

FEED VALUE OF WHITE LUPINS

The search for suitable protein sources for use in cattle feed is being intensified by a number of factors, including the general climate-related feed shortage, the increasing demands of the food retail trade for GMO-free products, the reduction of soybean meal in feed rations and the rising costs for protein components such as rapeseed meal. The following looks at the nutritional value of the white lupin.

As a native legume, lupins not only offer ecological advantages for sustainable land management, they also harbour great potential for use in animal feed due to their high crude protein content.

In the past, increased alkaloid contents initially limited the use of lupins as feed, as these significantly reduce palatability

and in some cases have a toxic effect. Yet breeding measures have led to significantly reduced and ultimately harmless levels of alkaloid in the so-called „sweet lupin“, with current varieties containing less than 0.5 g/kg. Lupin species (white, yellow, blue lupin) differ in their cultivation characteristics and some nutritional content, for

example in the crude fat and phosphorus content.

The present study tested the digestibility of the seeds of the Frieda and Celina white lupin varieties from the Deutsche Saatveredelung AG (DSV), Lippstadt. These varieties are tolerant to anthracnose. The digestibility of three grain legumes (soybean, broad bean and pea) was measured at the Test and Training Centre for Agriculture at Haus Riswick, Kleve, Germany.

TABLE 1: CRUDE NUTRIENT CONTENT, IN VITRO PARAMETERS AND BULK ELEMENT CONTENT OF WHITE LUPIN SEEDS *

		FRIEDA WHITE LUPIN	CELINA WHITE LUPIN	White lupin*
DM	g/kg	889	888	880
Crude ash	g/kg DM	39	38	40
Crude protein	g/kg DM	376	408	385
Crude fat	g/kg DM	103	85	94
Crude fibre	g/kg DM	122	117	128
Starch	g/kg DM	93	80	88
Total sugar	g/kg DM	82	89	73
aNDFom	g/kg DM	197	192	190
ADFom	g/kg DM	173	168	145
Gas formation (HFT)	ml/200 mg DM	52.97	52.96	
ESOM	g/kg DM	939	936	
Calcium	g/kg DM	3.1	3.0	2.2
Phosphorus	g/kg DM	4.0	3.7	5.5
Sodium	g/kg DM	0.17	0.21	0.5
Potassium	g/kg DM	12.0	11.5	12.0
Magnesium	g/kg DM	1.8	1.8	1.5

*The values refer to the information on the white lupin from the literature and the UFOP monitoring report.
DM: Dry matter; sources: UFOP Monitoring Report 2015, Mitteilungen Bayerische Landesanstalt für Landwirtschaft 2013–2015 (Bavarian Regional Office for Agriculture 2013–2015 Report), Jeroch et al. 2016, DLG Ruminant Feed Value Tables 1997, Seifried et al. 2016, CVB 2011, Zuber et al. 2019.

Highly digestible

Table 1 shows the determined crude nutrient content, in vitro parameters and bulk element content of the Frieda and Celina white lupins as well as values for the white lupin according to the literature. In most cases, the nutrient and bulk element content of the lupins tested correspond to the mean values for lupins from the UFOP (Union for the Promotion of Oil and Protein Plants) monitoring report.

White lupins have a high crude protein and crude fat content. The lupins tested had a phosphorus content that was about 1.5 g/kg DM lower than the comparative values from the literature.

Determining enzyme-soluble organic matter (ESOM) is an in-vitro method which is used to estimate the digestibility of a feed. The ESOM values are over 900 g/kg DM, which is very high and indicates that lupins are highly digestible.



The sheep are being monitored closely during the feed test.

TABLE 2: FRACTIONATION OF CRUDE PROTEIN IN “FRIEDA” AND “CELINA” WHITE LUPIN SEEDS

		“FRIEDA” WHITE LUPIN	“CELINA” WHITE LUPIN
Dry matter	g/kg	904	903
Pepsin insol. crude protein	% of pure protein	5.7	5.3
Protein solubility	% of pure protein	84.0	81.0
A(NPN)	% of pure protein	5.4	2.9
B1 (buffer-soluble pure protein)	% of pure protein	78.7*	78.1*
B2 (buffer-insoluble pure protein)	% of pure protein	14.2	17.3
B3 (cell wall-bound soluble pure protein)	% of pure protein	0.3*	0.4*
C (cell wall-bound insoluble pure protein)	% of pure protein	1.4	1.3

*Parameters B1 and B3 are outside the detection limit—NPN: Non-protein nitrogen compounds

Table 2 shows the protein solubility and crude protein fractions of the white lupins tested. Both lupin varieties have a protein solubility of over 80%, which is very high. Fraction A, i.e. the non-protein nitrogen compounds (NPN), accounts for a percentage as low as 5.4% and 2.9% respectively. Fractions B1 to B3 are rapidly to slowly degradable in the rumen, fraction C is indigestible. Depending on the passage rate and retention time in the rumen, fractions B2 and B3 can be made available to the ruminant directly in the small intestine as a protein supply. At over 78%, the percentage of fraction B1 (buffer-soluble pure protein which breaks down rapidly in the rumen) is very high in both lupin varieties. This means

that most of the available protein is broken down in the rumen into ammonia by bacterial enzymes and synthesised to microbial protein with available energy. 14% and 17% of the pure protein belong to the B2 fraction and only 0.3% and 0.4% are slowly released and belong to the B3 fraction. Only a small proportion – 1.4% and 1.3% respectively - of the pure protein is cell wall-bound and thus indigestible. These results shed light on the recommendation to protect lupins and other grain legumes from rapid breakdown in the rumen by giving it a pre-treatment (e.g. roasting or toasting) which slows down the rapid breakdown of fractions A and B1 and shifts the protein digestion process to the small in-

testine. The rapid breakdown of protein in the rumen results in a considerably positive nitrogen balance in the rumen (RNB), something which must be taken into account in ration planning.

Table 3 shows the digestibility of the nutrients and the energy content of the Frieda and Celina lupin varieties tested as well as comparative values from the UFOP monitoring report. It also shows broad bean and pea nutrient digestibility for better orientation. These results also come from the North Rhine-Westphalian Chamber of Agriculture’s (LWK NRW) own tests.

TABLE 3: DIGESTIBILITY OF NUTRIENTS AND ENERGY CONTENT OF THE TWO LUPIN VARIETIES, THE BROAD BEAN AND THE PEA, AS CALCULATED IN THE “HAMMELTEST” (FEED TEST ON SHEEP) IN HAUS RISWICK, KLEVE, GERMANY, AND INFORMATION ON THE DIGESTIBILITY AND ENERGY CONTENT OF THE WHITE SWEET LUPIN FROM THE DLG FEED VALUE TABLE

		“FRIEDA” WHITE LUPIN		“CELINA” WHITE LUPIN		White lupin UFOP	Broad bean		Pea	
Number of sheep		4	±	4	±		4	±	4	±
dOS	%	91.8	1.16	95.0	1	90	90.5	2.2	93.3	0.98
dXP	%	89.7	1.06	92.3	0.12		87.2	1.39	88.3	2.96
dXL	%	85.0	2.7	87.6	0.8	91	78.4	6.85	74.0	2.71
dXF	%	98.7	1.17	100.0	0	94	87.9	4.59	92.2	7.77
dNDFom	%	76.2	3.3	83.1	2.84		77.4	4.82	86.7	5.24
dADFom	%	83.0	2.55	86.5	2.29		79.4	14.65	100	0
NEL	MJ/kg DM	9.56	0.16	9.82	0.11	8.3	8.62	0.26	9.11	0.11
ME	MJ/kg DM	15.18	0.2	15.47	0.14	13.1	13.67	0.33	14.23	0.13

dOS: Digestibility of organic matter; dXP: Digestibility of crude protein; dXL: Digestibility of crude fat; dNDFom: Neutral detergent fibre digestibility; dADFom: Acid detergent fibre digestibility; NEL: Net energy lactation; ME: Metabolisable energy; DM: Dry matter; sources: UFOP Monitoring Report 2015, Mitteilungen Bayerische Landesanstalt für Landwirtschaft 2013–2015 (Bavarian Regional Office for Agriculture 2013–2015 Report), Jeroch et al. 2016, DLG Ruminant Feed Value Tables 1997, Seifried et al. 2016, CVB 2011, Zuber et al. 2019.

At 92% and 95% respectively, the digestibility of the organic mass is very high for both lupin varieties, making them highly digestible feeds for ruminants. The variables crude fibre (dXF), neutral detergent fibre (dNDFom) and acid detergent fibre (dADFom) are also highly digestible. The energy values calculated from the digestibility of the raw nutrients are 9.56 and 9.82 MJ NEL/kg DM, respectively, and thus higher than the mean values stated in the UFOP monitoring report. This means that both lupin varieties deliver more energy than broad beans and peas, which is explained by different raw nutrient contents and digestibilities.

Summary

The Frieda and Celina white lupin varieties are highly digestible feeds, the protein of which is broken down in the rumen to a high percentage. Due to their energetic nutritional values, white lupins are suitable as beef and dairy cattle feed and can provide an alternative source of protein. The two varieties have

high crude fat and low phosphorus content levels. However, the high protein degradability in the rumen must be taken into account when rationing. The present study once again confirms the special nutritional value of native grain legumes and especially that of the white lupin. Consequently, white sweet lupins can be recommended without reservation for use as a feed component in balanced ruminant rations.

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