

EFFICACY OF PHYTO MEDICINES AS SUPPLEMENT IN FEEDING PRACTICES ON RUMINANT'S PERFORMANCE: A REVIEW

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ABSTRACT

This article summarizes the experimental knowledge on efficacy, possible modes of action, and aspects of application of phyto medicine as feed additives for ruminant. Phyto-genic feed additives comprise a wide variety of herbs, spices, and products derived thereof, and are mainly essential oils. The assumption that phyto medicine compounds might improve the palatability of feed has not yet been confirmed by choice-feeding studies. In total, available evidence indicates that phyto-genic feed additives may add to the set of non-antibiotic growth promoters for use in livestock, such as organic acids and probiotics. However, a systematic approach toward the efficacy and safety of phyto-genic compounds used as feed additives for livestock is still missing.

KEYWORDS: Phyto medicine, ruminant, feed additive

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1. INTRODUCTION

Phytogenic feed additives are plant-derived products used in animal feeding to improve the performance of agricultural livestock. This class of feed additives has recently gained increasing interest, especially for use in livestock sector. This appears to be strongly driven by the ban on most of the antibiotic feed additives within the European Union in 1999, a complete ban enforced in 2006, and ongoing discussions to restrict their use outside the European Union because of speculated risk for generating antibiotic resistance in pathogenic microbiota. In this context, phytogenic feed additives are discussed possibly to add to the set of non-antibiotic growth promoters, such as organic acids and probiotics, which are already well established in animal nutrition. Phytogenics, however, are a relatively new class of feed additives and our knowledge is still rather limited regarding their modes of action and aspects of their application. Further complications arise because phytogenic feed additives may vary widely with respect to botanical origin, processing, and composition. Most studies investigate blends of various active compounds and report the effects on production performance rather than the physiological impacts. In this context, the following provides an overview of recent knowledge on the use of phytogenic feed additives in piglet and poultry diets, possible modes of action, and safety implications. Phytogenic feed additives (often also called phytobiotics or botanicals) are commonly defined as plant-derived compounds incorporated into diets to improve the productivity of livestock through amelioration of feed properties, promotion of the animals' production performance, and improving the quality of food derived from those animals. (Windisch *et al.*, 2008). The use of feed additives is usually subject to restrictive regulations. In general, they are considered as products applied by the farmer to healthy animals for a nutritional purpose on a permanent basis (i.e., during the entire production period of the respective species and category), in contrast to veterinary drugs (applied for prophylaxis and therapy of diagnosed health problems under veterinarian control for a limited time period, partially associated with a waiting period). In the European Union, for example, feed additives need to demonstrate the

identity and traceability of the entire commercial product, the efficacy of the claimed nutritional effects, including the absence of possible interactions with other feed additives, and the safety to the animal (e.g., tolerance), to the user (e.g., farmer, worker in feed mills), to the consumer of animal-derived products, and to the environment (EU commission, 2003)

A knowledge of the chemical constituents of plants is desirable, not only for the discovery of therapeutic agents, but also because such information may be of value in disclosing new sources of such economic materials as tannins, oils, gums, precursors for the synthesis of complex chemical substances, etc.

Therefore keeping in mind aforesaid constraints and possible benefits, present study was planned with the following objectives:

- To study the effect of herbal supplementation on feed intake and feed conversion efficiency of ruminant production management.
- To study the effect of medicinal plants supplementation on production performance of ruminant production management.

2. Effect of polyherbal supplementation on:

2.1. Milk production

Leptaden[®] tablet containing *Shatavari* (*Asparagus racemosus* Willd.) as a major component enhances milk production significantly in buffaloes and cows but not in goat and sheep (Anjaria and Gupta, 1967). Result happened in crossbred cows (Chauhan *et al.*, 1971). Supplementation of 'Galog[®]' an herbal preparation having *Shatavari*, enhanced milk production and persistency throughout lactation in the treatment group. Similarly, supplementation of *Shatavari* based herbal formulation Payapro[®] enhanced milk production (Arora *et al.*, 1978). The increase in milk production was on an average 30.9%. It has been concluded that herbal preparation showed galactopoeitic activity and can be considered as an alternative for lactogenic hormones for inducing and enhancing milk yield in crossbred cows (Singhal, 1995). Supplementation of 'Galactin[®]' (50 g

/d/animal), a *Shatavari* based polyherbal galactagogue, in lactating crossbred cows had improvement in milk production over control group (Ramesh *et al.*, 2000).

A. racemosus in combination with other herbal substances in the form of 'Ricalex[®]' tablets (Aphali pharmaceutical Ltd. Ahmednagar) has been shown to increase milk production in females complaining of deficient milk secretion. Gradual decrease in milk secretion, on withdrawal of the drug suggested that the increase in milk secretion was due to drug therapy only and not due to any psychological effect (Joglekar *et al.*, 1967). Galactagogue effect of roots of *A. racemosus* has been shown in buffaloes (Patel and Kanitkar, 1969). However, no increase in prolactin levels in females complaining of secondary lactational failure with *A. racemosus* suggesting that it has no lactogenic effect (Sharma *et al.*, 1996).

It was assessed the effect of some herbal biostimulators of Galog[®], Hbstrong[®] and Livol[®] (trade marks of polyherbal medicines in India) in optimizing ruminal digestion and milk production and also their effect on various biochemical constituents in dairy cows. There was significant increase in milk yield in the three treatment groups with maximal increase being recorded in Galog[®] group followed by Hbstrong[®] and Livol[®] groups as compared to control group. The average milk yield in all the treatment groups even at the termination of the experimental study was still higher than the base value. Further, the milk yield declined in control group by 18.65 percent with the progress in the process of lactation and in normal lactation curve, whereas the treated groups showed steady increase in milk yield. Results showed gross over activity of rumen microflora particularly of the predominance of cellulolytic bacteria with increased total volatile fatty acids and normal pH of rumen liquor. There was marked increase in protozoal concentration and motility in rumen liquor due to herbal feed additives especially Hbstrong[®] which helped better digestion of the cellulose matter of the feed and thus renders energy supply for milk production followed by Livol[®] and Galog[®]. There was also increase in molar proportion of propionic acid which is glucogenic. In the rumen there was faster

rate of ammonia metabolism into microbial proteins (Randhawa *et al.*, 1995).

The efficacy of the herbal galactagogue Payapro[®] in lactating buffaloes was conducted at an organised farm. Ten healthy Murrah buffaloes, calved 35–74 days earlier were fed Payapro[®] at the rate of 4 bolus daily for 16 days. The effect of increased milk yield was manifested within 7 days of treatment, reached its maximum level at day 21 and remained above pre-treated level till day 35. However, the beneficial effect in arresting the decline in milk yield vis-à-vis untreated animals was seen till the last observation at day 49. The cumulative gain in milk yield in treated animals over the control animals during the 7 weeks observation worked out to 35.5 Kg per animal. The economics of medication was highly favourable. The influence of the Payapro[®] was applied in twenty five crossbred cows, calved 60–89 days earlier were divided into 2 groups viz., treated (15 animals) and control group (10 animals), near identical in terms of body weight., calving and lactation status. The animals in treated group were administered Payapro[®] at the rate of 4 bolus per animal daily along with feed consecutively for 15 days while the control animals were given feed without Payapro[®]. The daily milk yield was recorded at the start of trial and thereafter for each animal in both the groups for 49 days. The result indicated that Payapro[®] administered in the declining phase of lactation resulted in both increased milk yield compared to pre-treatment levels and persistence of lactation levels compared to the control groups. This was evident by extra milk yield of 30.4 l/animal over a Seven weeks period in treated animals along with sustenance of increased milk yield for as long as 7 weeks. The treatment was also found highly cost effective with a cost benefit ratio of 1 : 3 (Khurana *et al.*, 1996).

2.2. Colostrum and milk composition

Goat milk has less fat, higher vitamin A content, less lactose, tuberculosis virus resistant than cow's milk. The reaction of goat milk is alkaline, the same as Mother's milk. Cow milk produces an acid reaction. Normal milk from high producing Holstein or Friesian dairy cows is composed of water (87%), fat (3.8%), protein (3.4%), sugars

(i.e., lactose, 4.5%) and other solids such as minerals (1.3%). Milk also contains a number of minor components including sloughed epithelial cells and white blood cells. High quality milk should be white in appearance, have no objectionable odors and be free of abnormal substances such as pesticides, added water or antibiotic and antiseptic residues. In most developed dairy countries milk quality is defined by the somatic cell count and the bacterial count (standard plate count) in pre-pasteurized bulk tank milk. Somatic cells are composed of white blood cells and occasional sloughed epithelial cells. Most cells found in normal bovine milk are a type of white blood cells (macrophages) that function as early warning signals when bacteria invade the udder.

Effect of 10 herbal feed supplementations was studied on the performance of lactating cows. Results showed that the herbal feed supplement did not have any significant effect on dry matter intake, digestibility of nutrition, live weight changes, whereas milk and fat corrected milk yield was improved without affecting its composition. It was concluded that dietary supplementation of a commercial herbal feed additive 10 g/d to lactating crossbred cow, increased the milk yield (Thakur *et al.*, 2006). Supplementing of lactating goat's diet with fenugreek and *Nigella sativa* seeds galactagogue on milk yield, composition and its effect on Domiati cheese have been studied, fenugreek increased milk yield and total nitrogen soluble nitrogen and salt contents. The acidity tyrosine and tryptophan in cheese increased significantly compared with the control. However, a decrease in total solids, fat and fat/total solids and total nitrogen/soluble nitrogen was also observed in cheese over the control. However, *N. sativa* decreased total solids, fat and total nitrogen soluble nitrogen and pH of milk. The organoleptic properties of treated cheese were better than the control, except in colour, storage period significantly affected organoleptic properties and cheese composition. It is concluded that fenugreek was economically better than the other groups (Kholif *et al.*, 2001).

2.3. Somatic cell and immunoglobulin G concentrations in milk

The white blood cells in milk, together with a relatively small number of epithelial cells from milk-secreting tissues, are known as somatic cells. These cells are an important part of the goat's natural defence mechanism. When udder tissue is injured or becomes infected, significant numbers of white blood cells accumulate in the milk. Normal goat milk has a higher cell count than normal milk from cows. This has long been a concern of goat owners because of regulatory standards and marketing problems. Current Grade A standards require that milk contain no more than 4,000,000 cells/ml. Despite this reduction for cow milk, regulatory standards for goat milk will remain at 1,000,000/ml. This is because somatic cell counts in goat milk may easily approach 750,000/ml and still be normal.

The influence of different somatic cell count on the average daily milk production, composition and some properties of goat milk were evaluated. 110 lactating dairy goats (Bulgarian Dairy White) were investigated during the lactation period. No statistical differences were found in the average daily milk production at 3.2% fat corrected milk and at 3.0% protein corrected milk between the number of somatic cell count less than 400,000/ml (275,000/ml), SCC from 400,000 to 1,000,000/ml (652,000/ml) and somatic cell count over 1,000,000/ml (3,150,000/ml), (Petrova *et al.*, 2008).

The synergistic effect of polyherbal immunomodulator along with the antibiotic therapy was assessed in the treatment of subclinical mastitis in cows. The immuno-modulatory effect was evaluated based on the increase in absolute lymphocyte count and immunoglobulin G level along with clinical recovery. The curative effect was assessed based on the increase in milk yield and reduction in somatic cell count below 0.5 million cells/ml. Significant increases in absolute lymphocyte count and immunoglobulin G were observed in individual cows treated with polyherbal immunomodulators alone and in antibiotic combination. The immuno-modulatory effect of the herbal immuno-modulator was at par with that of levami-

sole. Polyherbal immuno-modulator alone was found to be effective in 60% of subclinical mastitis cases and it was effective in 100% of the cases when used with antibiotics. Recently, the efficacy of a commercial herbal immuno-stimulant product (ImmuPlus[®]) for prevention and effective treatment of clinical mastitis in bovines was evaluated. The different groups of cows suffering from clinical mastitis and those which were more vulnerable to this disease were administered Immu-21[®] alone and in combination with antibiotics, to assess their comparative clinical and immunological benefits. When animals affected with clinical mastitis were treated with Immu-21[®] alone they showed 20% clinical recovery along with significant rise in immunoglobulin G levels (Das *et al.*, 2003).

The effect of Immu-21[®] (a herbal immuno-modulator manufactured by Indian herbs containing *Withania somnifera*, *Sphaeranthus indicus*, *Loranthus falcata*, *Scrophularia lizzi*, *Panax ginseng*, *Nyctanthes arbor-tristis*, *Phyllanthus emblica*, *Mimosa tenuiflora*, *Ocimum tenuiflorum* and/or *Tinospora cordifolia* were applied to Black Bengal goat in the last month of the pregnancy and their kids. They reported significantly higher birth weight and absence of kid mortality respectively. They concluded that the supplementation of polyherbal preparation during the later part of pregnancy in goats and to kids during the growth period is much more beneficial than administration at either stage alone (Sahoo *et al.*, 2001).

Efficacy of supplementation of immu-21[®] to Black Bengal goats showed, in the last month of the pregnancy and /or kids and reported significantly higher birth weights, increased concentrations of blood protein and colostrum immunoglobulin and absence of kid mortality respectively. They concluded that the supplementation of immu-21[®] during the later part of pregnancy in goats and to kids during the growth period is much more beneficial than administration at either stage alone (Sahoo *et al.*, 2001).

Influence of intramammary application of Tilo[®] (ampicillin plus cloxacillin; compared to 4 cows with 11 positive quarters) with the topical application of a paste containing roots of *Withania*

somnifera, *Asparagus racemosus* and *Curcuma amada* and leaves of *Ocimum sanctum* (5 animals with 12 positive quarters) for treatment of subclinical mastitis and found both the preparations effective, as assessed by a return to normal biochemical milk profiles, but the plant preparation acted more slowly (Kolte *et al.*, 1999). Effect of anti-histaminic and anti-anaphylactic property of PulmoFlex[®] (polyherbal supplementation) was studied in mice. The results indicated that PulmoFlex[®] protected histamine aerosol induced collapse in guinea pig and compound 48/80 induced histamine release from guinea pig chopped lung preparation. PulmoFlex[®] also exhibited significant protection in passive foot anaphylaxis and passive cutaneous anaphylaxis in albino mice. Bovine serum albumin induced anaphylactic shock in male albino mice was also antagonised by PulmoFlex[®] (Gomes and Dasgupta, 2000).

2.4. Blood glucose and total leucocyte concentrations

After calving, the initiation of milk synthesis and rapidly increasing milk production greatly increases demands for glucose for milk lactose synthesis, at a time when feed intake has not reached its maximum. Because much of the dietary carbohydrate is fermented in the rumen, little glucose is absorbed directly from the digestive tract. Consequently, dairy cows rely almost exclusively on gluco-neogenesis from propionate in the liver to meet their glucose requirements. Limited feed intake during the early postpartum period means that supply of propionate for glucose synthesis also is limited. Amino acids from the diet or from skeletal muscle breakdown as well as glycerol from mobilized body fat contribute to glucose synthesis. Glucose supply to the mammary gland is also enhanced by the decreased oxidative use of glucose that accompanies the initiation of lactation (Drackley *et al.*, 2001). Negative energy balance during early phase of lactation is more intense in cattle than buffalo (Drackley *et al.*, 1999). Plasma glucose concentrations are lower during the catabolic phase of lactation, and are higher during the anabolic phase of lactation when energy intake is equal or superior to the energy release (Goff, 1999).

Plasma glucose concentration and hepatic glycogen decreased, while the lipid was increased during the transition period (Grummer, 1995). In addition, the effect of *Leptadenia reticulata* powder and Leptaden[®] tablets on lactogenic property of goats, sheep, cows and buffaloes was evaluated; the experiment was conducted on identical sets of animals in each group. Leptaden[®] tablets, 4 twice daily in goats and sheep, 10 twice daily in cows and buffaloes; and *L. reticulata* powder, 536 mg, (equivalent to the *L. reticulata* content of 4 Leptaden[®] tablets) in goats and sheep, 1340 mg (equivalent to the *L. reticulata* content of 10 Leptaden[®] tablets) in cows and buffaloes were given for 12 days. Both drugs produced galactopoietic response in most of the experiments. No changes were produced in the contents of milk and blood of goats as shown by their analysis during the experimental period (Anjaria and Gupta, 1967).

There was gradual increase of blood glucose concentration with feeding Livol[®] associated with marked increase in milk yield due to the stimulatory effect on liver functions and thus enhanced gluconeogenesis. The increase in blood glucose concentration was found steadily high due to increased synthesis even though there was increased demand for lactose synthesis to meet requirement for increased milk yield. An interesting finding was that with increased demand for conversion of blood glucose into lactose due to increased milk yield in all three feed additives groups, the plasma ketone bodies levels were within the normal range and even below base value throughout the period of study. There was no adverse effect due to regular feeding of the herbal products and there were also no alterations in blood biochemical profile. The decline in electrical conductivity of the milk and lower somatic cell counts due to feeding of herbal products showed positive effects of the products in maintaining the integrity and health of the udder. The increased sustained milk production in all the three treatment groups was due to the galactopoietic effect of the feed additives which helped in better utilization of absorbed nutrients in the body tissues and lactopoietic system (Randhawa *et al.*, 1995).

2.5. Ketosis

The product herbal Nebsui as growth promoter feed additive was non-toxic, safe and without any residual or other side effect in dairy cows (Wheeler and Agrawal, 1999). The response of different therapeutic combinations against ketosis were studied. 42 ketotic cows were selected at random and were divided into 7 groups (Gr- 1, 2, 3, 4, 5, 6 and 7) having 6 cows in each. Gr-1 was kept as non-treated control and the remaining (Gr-2–7) were utilized to study the efficacy, safely and cost-economics of different treatments. Before the commencement of therapy there was fall in serum glucose, insulin, cholesterol, plasma calcium phosphorus and magnesium and rise in serum ketone bodies in ketotic cows. Rothra's test and Ross test were also positive for ketone bodies in urine and milk respectively. Six different therapeutic combinations were tried against ketosis. On 7th day post treatment all the parameters like blood metabolites returned to normal and ketone bodies in urine and milk were found negative. There was general clinical recovery and improvement in appetite and digestion, the milk yield increased by 30–50 % in different treated groups. It is observed that the therapeutic regimen applied for the treatment of ketotic cows of Gr-3 with herbal anti-stress and metabolic and liver tonic products and MeboLiv[®] orally once daily for 7 days was found to be more scientific, rational, efficient, safe, economical and comparatively quicker in recovery without relapse of ketosis. There was steady increase in milk yield of the treated cows (Nayak and Nayak, 2001).

2.6. Some physiological parameters

Three trials with Brown Swiss and aged Holstein cows with Leptaden (extracts of plants -*L. reticulata* and *Breynia patens*) added to a standard ration. The cows were in late, early, and middle stages of lactation in Trials 1, 2 and 3, respectively. Following three weeks pre-treatment, cows in the Leptaden[®] group were administered 10 Leptaden[®] tablets (268 mg/tablet) twice daily in the first trial and 15 tablets twice daily in the second and third trials for 21 days. This period was succeeded by a three week post-treatment period. Leptaden[®] feeding did not produce any significant

effect on average feed intake. Both control and experimental groups lost body weight during the trials, but there was no significant differences in weight change between the groups. Leptaden[®]-fed cows did not increase in milk production or change in the content of fat or total solids in their milk compared to the controls. Heart rates, respiratory rates, and rectal temperatures of all cows were within normal ranges in all periods. The serum protein-bound iodine and blood glucose indicated that Leptaden[®] did not impair thyroid activities of the cows. No significant differences were noted in other health related data between the Leptaden[®]-fed and control cows (Dash *et al.*, 1992).

Effect of herbal ART-400[®] powder 20 g orally mixed in treacle daily to the male calves as III group, group II treated by diclofenac sodium and group I served as control, The elevated respiration and heart rate on 5th post-induction day, started declining and by 24th post-induction day, these parameters reached to near normal base values, however the rectal temperature remained within normal range in all the animals of different group (Kanwar and Varshney, 2003). Therapeutic efficacy of Caflon[®], an herbal product of Indian herbs, Saharanpur, against non-specific respiratory disorders of goats. Treatment with Caflon[®] at the rate 10 g/animal, twice daily orally for 5 days had given the best results (100% cure on 5th day of treatment), treatment with Caflon[®] only at the rate 10 g/animal, twice daily, also had a remarkable positive response against the non-specific respiratory disorders in goats in comparison to the unmedicated group (Ghosh *et al.*, 1994).

2.7. Reproductive performance

Influence of herbal Prajana SS[®] Premix on synchronisation of oestrus and conception rate was evaluated in cows. In experiment 1, all cows and heifers came in oestrus and were served by all. Out of 9 cows and 5 heifers 86 % became pregnant on first oestrus. The remaining two cows repeated 21 days later and became pregnant by natural service. In experiment 2, all the 20 cows came in oestrus, within 10 h of each other, after 6 days of last Prajana SS[®] administration. It was noteworthy that unlike with the use of Pros-

taglandins, the length of oestrus period was not reduced in the Prajana SS[®] Premix treated cows, which made it possible to easily complete AI in the whole herd (Wheeler and Agrawal, 1999). The efficacy of "Replanta[®]" an herbal product for improving breeding efficiency was assessed in cows; it improved uterine tone when used for resolving reproduction problems like retention of placenta and other postpartum complications in cows. Replanta[®] being purely herbal and biodegradable and with no problem of withdrawal time has big advantage over chemical treatments. Further, with the use of Replanta[®] it is also observed that the service period and the interval of insemination can also be reduced along with faster uterine involution. Replanta also ensured early start of the ovarian cycle and insemination (Koutecka, 1997).

Drug trial on 60 cows and 10 buffaloes was conducted which were divided randomly into five groups with equal number in each group including cows and buffaloes, out of those five groups, four groups were experimental and one served as control. Experimental groups were separately dosed with Replanta[®] powder, Replanta[®] liquid, Uterotone liquid and a cleansing drench containing ergot immediately after parturition and observations recorded. The cows and buffaloes treated with Replanta[®] powder and Replanta[®] liquid came early in first heat after calving and reproductive cycle was found to be more regularised as compared to other drugs tested. Replanta[®] treated animals come to heat second time also (Pandey and Raghuvanshi, 1992). The efficacy of Replanta[®] treatment on placental expulsion, lochial cessation, uterine involution and post partum oestrus was assessed in Murrah buffaloes. In all, 92.0% buffaloes of Replanta[®] treated group expelled their foetal membranes within a mean duration of 6.30 h as compared to 84.0% buffaloes of control group within 7.4 h of parturition. Earlier cessation of lochia and uterine involution was observed in Replanta[®] treated group than the untreated control group of buffaloes. 88% buffaloes of Replanta[®] treated group expressed first post partum oestrus with a mean duration of 78.2 d as compared to eighty per cent buffaloes of control group within 87.0 d post partum (Paul *et al.*, 1995).

2.8. Ruminant fermentation and methane emission

Livestock contribute both directly and indirectly to climate change through the emissions of greenhouse gases such as carbon dioxide, methane and nitrous oxide. Globally, the sector contributes 18 percent (7.1 billion tonnes CO₂ equivalent) of global greenhouse gas emissions. Although it accounts for only nine percent of global CO₂ emissions it generates 65% of human-related N₂O emissions and 35 percent of CH₄ emissions, which have 296 times and 23 times the Global Warming Potential of CO₂ respectively. CH₄ emissions mostly occur as part of the natural digestive process of animals (enteric fermentation) and manure management in livestock operations. CH₄ emissions from livestock are estimated at about 2.2 billion tonnes of CO₂ equivalent, accounting for about 80% of agricultural CH₄ and 35% of the total anthropogenic methane emissions. N₂O emissions are associated with manure management and the application and deposition of manure. Indirect N₂O emissions from livestock production include emissions from fertilizer use for feed production, emissions from leguminous feed crops and emissions from aquatic sources following fertilizer application. The livestock sector contributes about 75 percent of the agricultural N₂O emissions (2.2 billion tonnes of CO₂ equivalent). CO₂ emissions from the livestock sector are related to fossil fuel burning during production of fertiliser for feed production, the livestock production process, processing and transportation of refrigerated products. Furthermore, livestock are a major driver of the global trends in land-use and land-use change including deforestation (conversion of forest to pasture and cropland), desertification, as well as the release of carbon from cultivated soils. The overall contribution of CO₂ emissions from the livestock sector are estimated at 2.7 billion tonnes of CO₂ (Mirzaei, 2010). Feed additives that manipulate the microorganisms living in the rumen to quicken microbial fermentation (Mirzaei and Hari, 2012).

There is currently interest in the role of plant secondary metabolites such as saponins and tannins in reducing CH₄ emissions (Wallace, 2004). Saponins have been shown to possess strong de-

faunating properties both *in vitro* and *in vivo* which could reduce CH₄ emissions (Wallace and McPherson, 1994). Scientists recently reviewed literature related to their effect on CH₄ and concluded that there is evidence for a reduction in CH₄ from at least some sources of saponins, but that not all are effective. Likewise they reported that there is evidence that some condensed tannins can reduce CH₄ emissions. Some legumes contain condensed tannins, but unfortunately these may reduce forage digestibility and the condensed tannins containing varieties tend to have weak agronomic performance. Extracts from plants such as rhubarb and garlic could decrease CH₄ emissions, while there is insufficient evidence to conclude on the potential of plant secondary compounds or extracts as mitigation strategies, this is likely to be an area of significant research over the coming years (BSAS, 2008).

An experiment tested on combination of certain herbs having galactagogue and stomachic actions to test its efficiency on milk production in jersey crossbred cows, fed diets according to NRC standard computed on fortnightly basis. The mean dry matter intakes cow/ day were similar in both the groups for the full lactation. It was observed that the cows showed an increase in milk production by 74.0 Kg given this combination of herbs over the control group; the effect was noticed mainly in the mid trimester. The feed efficiency for milk production was 1.4 Kg DM/kg milk in herbal supplemented group (Tiwari *et al.*, 1993).

The effect of supplementing four medicinal herbs and plants (garlic, fenugreek, *Nigella sativa* and camomile) assigned to Zaraibi goat ration on their performance. Results showed improvement in digestibility coefficients of dry matter, organic matter, and crude protein. Ration with non-supplement showed the highest nutritive values, but milk yield was increased in all treatment groups fed by supplementation compare to control group. It was concluded that medicinal herbs and plants improved feed conversion, economic return and decreased feed cost of 1 Kg milk compared with control group (Allam *et al.*, 1999). Clinical efficacy of some herbal preparations (The combination of *Leptadenia reticulata*, *Nigella sativa*,

Foeniculum vulgare, *Pueraria tuberosa* and *Asparagus racemosus*) was evaluated and reported that, this supplementation was effective in curing digestive disorders and early restoration of normal milk production in lactating Bufaloes (Kumari and Akbar, 2006).

2.9. Feed intake and feed conversion ratio

Smith *et al.*, (2005) compared the nutritional values of *Acacia nilotica* and *Dichrostachys cinerea* fruits treated with NaOH and Polyethylene Glycol. After 48 h incubation, *in vitro* organic matter digestibilities of both species were increased by Polyethylene Glycol and NaOH treatment. Dry matter (DM) intake and DM digestibility were lowest and N-retention negative in goats fed. Farmantan, a natural extract from Chestnuts tannins improved body weight gain and feed conversion efficiency in lactating cow (Dumanovski and sotoseki, 1998). Similarly, Errante *et al.*, (1998) reported farmantan at 120 g/day increased daily weight gain and feed conversion efficiency by 33% and 7%, respectively in dairy cow. Similarly, Bensalem *et al.*, (2002) reported that supplementation of lambs feeding on spineless cactus pods with 100 g of air-dried *Acacia* leaves and SBM increased growth rate to 102 g/d from 75 g/d of control diet. Bayssa, (2006) studied the effects of feeding untreated and treated *Acacia nilotica* pods on lactating goats. Four diets were prepared. The diet consisted of green maize fodder and concentrate in 50: 50 ratio (TMR I) where as in TMR II untreated babul pods (4% tannins) was added to the extent of 22.2% while, in TMR III, the babul pods(6% tannin) to the extent of 33.3% treated with 3% Ca(OH)₂ and TMR IV, the babul pods (6 % tannins) to the extent of (33.3%) treated with 3% Ca(OH)₂ + PEG (0.10 Polyethylene glycol : Tannin). He found non-significant difference among all treatment groups in terms of DMI, DOMI, CPI and TDNI. The feed conversion efficiency (DMI, kg/kg milk production) also showed similar trend and was better than control (1.75 versus 1.39 kg DMI/kg MY). Similarly the gross energetic efficiency (%) was comparatively higher in treated group than control diet but the gross protein efficiency remained similar across the dietary treatments.

The data further suggested that 4 % tannins through babul pods in the diet of lactating goats can be incorporated without affecting the production performance of animals.

2.10. Growth rate, daily weight gain) in growing fattening ruminants

Wina *et al.*, (2005) reported large increase in average daily gain in goats fed diet containing water soaked *Acacia villosa* leaves and cassava flour (71 g/day) compared to those fed diet containing unsoaked leaves and water soaked leaves (38.9 and 44.7 g/day) ($P < 0.05$). Tanner *et al.* (1990) reported that supplementation of *Acacia nilotica* pods with seeds to growing rams reduced growth rate significantly ($P < 0.05$) as compared to control. Rate of gain in growing animals reflects total intake and availability of nutrients in the diet. Low total intake and low growth rates were also observed in animals eating *A. sieberiana* pods and leaves of *A. cyanophylla* (Reed *et al.*, 1990). Rubanza *et al.*, (2007) reported that supplementation with browse tree leaves resulted to improved weight gains ($P < 0.05$) of animals fed on *Leucaena leucocephala* than those supplemented with *A. nilotica* and *A. polyacantha*, compared to the control group, which lost weight. Improved weight gains were mainly due to the corrected dietary crude protein (CP) in the basal diet from browse supplements and probably due to improved feed digestibility and nutrients supply to the animals. Supplementation of animals with *A. nilotica* and *L. leucocephala* leaves at 20% of the expected dry matter intake (DMI) optimized weight gains. Dubey (2007) reported that In all the treatment groups, body weight did not differ significantly showing that 16.7% babul pods equivalent to 3% tannins in the diet may be considered safe level of untreated babul pods whereas 27.8% babul pods equivalent to 5% tannins in the diet treated with either calcium hydroxide or polyethylene glycol may be considered safe level in diet of growing crossbred calves without affecting body weight gain. Supplementation of 5 g Polyethylene Glycol -6000 to kids grazing on khejri (*Prosopis cineraria*) containing 11.6% condensed tannin, increased body weight gain by 2.5% with increased DMI and CP digestibility as

compared to condensed tannin acting group (Bhatta *et al.*, 2002).

CONCLUSION

Ethno-veterinary alternatives (based on medicinal plants) are an option for small-scale live-stock farmers who cannot use allopathic drugs or for those larger conventional farmers whose economic circumstances prevent the use of veterinary services for minor health problems of livestock. Current scientific evidence suggests there is significant potential to use plants to enhance animal health in general and that of ruminants. Active areas of research for plant bioactives

(particularly saponin and tannin containing plants) include reproductive efficiency, milk and meat quality improvement, foam production/bloat control and methane production. Nematode control is also a significant area of research and the evidence suggests a much broader range of phytochemicals may be effective. This review presents a summary of the literature and examines international research efforts towards the development of plant bioactives for animal health. This review suggests that plants may indeed be beneficial for animal health, whilst at the same time, highlights the need for more controlled *in vivo* research to validate plant bioactivity.

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