THE NUTRITIVE QUALITY AND FEEDING VALUE OF SOYBEAN STUBBLE

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SUMMARY

Soybean has emerging prominence both as a cash crop and soil ameliorative in Australia and high value food crop in developing countries. The stubble residue may have value as an animal feed.

Survey of world feed composition tables provides limited data to show that soybean stubble is highly fibrous and low in nitrogen, minerals and digestibility. There is no information on the feeding value of unsupplemented stubble nor the role of nitrogen and energy supplements in improving feeding value.

Data are presented on the composition, intake and digestion coefficients of various grades of Australian soybean stubble and the nitrogen balance of sheep fed stubble supplemented with urea and molasses.

(Keywords : soybean, stubble, nutritive, value)

INTRODUCTION

Soybean stubble is a potentially significant residue of a crop that has attained prominence as an important cash crop, high value food crop, and also as a soil ameliorative. Soybean culture in Australia is a fledgeling yet emerging industry with crop area totalling 68,000 ha in the 1983/84 season with some 80 percent of the crop grown in subtropical regions (Desborough et al. 1984). The potential of stubble as a roughage resource for ruminant livestock is suggested by the magnitude of yield estimates at 2,200 kg DM/ha (Gupta et al. 1978).

The nutritive quality of soybean as standing forage or hay is relatively high (Johri et al. 1971). However, with the onset of maturity, cell wall constituents (CWC) and lignin levels increase and digestibility declines as nutrients are translocated from leaf, stem and pod to the developing seed. At maturity, leaves drop and following harvest with a conventional header the stubble comprises predominantly stem and pod and is reputed to be one of the most lignified of forage products, a structural characteristic that impedes fibre digestion and limits feed digestibility.

A primary limiting factor with low quality roughage diets is low ad lib. intake. Added urea provides a source of readily degradable nitrogen which in the presence of a suitable carbohydrate source (like molasses or starch) promotes rumen cellulolytic activity and microbial protein synthesis and stimulates increased intake corresponding to an acceleration in digesta flow. For cereal straws these effects are optimal at low levels of urea (Coombe and Tribe 1963).

Despite the world-wide significance of soybean culture there is little data on the nutritive quality and feeding value of the crop residue. There is no information on the feeding value of unsupplemented stubble nor on the role of non protein nitrogen supplements in improving its nutritive value.

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MATERIALS AND METHODS

The composition of soybean stubble was examined firstly by reference to feed composition tables (table 1) and secondly (table 2) by chemical analysis of local forage samples.

Analytical determinations complied with conventional methods. Organic matter (OM) was determined by ashing at 550°C for 16 hours., total nitrogen (N) by the Kjeldahl procedure of the A.O.A.C. (1980) using a selenium catalyst., in vitro digestibility by the procedure of Tilley and Terry (1963)., cell wall constituents (CWC) was determined by the procedure of Van Soest and Wine (1967) and adjusted for ash content to derive cell wall organic matter (CWOM)., and total mineral concentration was determined on an acid digested solution with phosphorus (P) estimated colorimetrically by the method of John (1970) and potassium (K), calcium (Ca) and magnesium (Mg) estimated by atomic absorption spectrophotometry.

Feeding value was determined in two digestion trials with sheep. In trial I, voluntary intake and apparent digestibility were determined for 3 diets; (i) 1st grade soybean stubble, (ii) leafy lucerne hay, (iii) stemmy lucerne hay. In trial II, 4 diets were compared; (i) soybean stubble, (ii) soybean stubble plus urea, (iii) soybean stubble plus molasses, (iv) soybean stubble plus urea and molasses. The urea supplement (1.25% diet DM) was sprayed onto stubble chaffed into 2-3 cm lengths, molasses was fed at 10% diet DM and animals received a complete mineral supplement. The nitrogen concentration of the 4 diets was 0.81, 1.35, 0.83, and 1.38 g N/100g DM respectively. The stubble sample in trial II was 80.9% stem, 18.0% pod, 0.9% seed, and 0.2% leaf. Each digestion trial comprised 10 days transition feeding followed by 10 days collection with 4 cross-bred wethers (14 months of age, 42 kg liveweight) per diet in trial I and 5 in trial II. Feeding was ad lib., total faeces collections were taken daily and composited under cold storage, urine was collected in IN H_2SO_4 and maintained at pH 2.0 - 3.0.

RESULTS AND DISCUSSION

The feed composition data (table 1) confirms that soybean stubble is highly fibrous and low in crude protein and mineral status, and low in digestibility.

Table 1 Nutrient constituents and digestion coefficients of soybean straw, various sources (1 : Leche et al. 1982, 2 : NRC 1971, 3 : McDowell et al. 1974, 4 : MAFF 1975)

	OM (%)	OMD (%)	ME (MJ/kg)	CP (%)	Dig.CP (%)	CWC (%)	P (%)	Ca (%)	Mg (%)	K (%)
AFIC[1] (Aust) n = 7	94.9	-	-	5.1	-	71.7	-	-	-	-
NRC[2] (USA) n = 4	93.6	-	-	5.2	27		.06	1.59	.92	.56
INFIC[3] (Latin America) n = 1	95.9	-	-	4.8	23		.07	.86	-	-
MAFF33[4] (UK) n : unstated	87.9	48	7.5	8.8	50		-	-	-	-

Data from local material (table 2) highlights a contrast in nutritive quality between soybean hay (unharvested crop) and soybean stubble (crop residue following harvest). Compared with leafy lucerne hay (15% CP, 46% CWC and 63% IVD) soybean hay (17.5% CP, 34% **CWOM**, 67% IVD) is superior in quality. By contrast, the quality of soybean stubble was extremely low with CP ranging between 2.7 - 3.3%, CWOM 67.0 - 78.6%, and IVD 38 - 15% depending on degree of weathering. The mineral status of stubble was also depleted.

Table 2 Nutrient constituents of soybean hay and three grades of soybean stubble

	OM (%)	N (%)	IVD (%)	CWOM (%)	P (%)	Ca (%)	Mg (%)	K (%)
1. Soybean hay (unharvested crop)	92.6	2.83	66.8	34.2	.24	1.48	.94	1.30
2. Soybean stubble (1st grade)	88.2	.43	38.4	67.0	.03	.72	.45	1.53
3. Soybean stubble (2nd grade)	92.1	.46	31.0	73.6	.01	.58	.37	.80
4. Soybean stubble (3rd grade)	93.9	.52	14.7	78.6	.03	.57	.16	.23

Results from trial 1 (table 3) show the low feeding value of soybean stubble compared with lucerne hay. The best soybean stubble (grade 1 sample) was substantially lower in in vivo digestibility than both leafy and stemmy lucerne hay (49.9 v 69.7 and 57.9% **OMD**). The digestibility value of 49.9 for soybean stubble is comparable with published values (47 - 48% OMD, table 1) but higher than values 39 - 41% **OMD** determined by Gupta et al. (1978) for American cultivars. Voluntary intake at 10.3 g/kg LW was extremely low; Gupta et al.(1978) reported values of 15 - 21 g/kg LW but in their work the stubble was fortified with a protein concentrate mineral/vitamin supplement.

Table 3 Intake and digestion coefficients of soybean stubble cf. two grades of lucerne hay fed to crossbred wether sheep

	DM Intake (g/kg LW)	OM Digestibility (%)
Soybean stubble (1st grade)	10.3 $\pm$ 1.1	49.9 $\pm$ 1.5
Lucerne hay (leafy)	26.2 $\pm$ 2.8	69.7 $\pm$ 0.7
Lucerne hay (stemmy)	19.6 $\pm$ 1.9	57.9 $\pm$ 3.1

Results from trial II (table 4) show that animals fed on unsupplemented soybean stubble had a nitrogen intake of 118 mg $N/LW^{.75}$ which is only about 20 percent of the nitrogen requirement for maintenance reported by Gupta et al. (1978). Animals were in substantial nitrogen imbalance with daily excretion exceeding 4 g/day. Liveweight loss was .34 kg/day. Although there was no significant effect of urea supplementation on intake or nitrogen balance, supplementation with urea tended to reduce nitrogen loss due to a combination of increased nitrogen intake and an apparent improvement in the efficiency of utilization of nitrogen. Supplementation with urea plus molasses tended to increase feed intake that in turn increased nitrogen intake to 290 mg $N/LW^{.75}$ which is 50 percent of the reported requirement. However, excretion remained substantial and the reduction in nitrogen loss was only marginal.

Table 4 The effects of supplementing soybean stubble with urea and molasses on the intake, digestion and nitrogen balance of crossbred wether sheep

	DM Intake (g/day)	OM Digestibility (%)	Feed N (g/day)	Faecal N (g/day)	Urine N (g/day)	N Retention (g/day)
Soy stubble	232a	36.1a	1.88	2.30b	3.75ab	-4.18a
	(29)	(2.1)		(.21)	(.35)	(.44)
Soy stubble	246a	40.8a	2.04	3.65a	3.16b	-4.78a
+ Molasses	(48)	(2.8)		(.35)	(.36)	(1.02)
Soy stubble	220a	36.4a	2.97	1.91b	3.74ab	-2.68a
+ Urea	(17)	(0.9)		(.14)	(.14)	(.20)
Soy stubble	323a	39.4a	4.45	2.97ab	4.57a	-3.09a
+ Urea	(48)	(2.0)		(.40)	(.12)	(.33)
+ Molasses						

Values in columns with differing superscripts are significantly different (P<0.05)

The data do not show whether supplementation with urea alone at a higher level than 1.25% would fully meet requirements for maintenance. Soybean stubble may be so frankly deficient in dietary protein because plant protein is so inaccessibly bonded with structural constituents that the nitrogen requirement might only be satisfied by supplementation with a protein concentrate. Further work is planned to resolve the nature of the nitrogen requirement to allow better exploitation of this crop residue.

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