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Nutritional evaluation of soybean hulls in sheep

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Abstract
Soybean hulls collected from soybean processing centres were analysed for chemical composition. The digestibility of nutrients and nutritive value was estimated in adult sheep. Soybean hulls contained 89.55% Dry Matter (DM), 94.80% Organic Matter (OM), 12.32% Crude Protein (CP), 32.54% Crude Fibre (CF), 2.70% Ether Extract (EE), 47.24% Nitrogen Free Extracts (NFE), and 5.20% Total Ash (TA). Fibre fractions of soybean hulls were estimated to be 66.10% Neutral Detergent Fibre (NDF), 49.72% Acid Detergent Fibre (ADF) and 2.75% Acid Detergent Lignin (ADL). The major minerals namely Calcium and Phosphorus were 0.64% and 0.20%, respectively. The digestible crude protein (9.01%) and total digestible nutrient (70.58%) contents indicated that soybean hulls were highly digestible in sheep. Soybean hulls could provide adequate nutrients to meet maintenance and growth requirements of adult sheep when fed as a sole feed.

Keywords: Soybean hulls, sheep, chemical composition, nutrient digestibility

Introduction
Soybean is the second most important oilseed crop next only to groundnut and mainly used as a food for humans. Soybean is cultivated in a large area in different parts of India under different agro-climatic conditions [15]. Soybean hulls are an important by-product of the soybean crushing industry. They are obtained during the process of separation of cortex from soybean seed for production of soybean meal with high protein content (48%) that is commonly used as a feed for poultry and swine [18]. Soybean hulls make up approximately 8% of the whole seed and contain 86% complex carbohydrates [7]. About 20kg soybean hulls are produced from every tonne of soybeans during processing. Agro industrial residues like soybean hulls obtained in large quantities as a result of processing have the potential to be used as non-conventional animal feed resources. Many researchers have suggested that soybean hulls on inclusion in dairy diets could provide energetic value similar to corn, and some others have observed that they can replace forage fibre due to the presence of highly digestible NDF. Due to the fibrous nature of soybean hulls, the energy release on digestion in rumen is slower than grains based diets. Hence potentially soybean hulls could replace grains in dairy diets. Moreover, in rations of early lactating cows containing high starch because of high inclusion of concentrate ingredients, supplementation of soybean hulls may reduce the risk of ruminal acidosis [12]. Soybean hulls though fibrous in nature could provide adequate energy comparable to barley grain based diets [9]. Goat kids achieved better body weight at slaughter at an early age when fed with soybean hulls replacing 50% of ground maize in concentrate diets [13]. Supplementation of soybean hulls at 40% level in concentrate diet improved digestibility of fermentable carbohydrates without any negative impact on the blood glucose level of horses exercised at moderate intensity level [3]. Ani *et al.* [1] observed that inclusion of soybean hulls at 20% level in the diets of weaner pigs did not have any adverse effect on growth and haematological parameters. Inclusion of soybean hulls up to 20% level in quail diets did not produce any deleterious effect on metabolisable energy, egg quality, serum cholesterol and triglycerides [5]. Tamil Nadu is one of the important soybean producing states in India and therefore soybean hulls are available from the processing units as a feed resource for livestock. Hence, with an aim to propagate among farmers the usefulness of soybean hulls as an energy substitute in livestock feeds, a study was undertaken with the objective to analyse its nutrient composition and evaluate its nutritive value in sheep.

Materials and Methods
Random samples of soybean hulls (six nos. each) were collected from three soybean processing units located in western Tamil Nadu. The samples were analysed for dry matter by

drying overnight at 100 °C in hot air oven. Then the oven dried samples were ground to pass through 1mm sieve and analysed for proximate principles – crude protein (CP), crude fibre (CF), ether extract (EE), total ash (TA), major minerals – calcium, phosphorus [2], fibre fractions - NDF, ADF, ADL [17]. Hemicellulose is calculated as the difference between NDF and ADF contents. A digestion trial was conducted using four adult rams of local Kilakarisal sheep breed, about 12 months old with mean body weight 23.15 ± 0.27kg. The selected rams were dewormed and placed in individual pens with facilities for providing feed and water separately. They were provided with soybean hulls *ad libitum* as sole feed and adapted for a period of fifteen days followed by collection of dung samples for seven days. Average daily consumption of dry matter was calculated from the daily records of feed intake. The samples of soybean hulls pods, faeces were analysed for dry matter and proximate principles and digestibility, nutritive value were calculated from digestion co efficient values. Statistical analysis was done as per the methods of Snedecor and Cochran [16].

Results and Discussion

Soybean hulls collected from different sources contained 89.55 per cent dry matter and 94.80 per cent organic matter, 12.32 per cent crude protein, 2.70 per cent ether extract, 32.54 per cent crude fibre, 5.20 per cent total ash and 47.24 per cent nitrogen free extracts (Table 1). The estimated values of DM, OM, CF, EE of soybean hulls were comparable to the values reported by Kemlang *et al.* [8]. Higher CP content of soybean hulls observed in this study was similar to the values of Zervas *et al.* [18]. Major minerals namely calcium and phosphorus contents were low at 0.64 and 0.20 per cent respectively in soybean hulls that were similar to the observations of De Frain *et al.* [4]. Soybean hulls were observed to contain high NDF – 66.10% and ADF – 49.72%, low hemicellulose - 16.38% and lignin – 2.75% (Table 1) similar to the results of Lopez and Fernandez [9].

Table 1: Chemical composition of Soybean hulls

Chemical Composition	Mean ± SE
Dry matter (DM)	89.55 ± 1.05%
Proximate Principles (% DM)	
Organic matter (OM)	94.80 ± 1.23
Crude protein (CP)	12.32 ± 0.56
Ether extract (EE)	2.70 ± 0.34
Crude fibre (CF)	32.54 ± 1.43
Nitrogen free extract (NFE)	47.24 ± 1.23
Total ash (TA)	5.20 ± 0.47
Minerals (% DM)	
Calcium	0.64 ± 0.11
Phosphorus	0.20 ± 0.04
Fibre fractions (% DM)	
Neutral Detergent Fibre (NDF)	66.10 ± 1.87
Acid Detergent Fibre (ADF)	49.72 ± 1.05
Hemi cellulose (HC)	16.38 ± 0.75
Acid Detergent Lignin (ADL)	2.75 ± 0.34

The results of the digestion trial in adult male sheep fed soybean hulls as a sole feed for the parameters *viz.*, dry matter intake (DMI), digestibility of DM, digestibility of proximate principles and fibre fractions and the calculated nutritive value in terms of digestible crude protein (DCP), digestible NDF, ADF and total digestible nutrients (TDN) are presented in Table 2.

Table 2: DM intake, nutrient digestibility and nutritive value of Soybean hulls

Parameter	Mean ± SE
Dry matter intake (DMI)	3.72 ± 0.65%
Nutrient digestibility (%)	
Dry matter (DM)	66.48 ± 2.16
Crude protein (CP)	73.12 ± 1.04
Ether extract (EE)	80.55 ± 0.78
Crude fibre (CF)	65.91 ± 1.94
Nitrogen free extract (NFE)	74.60 ± 1.90
Neutral Detergent Fibre (NDF)	63.15 ± 1.86
Acid Detergent Fibre (ADF)	60.28 ± 1.54
Nutritive value (%)	
Digestible crude protein (DCP)	9.01 ± 0.59
Digestible NDF	41.74 ± 1.08
Digestible ADF	29.97 ± 0.83
Total digestible nutrients (TDN)	70.58 ± 1.76

DMI of 3.72 per cent observed in this experiment was found to be adequate to support maintenance and growth requirements (weight gain @ 50 g/day) in adult sheep [14]. High DM digestibility of soybean hulls (66.48%) observed in the present study, may be related to a high amount of pectin (even up to 30%) in the structural carbohydrates of soybean hulls [7] as increased pectin concentration invariably improves the digestibility of the feed as a whole and its fiber fractions. The low CP digestibility (73.12%) observed in this study could be attributed to damage in protein of soybean hulls due to the heat processing [18]. EE, CF and NFE digestibility was found to be 80.55, 65.91 and 74.60 percent respectively. In the present study, digestibility values of NDF and ADF fractions of fibre in soybean hulls were observed to be 63.15 per cent and 60.28 per cent respectively that were comparable to the values reported by Garleb *et al.* [6]. Soybean hulls are potentially more digestible than silage or hay of fodder crops due to smaller particle size that might increase the surface area available for attachment of rumen cellulolytic bacteria ultimately resulting in improvement in digestibility of the cellulose component of the NDF fraction [10]. The high digestibility of fibre fractions could also be attributed to low level (2.75%) of ADL that might have made more cellulose available for digestion. The nutritive value expressed in terms of DCP and TDN of soybean hulls in sheep fed as a sole feed were 9.01 and 70.54 per cent respectively and found to be higher than the values observed by Nagalakshmi and Narasimha Reddy [11] in sheep fed conventional ration containing *ad lib* sorghum stover and concentrate mixture, establishing that soybean hulls could provide more protein and energy than conventional rations to meet the maintenance and growth requirements of adult sheep. The higher digestibility of nutrients in soybean hulls was probably the result of more digestible NDF (41.74%) and digestible ADF (29.97%) and creation of favorable conditions for microbial cellulolysis in the rumen.

Conclusion

Evaluation of soybean hulls revealed adequate nutrient content, high dry matter intake and highly digestible nutrients that could support maintenance and growth requirements in adult sheep. Soybean hulls were observed to possess nutritional characteristics that make it a potential source of energy and can be used in the formulation of ruminant diets. Soybean hulls, a by-product feed being low in starch and high in digestible fibre represents a potential alternative to high

cost conventional feedstuffs particularly grains by partially or fully replacing them in the dry matter of ruminant diets to reduce the cost whenever they are available at comparatively cheaper rates.

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