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Extracting full value of Australian barley for broilers and layers in Indonesia using enzymes

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GRDC Grains Research & Development Corporation

AEGIC is an initiative of the Western Australian State Government and Australia's Grains Research and Development Corporation

Key messages

- Poultry production is competitive and cost sensitive
- Feed is the single biggest cost - need to be flexible regarding ingredients
- Poultry are adaptable omnivores that can meet their nutrient requirements from a broad range of feedstuffs
- Corn and soy are not essential ingredients for diets
- Australian poultry diets use mainly wheat, sorghum and barley with legumes and canola meal as well as soybean meal with excellent results
- Australia will produce 12 million metric tonnes of barley in 2020/21
- Australian barley is accessible and attractively priced

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In this presentation

- Poultry nutrition
- Comparing common feed ingredients
- Features of Australian barley
- Raw feed materials: the science
- Factors effecting feed grain processing
- Selecting the preferred grain base for diets

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Poultry nutrition

- Metabolizable energy (ME) and Standardised ileal digestible amino acids (SID AA)
- Can come from a wide range of sources
- Grains are the main source of energy (starch)

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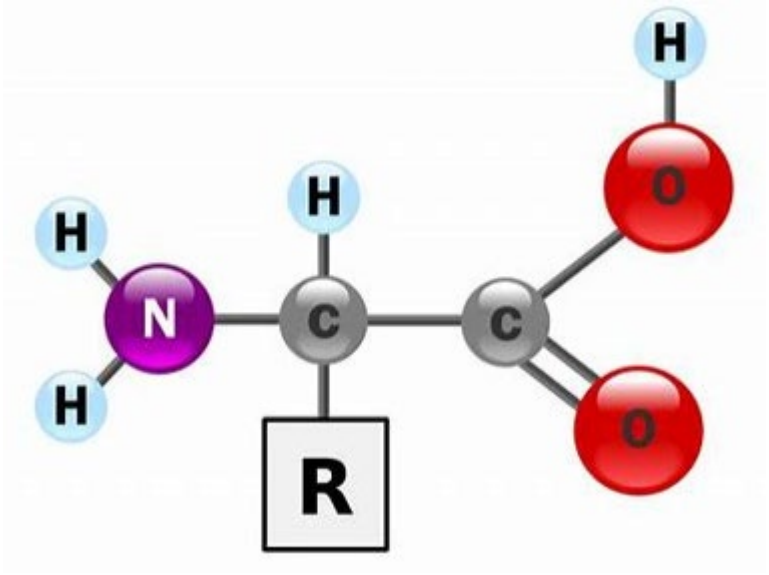
Energy

- Metabolizable energy (ME) is derived by the digestion of various fractions in the diet:
  - Starch → Glucose
  - Fat → Fatty Acids
  - Protein → Amino Acids
- Grains vary in the content of these potential energy yielding components and their digestibility (both between and within grain types)
- ME is either measured by bio assay or predicted by NIR* (AUSSCAN)

*NIR = Near- infrared spectroscopy

Protein

- Poultry have no real requirement for protein but rather the specific amino acids derived from the protein
- Amino acid requirements vary between different types and stages of production and are primarily supplied by proteins and synthetic amino acids, but the grain protein makes a significant contribution



Comparing common feed ingredients

Feed ingredients used in stockfeed manufacturing in Australia

Cereals	Legumes	Animal protein	Vegetable protein	Milling offal	Synthetic amino acids	Food industry by-products	Sundry
Wheat *	Lupins *	Meat meal *	Soybean meal *	Millmix *	Lysine *	Whey *	Minerals *
Barley *	Peas *	Blood meal *	Full fat soya *	Rice pollard *	Methionine *	Brewers yeast	Vitamins *
Oats *	Faba bean	Fishmeal *	Cottonseed meal *	Oat offals	Threonine *	Bread	Tallow *
Sorghum *	Chickpeas	Poultry meal	Canola meal *	Pea offals	Tryptophan *	Biscuits	Vegetable oil *
Triticale	Mung bean	Milk powder	Sunflower meal	Hominy	Isoleucine *	Cereals	Chicken oil
Corn	Lentils	Yeast	Peanut meal		Valine *	Confection waste	Lucerne
Rye	Vetch	Feather meal	Safflower meal		Arginine	Pet food waste	Molasses
Rice		Plasma	Copra			Distillers grain	Cassava

* Major use materials

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Cereal grains

Comparing common feed ingredients

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Protein meals

ANIMAL

PLANT

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Barley as a grain base to poultry diets

- In countries where barley is grown extensively (Europe, Canada, Australia), barley is often available as a competitively priced ingredient
- Good use can be made of barley in broiler, layer, breeder, duck and turkey diets when there is an economic advantage
- Barley is different
- It has higher fibre, lower starch, hence lower ME than other grains
- It is considered a viscous grain due to its relatively high NSP content. But this is readily addressed via exogenous enzymes removing any impediment to use

Comparative typical proximate analyses of grains

Specification		Corn	Wheat	Barley	Sorghum
Moisture (%)		13	12	12	13
Protein (%)		8	11	11	9.5
Fat (%)		4	2.3	2.6	3.5
Ash (%)		1.15	1.7	2.2	2.0
Fibre	Crude (%)	2	2	4.8	2.3
	NDF[1] (%)	9	8.5	16.0	8.0
	ADF[2] (%)	2.2	2.5	5.5	2.5
Starch + Sugar		64.6	63	53.9	63
Broiler ME MJ/kg (Kcal/kg)		13.45 (3215)	12.56 (3000)	11.2 (2677)	13.21 (3157)
Layer ME MJ/kg (Kcal/kg)		13.75 (3285)	13.00 (3105)	11.8 (2820)	13.50 (3227)
Australian broiler values (Kcal/kg)		3350	3200*	2900*	3300

* with NSP enzyme

Note: Typical values only - composition can vary widely with different agronomic conditions

*With Non-Starch Polysaccharides (NSP) enzyme

NDF[1] = Neutral detergent fibre ADF[2] = Acid detergent fibre

Source: Premier Atlas (2008)

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Grain SID* Amino acid, Calcium, Phosphorus and Phytate content at typical protein levels

	Corn	Barley	Wheat	Sorghum
PROTEIN (%)	**7.6**	**10.5**	**11.7**	**9.2**
SID Lys	0.18	0.29	0.27	0.15
SID Met	0.14	0.14	0.16	0.13
SID M+C	0.28	0.33	0.40	0.25
SID Thr	0.22	0.28	0.28	0.23
SID Iso	0.22	0.30	0.35	0.28
SID Try	0.05	0.11	0.13	0.09
SID Arg	0.32	0.45	0.52	0.27
SID His	0.19	0.19	0.24	0.15
SID Leu	0.81	0.59	0.69	0.96
SID Val	0.31	0.41	0.44	0.34
SID Phe	0.32	0.43	0.48	0.38
Calcium (%)	0.01	0.05	0.04	0.01
Phosphorus (%)	0.22	0.28	0.26	0.24
Phytate P (%)	0.17	0.16	0.17	0.17

*SID = Standardised ideal digestibility

Source: Evonik AminoDat 5.0

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Variability in broiler ME as detected by AUSSCAN

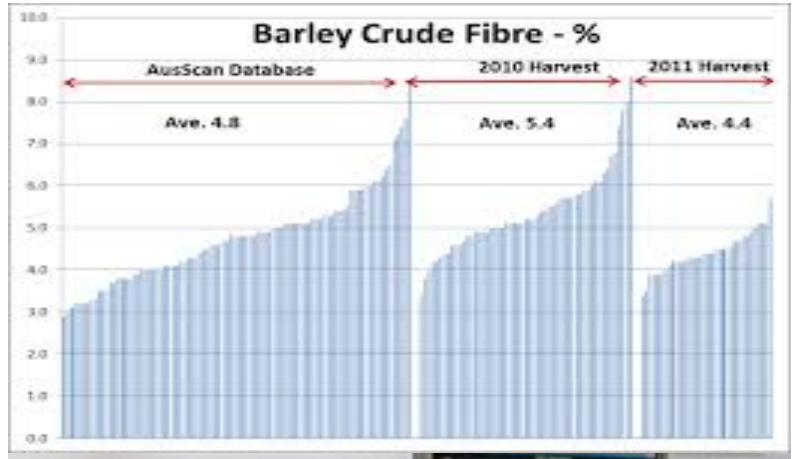
Grain	Broiler AME MJ/kg (kcal/kg)		
	Minimum	Median	Maximum
Wheat	11.86 (2835)	12.72 (3040)	13.64 (3260)
Barley	10.71 (2560)	11.42 (2730)	12.13 (2900)
Sorghum	13.44 (3210)	14.32 (3420)	14.79 (3535)

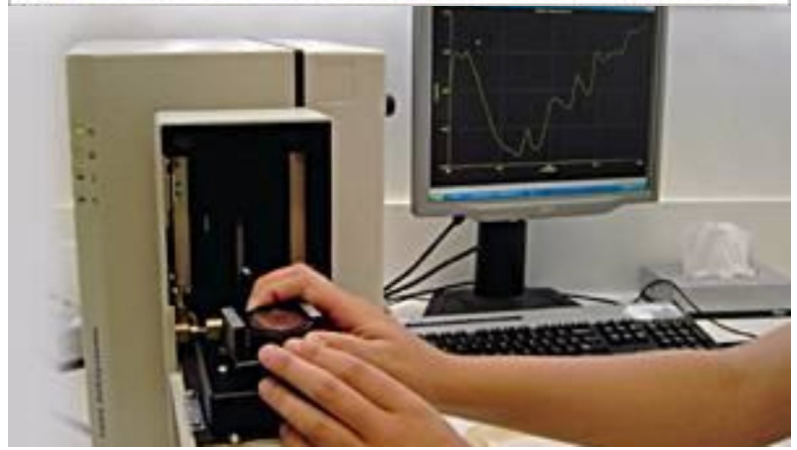
*AME = Apparent Metabolisable Energy

Source: AUSSCAN calibration (2010)

Raw material variation monitoring (Ausscan)

Parameter analysed	Value
Broiler AME*	Accurate energy value
Layer AME	Accurate energy value
Broiler AME intake index	Estimate of energy intake (palatability, throughput, density)
Major nutrients	Protein, Moisture, Fibre, Fat, Starch, Ash
Fibre components	Crude, ADF, NDF
NSP characterization	Soluble & Insoluble content, NSP type - arabinoxylan, ß-glucan
Hydration capacity	Pelleting effect, gelatinisation properties and enzyme access





AusScan

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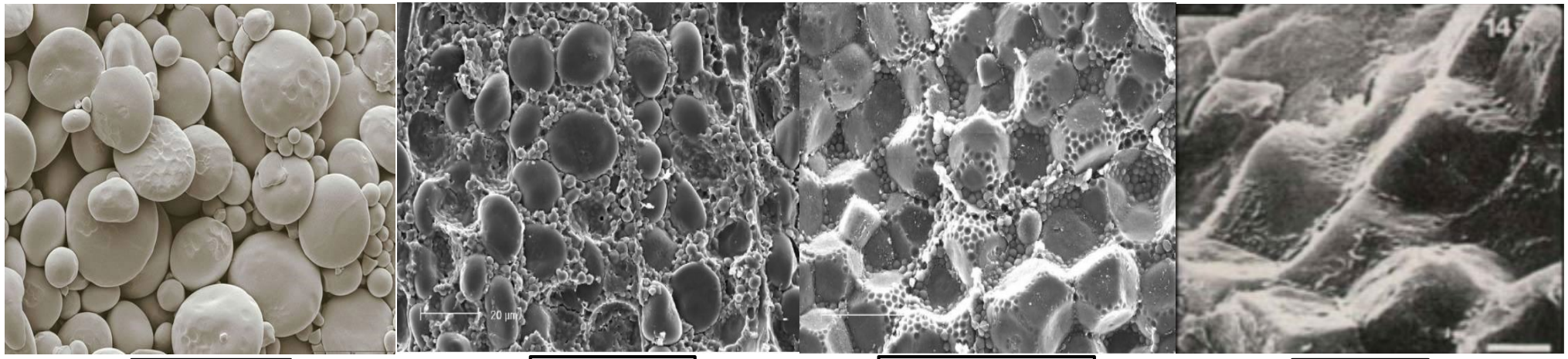
Structure of grain starch

- Starch stored in different ways in grains
- Impact availability of starch for digestion
- Complex structures → less available starch
  - Processing can increase availability



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Features of Australian barley

- Temperate winter crop (harvest October – December)
- Mainly 2–Row varieties, spring type – malting characteristics
- Medium grain size, white with hull
- Low mycotoxin contamination – harvested and stored dry
  - High quality storage facilities and management
- No yellow pigments
- Viscous: contains soluble NSP's = β-glucans + Arabinoxylans
  - But easily managed with supplementary enzymes

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Features of Australian barley con't

- Lower in energy than corn, wheat or sorghum due to higher fibre content and lower starch
  - Fibre content considered an asset in regard to gut health
- Protein typically higher than corn but similar or lower than wheat and of higher biological value
- Used extensively in poultry diets as a safe and reliable feed component
- Robust and reliable grading system for grain trading

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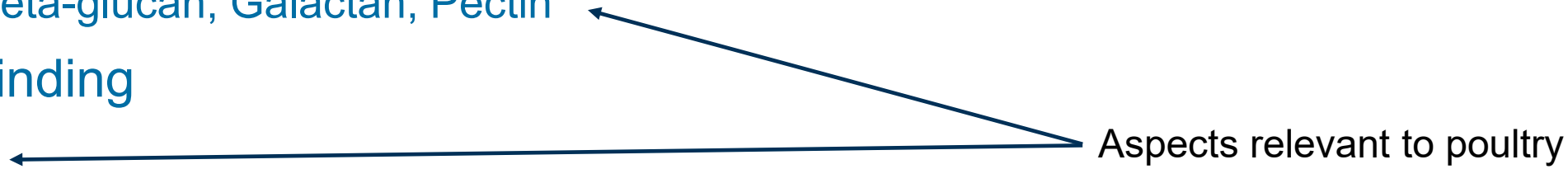
Raw feed materials: the science

Anti-nutritional factors (ANF)

- Compounds limiting the availability of nutrients for digestion
- Structural ANF's
  - Non-Starch Polysaccharides (NSP) – soluble & insoluble
  - Xylan, Beta-glucan, Galactan, Pectin
- Mineral binding
  - Phytate
  - Oxalates
- Reduce protein digestion and utilisation
  - Protease inhibitors
  - Tannins
- Know how to overcome these challenges



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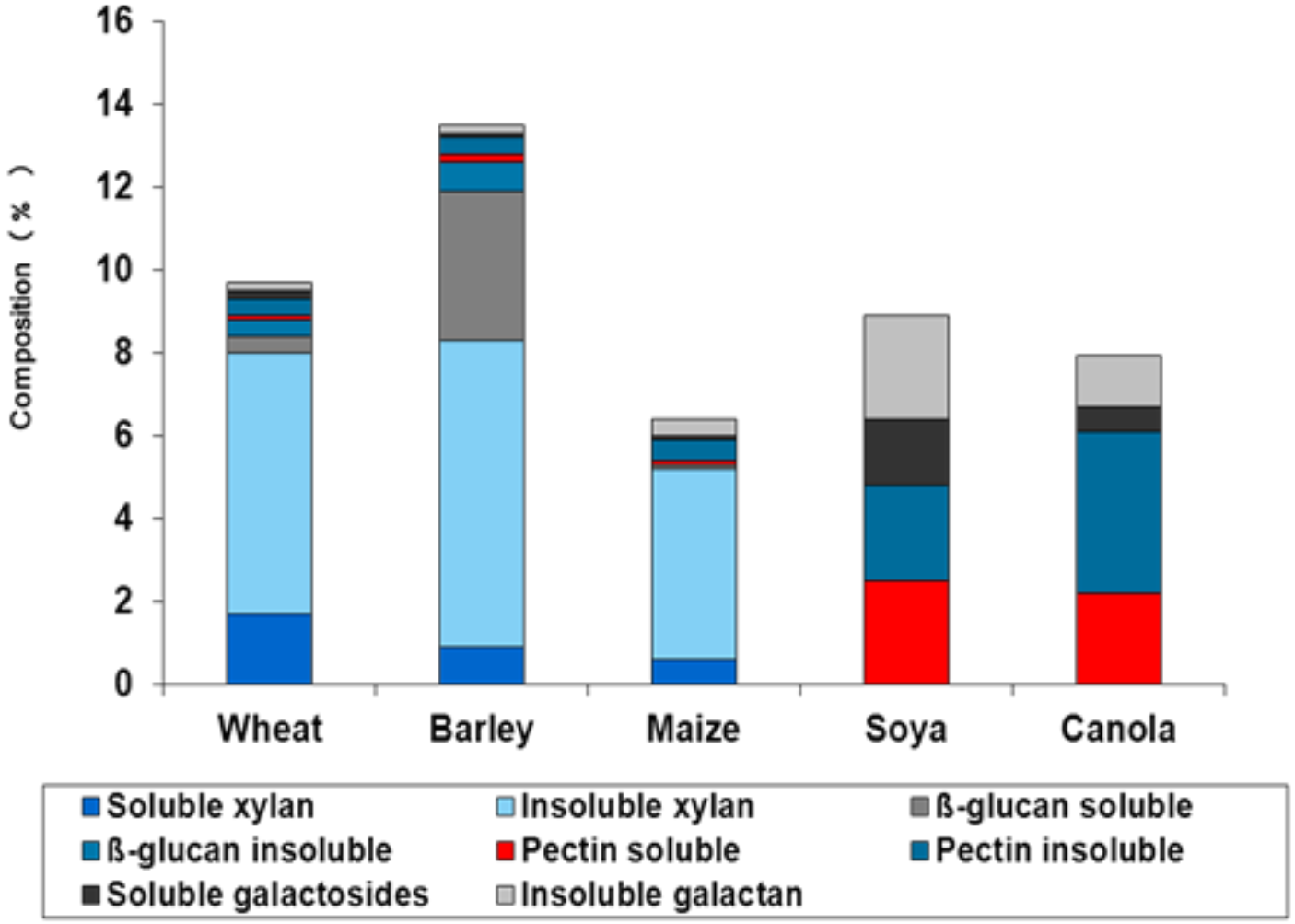
NSP profile of raw materials



Source: Bach Knudsen KE., 1997; Choct. M.,1997

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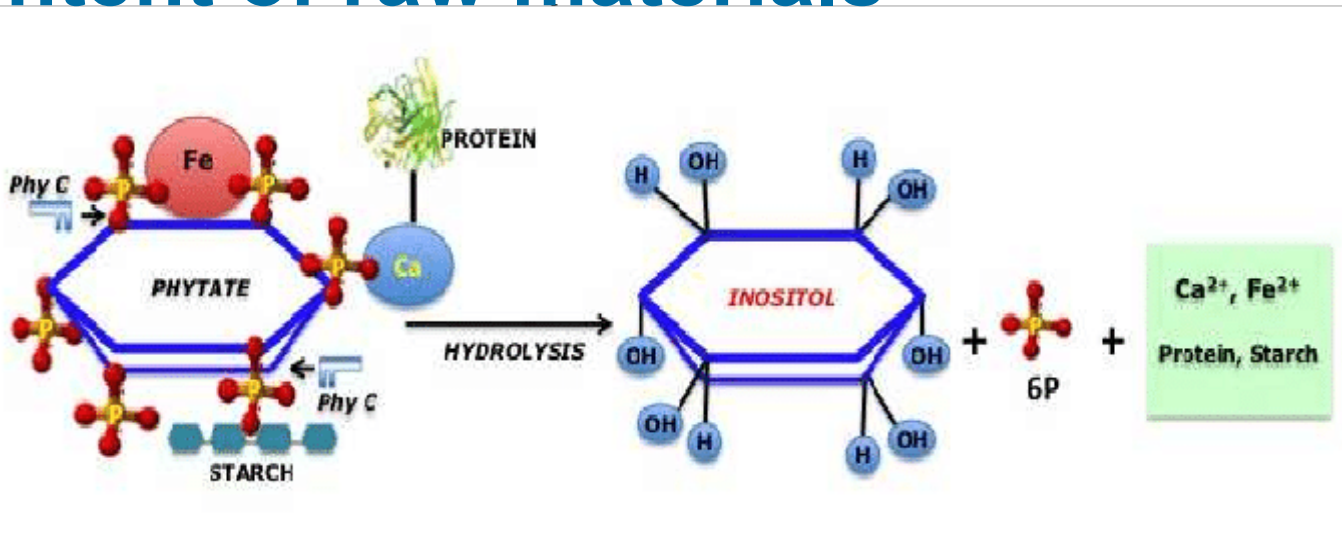
Phytate content of raw materials



Raw material	Total P (g/kg)	Phytate (g/kg)	Phytate-P (g/kg)	Phytate-P / Total P (%)
BARLEY	3.2	7.0	1.9	61
CORN	2.6	6.7	1.9	72
WHEAT	3.1	7.8	2.2	72
SORGHUM	3.0	7.7	2.2	73
SOYBEAN MEAL	6.5	13.8	3.9	60
CANOLA MEAL	9.7	22.9	6.5	66

Managing anti-nutritional factors

Exogenous enzymes

- NSPases: ß-Glucanase, Xylanase
  - Structural NSP's limit endogenous enzymes access to nutrients → animal produce limited quantity
  - Various commercially available products able to address specific NSP challenges
- Phytase
  - Cleaves Phytate-P – increase P availability
- Protease

Heat treatment

- Reduce activity of deleterious compounds:
  - Trysin inhibitor = Soybean meal

Typical formulation limits on grains

These are somewhat arbitrary reflecting the experience and confidences of the nutritionist to address the issues involved and risk management approaches

Diet	Corn	Wheat	Barley	Sorghum
Broiler starter / chick	100	100	0 – 15	0 – 30
Broiler grower / finisher	100	100	0 – 30	0 – 60
Layer	100	100	0 - 50	100

Selecting the preferred grain base for diets

- Poultry are very adaptable omnivores that can utilize a wide range of different feedstuffs most effectively
- A megajoule of energy or a gram of standardised ileal digestible amino acid can come from any source with equal efficacy
- Feed formulation is more about nutrient delivery than ingredient use
- All feedstuffs have their specific properties that we need to be cognisant of when combining with other components to make up a complete diet
- With a full appreciation of the available nutrient content of feedstuffs and any peculiar constraints to use, the prime determinant becomes the relative cost of delivering the necessary nutrients
- To be economically competitive, we need to maintain an open mind to all options
- Corn + Soybean meal may be dominant components in much of the world's pig foods but they are not essential

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Conclusions

Poultry have an ability to utilise a broad range of feedstuffs to meet their nutritional needs

Traditionally in Asia, corn has been the predominant grain employed. However, with increasing international trade other grain alternatives have emerged representing a real economic advantage

Australia is enjoying a very productive barley harvest this year resulting in significant quantities being available for export at competitive prices

The domestic Australian poultry industry will take advantage of this situation and utilise barley as part of the grain base to diets

The opportunity also presents itself to near Asian neighbours and is well worth considering

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