Hulless Barley:
A New Look for Barley in Idaho

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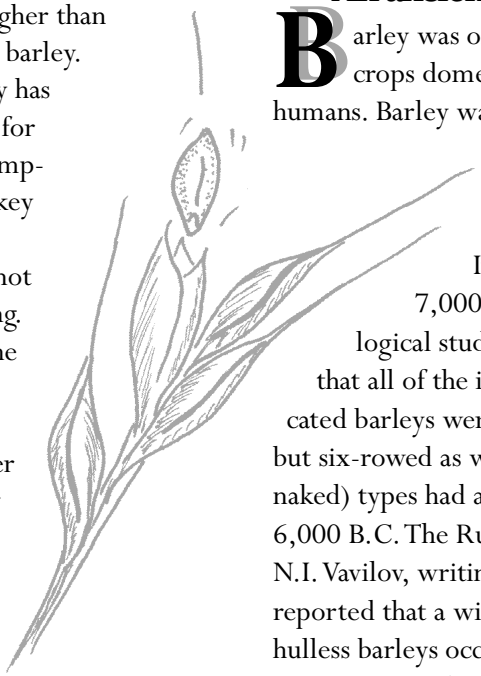
Barley is a short-season, early maturing crop with high yield potential and a wide range of adaptation. Barley is very well adapted to Idaho and is produced commercially in both irrigated and dryland environments throughout the state. Worldwide, it can be grown successfully where other grain crops are poorly adapted, including high latitude and high elevation regions and even bordering desert.

Hulless or naked barley is very similar in appearance to other barley when growing in the field. The principal difference becomes apparent at harvest when it threshes free from the hull in a fashion similar to wheat.

Recent interest in hulless barley has been sparked by the development and introduction of several hulless varieties in western North America, led by the release of 'Scout' by the University of Saskatchewan in 1982 (table 1). Indeed, hulless barley has several advantages over hulled barley:

- Because it has no hulls, hulless barley takes 10 to 15 percent less space to store and transport.
- Its feed value averages 7 to 14 percent higher than that of hulled barley.
- Hulless barley has greater value for human consumption because key vitamins and minerals are not lost in pearling.
- The cost of the pearling operation for food and other uses of barley is avoided.



The main drawback is that hulless barley tends to yield about 20 percent less per acre than the control varieties (Baronesse and Steptoe) in Idaho test plots (tables 2-6). The question for producers is whether the savings in storage and transportation costs, the higher feed value, and the additional marketing options compensate for the reduced yield.

An ancient crop

Barley was one of the earliest crops domesticated by humans. Barley was cultivated in the Near East region in what is now Iran as early as 7,000 B.C. Archeological studies have revealed that all of the initially domesticated barleys were two-rowed, but six-rowed as well as hulless (or naked) types had appeared by 6,000 B.C. The Russian scientist N.I. Vavilov, writing 100 years ago, reported that a wide diversity of hulless barleys occurred in southeastern Asia, China, Japan, and regions adjacent to Tibet, probably including Nepal. Swedish scientists Brucher and Aberg reported in the 1950s that a series of 2,800 barleys from the Tibet-Sikkim area of the Himalayas contained 95 percent hulless barelys.

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A botanical difference

The barley hull is composed of the dorsal lemma and ventral palea. These outer floral parts adhere to the caryopsis (grain) at maturity in hulled barley but not in hulless barley. The hulless character in barley is controlled by a single recessive gene, so it is not difficult to transfer the hulless trait into existing hulled varieties.

The hull on traditional barley (above) clings to the kernal, and requires extensive processing to remove.
The hulless barley kernal (below) pops free of the hull during harvesting.

Barley production in colonial America was predominately for malt used in brewing. These were hulled barleys, brought from Europe by the colonists. The excess crop supplied grain for livestock consumption, and in times of wheat scarcity, barley flour was used to produce bread. Barley for human consumption, especially hulless barley, has always played a minor role in the American diet.

Today, in areas where barley is grown almost exclusively for human food, hulless types are preferred. They are common only where barley is the principal grain grown for human consumption and occur widely over the whole region from Turkey to Ethiopia to northwestern India. The barleys of Tibet, China, southern Japan, and southern Korea carry a high frequency of genes for hulless grain.

Hulless barley has greater value for human consumption because key vitamins and minerals are not lost in pearling.

Barley in Idaho

Barley was probably first produced commercially in Idaho in the 1860s. An 1869 barley distribution map indicated that Idaho produced about 70,000 bushels or about one-tenth of 1 percent of Idaho's current production. It is likely that little hulless barley was produced commercially in Idaho prior to the release of the variety 'Godiva' by Utah State University and the USDA-ARS in 1965.

Hulless barleys from the Himalaya region have, however, contributed to the development of malting barleys grown in Idaho. The malting variety 'Karl' has in its parentage the hulless variety 'Everest' (CI 4105) collected in the Himalaya Mountains in the 1920s on the track taken by the Mt. Everest expedition at an elevation of 15,500 feet.

In 1993 the North Dakota Barley Commission reported that most of the barley produced in the United States was used for malting (36%) and feed (58%), with very modest amounts being utilized for human consumption in forms other than malt products. In Idaho, over 50 percent of the barley acreage is seeded to malting varieties, according to reports of the Idaho Agricultural Statistics Service, with the balance planted to feed barley varieties.

Hulless feed barley

Virtually all the barley used in Idaho for feed is hulled. Comparisons among two hulled and hulless bulk F_2 populations found that neutral detergent fiber (NDF) and acid detergent fiber (ADF) of the hulless populations in both genetic backgrounds were significantly lower than those of the hulled populations (table 7). Lower fiber in the hulless barley was associated with greater ISDMD (digestion) after an 18-hour digestion period in the rumen. These data suggest hulless barley provides more available energy for ruminants than hulled barley.

Hulless barley was reported to be equal to wheat in feed value for pigs and chickens. Hulless barley has been demonstrated to be superior to hulled barley in several feeding trials with swine; however, Newman and colleagues found that hulled and hulless isogenic lines were equal in two of three trials with weanling pigs in Montana. Further research is warranted to develop optimal feed management strategies that take advantage of the apparent superior nutrient composition of hulless barley.

Hulless barley for food

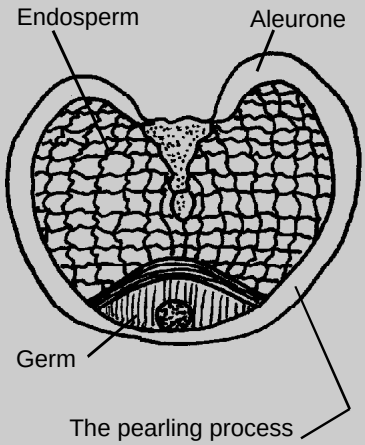
In ancient Greece and Rome, barley became the general food of the gladiators who were also known as "hordearii," related to the scientific name of barley, *Hordeum vulgare*. The use of barley as food in Finland (Rie-sha, an unleavened bread), England (barley bread), and Denmark (main food) dates back over 19 centuries. Several other countries use barley for traditional dishes such as "kasha" in Russia and Poland; "tsampa" in Tibet; "miso" in Japan; "sattu" (popped barley) in India; "Soju" wine, "poricha" (barley tea), and everyday fare in Korea; and porridge in west Asian-north African regions.

Hulless barley is a staple food crop in Tibet. It grew on nearly 300,000 acres in 1989. In addition to tsampa (roasted barley flour), hulless barley is also made into cake, soup, porridge, and snack foods.

Barley has a high dietary fiber content and is recognized as an important source of this dietary component. A unique type of hulless barley is "waxy hulless" barley, including varieties such as 'Waxbar' and 'Shonkin'. Waxy barley contains the highest level and quality of soluble fiber or beta-glucans found in any barley. Today consumers are more conscious of their diet in regard to fiber's reported benefits for cholesterol control, gastrointestinal function, cancer prevention, and general

A more nutritious alternative

Nonmalting uses of hulled barley, especially for food and industrial applications, typically require removal of the hull by abrasion, or pearling, in early stages of processing. The aleurone, or outer layer, of the endosperm is removed along with the hull during this process, resulting in significant losses in essential amino acids and vitamins.



The pearling process removes the outer layer of the barley kernal, which contains vitamins and significant amino acids.

Hulless barley not only reduces or eliminates these losses, but also reduces or eliminates the costs associated with pearling and with transporting and storing the attached hulls before pearling. The hull represents at least 10 to 15 percent of the weight and volume of comparable *(word needed?)* hulled varieties.

physical fitness. As a result, whole grain barley, and especially waxy, hulless barley, has gained in popularity.

Hulless barley in industry

Barley is a rich source of easily obtained starch, which makes up 65 percent of barley's dry weight. Starch from different varieties has different compositions such as waxy (100% amylopectin), high amylose (about 50% amylose), and normal (about 75% amylopectin and 25% amylose). This wide range of starch characteristics provides flexibility in barley's industrial uses. For example, amylopectin starch is exceptionally bland in flavor and has superior cold and freeze-thaw stability making it a good choice for the frozen and canned food industries.

Barley carbohydrates could also be useful as source material for plastics, films, and gels and for incorporation into products for the ceramic, agrichemical, pharmaceutical, and nutraceutical (dealing with foods that provide health benefits) industries. Barley is also a rich source of beta-glucans, which offer unique properties useful in food processing and industry. For example, the solubility properties of isolated beta-glucans give this barley component potential as a thickening agent in foods, as an industrial hydrocolloid (water-absorbing material), and in pharmaceuticals. Because barley generally needs to be dehulled before industrial use, hulless barleys should hold an advantage over hulled varieties.

Table 1. Characteristics and origin of selected hulless feed/food spring barley varieties.

Variety	Spike type	Origin	Release date
Azhul	Six-Rowed	USDA-ARS/University of Arizona	1993
CDC Buck	Six-Rowed	University of Saskatchewan	1990
CDC Candle	Two-Rowed	University of Saskatchewan	1994
Condor	Two-Rowed	Alberta Agriculture	1988
Dawn	Two-Rowed	University of Saskatchewan	1995
Falcon	Six-Rowed	Alberta Agriculture	1993
Godiva	Six-Rowed	Utah State University/USDA-ARS	1965
Merlin	Two-Rowed	Western Plant Breeders	1995
Phoenix	Two-Rowed	Alberta Agriculture	1993
CDC Richard	Two-Rowed	University of Saskatchewan	1990
Rowax	Six-Rowed	Western Plant Breeders	1996
Scout	Two-Rowed	University of Saskatchewan	1982
Shonkin	Two-Rowed	Montana State University	1990
CDC Silky	Six-Rowed	University of Saskatchewan	1994
Tupper	Six-Rowed	University of Saskatchewan	1984
Waxbar	Two-Rowed	Western Plant Breeders	1989
Waxel	Six-Rowed	Western Plant Breeders	1996
WA11045-87	Two-Rowed	Washington State University	1996
81Ab11843	Two-Rowed	University of Idaho/USDA-ARS	—

Table 2. Agronomic data for hulless barley varieties and selections grown under irrigation at Aberdeen, Idaho, 1992-94.

	Yield (bu/acre)	Test weight (lb/bu)	Plump barley (%)	Heading height (inches)	Date (Julian)	Lodging (%)
No. years	3	3	3	3	3	3
CDC Buck	150.2	58.2	73	42	172	8
Godiva	144.2	59.5	73	34	179	9
Shonkin	120.8	56.8	66	37	176	21
Tupper	128.4	56.7	75	43	174	9
Waxbar	131.6	55.8	62	38	179	38
81Ab11843	123.5	60.0	79	34	177	3
Steptoe1	168.7	50.6	95	35	168	14

[1]Hulled check.

Table 3. Agronomic data for hulless barley varieties and selections grown under irrigation at Aberdeen, Idaho, 1993-94.

	Yield (bu/acre)	Test weight (lb/bu)	Plump barley (%)	Heading height (inches)	Date (Julian)	Lodging (%)
No. years	2	2	2	2	2	2
CDC Buck	148.9	56.7	73	45	177	10
Condor	119.8	58.4	84	35	181	2
Godiva	137.6	58.6	67	35	184	13
Merlin	123.3	54.9	87	24	193	2
Shonkin	116.7	56.6	69	41	179	29
Tupper	129.8	56.2	75	46	179	13
Waxbar	127.1	55.9	62	41	184	44
81Ab11843	119.5	60.3	82	36	181	4
Steptoe[1]	167.8	49.9	94	37	173	20

[1]Hulled check.

Because it has no hulls, hulless barley takes 10 to 15 percent less space to store and transport.

Table 4. Agronomic data for hulless barley varieties and selections grown on dryland at Moscow and Bonners Ferry, Idaho, 1994-95.

	Yield (bu/acre)	Test weight (lb/bu)	Plump barley (%)	Heading height (inches)	Date (Julian)	Lodging (1-9)
Years/Locations	4	4	4	4	4	4
CDC Buck	76.6	49.6	26	34	174	6.1
Condor	56.9	58.6	33	28	180	2.1
Falcon	61.6	55.0	26	25	179	4.0
Godiva	75.9	54.9	35	29	182	3.6
Merlin	69.1	54.3	47	23	181	4.0
Phoenix	78.1	51.5	32	32	177	5.2
CDC Richard	67.5	54.5	37	31	175	6.2
Scout	78.0	53.1	49	33	177	4.3
Shonkin	65.7	53.7	39	32	179	4.6
Waxbar	53.3	50.1	30	30	181	5.7
Bei Qing #1	56.8	60.1	55	32	169	6.8
81Ab11843	77.2	56.1	36	31	176	3.4
WA11045-87	77.7	52.5	30	31	178	3.1
Steptoe[1]	99.9	46.4	68	30	170	4.4
Baronesse[1]	95.4	50.6	60	29	175	3.1

[1]Hulled check.

Table 5. Agronomic data for hulless barley varieties and selections grown under irrigation at four Idaho locations, 1994-95.

	Yield (bu/acre)	Test weight (lb/bu)	Plump barley (%)	Heading height (inches)	Date (Julian)	Lodging (1-9)
Years/Locations	7	7	3	6	6	6
Waxel[1]	80.9	57.9	52	38	169	49
Godiva	88.2	57.1	52	36	177	30
Rowax[1]	87.9	58.6	57	39	168	35
Shonkin	86.6	63.0	55	38	175	64
Tupper	84.5	56.9	44	41	171	56
Merlin	100.9	59.4	—	27	177	3
Excel[2]	107.8	50.9	76	39	167	44
Steptoe[2]	129.1	49.0	89	37	168	37

Note: Locations are Kimberly, Rupert, Aberdeen, and Ririe. Height at Kimberly, Rupert, and Ririe only. Heading date at Kimberly, Aberdeen, and Rupert only. Lodging at Kimberly, Rupert, and Ririe only.

[1]Waxel is a waxy hulless near-isogenic version of Excel, and Rowax is a waxy hulless near isogenic version of Robust.

[2]Hulled checks.

Feed value of hulless barley averages 7 to 14 percent higher than that of hulled barley.

Table 6. Agronomic data for hulless barley varieties and selections grown on dry land near Idaho Falls and Soda Springs, Idaho, 1994-95.

	Yield (bu/acre) Years/Locations	Test weight (lb/bu) 4	Plump barley (%) 4	Heading height (in) 2	Date (Julian) 4	Lodging (1-9) 4	1
Waxel[1]	39.4	58.0	16	27	191	10	
Godiva	30.6	54.9	57	23	198	0	
Rowax[1]	37.7	56.4	35	26	191	7	
Shonkin	42.4	58.3	19	28	196	20	
Tupper	43.3	59.3	35	28	192	7	
Merlin	41.3	57.7	—	22	198	0	
Excel[2]	62.5	48.9	60	26	190	17	
Steptoe[2]	72.0	47.3	78	27	188	7	

Note: Plump barley from 1994 only. Lodging at Soda Springs in 1995 only.
[1]Waxel is a waxy hulless near isogenic version of Excel, and Rowax is a waxy hulless near-isogenic version of Robust.
[2]Hulled checks.

Table 7. Feed quality of two hulless and hulled bulk F2 populations, in percent.

Population		DM	CP	NDF	ADF	ISDMD
91Ab939/Godiva	Hulless	91.50	13.99	13.87	2.46	88.70
	Hulled	91.65	14.31	21.42	7.09	81.90
Eight-Twelve/Godiva	Hulless	91.89	13.26	13.15	1.95	90.22
	Hulled	91.80	13.56	31.96	5.84	76.00

Note: DM = percentage dry matter; CP = percentage crude protein; NDF = percentage neutral detergent fiber; ADF = percentage acid detergent fiber; ISDMD = percentagein situ DM disappearance, 18-hour ruminal incubation.

The cost of the pearling operation for food and other uses of barley is avoided.

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Further readings

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