Long term feeding of Karanj seed cake is deleterious for lambs

The large gap between the availability and requirements of animal feeds necessitated the exploration of alternate unconventional feeds for their use in livestock rations. *Pongamia pinnata* Pierre (Hindi — Karanj) seed cake is available in large quantity, i.e. 80 thousand tonnes/annum in India and it contains about 300g crude protein/kg. However, raw karanj cake (KC) is not commonly used as a feed for livestock and poultry due to its poor intake and toxic factors, i.e. furanoflavones like karanjin, pongamol and certain other polyphenolic compounds. Physical methods such as autoclaving, water washing, soaking and partial de-oiling, i.e. 25–30g EE/kg and chemical methods such as alkali treatments have been tried to detoxify the karanj cake. These toxic factors being fat soluble can largely be removed by oil extraction. A study conducted by researchers at Animal Nutrition Division, Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India reported the effects of feeding of these cakes for 255 days on various nutritional, biochemical, carcass, radiographical and histopathological parameters in lambs.

Fifteen healthy non-descript growing male lambs (10.6±0.5kg) were divided into three equal groups following completely randomized design and were fed a concentrate mixture containing de-oiled groundnut cake, expeller pressed karanj cake and solvent extracted karanj cake, respectively, in groups 1-3. The digestibility of dry matter, organic matter and ether extract was comparable *(P>0.05)* among three groups. No gross pathological lesions could be seen in vital organs among three groups but spermatogenesis was affected. Long term feeding of expeller pressed and solvent extracted karanj cake revealed deleterious effects on the performance of lambs.

The researchers concluded that the long term feeding of expeller pressed and to some extent solvent extracted karanj cake had deleterious effects on the nutrient utilization, blood biochemical profile, rumen fermentation pattern, carcass characteristics and manifested clinico-pathological changes in bone and tissues of vital organs [Singh P, Sastry VRB, Garg AK, Sharma AK, Singh GR and Agrawal DK, Effect of long term feeding of expeller pressed and solvent extracted karanj (*Pongamia pinnata*) seed cake on the performance of lambs, *Anim Feed Sci Technol*, 2006, 126(1-2), 157-167].

Conservation of sugarcane tops for scarcity period

Sugarcane tops and their leaves are normally used as a source of roughage for ruminants. The surplus tops can be ensiles alone as they contain high amount of soluble sugars. Hence, researchers at Department of Animal Nutrition, Punjab Agricultural University, Ludhiana, India carried out studies to evaluate the silage made from sugarcane tops in order to explore its potential for feeding during lean periods. Sugarcane tops were chopped with chaff cutter (2-3cm length) and ensiled in air-tight plastic containers for a period of 45 days. Then they were dried to constant weight in an oven at 60°C and ground to pass through mesh screen of 2mm and analyzed for chemical composition and digestibility. The silage when fed was well accepted by the buffalo calves. This indicated that the silage could serve as good source of roughage particularly in sugarcane belt area [Singh Ajaib and Gill MS, Conservation of sugarcane tops for scarcity period, *Forage Res*, 2006, 31(4), 272-273].
The use of by-products for livestock feeding allows us to convert material that has limited application for use as human food into animal protein; ruminants are fundamental elements in that process. Citrus pulp is a by-product feed obtained during the manufacture of orange juice and processing of citrus fruits for other products. Citrus pulp is composed of approximately 250 g pectins/kg dry matter. Neutral detergent soluble fibre (NDSF) fraction which include pectins, represents 250-440 g/kg DM. Additionally, this feedstuff contains between 120 and 400 g of sugars and less than 10 g starch/kg DM. Pectins are highly digested in rumen (over 980 g/kg DM). Neutral detergent fibre (NDF) content is 230 g/kg DM with a digestibility of 780-840 g/kg DM.

Pelleted citrus pulp (PCP) has been used in some subtropical regions of the United States (Florida, California, Texas) and in other areas of the tropical Americas. In Costa Rica (Central America), use of PCP has been recently introduced. Use of citrus pulp has been associated with positive effects on ruminal fermentation, fibre digestion, and microbial protein synthesis. Citrus pulp has also been studied as an alternative energy source, replacing some grain in concentrate diets. Positive effects have been reported in dairy cattle and in small ruminants. Some negative effects (reduced milk yield, milk protein content and yield) were noted in dairy cattle when citrus pulp was compared with other by-products (corn meal and hominy) primarily intended as a source of dietary energy. However, the impact of citrus pulp supplementation on forage utilization has not been studied extensively.

Researchers of Costa Rica and USA evaluated the effect of different amounts of PCP supplementation on digestibility, intake and ruminal pH in a grass-based (*Cynodon nlemfuensis* Vand.) diet fed to beef cattle. Additionally, fecal recovery of acid detergent insoluble ash (ADIA) and indigestible acid detergent fiber (IADF) were measured for the dietary treatments evaluated. Three steers (average body weight = 324 ± 16 kg) were randomly assigned to three levels of pelleted citrus pulp supplementation (0, 1.25, and 2.5 kg/animal/day; as-fed) in a 3 × 3 Latin square design to evaluate its effects on forage intake, digestion and ruminal pH. The basal diet was stargrass harvested and chopped every day and fed fresh. The results suggest that high levels of citrus pulp to beef cattle can lower forage intake, but increase total energy intake. High levels of citrus pulp supplementation could be beneficial in combination with forages high in rumen degradable protein.

Thus, Citrus pulp seemed to be an acceptable supplement choice for ruminants consuming stargrass with moderate to low nutritional quality. Although citrus pulp supplementation was compatible with maintenance of forage digestion and desirable ruminal pH, it was associated with a decline in forage intake. The decline in forage intake was most evident at higher levels of supplementation, however, caution should be exercised in the choice of supplementation level. Both ADIA and IADF seem to be acceptable for use as internal markers in grazing studies with forage of similar genetic make up and maturity [Villarreal M, Cochran RC, Rojas-Bourrillón A, Murillo O, Muñoz H and Poore M, Effect of supplementation with pelleted citrus pulp on digestibility and intake of feed in beef cattle fed a tropical grass-based diet (*Cynodon nlemfuensis*), *Anim Feed Sci Technol*, 2006, 125 (1-2), 163-173].
Replacing rice straw with dry wormwood (*Artemisia* sp.) in sheep feed

Wormwood is a self-propagating, medicinal, perennial plant belonging to the genus *Artemisia* Linn. It contains various bioactive materials, such as alkaloids, vitamins A, B₁, B₂, C and various minerals. It has been used to treat gastrointestinal problems, uterine bleeding and asthma. Furthermore, wormwood contains various other substances like coumarine derivatives, which protect liver function. Recently, wormwood was recognized as an effective antioxidant and anticarcinogen. However, the bitter taste of freshly harvested wormwood has limited its exploitation as a forage source for ruminants. Nevertheless, it was recently discovered that wormwood contains considerable crude protein (140-160 g/kg DM) and when dry wormwood was fed to Hanwoo (Korean native beef cattle) heifers, it increased their loin-eye area and decreased back-fat thickness. Thus, researchers at Faculty of Animal Science, Gyeongsang National University, Jinju, South Korea and Department of Animal Sciences, University of Florida, Gainesville, USA explored the nutritional potential of dry wormwood as a forage source for livestock. The objective was to investigate the effect of replacing rice straw with air-dried wormwood (*Artemisia* sp.) on nutrient digestibility in vivo, nitrogen (N) balance and ruminal fermentation in sheep.

Four Corriedale×Polwarth sheep (51.7 ± 1.3 kg) were individually housed in metabolism cages and fed diets (ad. libitum) with a 70:30 forage to concentrate ratio (DM basis), in which the basal rice straw was substituted with 0 (Control), 30 (LW), 50 (MW) or 100 (HW) g/kg of dry wormwood. The experimental design was a 4×4 latin square design in which 10 days of dietary adaptation was followed by 6 days of total faeces and urine collection in each period.

It is concluded that replacing rice straw with wormwood improved DM, OM, CP and EE intake, N retention, microbial N synthesis and digestibility of CP and EE in sheep. Animal performance was better when sheep were fed diets in which 50 or 100 g/kg DM of rice straw was substituted with dry wormwood than those in which 30 g/kg DM of rice straw was substituted [Ko YD, Kim JH, Adesogan AT, Ha HM and Kim SC, The effect of replacing rice straw with dry wormwood (*Artemisia* sp.) on intake, digestibility, nitrogen balance and ruminal fermentation characteristics in sheep, *Anim Feed Sci Technol*, 2006, 125 (1-2), 99-110].

Effect of storage on the nutritional quality of meat and bone meal for animal diets

Meat and bone meal is a co-product of the meat industry and used as a valuable ingredient in pig and poultry diets. Researchers at Animal Nutrition Group, Wageningen University and Research Centre, Wageningen, The Netherlands and Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand investigated the effect of storage on the nutritional quality of meat and bone meal. Three meat and bone meal samples were stored for 1, 2, 3, 6 and 9 months, with or without the addition of the antioxidants (butylatedhydroxytoluene and butylatedhydroxyanisole). Gross composition, thiobarbituric acid reactive substances (TBARS), gross amino acid content and the coefficient of the ileal apparent digestibility (CIAD) of amino acids was determined at each time point. The concentration of TBARS increased sharply during the first 2 months of storage thereafter, TBARS decreased until 9 months. The addition of antioxidants to the meat and bone meal significantly decreased the TBARS compared to the unsupplemented samples. There was a significant (P<0.05) effect of time on the dry matter, crude protein, crude fat, cysteine, histidine and methionine content. There was no significant (P>0.05) effect of antioxidant addition or the interaction between time and antioxidant addition on the gross content of nutrients and the CIAD of any of the amino acids with the exception of methionine and cysteine for which a significant (P<0.05) effect of time was found. A significant quadratic trend over time was obtained for the dry matter content while no significant linear or quadratic regression was obtained for the other components. The CIAD of methionine decreased linearly over time while no significant trend was found for cysteine. Storage of meat and bone meal at ambient temperatures, although resulting in oxidation of the fat, does not add to the variation in the CIAD of amino acids normally observed. The findings showed that digestibility values of amino acids of meat and bone meals measured soon after production are applicable for up to 9 months after determination and can therefore be used with confidence in least cost diet formulation for animals [Hendriks WH, Gottam YH and Thomas DV, The effect of storage on the nutritional quality of meat and bone meal, *Anim Feed Sci Technol*, 2006, 127 (1-2), 151-160].
Feed/Fodder

**Nutritional improvement of feather protein for its usage as animal feed additive**

The feathers constitute up to 10% of total chicken weight, reaching more than 7.7×10^8 kg/year as a by-product of the poultry industry. This excessive material is discarded in several cases, being a material of difficult degradation that may become an environmental problem. Considering that feeds correspond to a significant part of the poultry production cost, it is relevant to investigate alternatives to the most expensive dietary ingredients. Since, feathers have elevated keratin content, the use of this protein source should be considered.

The production of enzymatic hydrolysates from chicken feathers and the evaluation of their *in vitro* digestibility has been described by scientists of Brazil. Chicken feather hydrolysate was produced by proteolysis with a keratinolytic bacterium. Feather hydrolysate was produced by using the whole culture on 60g feathers/l (WCH), or alternatively, using only the culture supernatant of cultivation on 10g feathers/l (CSH). The amino acid composition of the resulting hydrolysates was determined, indicating deficiency in methionine, lysine and histidine. CSH showed higher amounts of sulfur-containing amino acids than WCH. *In vitro* digestibility with pepsin plus pancreatin was also evaluated. WCH had lower digestibility than soy protein, but higher than feather meal and milled raw feathers. CSH had similar digestibility than casein and soy protein. Predicted nutritional parameters for WCH, CSH and feather meal were calculated. WCH showed higher predicted values of protein efficiency ratio (PER) and biological value (BV) than CSH, which presented higher protein digestibility-corrected amino acid scoring (PDCAAS). These bacterial feather hydrolysates showed potential for utilization as ingredients in animal feed.

Production of digestible protein from low nutritional value by-products may be an option to obtain one of the most expensive ingredients of diets. Future studies should be conducted to evaluate the use of these hydrolysates as feed additive *in vivo* [Grazziotin A, Pimentel FA, de Jong EV and Brandelli A, Nutritional improvement of feather protein by treatment with microbial keratinase, *Anim Feed Sci Technol*, 2006, **126** (1-2), 135-144].

**Ensiling of potato pulp with or without bacterial inoculants**

Potato pulp is an agricultural by-product of increasing importance in Hokkaido, the northern island of Japan. It is used locally as fertilizer, as substrate for cultivation of fungi or incorporated in livestock diets. However, its use in livestock feeding is limited due to high moisture content [about 830 g/kg in dry matter (DM)]. Drying of potato pulp for use in livestock feeding is an option, but the high cost involved makes this uneconomical. This has necessitated the need for conservation or conversion into an alternate stable product that would enhance economic value.

Effect of addition of two bacterial inoculants at ensiling on the fermentation quality, change in nutritive composition and the nutritive value of potato pulp silage (PPS) was investigated by researchers at Department of Agro-environmental Science, Obihiro University of Agriculture and Veterinary Medicine, Obihiro, Japan. Two separate experiments were carried out on a laboratory scale using two bacterial inoculants: *Lactobacillus rhamnosus* alone (L), *Rhizopus oryzae* alone (R) and a combined application of the two inoculants (R + L). The first involved a study on the time course changes in fermentation characteristics and nutrient composition of the silage, while the second focused on the chemical composition after 50 days of ensilage. The nutritive value of PPS was studied *in vivo* digestibility trial using sheep in a 4 × 4 Latin square design. Ensiling potato pulp with *L. rhamnosus* and *R. oryzae* and their combined application reduces the pH and improves the fermentation quality of the silage. However, potato pulp can ensile well with or without the bacterial inoculants. Lactic acid production was low with inoculation with *R. oryzae* alone and further studies are required to ascertain the optimum conditions for its effectiveness in lactic acid production in potato pulp silage. The nutritive value of potato pulp silage is comparable to other by-products like citrus pulp and beet pulp and could be a useful feed ingredient in ruminant diets [Okine A, Hanada M, Aibibula Y and Okamoto M, Ensiling of potato pulp with or without bacterial inoculants and its effect on fermentation quality, nutrient composition and nutritive value, *Anim Feed Sci Technol*, 2005, **121** (3-4), 329-343].