, lesion score, and mortality in broiler chickens challenged with *Clostridium perfringens* (Maple Leaf Foods Agresearch Trial 2; “hot” strain to be considered).

Potential prebiotic effect of NSP hydrolysis products

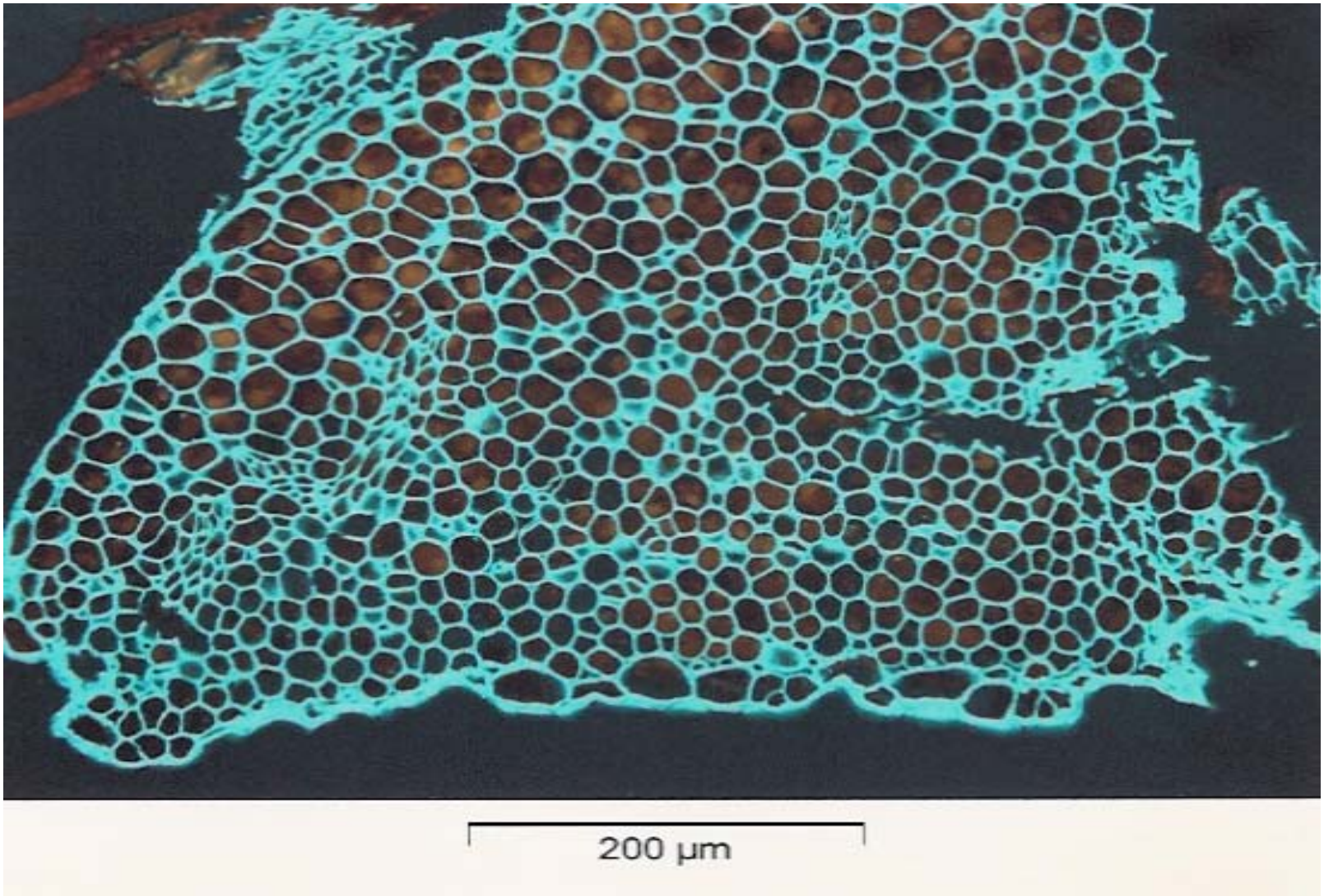
- In the process of depolymerizing various polysaccharides in the diet, exogenous enzymes may produce short xylo-, manno-, gluco- or galacto-oligomers which may facilitate proliferation of bacteria associated with a probiotic effect (lactobaccili) and decrease the abundance of pathogens such as *Clostridium*, *Salmonella* and *E. coli*.

A Model of Cell Wall Architecture



Broiler Chicken Experiment
Effect of α-Galactosidase Supplementation

Diet	Oligosaccharide digestibility (%)	BWG (g/14 days)	FCR
Control (no enzyme)	27.2[a]	447.4	1.52
α-Galactosidase (0.01%)	32.1[a]	454.1	1.52
α-Galactosidase (0.05%)	57.4[b]	439.7	1.53


200 µm