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Feeding Barley to Sheep

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Introduction

Barley is an energy-rich feed grain grown in the temperate climates of North America and Europe. Sheep operations in these areas, as well as others throughout the world, rely on barley as a source of energy and protein in lamb and ewe diets. This report is intended to review the recent scientific literature related to the use of barley in sheep diets and to give recommendations for its successful use in sheep diets.

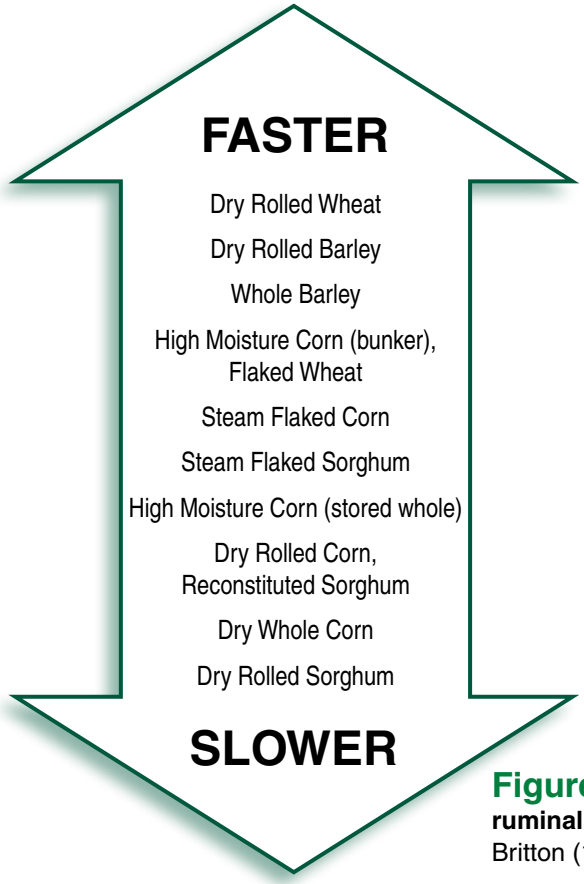

Figure 1. Grain sources categorized by rate of ruminal starch digestion. Adapted from Stock and Britton (1993).

Energy and Protein Content of Feed Barley

The nutrient content of barley (Table 1) compares favorably with that of corn, oats, wheat and milo, as reported by the National Research Council (NRC, 1996). Barley is used primarily as an energy and protein source in sheep diets. The energy content (total digestible nutrients [TDN], net energy for maintenance [NE_m], net energy for gain [NE_g]) for barley is slightly lower than the energy value for corn. The lower energy content of barley may be attributed partially to its higher fiber content (neutral detergent fiber [NDF], acid detergent fiber [ADF]).

The starch in barley ferments rapidly, compared with other cereal grains (Figure 1). Grains with more rapid rates of starch digestion require a higher degree of management in high-concentrate finishing rations because the occurrence of acidosis and related metabolic disorders is greater with grains that ferment more quickly (Stock and Britton, 1993). Lambs are very sensitive to acidosis; therefore, sheep producers should transition lambs slowly from a forage-based diet to a barley-based diet.

The crude protein content of barley is higher than that of corn and similar to other major feed grains. Protein degradability of barley is similar to other small grains at approximately 20 to 30 percent undegraded intake protein (UIP). Corn and sorghum have higher UIP values than barley (Table 1).

Table 1. Nutrient content of various feed grains (NRC, 1985; NRC, 1996).

	Barley	Corn	Wheat	Oats	Sorghum
TDN, %	86	87	87	77	86
NE_m, Mcal/kg	2.12	2.15	2.15	1.85	2.12
NE_g, Mcal/kg	1.45	1.48	1.48	1.22	1.45
CP, %	13.5	10.1	16.0	13.3	11.5
UIP, % of CP	27	55	23	17	57
NDF, %	18.1	10.8	11.8	29.3	16.1
ADF, %	5.8	3.3	4.2	14.0	6.4

Mineral and Vitamin Content of Feed Barley

Table 2 lists the mineral and vitamin content of feed barley (NRC, 1996). All cereal grains are low in calcium and relatively high in phosphorus, necessitating the use of supplemental calcium in high-grain diets for lambs, especially males. The addition of ammonium chloride at a rate of 0.5 percent of the diet helps reduce the risk of urinary calculi (water belly) caused by an imbalance of calcium and phosphorus. Barley's phosphorus content is similar to corn and sorghum but lower than wheat or oats. Barley is higher in potassium than other feed grains. Barley also is higher in vitamins A and E than the other major cereal grains.

Table 2. Mineral and vitamin content of major cereal grains (NRC, 1996).

	Barley	Corn	Wheat	Oats	Sorghum
Calcium, %	0.05	0.03	0.05	0.01	0.04
Phosphorus, %	0.35	0.32	0.44	0.41	0.34
Potassium, %	0.57	0.44	0.40	0.51	0.44
Magnesium, %	0.12	0.12	0.13	0.16	0.17
Sodium, %	0.01	0.01	0.01	0.02	0.01
Sulfur, %	0.15	0.11	0.14	0.21	0.14
Copper, ppm	5.3	2.51	6.48	8.6	4.7
Iron, ppm	59.5	54.5	45.1	94.1	80.8
Manganese, ppm	18.3	7.89	36.6	40.3	15.4
Selenium (ppm)	–	0.14	0.05	0.24	0.46
Zinc (ppm)	13.0	24.2	38.1	40.8	0.99
Cobalt (ppm)	0.35	–	–	0.06	–
Molybdenum (ppm)	1.16	0.60	0.12	1.70	–
Vitamin A (1,000 IU/kg)	3.8	1.0	0.0	0.2	0.05
Vitamin E (IU/kg)	26.2	25.0	14.4	15.0	12.0

Effect of Barley Processing in Sheep Diets

A companion publication to this report, "Feeding Barley to Beef Cattle" (Lardy and Bauer, 1999), documents the advantages of processing barley for use in beef cattle diets. However, sheep do not appear to respond to barley processing in the same manner as cattle, perhaps because sheep chew their feedstuffs to a greater degree.

Research at several locations indicates little or no benefit to processing (steam rolling, grinding, pelleting or dry rolling) when compared with feeding barley whole in forage or concentrate diets for sheep. Table 3 summarizes research trials related to barley processing and the effects on lamb performance.

Research conducted at Washington State University found no advantage to steam rolling barley (compared with feeding barley whole) in diets that contained 25 to 50 percent barley (Morgan et al., 1991). In diets that contained 75 to 85 percent barley, Hatfield et al. (1993) found that the starch in whole barley had 98 percent digestibility.

Small increases in diet organic matter digestibility were noted when .66 or 1.32 pounds of processed barley (rolled or ground) were offered to gestating ewes consuming a forage diet, compared with feeding whole barley (Chestnutt, 1992). The author also noted that approximately 20 percent of the whole barley fed in these diets passed through the digestive tract. The authors did not indicate if the barley was intact hulls or viable seed.

Table 3. Summary of research related to barley processing for sheep fed high-grain diets.

		Processing Method			
Trial	Variable	Whole	Ground	Rolled	Pelleted
Tait and Bryant, 1973	ADG (lb/day)	.64	–	.55	.48
	F/G	3.85	–	4.43	3.98
Erickson et al., 1988a	ADG (lb/day)	.50	.48	–	–
	F/G	5.6	6.26	–	–
Erickson et al., 1989	ADG (lb/day)	.53	.52	–	–
	F/G	6.61	6.61	–	–
Erickson et al., 1987b 40 lb/bushel	ADG (lb/day)	–	.67	–	.86
	F/G	–	5.70	–	5.37
Erickson et al., 1987b 49 lb/bushel	ADG (lb/day)	–	.70	–	.86
	F/G	–	5.63	–	5.32
Hatfield, 1994	ADG (lb/day)	.40	–	–	.37
	F/G	7.53	–	–	7.76

Yoon et al. (1986a) found only small differences in the feeding value of whole, rolled or steam-rolled barley when comparing those grains to cracked corn in high-concentrate diets (forage-to-concentrate ratio of 23-to-77). Data from that trial indicated steam rolling barley may increase the efficiency of microbial protein synthesis but had little, if any, effect on other parameters measured. Yoon et al. (1986b) noted that dry-rolled and steam-rolled barley had greater ruminal bacterial protein synthesis than whole-barley or cracked-corn diets. This may be significant in diets where the metabolizable protein supply is limiting. It may occur in rapidly growing lambs or with ewes that have high milk production.

Research conducted at the Hettinger Research Extension Center in North Dakota indicates no advantage in lamb performance from feeding ground vs. whole barley (Erickson et al., 1989a). Average daily gain, feed efficiency and feed intake were not different for the whole-barley vs. ground-barley treatments. Carcass characteristics were similar for both treatments as well.

Earlier research conducted at the Hettinger Research Extension Center investigated feeding corn or barley in whole or ground forms to finishing lambs (Erickson et al., 1988a). The results of this research showed no significant differences between lamb performance on whole- or ground-barley diets. Lambs fed whole barley had significantly better feed conversions compared with whole corn. However, lambs fed ground corn had significantly higher average daily gains compared with lambs fed whole corn.

Lambs fed pelleted-barley diets gained faster and consumed more feed than lambs fed ground barley diets and had similar feed efficiencies (Erickson et al., 1987b). Research conducted in Canada (Tait and Bryant, 1973) found that lambs fed whole barley (.64 pound/day) gained faster than lambs fed rolled or pelleted barley (.55 and .48 pound/day, respectively). No differences were noted in feed intakes or feed conversions.

Hatfield (1994) noted no differences in lamb performance when whole- or pelleted-barley diets were fed. Cost of gain was lower with whole-barley diets because no processing cost was necessary in those diets.

Based on these data, extensive processing of barley does not appear to be necessary for optimum utilization in sheep diets.

Use of Barley in Growing and Finishing Lamb Diets

Barley vs. Other Grain Sources in Finishing Diets

A summary of lamb performance (average daily gain and feed efficiency) from several trials in which barley was compared with other cereal grains appears in Table 4.

Barley and soybean meal were used to replace hull-less or naked oats (var. Paul) in diets for finishing lambs. Lambs fed combinations of barley and soybean meal had greater average daily gains, higher final weights and greater feed intakes than lambs fed increasing levels of hull-less oats. Feed efficiencies were similar (Poland and Faller, 1997).

Additional research conducted at North Dakota State University compared barley and milo as energy sources in finishing diets for lambs (Erickson et al., 1990a). No differences in average daily gain or feed efficiency were noted. Carcass weights and dressing percentages were higher in lambs fed milo compared with barley. In contrast to research conducted with beef cattle, which shows benefits to including mixtures of rapidly and slowly fermenting grains (Bock et al., 1991; Kreikemeier et al., 1987; Stock et al., 1987), no benefits were noted with combinations of barley and milo in diets for finishing lambs.

In another comparison involving milo and barley, feed efficiencies were similar, but average daily gains tended to be higher (Erickson et al., 1990b) for lambs fed milo. Final weights and carcass back fat were higher for lambs fed milo.

Lambs fed ground barley had similar gains compared with lambs fed ground corn and higher gains than lambs fed ground oats (Erickson et al., 1985). Feed efficiencies were similar for all three grains, but feed intakes were lower for barley, compared with corn.

Additional trials that compare barley with other feed grains have had mixed results. Barley-fed lambs had similar feed efficiencies but consumed less dry matter and gained more slowly than corn-fed lambs (Erickson et al., 1988b). Lambs fed barley consumed less feed and had similar feed efficiencies but gained more slowly than milo-fed lambs (Erickson et al., 1989a). Lambs fed barley had lower average daily gains, similar feed intakes and poorer feed conversions, compared with corn-fed lambs, in additional North Dakota research (Rupprecht et al., 1992). Lambs fed pelleted barley (49.8 pounds/bushel) had similar gains, compared with pelleted or ground corn (56 pounds/bushel; Erickson et al., 1987b).

Research conducted in Canada compared the energy value of barley and wheat (Tait and Bryant, 1973).

No differences were noted in lamb average daily gain, feed intake and feed conversions. Lamb average daily gains averaged .55 pound/day in this trial.

Hatfield (1994) noted no differences in lamb performance when comparing barley and corn in lamb-finishing diets. Cost of gain was lower for barley-based diets.

Barley appears to be an effective substitute for corn or other cereal grains in lamb-finishing diets. In many cases, barley may be used to lower the cost of gain, compared with corn, due to the price differential that exists in some markets, especially if inclusion of barley lowers the need for more expensive protein supplements.

Table 4. Comparison of barley with other cereal grains as an energy source in diets for finishing lambs.

		Grain Source				
Trial	Variable	Barley	Corn	Oats	Milo	Hull-less Oats
Erickson et al., 1984	ADG (lb/day)	.54	–	.54	–	–
	F/G	7.04	–	7.47	–	–
Erickson et al., 1985	ADG (lb/day)	.66	.72	.49	–	–
	F/G	4.53	5.01	5.30	–	–
Erickson et al., 1988a Whole Grains	ADG (lb/day)	.50	.49	–	–	–
	F/G	5.60	6.71	–	–	–
Erickson et al., 1988a Ground Grains	ADG (lb/day)	.48	.54	–	–	–
	F/G	6.26	6.43	–	–	–
Erickson et al., 1988b; With DDG[1]	ADG (lb/day)	.76	.84	–	–	–
	F/G	4.78	4.96	–	–	–
Erickson et al., 1988b; With SBM[2]	ADG (lb/day)	.75	.90	–	–	–
	F/G	4.67	4.44	–	–	–
Erickson et al., 1989a; Whole Grains	ADG (lb/day)	.53	–	–	.57	–
	F/G	6.61	–	–	6.68	–
Erickson et al., 1989a; Ground Grains	ADG (lb/day)	.52	–	–	.55	–
	F/G	6.61	–	–	7.32	–
Erickson et al., 1989b; With DDG[1]	ADG (lb/day)	.87	–	–	1.04	–
	F/G	3.98	–	–	4.03	–
Erickson et al., 1989b; With SBM[2]	ADG (lb/day)	.88	–	–	1.00	–
	F/G	3.79	–	–	3.85	–
Erickson et al., 1990a	ADG (lb/day)	.59	–	–	.60	–
	F/G	7.11	–	–	6.97	–
Erickson et al., 1990b	ADG (lb/day)	.802	–	–	.950	–
	F/G	5.53	–	–	4.97	–
Rupprecht et al., 1992; With Lasalocid	ADG (lb/day)	.82	.91	–	–	–
	F/G	4.29	3.76	–	–	–
Rupprecht et al., 1992; W/O Lasalocid	ADG (lb/day)	.76	.93	–	–	–
	F/G	4.41	3.69	–	–	–
Hatfield, 1994 Whole Grains	ADG (lb/day)	.40	.37	–	–	–
	F/G	7.53	7.85	–	–	–
Hatfield, 1994 Pelleted Diets	ADG (lb/day)	.37	.40	–	–	–
	F/G	7.76	8.10	–	–	–
Poland and Faller, 1997	ADG (lb/day)	.63	–	–	–	.49
	F/G	6.80	–	–	–	6.64

[1]DDG=Dried Distillers Grains
[2]SBM=Soybean Meal

Ionophores in Barley-based Finishing Diets

Ionophores are compounds that improve feed efficiency in ruminants by interfering with ion transport in certain bacterial species. Ionophores change bacterial populations and provide benefits as a coccidiostat. As expected, the addition of lasalocid (Bovatec) to barley-based lamb finishing diets improved feed efficiency with no changes in average daily gain or daily feed intake (Rupprecht et al., 1992).

Combinations of Barley With Other Energy Sources in Finishing Diets

The addition of 20 percent beet pulp to barley- or milo-based finishing diets for lambs tended to improve average daily gain and feed efficiencies in the barley diets but had the opposite effect in the milo diets (Erickson et al., 1990b). No differences were noted in carcass characteristics.

The addition of 15 percent beet pulp to barley-based lamb-finishing diets improved average daily gains in finishing lambs (Erickson et al., 1991b). Additional increases in the level of beet pulp did not improve performance further. Because barley starch is fermented rapidly, the addition of beet pulp or other highly digestible fiber sources may alleviate subacute acidosis and improve feed conversions.

Average daily gains, feed intakes and feed efficiencies were similar for lambs fed combinations of barley and oats (100 percent barley; 67 percent barley/33 percent oats; 33 percent barley/67 percent oats; and 100 percent oats; Erickson et al., 1984). Researchers found a numerical tendency for feed efficiencies to improve and feed intakes to drop as barley level in the diet increased.

Effect of Light Test Weight Barley on Lamb Performance

Average daily gains were similar when light barley (39.8 pounds/bushel) was compared with heavy barley (49.6 pounds/bushel; Erickson et al., 1987a). However, feed intake and feed efficiencies were numerically better for the heavy test weight barley.

Forage Levels in Barley-based Lamb-finishing Diets

In general, forages in high-concentrate diets improve rumen function and reduce the risk of digestive disorders; however, high-grain diets typically result in greater rates of gain and feed efficiency when fed properly.

Research conducted at the Hettinger Research Extension Center indicates little difference in average daily gains when the alfalfa level in barley-based finishing diets is increased from 5 to 45 percent (Erickson et al., 1993). Lambs fed 15 percent alfalfa showed slight improvement in lamb performance, but the difference was minimal. Overall, feed intakes increased and feed efficiencies decreased as the alfalfa level increased. Similar results also were reported from earlier work (Erickson et al., 1991a) when the level of alfalfa increased from 10 to 40 percent.

More recent research has shown that a 10 percent inclusion of highly digestible or indigestible fiber increased lamb intakes and gains, regardless of grain processing (Hejazi et al. 1999).

The choice of the forage level in barley-based lamb-finishing diets should be based on the price of feedstuffs and the feeder's ability to manage high-concentrate diets. Because barley ferments more rapidly, higher levels of forage may be needed to reduce the risk of subacute acidosis, compared with other grains.

Using Barley as a Supplemental Energy Source in Ewe Diets

Diets for gestating and lactating ewes are largely forage-based in most areas of the world. Depending on the stage of production (gestation vs. lactation) and the nutrient composition of the forage, supplementation is necessary to reach adequate performance. Barley can be used effectively as a source of supplemental energy in ewe diets.

Research conducted at Montana State University compared barley, soybean meal, barley plus blood meal, barley plus feather meal or control (no supplement) as supplements for gestating ewes grazing dormant native range (Thomas et al., 1992). Nonsupplemented ewes lost more weight than ewes fed supplements, ewes fed barley alone had intermediate weight gains, and ewes fed soybean meal, barley plus feather meal or barley plus blood meal had the highest weight gains. No differences were noted in subsequent reproductive performance, indicating that the economic advantage lies with the low-cost supplementation program.

Dormant native forages generally are limiting in rumen-degradable protein, not energy, which likely explains the differences noted in this research. The supplements that contained barley and rendered byproducts contained 75 to 77 percent barley, with the remainder being rendered byproducts, minerals and vitamins.

Similar research, also conducted at Montana State University, compared control (no supplementation), barley, barley/feather meal/blood meal or barley/feather meal/blood meal/urea (Hatfield et al., 1997). Control ewes lost the most weight, barley-supplemented ewes were intermediate, and the ewes fed barley plus rendered byproducts gained a small amount of weight.

Ewes receiving no supplement lost the most body condition, while the barley/feather meal/blood meal ewes lost the least condition. The barley and barley/feather meal/blood meal/urea treatments were intermediate in condition score loss. No differences were noted in fleece weight.

Effects of Vomitoxin (DON)-contaminated Barley on Performance of Sheep

Vomitoxin (DON, deoxynivalenol) is a trichothecene mycotoxin produced by Fusarium fungi in scab-infected grain. While vomitoxin can cause problems in performance when feeding swine, no evidence exists that sheep are adversely affected.

Research conducted at North Dakota State University suggested that diets containing up to 25 parts per million (ppm) vomitoxin (DON) throughout pregnancy have no effect on weight gain in pregnant ewe lambs, reproductive performance of the ewe lambs or survivability of the lamb crop (Haugen et al., 1996).

Conclusions

Barley is a useful feedstuff for sheep. It does not require processing when used in sheep diets. Barley contains higher crude protein levels than corn. Consequently, when used as a supplement, barley can reduce or eliminate the need for protein supplementation. This should be taken into account when pricing barley.

Vomitoxin does not appear to have any adverse effects on ruminants, including sheep. Vomitoxin level should not be used to discount the value of barley in ruminant diets.

Barley and corn have similar energy values in high-grain lamb-finishing rations. In general, barley ferments more rapidly than corn and tends to reduce lamb performance when the grains are ground. However, whole barley can be substituted for corn in lamb-finishing rations without reductions in performance.

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