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Efficacy of polyherbal feed additives on nutrient digestibility, milk yield and composition of lactating crossbred goats

F MIRZAEI [1], S PRASAD[2], A K DANG[3] and J P SEHGAL[4]

National Dairy Research Institute, Karnal, Haryana 132 001 India

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One of the most successful attempts accomplished in the last decade is using feed additives such as natural additives (medicinal plants as its seeds, leaves and roots).These additives help in improving animal productivity and increasing milk production (Campanile *et al.* 2008, Wang *et al.* 2009), however, most studies have been conducted with lactating cows. In the last decade, natural additives such as *Asparagus racemosus, Trigonella foenum graecum* seeds, *Carum carvi, Nigella sativa* and chamomile flower have attracted the attention of scientists as useful resource for treating diseases and improving animal productivity. Medicinal plant seeds improved the productivity of lactating animals and its hormonal alert effect on animals resulted into increasing prolactin and growth hormone release and in activating udder tissues in line with increasing glucose concentration with a reduction in cholesterol concentration in blood (Drackley *et al.*2001,Abo El-Nor *et al.* 2007).

Natural additives have been used to improve animal productivity from milk that depends on direct manipulation in rumen environment. The remarkable effect was, increasing propionate level in the rumen with maintaining the acetate to propionate ratio to be constant to maintain fat concentration in milk. Therefore, the present study was undertaken to see the effect of natural additives in combination on milk yield and composition of lactating goats.

This study was conducted at the experimental farm in goat section of National Dairy Research Institute, Karnal, India during January to April 2009.

Preparation of herbal supplements: Individual herb was procured from local market after assessing their quality in consultation with ayurvedic practitioners and drug manufacturers. Each herb was pulverized separately. The polyherbal biostimulator feed additive was prepared after mixing powderized herbs in specific proportion. The polyherbal supplementation contained; *Asparagous racemosous* (*shatavari*), *Leptadenia reticulata* (*jivanti*), *Nigella sative* (*kolonji*), *Cuminum cyminum* (*jeera*) and *Pueraria tuberosa* (*vidarikand*).

Lactation trial: Two levels of polyherbal combination with concentrate mixture and *ad lib.* green fodder were chosen to be used in the lactation trial.

Feeding and management: Lactating Alpine × Beetal crossbred goats (30), 2–3 year-old, weighting on average of 42±3.25 kg (at the second and third season of lactation), after 2 weeks of kidding were randomly assigned into 3 groups (10 each) using complete random block design. The experimental period was extended to 12 weeks. The animals were introduced to the following treatments; (i) control group without polyherbal supplement as T_1, (ii) treatment 1 with 125 mg/kg body weight polyherbal supplement as T_2, (iii) treatment 2 with 250 mg/kg body weight polyherbal supplement as T_3.

Experimental additives were mixed with 1 kg of concentrate mixture and introduced to animals in daily morning meal. Diet was formulated to meet the animal's requirements (N R C2 1981). Animals were fed grouply with concentrate mixture and green fodder (berseem) were offered twice daily at 9:00 AM and 2:00 PM respectively. Dry matter intake (DMI) was recorded every 2 weeks by weighing feeds offered and refused by the animals. Freshwater was made available to the animals all the time. Chemical composition of ingredients is shown in Table 1.

Apparent digestibility: Digestibility trial was applied during the last week of experiment using 6 animals from each group. Offered, residuals and faecal samples were collected after 24 h and were taken 100 g of each samples for further achievements, then were dried at 55 °C for 48 h, and then ground to pass a 1 mm sieve in a feed mill for

Present address: [1]Scientist (e mail: farmir2003203 @yahoo.com), Livestock Production and Management Division, ASRI, IRAN.

[2]Principal Scientist and Head (e mail: shiv_kimothi @rediffmail.com), Livestock Production and Management Division; [3]Senior Scientist (e mail: ajaydang @rediffmail.com), Dairy Cattle Physiology Division; [4]Senior Scientist (e mail: jpsehgal@rediffmail.com), Dairy Cattle Nutrition Division.

Table 1. Chemical composition of concentrate, polyherbal supplement and green fodder (% on DM basis)

Item	Concentrate	Polyherbal supplement	Berseem-mustard mix	Lucerne	Berseem
DM	89.57	91.26	10.59	18.36	15.44
Ash	8.09	5.20	21.31	12.73	13.47
OM	91.91	94.80	78.69	87.27	87.53
CP	20.85	15.75	19.42	22.09	18.86
EE	2.83	13.80	2.81	3.8	3.9
CF	9.65	21.21	13.64	19.82	21.11
NFE	58.57	44.04	39.87	41.56	42.66

chemical analysis. The digestibility coefficient of certain nutrient was calculated according to the formula used by Ferret *et al.* 1999.

Feed and fecal analysis: Feedstuffs and fecal samples were analyzed according to the AOAC (1995) methods to determine crude protein (CP), ether extract (EE), crude fibre (CF) and ash contents. Organic matter (OM), nitrogen free extract (NFE) contents and total digestible nutrients (TDN) were calculated by related formula.

Sampling and analysis of milk: Individually, milk samples were collected daily along the experimental period (12 weeks). The animals were hand milked (twice/day) and milk yield was recorded. Milk samples were analyzed for total solids, solids not fat, fat, protein by infrared spectrophotometry according to AOAC (1997) procedures. Fat corrected milk (4% fat) was calculated by using the following equation according to Gaines (1928), i.e.

4%FCM = 0.4 × milk yield (kg) + 15 × fat yield (kg)

Blood parameters: Blood samples were collected from the jugular vein of each animal at the last day of each fortnight (1 h before the 07:00 h feeding). The collected blood samples were centrifuged at 4000 r p m/20 min to separate the plasma. The obtained plasma was stored at -18°C till analysis. Total leukocyte count (TLC) was determined by the haemocytometer as described by Schalm (1981) and glucose by end point o-Toluidine method (Dubowski 1962).

Statistical analysis: Data were analyzed using the SYSTAT Software to account for effects of treatment, period, interactions between treatment and period and animal within treatment. The treatment was considered a fixed effect period and animals within treatment were considered random effects. The Duncan's multiple range test was used to test the significance between means (Duncan 1955).

Apparent digestibility: It is well established that, all combination additives slightly increased (P>0.05) the values of apparent nutrient digestibility coefficients than that in control (Table 2). Animals fed T_2 and T_3 showed higher (P>0.05) digestion coefficients for dry matter and crude protein than those fed T_1 (control). Also, all additives showed higher (P>0.05) digestion coefficients for organic matter,

Table 2. Apparent nutrient digestibility and nutritive value of the experimental rations

	T_1 (Control)	T_2	T_3	SEM	P
Apparent nutrients digestibility (%)					
DM	65.32	69.00	71.20	2.25	NS
OM	69.80	74.52	74.52	1.89	NS
EE	51.14	61.04	59.64	6.37	NS
CF	50.94	52.42	54.23	3.42	NS
CP	72.48	75.57	75.73	1.62	NS
NFE	75.22	76.72	79.59	1.52	NS
Nutritive value (*g/h/day*)					
DCP	366.49^b	366.63^b	344.78^a	2.32	0.001
TDN	1251.48^b	1251.95^b	1177.35^a	7.93	0.001

Each value is an average of 7 samples; TDN,total digestible nutrients;T_1 ,control ration with any supplementation;T_2, ration with 125 mg//head/day of polyherbal supplement; T_3, ration with 250 mg/head/day of polyherbal supplement; means in the same line with different superscripts are significantly different.

crude fiber and nitrogen free extract than control. However, all additives showed higher (P>0.05) digestion coefficients of ether extract than control. Moreover, Alam *et al.* (2005) also did not find significant difference in DM, OM and N digestibility when *Albizia* were offered to growing goats untreated or treated with calcium hydroxide. Bayssa (2006),found digestibility coefficient of EE significantly higher (P<0.05) in treatment groups than control.

Experimental additives in T_2 slightly improved nutritive values as total digestible nutrients and digestible crude protein of rations compared with T_3 and T_1 (Table 2). Results obtained with polyherbal biostimulants in low level might indicated the stimulation of rumen micro-flora activity through saving some micro factors to rumen micro-flora such as micro elements, vitamins, hormones and enzymes which are required to the efficient digestion, absorption and metabolism (Aboul-Foutouh *et al.* 2000) and/or minimizing effectively hazards of mycotoxins by inhibition of fungi

Table 3. Effect of different additives on some blood parameters of lactating goats

	T_1 (Control)	T_2	T_3	SEM	P
Glucose (mg/dl)					
First month	72.40	82.70	76.60	4.69	NS
Second month	69.20	69.70	72.30	1.64	NS
Third month	55.70	54.40	60.10	3.58	NS
Overall	65.77	68.93	69.67	2.04	NS
Total leukocyte count (*cells/ml*)					
First month	11350.00	9570.00	12065.00	1057.80	NS
Second month	10515.00 ^{a}	11835.00^a	14470.00 ^{b}	1004.04	0.03
Third month	10205.00	10360.00	12715.00	970.34	NS
Overall	10690.00^a	10588.33 ^{a}	13083.33 ^{b}	583.91	0.004

Means in the same line with different superscripts are significantly different.

growth and aflatoxins production (Allam *et al.* 1999 and Mohamed *et al.* 2003). Aboul-Foutouh *et al.* (2000), Ali *et al.* (2005) and El-Ashry *et al.* (2006) observed similar results when they added polyherbal supplements or other medicinal plants to dairy buffaloes or growing lambs.

Blood parameters: Animals fed supplemented rations had higher (P<0.01) TLC concentrations than control (Table 3). These results may be due to the improvements occurred in metabolic process as a response to the experimental additives. The concentrations of glucose were in the normal range for healthy animals and were higher in supplemented groups than control. These results are parallel with values of Ali *et al.* (2005) who found that chamomile supplemented goats ration increased blood glucose values (P<0.05). Stella *et al.* (2007) found no significant effect of yeast culture supplementation on plasma glucose of lactating goats. These results indicated that tested additives to lactating goat's rations did not negatively affected liver activity or animal's health.

Dry matter intake: Total dry matter intake (DMI) was not significantly affected by experimental additives (Table 4). Values of DMI calculated as proportion from metabolic body size (MBS) (kg$W^{0.75}$/day) showed a slightly increase (P>0.05) with experimental additives compared to control. Kholif and Khorshed (2006), Campanile *et al.* (2008) and Wang *et al.* (2009) suggested that DMI was not affected by additives to animal rations while, Abo El-Nor and Kholif (2005) reported that DMI was not affected by additives to dairy goat's rations.

Milk yield and composition: The productive performance data and milk analysis are shown in Table 4. Milk and 4% FCM yields in the present study were slightly higher (P>0.05) in low level supplemented group compared to high level supplemented and control groups and were found in agreement with Kholif and Khorshed (2006), Abo El-Nor *et al.* (2007) and Campanile *et al.* (2008). The addition of polyherbal combination increased the net energy of milk for dairy goat, according to higher organic matter digestibility, thus leading to an increase in milk yield. The relative improvement of milk production of T_2 might be due to the healthy effect of polyherbal additives and the associated effect between acetate and succinate on rumen microflora, which lead to improvement of feed efficiency and milk production (Abo El-Nor and Kholif 2005). In this study, levels of serum energy indicators (glucose) of treated goats was higher (Table 3) suggesting that higher dry matter utilization of treated goats provided enough energy to support the increased milk production (Stella *et al.* 2007).

Milk protein, fat, TS and SNF contents were higher (P>0.05) in animals fed experimental additives than control. Kholif and Khorshed (2006) found that rations supplemented with yeast, significantly increased milk protein and lactose contents compared with control. In the other studies, milk fat, protein and lactose contents were not affected by polyherbal supplementation (Erasmus *et al.* 2005 and Campanile *et al.* 2008) fed lactating goats on polyherbal supplemented rations and found that treatments slightly increased milk TS and SNF.

Table 4. Effect of different additives on milk yield, FCM, milk composition % and feed and economic efficiencies in lactating goats

	T_1 (Control)	T_2	T_3	SEM	P
Live body weight (kg)	42.85	42.30	43.50	2.06	NS
DMI (kg/h/d)	56.65	52.22	51.69	9.32	NS
MBS ($W^{0.75}$/kg)	142.01	134.56	131.88	22.86	NS
Milk yield (kg/h/d)	2.20^b	2.27^b	2.00^a	0.07	0.01
Fat corrected milk (kg/h/d)	1.98	2.14	1.84	0.12	NS
Milk composition					
Protein (%)	2.97	2.99	3.00	0.01	NS
Fat (%)	3.32	3.38	3.40	0.06	NS
Lactose (%)	4.51	4.47	4.47	0.02	NS
Solids not fat (%)	8.24	8.23	8.30	0.04	NS
Total solids (%)	11.56	11.54	11.68	0.08	NS
Feed and economic efficiencies					
DMI / milk yield (kg)	1.05	0.98	1.32	0.17	NS
DMI / 4% FCM (kg)	1.19	1.05	1.47	0.19	NS
Overall cost of diet/h/d($)	0.32	0.34	0.35	0.02	NS
Return milk sale/h/d($)	0.67	0.70	0.67	0.04	NS
Net return over feed cost/h/d($)	0.36	0.37	0.29	0.04	NS

Means in the same line with different superscripts are significantly different

In general, feed efficiency calculated as milk yield/DMI and 4% FCM/DMI were significantly improved in T_2 followed by T_3 and T_1. Also, economic efficiency of these additives followed the same trend of feed efficiency (Tables 4,5). The highest relative efficiency was recorded with T_2 whereas groups T_1 and T_3 showed the lower efficiencies in that order.

Milk yield and 4% FCM increased (P>0.05) gradually with periods advancement up to eighth week of lactation period and decreased gradually thereafter (Table 5). Also, feed efficiency (milk yield/DMI) and (FCM/DMI) were taking the same trend of milk yield. Milk constituents showed significant variations among different weeks in different groups. These results clearly indicated that highest milk production and feed efficiency were recorded in T_2 group as compared to T_3 and T_1. Kumar (2009) and Beyan (2009) found similar trend of milk yield in different phase of lactation of lactating cows and goats respectively.

It could be concluded that lactating goat's ration supplemented with combination of polyherbal supplements showed improvement of nutrients digestibility, milk production, milk composition and economic efficiency compared to animals fed the control diet. Also, no deleterious effects on general health of the treated animals were observed. However, polyherbal supplementation of diet improved their

Table 5. Weekly means of DM intake, milk yield, milk composition and feed efficiency in treatment groups

	Periods (week)							
Item	2	4	6	8	10	12	SEM	P
T_1								
DMI (kg/h/d)	1.38^{a}	1.43^{b}	1.93^{c}	1.94^{c}	2.08^{e}	1.99^{d}	0.02	0.001
MY (kg/h/d)	2.46	2.41	2.35	2.45	2.05	2.32	0.22	NS
4% FCM (kg/h/d)	1.99	2.08	2.15	2.11	1.97	1.87	0.17	NS
Milk composition								
Protein (%)	3.00^{c}	2.90^{a}	2.91^{a}	2.88^{a}	2.88^{a}	2.96^{b}	0.03	0.05
Fat (%)	2.98	2.97	3.11	2.70	3.17	2.83	0.15	NS
TS (%)	10.92	11.05	11.04	11.10	10.70	11.36	0.17	NS
SNF (%)	8.34^{c}	8.07^{ab}	8.08^{ab}	8.00^{a}	8.00^{a}	8.20^{bc}	0.08	0.04
Feed efficiency (kg)								
Milk yield/DMI	1.78^{c}	1.69^{c}	1.24^{b}	1.26^{b}	0.99^{a}	1.16^{b}	0.09	0.001
4%FCM/DMI	1.42^{c}	1.46^{c}	1.12^{b}	1.09^{b}	0.95^{a}	0.94^{a}	0.11	0.05
T_2								
DMI (kg/h/d)	1.39^{a}	1.42^{a}	1.94^{b}	1.92^{b}	2.17^{c}	1.91^{b}	0.03	0.001
MY (kg/h/d)	2.23	2.19	2.43	2.42	2.22	2.58	0.20	NS
4%FCM (kg/h/d)	1.91	1.72	2.41	2.22	2.02	2.08	0.17	NS
Milk composition								
Protein (%)	2.99d^{e}	2.98^{d}	2.80^{a}	2.84^{b}	2.89^{c}	3.02^{e}	0.02	0.001
Fat (%)	3.19^{c}	3.20^{c}	3.13^{c}	2.72^{b}	3.52^{d}	2.49^{a}	0.12	0.001
TS (%)	10.66^{a}	10.97^{ab}	10.94^{ab}	11.01^{b}	10.76^{ab}	11.84^{c}	0.26	0.04
SNF (%)	8.33	7.78	7.74	7.88	8.04	8.32	0.21	NS
Feed efficiency (kg)								
Milk yield/DMI	1.60c	1.54c	1.25b	1.26b	1.03a	1.35b	0.11	0.03
4%FCM/DMI	1.37	1.21	1.24	1.16	0.93	1.09	0.11	NS
T_3								
DMI (kg/h/d)	1.31^{a}	1.44^{b}	1.77^{cd}	1.78^{d}	2.08^{e}	1.72^{c}	0.03	0.001
MY (kg/h/d)	1.95	1.81	2.14	2.15	1.94	2.46	0.26	NS
4%FCM (kg/h/d)	1.59	1.50	2.04	2.14	1.68	2.12	0.23	NS
Milk composition								
Protein (%)	3.04^{d}	2.95^{bc}	2.84^{a}	2.91^{b}	2.99^{c}	3.06^{d}	0.03	0.001
Fat (%)	3.14^{c}	2.78^{b}	3.15^{c}	3.11^{c}	3.31^{c}	2.46^{a}	0.17	0.007
TS (%)	11.60^{cd}	11.33^{bc}	10.64^{a}	11.24^{b}	11.40^{bc}	11.76^{d}	0.18	0.001
SNF (%)	8.43^{d}	8.19^{bc}	7.86^{a}	8.08^{b}	8.30^{c}	8.45^{d}	0.07	0.001
Feed efficiency (kg)								
Milk yield/DMI	1.5	1.26	1.21	1.21	0.93	1.43	0.22	NS
4%FCM/DMI	1.26	1.05	1.14	1.20	0.81	1.23	0.21	NS

Means in the same line with different superscripts are significantly different.

milk production. Further studies are needed to determine the exact ratio of these combinations and respective mechanisms that elicit positive effects on milk production on high yielding goats.

SUMMARY

This study was carried out to evaluate the effect of dried mixture of 5 herbal plants, viz. *Asparagus racemosus*, *Trigonella foenum graecum* seeds, *Carum carvi*, *Nigella sativa* and chamomile flower, as natural additives on milk yield and composition of crossbred dairy goats. Results clearly indicated that combination of herbal supplementation in different treatments recorded the lowest rate of dry matter digestibility (DMD) compared to control group. Lactating goats (30) after 2 weeks of kidding were divided into 3 groups (10 animals each) using complete random block design to evaluate the effect of herbal mixture supplement on the productivity of lactating goats. Treatment 2 (T_2) and treatment 3 (T_3) were supplemented with polyherbal combination @ 125 and 250 mg/kg body weight respectively. Goats without polyherbal combination served as control group (T_1). Animals were fed on 40% concentrate feed mixture and green fodder *ad lib*.

Dry matter intake (DMI) slightly increased for animals fed on T_2 ration compared to T_1 and T_3. Apparent nutrients digestibility and total digestible nutrients (TDN) were significantly improved by treatments. Milk yield, 4% fat corrected milk (FCM),milk protein, fat, total solids, feed

efficiency (DMI/milk yield and DMI/4% FCM) and economic efficiency were significantly higher for animals in T_2 followed by T_3 and T_1(control). Glucose contents and total leukocyte count (TLC) were higher in animals which received experimental additives than those received control. It may be concluded that adding the combination of polyherbal supplementation to rations improves the productivity of lactating goats with no deleterious effects on general health.

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