In recent years, the use of low-environmental impact biotechnology is giving new types of treatment in the textile industry. The use of protease enzymes to improve some physical and mechanical properties such as smoothness, drapeability, dyeing affinity and water absorbency is particularly interesting. In a study carried out at Color Control and Color Reproduction Department, Institute for Colorants, Paint and Coating, Tehran, Iran, wool yarns were first treated with different concentrations of protease enzymes in water solution including 1, 2, 4 and 6% o.w.f. (on weight of fabric) for 1h. The dyeing process was then carried out on the treated yarns with madder (50% o.w.f.). Tensile strength of treated yarns was decreased due to enzyme treatment and it continued to decrease with an increase in enzyme concentration in solution. The $L^*$ values decreased for the samples treated with enzyme. The wash and light fastness properties of samples were measured according to ISO 105-C05 and Daylight ISO 105-BO1. The washing fastness properties of treated samples were not changed. In the case of light fastness properties, it was increased a little for 4 and 6% enzyme treated samples. Scouring process disrupts hydrophobic barrier at the fibre surface where it allows the proteases to reach the protein layers of the wool cuticle as a whole. Protease damages the cuticle’s edge and overlapping area and to progressive damage to the matrix proteins and to the macrofibrils in the fibre cortex, allowing the dye molecules to penetrate more easily into the fibre cortex [Parvinzadeh Mazeyar, Effect of proteolytic enzyme on dyeing of wool with madder, Enzyme Microb Technol, 2007, 40 (7), 1719-1722].

Dye

Effect of proteolytic enzyme on dyeing of wool with madder

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Feed/Fodder

Response of laying Japanese quails to graded levels of essential amino acids

The effect on egg production of graded levels of ideal amino acids, combined with reduced protein in the diet, was investigated by the scientists of Central Avian Research Institute, Izatnagar and Rohilkhand University, Bareilly, Uttar Pradesh, India. During experiment 312 laying quails aged 6-18 weeks were offered six diets, each of which contained one of three levels of amino acids [85, 100 and 115% of essential amino acids (EAA)] together with 5% or without fishmeal (FM) (3 × 2 factorial design). Each diet was offered to 26 replicated groups of two quails each. Hen-day and hen-housed egg production did not differ as a result of EAA level, protein type or their interaction during the overall period of egg production. Egg weight improved linearly ($P<0.01$) with increased EAA levels, while egg mass output per bird per day remained similar at the 100 and 115% EAA levels. Quails fed higher (100 and 115%) EAA levels had an improved feed conversion ratio ($P<0.01$) compared to birds fed 85% EAA. The gain in body weight during the laying period was higher ($P<0.01$) at the 100 or 115% than at 85% EAA levels. The ratio of egg mass or egg mass and live weight gain, together, to protein intake improved ($P<0.01$) linearly with a decrease in EAA levels in the diets, while better ($P<0.01$) energy efficiency (EE, energy intake: egg mass) and net EE (energy intake: egg mass plus gain) was obtained in higher EAA levels (100 or
115%). Protein and energy efficiencies remained similar due to protein type or interaction. Shape index, albumen index, yolk index, yolk colour and relative shell weight did not differ due to EAA levels, protein type or their interaction. Eggs laid from quails fed diets with 100% EAAs without FM and 115% EAAs with or without FM had higher shell thickness than those on 85% EAAs irrespective of protein type. The retention of nitrogen and calcium retention was higher ($P<0.01$) at the 115% EAA level. It is concluded that a dietary level of 100% EAA [185 g/kg crude protein (CP)] with 12.13 MJ/kg was suitable for laying quails of 6-18 weeks of age [Kaur Sarabmeet, Mandal Asit B, Singh Kunwer B, Kadam Mukund M and Elangovan Arumbakam V, Response of laying Japanese quails to graded levels of essential amino acids profile with reduced dietary protein, *J Sci Food Agric*, 2007, 87(5), 751-759].

**Effect of supplementation of white clover or perennial rye grass diet with grape seed extract on lamb meat**

Higher indole and skatole concentrations in the meat of ruminants grazing pasture have been attributed to the high concentration of protein in plant material and the rapid degradation of that protein, resulting in a greater degradation of tryptophan to indole and skatole. Furthermore, rumen concentration of indole and skatole were higher in sheep that were fed white clover (*Lotus corniculatus* Linn.) compared to perennial rye grass and white clover. The scientists at New Zealand worked to determine the differences in rumen fluid, blood plasma and fat concentration of indole and skatole and the sensory attributes of meat from lambs fed white clover in comparison to perennial rye grass and white clover. The tannin in the form of a grape seed extract (GSE) was dosed to weaned wether lambs fed white clover (WC) or perennial rye grass (PRG) over a 9-week period to determine whether the flavour and odour of meat could be altered. The concentrations of the pastoral flavour compounds indole and skatole were determined in the rumen fluid, blood plasma and intermuscular fat. The odour and flavour of fat and meat from the slaughtered lambs was assessed by a trained panel. The rumen fluid and blood plasma concentrations of indole and skatole were higher in those lambs fed WC compared to PRG ($P<0.05$) and the overall meat flavour intensity was greater when feeding WC ($P<0.01$). The observed concentration of indole and skatole in the fat between WC and PRG feeding treatments was not statistically different. Power analysis indicated that increasing the number of lambs per treatment group from 20 to 65 would result in a higher fat skatole concentration ($P<0.05$) being detected in lambs fed WC compared to PRG. Dosing with GSE gave a small reduction in skatole concentration in the rumen fluid and reduced plasma concentration of indole and skatole ($P<0.001$). Odour and flavour scores of the fat and meat samples were not particularly high however, dosing with GSE lowered the overall and sweet odour and the sheepy, camphor, faecal and barnyard flavour ($P<0.05$). Although the plasma concentration of indole and skatole suggests that GSE reduced indole and skatole formation, the intermittent supply of the GSE to the rumen environment was not sufficient to reduce their concentration in the fat. Hence, the small difference in the scores for pastoral odour and flavour attributes associated with GSE treatment may arise from other unknown factors. From a primary investigation, there was no difference in the concentration of indole and skatole in fat samples collected from carcasses before and after chilling. Further, investigations into meat pastoral flavour are warranted through feeding
Under arid and semiarid conditions of the tropics and subtropics, poor quality and inadequate supply of feed and lack of water are among the major constraints on livestock production. Animals under extensive production systems of the tropics usually gain weight during rainy seasons and lose during dry seasons. Cactus pear \( [Opuntia ficus-indica (Linn.) Mill.] \) is found in vast stands in dry areas of Ethiopia and elsewhere. It is an extremely drought tolerant, highly productive and multipurpose succulent plant. A 90-day experiment conducted at Department of Animal Environment and Health, The Swedish University of Agricultural Sciences, Sweden, aimed to study the effects of plant species, stage of maturity, additive and their interactions on yield, chemical composition and fermentation characteristics of whole-crop cereal silage. Barley, triticale, oats and spring wheat were harvested at the early milk stage or at the early dough stage of maturity in 2002 and 2003 with three field replicates of the plant species within each year. Proens™ (Perstorp Inc, Perstorp, Sweden), which contained 2/3 formic acid and 1/3 propionic acid, was applied at 4L/tonne herbage and Lactisil 200® NB (Medipharm Inc, Kågeröd, Sweden), which contained \( Lactobacillus \) plantarum, Enterococcus faecium, Pediococcus acidilactici, Lactococcus lactis, cellulase and sodium benzoate, was applied at 200 000 colony-forming units/g herbage and both applications were compared to untreated silage. Unwilted herbage, chopped at 12 mm length, was ensiled in 4-L laboratory silos for 90 days. Barley had more starch whereas triticale had more sugar and crude protein but less neutral detergent fibre than other species \( (P<0.001) \). Barley and triticale had less acid detergent fibre and lignin but greater \( in vitro \) organic matter (OM) digestibility than oats and spring wheat \( (P<0.0001) \). Averaged over maturity stages, wheat had a greater yield of digestible OM than barley and oats \( (P<0.0001) \). Yield of digestible OM and concentration of starch increased whereas sugar concentration decreased with later maturity stage \( (P<0.0001) \). Late harvest increased the risks for high levels of butyric acid in silage when no additives were used \( (P=0.002) \). Additives resulted in increased lactic:acetic acid ratios but decreased protein degradation and DM losses \( (P<0.0001) \). Acid treatment was more effective than inoculation to degrade starch and to decrease protein degradation and DM losses during ensiling \( (P<0.0001) \). Harvest at the early milk stage of maturity resulted in more lactic acid and a lower \( pH \) than harvest at the early dough stage of maturity \( (P<0.0001) \). When considering both maximal yield of digestible organic matter and good silage quality, triticale, wheat or barley silage harvested at the early dough stage of maturity and ensiled with acid or inoculant is suggested [Nadeau Elisabet, Effects of plant species, stage of maturity and additive on the feeding value of whole-crop cereal silage, \( J \) Sci Food Agric, 2007, 87(5), 789-801].
experiment using a randomized complete block design with eight sheep per treatment was conducted by scientist at Ethiopia and Germany to determine the optimum cactus pear supplementation level and its contribution as source of water. Cactus pear replaced 0, 20, 40, 60 and 80% of pasture hay (C0, C20, C40, C60 and C80, respectively), on dry matter (DM) basis. Total DM, nutrients and water intake (P<0.001) and digestibility and sheep performance (P<0.05) were significantly affected. The highest DM intake was recorded on treatment group C60. Sheep on the control diet drank the highest amount of water (1226ml/day), while supplemented sheep drank negligible amount of water. There were no significant (P>0.05) differences in digestibility among treatments groups, except between C80 and the control group. Only sheep on treatment diet C80 were in a negative N balance. All experimental sheep maintained body weight, and the highest average daily gain (ADG) was recorded on treatment diet C20 (+33.0g/day). It is concluded that cactus pear could optimally substitute pasture hay up to 60% and its inclusion has a substantial contribution in satisfying the water requirement of the sheep. The study demonstrated the nutritional potential of cactus pear to mitigate feed and water shortages in drought prone dry areas of the tropics and sub-tropics [Tegegne Firew, Kijora C and Peters KJ, Study on the optimal level of cactus pear (Opuntia ficus-indica) supplementation to sheep and its contribution as source of water, Small Rumin Res, 2007, 72 (2-3), 157-164].

**Effect of tree leaf meal supplementation on performance of Small East African goats**

Optimal utilization of tannin-rich browse tree fodders including *Acacia* spp. foliages as crude protein (CP) supplements to ruminants in the tropics is limited by less available information on their feed nutritive potential. Researchers at Japan and Tanzania conducted two studies to: (1) determine rate and extent of ruminal dry matter (DM) degradability (DMD), and (2) investigate effect of sun-dried *Acacia nilotica* (Linn.) Delile (NLM), *A. polyacantha* Willd. (PLM) and *Leucaena leucocephala* (Lamk.) de Wit leaf meal (LLM) supplementation on growth performance of 20 growing (7-9 months old) Small East African male goats (14.6±0.68kg) fed on native pasture hay (NPH) basal diet for 84 days in a completely randomized design experiment in north-western Tanzania. The goats were randomized into four treatment groups consisting of five animals each. Three supplement diets: 115.3g NLM (T2), 125.9g PLM (T3) and 124.1g LLM (T4), used as a positive control, were supplemented at 20% of the expected DM intake (DMI; i.e., 3% body weight) to the three animal groups fed on NPH (basal diet) compared to the animals in a control group that were fed on NPH without browse supplementation (T1). NPH had significantly the lowest (P<0.05) CP of 45.5g/kg DM compared to NLM, PLM and LLM (159, 195 and 187g/kg DM, respectively). NPH had higher (P<0.05) fibre fractions; lower ruminal DM degradability characteristics and ME than NLM, PLM and LLM. Supplementation of the animals with browse resulted to (P<0.05) higher average daily weight gains (ADG) of 157.1g/day in T4 than the animals fed on T2 (114.3g/day) and T3 (42.9g/day) and even to those fed on T1 (control), which lost weight (-71.4g/day). Improved weight gains were mainly due to corrected feed nitrogen (N) or CP due to supplementation of the animals with browse fodder. Too low CP of the NPH would not meet the normal requirements of CP (80g CP/kg DM) for optimal rumen microbial function in ruminants. Higher ADG due to LLM (T4) and NLM (T2) supplementation suggest optimized weight gains due to browse supplementation (20% of expected DMI); while lower weight gains from supplementation with PLM (T3) indicate the possible utilization of *A. polyacantha* leaves to overcome weight losses especially during dry seasons [Rubanza CDK, Shem MN, Bakengesa SS, Ichinohe T and Fujihara T, Effects of Acacia nilotica, A. polyacantha and Leucaena leucocephala leaf meal supplementation on performance of Small East African goats fed native pasture hay basal forages, Small Rumi Res, 2007, 70 (2-3), 165-173].
Effect of dietary glucosinolates on nutrient utilization, milk yield and blood constituents of lactating goats

In India, mustard/rapeseed oil cake is extensively used as a protein supplement in ruminant diets due to its abundant availability. However, the antinutritional component, glucosinolate, present in mustard cake represents an important factor limiting its potential use as a protein supplement. But the feeding of rapeseed meal containing glucosinolate has been shown to have no adverse effects on milk yield and milk composition in lactating cows. Therefore, a study was conducted by researchers at National Dairy Research Institute, Karnal, Haryana, India to evaluate the effect of feeding glucosinolate, via a mustard cake containing diet to lactating goats and the effect on milk production, its composition and blood constituents as an indicator of thyroid, liver and kidney function.

Sixteen crossbred (Alpine×Beetal) lactating does (goats) were divided into two equal groups on the basis of milk yield, stage of lactation and lactation number. Group I was fed a concentrate containing groundnut cake as the sole protein source. In Group II groundnut cake was replaced with mustard cake containing 139.4 µmol/g glucosinolate, on a protein basis. Both concentrate mixtures were isocaloric and isonitrogenous, however the Group II concentrate contained 57.5 µmol/g glucosinolate, resulting in an average 13.04g glucosinolate intake per goat. Dietary glucosinolate affected the palatability of the diet and reduced (P<0.01) the intake and CP digestibility in Group II. Digestibility of dry matter, organic matter, cell wall components, 4% fat corrected milk yield and milk production efficiency were similar in both groups. Dietary glucosinolate increased (P<0.05) the milk thiocyanate and decreased (P<0.01) the iodide content. Milk fat, protein, total solids, solid-not-fat and urea concentration were however not affected. Feeding of glucosinolates diets reduced (P<0.05) the plasma T₄ concentration, with plasma T₃ concentration not being affected. Plasma iodide, total protein, urea and creatinine content as well as activity of γ-GTP were unaffected by dietary glucosinolate. Dietary glucosinolates adversely affected the palatability of the diet, increased milk thiocyanate and reduced milk iodide content and also reduced the plasma T₄ concentration without affecting nutrient utilization, milk yield and other milk composition. Costlier groundnut cake can be totally replaced by high glucosinolate containing mustard cake in the diet of lactating goats [Pailan GH and Singhal KK, Effect of dietary glucosinolates on nutrient utilization, milk yield and blood constituents of lactating goats, Small Rumin Res, 2007, 71 (1-3), 31-37].

Performance of Bt cottonseed as a protein supplement in lactating dairy cows

The scientists at National Dairy Research Institute, Karnal, Haryana, India evaluated Bt cottonseed as a protein supplement in the ration of lactating dairy cows and during experiment crossbred (Karan Swiss and Karan Fries) multiparous cows (20), housed in a well ventilated shed, were fed berseem (green fodder) ad lib wheat straw (1 kg/cow/day) and a concentrate mixture consisting of crushed cottonseed 40 parts according to their nutritional requirements for 13 days to adapt them to the cottonseed based diet. Average daily milk yield in these groups was 7.75 kg during the adaptation period. Thereafter, cows were divided in 2 groups of 10 each on the basis of their stage of lactation and milk yield. Group I (non-Bt) was continued on the same ration while in the concentrate mixture of group 2 cottonseed was replaced with transgenic cottonseed and designated as Bt group. Milk yield and voluntary feed intake were recorded daily for 4 weeks. The amount of Bt protein in Bt cottonseed was 52 µg/g cottonseed. Voluntary DM intake/100 kg body weight varied in the Bt group and non-Bt group, and cows maintained their body weight during the study. Average milk yield and milk composition including fat, protein, lactose, SCC and fatty acid composition of milk fat did not vary between groups. DM intake/100 kg body weight, nutrient digestibility and plane of nutrition in both the groups did not vary significantly between the groups. Milk and blood plasma samples did not exhibit the presence of Bt protein in both the groups at any stage of sampling in lactating cows. Lactating dairy cows performed in a similar fashion when fed Bt and non-Bt cottonseed during the experiment [Singhal KK, Kumar S, Tyagi AK and Rajput YS, Evaluation of Bt cottonseed as a protein supplement in the ration of lactating dairy cows, Indian J Anim Sci, 2006, 76(7), 532-537].
Researchers at Department of Animal Nutrition, Nagpur Veterinary College, Nagpur, India conducted a study to see the effect of supplementation of ashwagandha (*Withania somnifera* Dunal) root powder on growth performance and carcass characteristics of broilers. Seventy-five day-old broiler chicks were distributed in three equal groups in which control group was supplemented with standard broiler diet while the remaining groups were fed ashwagandha at 0.5 and 1% level in diet up to six week of age. It was noticed that dietary supplementation of ashwagandha root powder increased body weight, improved feed conversion ratio and dressing percentage of broiler chicks. The net profit per kg bird was highest in 1% ashwagandha group followed by 0.5% ashwagandha group and control. It is concluded that supplementation of 1% ashwagandha is economical in broiler production [Pedulwar SN, Choudhari AJ, Zanzad AA, Ramteke BN and Deshmukh GB, Effect of dietary supplementation of Ashwagandha (*Withania somnifera*) on Broilers, *Vet World*, 2007, 6 (2), 37-38].

Non-digestible feed components affect not only the quality but also the quantity of feed required in animal rearing. Positive effect on animal performance by aiding in the absorption of fat and other nutrients and by reducing the viscosity of digesta caused by non-starch polysaccharide (NSP) fractions present in various cereals has been reported. It is recognised that exogenous enzymes can also exert indirect effects on animal health by manipulating the growth of gastrointestinal tract (GIT) microorganisms, including bacterial pathogens. The researchers at Department of Food Science and Department of Animal Science, University of Manitoba, Winnipeg, Manitoba, Canada evaluated the
degree of polysaccharide hydrolysis of various feed components in the presence of conventional and experimental preparations of exogenous enzymes and to assess the in vitro growth of several pathogenic and probiotic bacteria in a basal medium containing these feed components with or without exogenous enzyme supplementation. In addition, a broiler chicken feeding trial has also been conducted using wheat-, barley- or corn-based diets with or without enzyme and probiotic supplementation. Growth performance and changes in bacterial populations in the caecum and ileum have been determined.

Increasing the growth performance of broiler chickens by supplementing their diets with exogenous enzymes can also contribute to positive changes in gut health. In this respect the growth of various bacteria normally associated with the gastrointestinal tract of poultry was assessed in vitro using a medium containing arabinoxylan, β-glucan, guar gum and raffinose and their corresponding enzymes. Overall, enzymes releasing the largest amounts of free sugars yielded the largest increase in bacterial numbers. Accordingly, β-glucan and raffinose treated with their respective enzymes promoted the largest number of bacterial types. Escherichia coli, coliforms, enterococci and aerobic and anaerobic spore formers were monitored for growth in both the caecum and ileum. Enzyme supplementation reduced E. coli levels in the caecum of broilers fed wheat- or corn-based diets. A further reduction in E. coli numbers was observed in broilers fed the same diets supplemented with a combination of enzyme and probiotic. Enzyme supplementation had much less of an effect on microbial populations in the ileum. Inclusion of probiotics reduced E. coli levels in the caecum and ileum but only in broilers fed wheat- and corn-based diets. Anaerobic spore levels in the ileum increased in all diets containing probiotic. Overall, inclusion of enzymes or probiotics exhibited mixed effects on gut bacteria, depending on the nature of the carbohydrate source and enzyme [Rosin Erin A, Blank Greg, Slominski Bogdan A and Holley Rick A. Enzyme supplements in broiler chicken diets: in vitro and in vivo effects on bacterial growth, J Sci Food Agric, 2007, 87(6), 1009-1020].

**Fibre**

Microencapsulation of herbal extracts for microbial resistance in healthcare textiles

As consumers have become more aware of hygiene and potentially harmful effects of microorganisms, the demand for antimicrobial finished clothing is increasing. Many plant extracts possessing antibacterial properties can be used as textile finishing agents in the crude form or as microcapsules to enhance the durability and controlled release of the extracts. Researchers at PSG College of Technology and PSG College of Art’s & Science, Coimbatore, India imparted antimicrobial finish to the cotton fabric using extracts of neem (Azadirachta indica A. Juss.) leaves and oil and leaves of Mexican Daisy (Tridax procumbens Linn.) by direct application and by microencapsulation using pad-dry-cure method. To enhance the durability of antimicrobial finish to number of washes, the microencapsulation of herbal extracts has been done using phase separation/coacervation. Microcapsules are produced using herbal extracts as core and gum acacia as wall material. Structure of microcapsules has been evaluated using light microscopy with image analysis technique, the presence of microcapsules by scanning electron microscopy, the antimicrobial efficacy by quantitative method in terms of bacterial reduction and the wash durability of antimicrobial activity by Agar diffusion method (AATCC 124). They exhibited potential for antimicrobial activity against Staphylococcus aureus and Escherichia coli. It was observed that the microencapsulated herbal extracts possess a very good resistance for microbes even after 15 washes [Thilagavathi G, Bala S Krishna and Kannaian T. Microencapsulation of herbal extracts for microbial resistance in healthcare textiles, Indian J Fibre Text Res, 2007, 32 (3), 351-354].