The use of barley in Asian broiler diets

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broiler QC
FEED QUALITY CONFERENCES

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Background: World barley and sorghum

* Barley and sorghum rank 4th and 5th respectively in world cereal production after corn, wheat and rice
* Large proportion of each fed to animals, including poultry

Cereal grains produced in Australia

* Major
  - Wheat (winter crop)
  - **Barley (winter crop)**
  - Oats (winter crop)
  - **Sorghum (summer crop**)
* Minor
  - Corn
  - Triticale

Australia top 6 cereal grains - average production last 5 years[1]

Grain	Mmt[2]
Wheat	24.877
Barley	9.849
Sorghum	1.543
Oats	1.429
Corn	0.421
Triticale	0.132

[1]ABARES Crop Report Jun 2018
[2]Mmt = million metric tonne

Grains used in Australian broiler feeds

* 3 major broiler grains: sorghum, wheat and barley
  - Wheat highest use, then sorghum, then barley
  - Used in all poultry feeds (broiler, breeder, layer, turkey and duck)
  - Corn and other grains use is minor
* Australian poultry performance is world-class (corn not needed for high performance)

Barley and sorghum nutritional attributes for broilers

* Most important attributes of ingredients for accurate feed formulation and value assessment:
  - Metabolisable energy (ME)
  - Protein / amino acids, particularly digestible essential amino acids
* Chemical composition and energy content surveyed ('PGLP'), NIR calibrations developed
  - Commercialised internationally as 'AusScan'

Now talk about barley ….

- Barley compared to corn (and sorghum and wheat) in this presentation

Barley types

* Many types around the world, differences include:
  - Number of seeds on the head (2- and 6-row)
  - Presence or absence of hull
  - Spring or winter (vernalisation)
  - Starch type (normal or waxy)
  - Aleurone (seed) colour

* <u>Australian feed barley</u> predominantly 2-row, spring type (grown in mild Australian winter), white seed with hull (not ‘naked’)

Starch

* Main contributor to ME (as for all grains)
* Barley starch lower than corn, sorghum and wheat
* Australian feed barley starch typically 49-56% as-fed
* Some variation due to soil type, fertilizer, rainfall, yield and general growing conditions
* Frosted and drought-affected crops may have low starch
* Barley amylose content similar to ‘normal’ (i.e. non waxy or high amylose) cultivars of other grains, typically 25-28% amylose and 75-72% amylopectin
* Barley starch digestibility high, similar to corn (typically about 94%)

Fibre

* Barley higher fibre (soluble and insoluble) than corn, sorghum and wheat
* Fibre = NSP (non-starch polysaccharides) + lignin
  - NSP: soluble and insoluble Lignin: insoluble
* Soluble fibre
  - Barley and wheat are ‘viscous’ grains (high soluble NSP)
  - Soluble NSP are anti-nutritional (increase digesta viscosity)
  - NSP enzymes reduce viscosity and ameliorate NSP effects
* Insoluble fibre
  - Nutritionally inert, but often beneficial for gut development and function, and bird behaviour (pecking)
  - Barley insoluble structural fibre benefit versus other grains, particularly for broilers without access to suitable fibre in litter

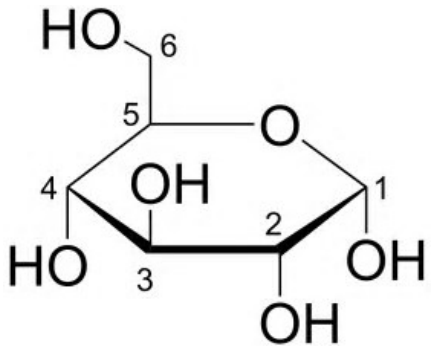
Fibre content of 4 grains

		Arabino-xylan	ß-Glucan	Cellulose	Other NSP[2]	Lignin	Total fibre
Barley	Soluble	0.80	**3.60**		0.10		**4.50**
	Insoluble	7.10	0.70	3.90	0.50	3.20	**15.40**
	Total	7.90	4.30	3.90	0.60	3.20	**19.90**
Corn	Soluble	0.10					0.10
	Insoluble	5.10		2.00	0.80	1.10	9.00
	Total	5.20		2.00	0.80	1.10	**9.10**
Sorghum	Soluble	0.10	0.10				0.20
	Insoluble	2.00	0.10	2.20	0.25	1.10	5.65
	Total	2.10	0.20	2.20	0.25	1.10	**5.85**
Wheat	Soluble	1.80	0.40		0.20		2.40
	Insoluble	6.30	0.40	2.00	0.30	1.80	10.80
	Total	8.10	0.80	2.00	0.50	1.80	**13.20**

[1]NSP = non-starch polysaccharides
[2]Mannans + Galactans + Uronic Acid

ß-glucans

* Starch, cellulose and ß-glucans are glucose polymers with different α and β linkages affecting solubility and hydrolysis by digestive enzymes
  - Starch: α-1,4 and α-1,6 side branches
  - Cellulose: β-1,4
* Barley and yeast ß-glucans are different
  - Barley: both β-1,3 and β-1,4
  - Yeast: β-1,3 with β-1,6 side branches



* Yeast cell wall ß-glucans immune modulating, not known if barley ß-glucans have similar properties

NSP enzymes

* NSP enzymes act on soluble NSP, reduce viscosity
* ß-glucans are the main soluble NSP in barley but arabinoxylans are significant
* In many barley enzyme studies, ß-glucanase product used also had xylanase activity
* Many studies report broiler performance improvements with ß-glucanase + xylanase in barley-based feeds
* Include ß-glucanase + xylanase in barley feeds to improve digestion and performance, and reduce water consumption (drier litter)

Metabolisable energy (ME)

* Reported grain ME values measured by bioassay typically with no enzymes in test diets, fed to growing broilers
* 2,750 kcal/kg as-fed commonly accepted barley ME 'book' value for broilers
* Indicative average ME for Australian feed barley with enzymes **2,900 kcal/kg as-fed** (12% moisture basis)
* Barley ME may increase for 3 - 4 months after harvest ('new season grain phenomenon') due to endogenous enzyme activity in storage
  - Not relevant to export markets

Protein / amino acids

* Australian feed barley crude protein (CP) average typically about 10% as-fed
  - About 2% higher than corn
  - Similar to sorghum
  - Lower than wheat
* Amino acid composition not constant ratio to CP
  - As CP increases, essential amino acids generally lower as % of protein
* Amino acid composition of barley, corn and wheat protein different

Protein digestibility

* Protein digestibility high for all grains, but lower for barley and sorghum than corn and wheat
* Digestibility differences mainly due to anti-nutritional effects of soluble NSP in barley and wheat, and to other factors in sorghum
* NSP enzymes reduce if not eliminate digestibility differences between barley, corn and wheat
* Standardised ileal digestible (SID) most common and widely accepted digestibility system for poultry

SID essential amino acid (SID EAA) composition

* At the same (9%) protein, barley has:
  - Higher SID Lys and Try than corn
  - Lower SID Met, M+C, Thr, Ile, Leu and Val than corn
  - Barley SID Leu:Ile ratio (2:1) closer to 'ideal' (< 1.6:1) than corn and sorghum (about 3.2:1)
* Barley, with typical 2% greater CP than corn, contributes more of every SID essential amino acid except for Met (and Leu) than corn

SID EAA[1,2] composition of barley, corn and wheat at the same CP (9%)

		As % of grain			As % of CP		
		Barley	Corn	Wheat	Barley	Corn	Wheat
CP	%	9.0	9.0	9.0	100	100	100
SID EAA							
Lys	%	0.29	0.25	0.24	3.2	2.8	2.7
Met	%	0.14	0.18	0.14	1.6	2.0	1.6
Cys	%	0.18	0.17	0.20	2.0	1.9	2.2
M+C	%	0.32	0.34	0.33	3.6	3.8	3.7
Thr	%	0.23	0.28	0.23	2.6	3.1	2.6
Try	%	0.08	0.06	0.11	0.9	0.7	1.2
Arg	%	0.37	0.36	0.39	4.1	4.0	4.3
Ile	%	0.26	0.30	0.28	2.9	3.3	3.1
Leu	%	0.51	1.03	0.55	5.7	11.4	6.1
Val	%	0.37	0.39	0.36	4.1	4.3	4.0

[1]SID EAA = standardised ileal digestible essential amino acid
[2]Evonik AminoDat 5.0

Oil / linoleic acid

* Lower in barley than corn and sorghum, similar to wheat
* Linoleic acid >1% in typical high barley feed, sufficient for broilers

Vitamins and minerals

* Similar in barley, corn, sorghum and wheat, differences commercially irrelevant
* Total and phytate P lower in barley (and wheat) than corn and sorghum

Pigments for skin colour

* Carotenoids not present in barley (or in sorghum and wheat)
  - Other pigment sources may be needed if yellow corn replaced by barley

Mycotoxins

* Australian feed barley low mycotoxin contamination (dry conditions at harvest, good storage after harvest)

Processing

* Barley suitable for mash (coarse milling) and whole grain feeding
* Barley PDI similar to corn (FPQF = 5 for both)
* Starch gelatinisation temperature range lower for barley (52-60ºC) than corn (62-72ºC), sorghum (68-78ºC) and wheat (58-64ºC)
* Digesta viscosity increased by steam pelleting (starch gelatinisation and NSP solubilisation)

Barley practical application – value and opportunity

* Barley commonly included up to 20% (sometimes above 30%) in commercial broiler feeds, when economical, in Australia, Spain, UK and elsewhere
* Suitable for all classes of poultry including broilers, broiler breeders, layers and ducks
* Lower mycotoxin contamination than locally produced corn?
* Consider including barley to reduce mycotoxin risk in breeder and duck feeds (higher susceptibility to mycotoxins)

Feed barley
Take Home Message

* Proven, reliable grain for poultry, including broilers
* Nutritional value for poultry well understood
* Low mycotoxin contamination
* Include NSP enzymes (ß-glucanase and xylanase) if barley above about 10% in feed
* Feed barley can be, and is included in broiler feeds (but more suited to breeders and layers than broilers because of lower ME)
* Not well understood or accepted for broilers in Asia?
* Should be considered for your situation and used when economic

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Thank you

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