



## **Amino Acids in Rumen Escape Protein**

### ***2. Grains and Whole Seeds***

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Dairy cattle require dietary energy to meet the requirements of their ruminal populations of microorganisms. If ruminal microorganisms, particularly bacteria, become energy deficient then their growth and fermentative activity can be restricted leading to reduced digestion of structural carbohydrates and declining levels of feed intake. These microorganisms, which die and wash out of the rumen to the small intestine, also provide a small proportion of the carbohydrate and lipid which is absorbed from the small intestine of the animal to meet the animal's metabolic requirements energy. However, to allow dairy cows with high milk production capability to achieve their high genetic potential, it is necessary to provide dietary ingredients with high levels of non-structural carbohydrates to support microbial growth in the rumen, as well as escape the rumen unfermented to be digested from the small intestine. The high starch grains and high fat whole seeds are often used for this purpose in commercial rations for dairy cows.

Grains and whole seeds are typically added to rations for lactating dairy cows to contribute fats, non-structural carbohydrates such as starch and variable quantities of protein that are available to be fermented by microbes in the rumen. However even the relatively low protein grains, containing between 10 and 14% crude protein of which 15 to 25% escapes the rumen undegraded, that are fed at 35% of total dry matter intake to high producing dairy cows, will also supply between 125 and 300 g of intestinally absorbable amino acids. These quantities represent between 5 and 15% of the animals' total intestinal amino acid requirement. Equivalent values for protein-rich whole seeds can be much higher. Thus it is important to accurately estimate the amino acid composition of these rumen escape proteins if the amino acid requirements of the animals are to be met, but not exceeded.

### ***Purpose***

The amino acid profile of the rumen escape protein of a number of feedstuffs commonly fed to dairy cows was determined over a period of several years as the feedstuffs were collected from various commercial sources. This article presents the amino acid profile of several grains and whole seeds. A previous article presented similar data for forages and plant source by-products and a subsequent article presents data for plant and non-plant source protein meals.

### ***Methods Used***

Samples of grains and whole seeds were collected from several sources. The amino acid composition of the rumen escape protein of these feedstuffs was estimated using a traditional rumen in situ method. Using this procedure, small quantities of various forages and plant source by-products were incubated in small nylon bags in the rumens of two dry cows fed a diet of grass hay and minerals at a maintenance level of energy intake. The undigested feedstuff residues, that were removed from the rumen at predetermined times, were dried and assayed for amino acids utilizing traditional amino acid assay procedures with a separate analysis for cystine and methionine that included oxidation with performic acid. Times of rumen incubation of all grains, except triticale and wheat, as well as whole cottonseed and extruded soybeans were 16 h (rumen rate of passage (kp) estimated to be 6.25 %/h). Those for the other whole seeds and triticale and wheat were 6 h (kp estimated to be 16.67 %/h). These rather short mean retention times were selected due to the very rapid rates of degradation of these feedstuffs in the rumen and a desire to have some residue to assay. These No corrections were made for truly indigestible amino acids in the feedstuff residues or microbial amino acid in the feedstuff residues. This may influence interpretation of the data.

### ***Results Available***

The amino acid profiles of the undigested grain and whole seed protein residues are shown in the Tables. Each of the feedstuff samples represents a different source of that particular feedstuff. There is substantial variation in the amino acid profile of the protein residues among feedstuffs, with differing extents of variation within a feedstuff among amino acids.

### ***Use of the Data***

The data presented in the tables can be utilized in preparing, or evaluating, rations for dairy cattle under situations where the requirements of the animals for intestinally absorbable amino acids have been estimated. The amino acid values in the tables can be directly applied to the estimated rumen escape of digestible crude protein.

### ***Future Perspectives***

This project is ongoing. The author plans to update this article on an annual basis to reflect new sample analyses that have become available during that period of time.

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**Table 1. Amino Acids in Rumen Escape Protein of Grains (% CP)**

Feedstuff	#		Lys	His	Arg	Thr	Gly	Val	Ile	Leu	Tyr	Phe	Cys	Met
Barley	5	Min	2.56	1.49	2.67	2.90	3.41	3.95	2.04	6.13	1.75	4.07	1.28	1.71
		Max	5.24	3.49	4.69	3.66	4.65	6.69	4.07	7.20	2.56	5.28	3.20	2.62
		Avg	3.69	2.15	3.69	3.20	4.02	4.85	2.94	6.51	2.29	4.71	2.21	2.08
Barley (roasted)	2	Min	2.47	1.79	3.49	2.76	3.44	3.36	1.97	6.30	2.38	4.17	2.38	2.13
		Max	2.51	1.81	3.57	2.77	3.89	3.49	2.38	6.35	2.93	4.43	2.61	2.13
		Avg	2.49	1.80	3.53	2.77	3.67	3.43	2.17	6.33	2.65	4.30	2.49	2.13
Barley (steam flaked)	2	Min	2.62	1.67	3.01	2.56	3.39	3.33	1.95	6.13	2.30	4.04	2.24	1.95
		Max	2.65	1.79	3.55	2.79	3.62	3.34	2.30	6.14	2.72	4.29	2.44	2.56
		Avg	2.64	1.73	3.28	2.67	3.51	3.34	2.13	6.14	2.51	4.16	2.34	2.26
Corn	4	Min	1.44	2.04	2.43	2.52	2.51	3.14	1.89	12.97	3.42	5.23	1.82	1.78
		Max	2.23	2.23	3.73	3.20	3.45	3.33	2.51	14.10	4.46	7.10	2.43	2.34
		Avg	1.84	2.13	2.93	2.88	2.90	3.24	2.16	13.28	3.94	6.08	2.09	2.15
Corn (HM, ear)	2	Min	1.64	1.83	2.15	2.60	2.60	3.28	2.34	13.40	2.71	5.04	1.73	1.35
		Max	1.68	1.87	2.31	3.08	2.71	3.64	2.41	13.45	3.08	5.40	2.15	1.96
		Avg	1.66	1.85	2.23	2.84	2.66	3.46	2.37	13.42	2.90	5.22	1.94	1.66
Corn (steam flaked)	2	Min	1.50	2.30	2.40	2.81	3.11	3.11	2.00	13.73	3.68	5.31	2.40	2.19
		Max	1.79	2.39	2.68	3.08	3.18	3.78	2.58	14.21	3.71	5.47	2.48	2.30
		Avg	1.65	2.34	2.54	2.94	3.14	3.44	2.29	13.97	3.69	5.39	2.44	2.25
Oats	2	Min	3.33	1.33	4.00	3.33	5.33	8.00	3.33	5.33	1.33	3.33	4.00	4.00
		Max	4.00	2.67	5.33	4.00	5.33	8.67	3.33	6.00	2.00	4.00	7.33	4.00
		Avg	3.67	2.00	4.67	3.67	5.33	8.33	3.33	5.67	1.67	3.67	5.67	4.00
Rye	2	Min	3.61	1.34	3.47	3.61	5.75	3.61	2.54	6.01	2.35	3.92	0.78	1.57
		Max	4.05	1.57	4.44	3.92	5.88	4.31	3.14	6.54	2.54	4.27	0.80	2.27
		Avg	3.83	1.45	3.96	3.76	5.81	3.96	2.84	6.27	2.45	4.10	0.79	1.92
Triticale	2	Min	3.09	2.16	4.34	3.03	4.46	3.52	2.56	6.46	2.64	4.63	0.91	1.71
		Max	3.28	2.23	6.08	3.28	5.28	3.83	2.80	6.80	2.69	4.96	1.28	1.76
		Avg	3.18	2.19	5.21	3.15	4.87	3.67	2.68	6.63	2.66	4.79	1.10	1.74
Wheat	2	Min	2.52	2.09	3.55	2.76	4.55	3.06	2.20	6.56	2.74	5.10	2.05	1.59
		Max	2.63	2.11	4.05	2.79	4.72	3.30	2.55	6.60	2.88	5.17	2.38	1.80
		Avg	2.57	2.10	3.80	2.77	4.64	3.18	2.38	6.58	2.81	5.14	2.21	1.69

**Table 2. Amino Acids in Rumen Escape Protein of Whole Seeds (% CP)**

Feedstuff	#		Lys	His	Arg	Thr	Gly	Val	Ile	Leu	Tyr	Phe	Cys	Met
Cottonseed (whole, lint)	2	Min	3.26	1.83	5.09	2.65	3.46	4.27	1.83	4.48	1.83	3.05	2.44	2.30
		Max	3.53	1.94	5.30	3.00	3.71	6.71	2.30	5.30	1.94	3.18	2.47	2.85
		Avg	3.39	1.89	5.19	2.82	3.58	5.49	2.06	4.89	1.89	3.12	2.46	2.57
Lupin seeds	2	Min	3.83	2.08	3.90	3.33	3.56	3.49	2.26	6.23	2.77	3.77	1.32	1.26
		Max	4.03	2.12	5.06	3.49	4.21	3.52	2.53	6.56	3.15	4.10	1.37	1.37
		Avg	3.93	2.10	4.48	3.41	3.88	3.50	2.40	6.40	2.96	3.94	1.35	1.31
Lupin seeds (roasted)	2	Min	4.07	2.02	6.46	3.70	4.32	3.29	3.00	7.33	3.87	4.49	1.40	1.21
		Max	4.12	2.43	6.55	3.88	4.37	3.44	3.15	7.40	3.92	4.49	1.46	1.23
		Avg	4.10	2.22	6.51	3.79	4.34	3.36	3.08	7.36	3.90	4.49	1.43	1.22
Peas	1	Avg	4.82	2.01	5.23	2.65	3.78	2.65	1.85	5.95	2.65	4.42	1.37	0.72
Soybeans	2	Min	4.64	2.61	5.39	3.71	4.43	4.19	3.58	7.20	3.12	5.26	1.09	1.23
		Max	5.26	2.64	5.79	3.73	4.51	4.83	3.73	7.23	3.17	5.65	1.20	1.36
		Avg	4.95	2.63	5.59	3.72	4.47	4.51	3.65	7.22	3.15	5.45	1.15	1.29
Soybeans (extruded)	2	Min	5.38	2.44	6.77	3.59	4.03	4.00	3.90	7.85	3.64	5.26	1.30	1.41
		Max	5.48	2.54	7.25	3.60	4.06	4.17	4.12	8.17	3.87	5.61	1.31	1.41
		Avg	5.43	2.49	7.01	3.60	4.05	4.09	4.01	8.01	3.76	5.44	1.31	1.41
Soybeans (micronized)	2	Min	5.35	2.55	6.17	3.77	4.21	4.21	3.84	7.82	3.22	5.07	1.41	1.44
		Max	5.68	2.61	6.83	3.84	4.63	4.33	3.96	7.99	3.33	5.23	1.47	1.51
		Avg	5.51	2.58	6.50	3.81	4.42	4.27	3.90	7.90	3.27	5.15	1.44	1.47
Soybeans (roasted)	3	Min	4.84	2.50	6.25	3.71	4.27	3.15	2.77	7.44	3.59	5.36	1.41	1.37
		Max	5.68	2.58	7.05	3.84	4.60	5.62	4.80	8.13	3.84	5.64	1.60	1.60
		Avg	5.39	2.55	6.58	3.75	4.48	4.20	3.63	7.86	3.73	5.49	1.50	1.46