Paper 14
FEED VALUE OF BARLEY

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INTRODUCTION

In New Zealand, from a compounded feed manufacturer's standpoint, barley constitutes an important grain source. It is the main feed energy source in the South Island, whilst maize is the major grain source in the North Island. However, prior to the introduction of large-scale maize cultivation barley provided the main grain base in the North Island also.

Table 1 gives an estimate of feed grain usage in New Zealand. It must be stressed that these figures are no more than a guesstimate and they encompass both feed compounders and home millers.

TABLE 1: Grain usage by the N.Z. feed industry including home millers (tonnes).

	South Island	North Island	Total
Maize	2,000	160,000	162,000
Wheat	25,000	15,000	40,000
Barley	75,000	60,000	135,000
	102,000	235,000	337,000

From these figures it is apparent that barley constitutes approximately 40% of total feed grains, whilst maize and wheat form 48% and 12% respectively. Naturally, because grains provide close to 70% of the feed tonnage, feed compounders are interested in the quality of the grain available for compounding. Table 2 gives the major feed categories and tonnages.

TABLE 2: Major feed users in 1981

User	tonnes/annum
Layer	180,000
Broiler	110,000
Pig	164,000
Other feeds	36,000
All	490,000

In this paper an attempt will be made to compare the nutritive value of barley with other grains, and also to highlight both the desirable and undesirable traits of barley as a feed source.

NUTRITIVE VALUE

The proximate compositions of some typical samples of two seasons' barley, wheat and maize are given in Table 3, and their essential amino acid profiles given in Table 4.

As can be seen, barley ranks below wheat but above maize in crude protein content. A varietal analysis of barley and wheat done by the NRM Feed laboratory, with 1982 South Island grain, showed higher crude protein value for barley than indicated in Table 3. The mean crude protein of 24 samples (9 'Goldmarker', 3 'Magnum', 4 'Kaniere', 3 'Hassan' and others) was 11.5% with a SD of 1.25. The wheat was found to contain 12.9% (SD ±2.9, n = 31) crude protein.

TABLE 3: Proximate composition of major grains.

	% On "As Fed" Basis			
	Crude Protein	M.A.D. Fibre	Ether Extract	Ash
Barley	9.7	4.7	1.6	2.0
Wheat	11.7	2.8	1.8	1.5
Maize	7.3	2.4	3.4	1.1

Source: Harris and Douglas (1982).

A scrutiny of critical amino acids shows that barley is significantly higher in lysine (0.35%) than both maize (0.22%) and wheat (0.30%). As a source of sulphur-containing amino acids it is comparable to maize and barley.

As a source of isoleucine, however, it ranks closer to wheat than maize, wheat being the better source. The above comparison was made on values unadjusted for high crude protein as seen in South Island barley. When adjusted for the higher crude protein the comparison tilts even more favourably towards barley.

Grains occupy approximately 60-70% of a compounded feed, constituting the main energy source. Therefore the basis for relative assessment of grains is the cost per unit of energy. The commonly used energy parameters are given in Table 5.

TABLE 4: Essential amino acid profile of major grains.

Amino Acid	As a % of Feedstuff Maize	Wheat	Barley
Arginine	.37	.52	.51
Cystine	.18	.24	.25
Glycine	.30	.43	.40
Histidine	.22	.24	.21
Isoleucine	.25	.36	.35
Leucine	.89	.70	.69
Lysine	.22	.30	.35
Methionine	.14	.17	.15
Phenylalanine	.35	.47	.49
Serine	.42	.56	.48
Threonine	.27	.31	.33
Tryptophan	.06	.15	.11
Tyrosine	.31	.31	.33
Valine	.35	.46	.49

Source: Harris and Douglas (1982).

TABLE 5: Energy values of grain.

	Gross Energy	Apparent[1] Metabolisable	True[1] Metabolisable	Digestible[2] Energy
Barley	16.3	11.3	13.80	13.34
Wheat	16.3	13.9	14.78	15.08
Maize	16.3	14.7	15.08	15.36

[1] for poultry
[2] for pigs

Until very recently the energy system used in poultry nutrition was the apparent metabolisable energy (AME) of feeds. The AME values were determined for each individual feedstuff using young chicks. These values are additive, and the AME of a compounded feed is determined by taking the proportional energy value of each ingredient in the feed.

The true metabolisable energy (TME) system using adult roosters was introduced by Sibbald, a Canadian worker, in 1976, and this system is now gaining world-wide acceptance. TME is considered to yield a more precise estimate of the actual energy available for total metabolism. On the AME system, barley is the least favoured and has about 18% less metabolisable energy than wheat. However, on the TME basis this difference is narrowed down to only 6.6%, thus lifting the value of barley as an energy source. It must be borne in mind that this comparison was made on overseas AME values and local TME values, and the actual differences may have not been so great.

Similarly, relative to maize the shift from AME to TME considerably improves the value of barley. However, it must be mentioned that doubts are being expressed about the applicability of the TME system for all classes of poultry. For example, the availability of such a high energy as claimed by the TME system for rapidly growing young broilers with a very high rate of passage is open to question. Therefore barley is still looked at with some suspicion in the area of meat bird nutrition.

DESIRABLE PROPERTIES

Barley is by far the most preferred grain in pig nutrition. It is recognised to be a palatable ingredient for pigs, helping to produce a pigment-free body fat with a firm consistency. High levels of maize in feeds on the other hand have the opposite effect. The high lysine in barley also presents an added advantage in feeding growing pigs.

UNDESIRABLE PROPERTIES

Pigments

Barley does not contain xanthophylls, whereas maize contains about 17 mg/kg xanthophyll. A layer diet with 60-70% maize will adequately meet the xanthophyll requirement to produce an acceptable yolk colour. With a barley diet on the other hand it is imperative that, at a cost, either lucerne or artificial pigments such as Carophyll are incorporated into the feed. Maize would fetch a premium relative to barley or wheat for this reason.

Hydrocolloids

The wet litter problem in layers is commonly attributed to the inclusion of a high level of barley in diets. The point must be made that quite often wet litter problems are caused by such factors as poor ventilation, leaky waterers and chronic enteric disorders or even high salt in the diet. However, barley becomes a prime suspect in such events and the presence of hydrocolloids is usually blamed. Also the sticky nature of barley protein has been blamed as another causative factor of wet litter (Head, 1974).

The term hydrocolloid is generally used to include gums, mucilages, and pectins as well as other thickening and gel-forming agents (Gohl, 1977). In the case of barley the significant component is a water-dispersible polysaccharide termed beta-glucan. Generally a high correlation is found between the levels of beta-glucan and the viscosity of barley extract. Greenberg (1974) found $r = +0.89$. A comprehensive study on hydrocolloids in barley was done by Gohl (1977), and some salient points established are:

Water treatment of barley improved digestibility, by the activation of endogenous enzymes breaking down polysaccharides to monosaccharides.

There was no difference in the rate of disappearance of free starch between water-treated and untreated barley.

The number of bacteria in the intestines of rats fed with untreated barley increased relative to those in rats fed with water-treated barley.

A hypothesis was extended that starch of viscous barley became trapped in microbial cells or converted to microbial carbohydrates, thus making it non-available.

Transit time of digestion was slow in rats fed with viscous barley and this was caused by beta-glucan.

The bulk of excreta produced was greater and also the excreta retained more water in the case of viscous barley. This may explain the wet litter problem.

Barley prematurely ripened in warm or dry harvest seasons contained more beta-glucan.

The hydrocolloid content of barley can be reduced by adding water, or alternatively adding the enzyme beta-glucanase which is responsible for breaking down beta-glucan.

A further complication of the presence of anti-nutritive factors is the variability of digestible protein. Guillaume and Gomez (1980) found certain barley cultivars showing low and highly variable digestible protein levels.

FEED SPECIFICATIONS

The current feed grade specifications for barley are:

(a) bushel weight — min. 50 lbs
(b) moisture — max. 14%
(c) screenings — max. 30%
(d) weed seeds and foreign matter — max. 0.5%.

A bushel weight less than 50 lbs is associated with a financial penalty. The maximum on screenings is important and closely adhered to, as screenings tend to pass through the grinder and end up as whole grain in the feed. Whole barley grains are largely indigestible, thus reducing nutrient availability.

CONCLUSIONS

Barley constitutes an important grain source in New Zealand and will continue to do so. Like all grains, barley will be assessed mainly on the basis of cost per unit energy, and as long as barley remains competitive feed millers will continue to use it. Any attempts to improve nutritive value by manipulating the protein content or composition are unlikely to receive encouragement from feed millers as this would invariably result in lower yields and higher prices. Feed millers look towards barley as an energy source and not as a protein source.

With the introduction of the true metabolisable energy system, barley appears closer to wheat and maize as an energy source.

However, feed compounders still treat barley with caution in diets for young poultry. In the future, no doubt, problems associated with hydrocolloids will receive greater attention. Water treatment of barley and addition of exogenous enzymes will be areas open to investigation.

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DISCUSSION

Coles: Should the possibility of having a high barley protein quality in connection with a low barley protein quantity, without reduction in yield, be considered?

Ranaweera: Well, we need barley as a source of energy, and at a competitive price. If that changes because of attempts to achieve high protein levels, it would be a negative point. But success in that direction would be welcome.

Thompson: Have you analysed the mineral content? We have heard recently that our grain is low in selenium.

Ranaweera: No. We do grain surveys confined to crude protein analysis regularly, but not minerals. We do know there can be selenium problems in the South Island, and take that into account in our mixes, ensuring adequate levels of selenium, Vitamin E and associated compounds.

Malcolm: So you actually add mineral compounds?

Ranaweera: Yes, we do.

Coles: Are there any empirical data to suggest that commercial feeds compounded using AME perform better than expected, suggesting that TME might be better?

Ranaweera: There are two schools of thought here. A lot of people vouch for the TME system, including the Canadians. Others, like Farrel from Australia, produce evidence that it is not valid. We would like to use TME, and I am personally convinced that TME is a better estimate. We have a current experiment with a 25%-barley broiler starter diet. If the findings on this are favourable, we would alter our buying strategy next season. But this season we are committed to high levels of wheat with minimum inclusion of barley. In the South Island we produce 20,000 tonnes of broiler feed, so a 10% increase would be significant — 2,000 tonnes of barley.

Coles: I imagine it is cheaper to transport grain to the North Island, compound it there and feed it to the broilers. Is the 25% adequate to feed broilers, and do you see a shift of investment to broiler production in the South Island to avoid double transport costs?

Ranaweera: That is a difficult question. The South Island is better off than the North Island. Larger broiler producers are leaving the South Island because they have to transport the broilers frozen, which costs 28c/kg.