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Effect of incorporation of detoxified karanja (*Pongamia pinnata*) and neem (*Azadirachta indica*) seed cakes in total mixed rations on milk yield, composition and efficiency in crossbred dairy cows

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Protein is an important macronutrient and an expensive constituent of animal diet and price escalation of protein sources such as groundnut cake (GNC), soybean cake (SBC) will have a bearing on profitability of dairy farmers. Two alternative unconventional protein sources such as karanja (*Pongamia pinnata*) cake and neem (*Azadirachta indica*) seed cake were tried as a replacement of conventional cakes in the total mixed rations (TMR) of dairy cattle. Neem and karanja cakes can be supplemented to livestock rations as replacement of conventional protein supplements after defatting and detoxification (Dinesh Kumar *et al*. 2011, Dutta *et al.* 2012, Dinesh Kumar *et al.* 2013, Rao *et al.* 2014, Rao and Dinesh Kumar 2015). However, there are no systematic reports available on the effect of feeding of these cakes on milk production. The present study was aimed to include detoxified neem and karanja seed cake as partial replacer of soybean meal in total mixed rations (TMR) of dairy cattle for their effects on milk yield, composition and efficiency.

Locally available maize fodder and concentrate feed ingredients (maize, soybean meal, deoiled rice bran) were procured from the local market. The maize fodder was dried, chaffed and ground in a chaffer cum grinder and mixed into complete rations in a horizontal mixer and concentrate mixtures were prepared in feed mixing plant at Department of Animal Nutrition, College of Veterinary Science, Tirupati. Detoxification processes on neem seed cake (Saxena *et al*. 2010) and karanja cake (Ravikanth *et al*. 2009) were upgraded so that resultant products contain less oil and minimum incriminating factors.

Eighteen crossbred cows (Jersey or Holstein-Fresian cross with local cattle) with a mean BW of 334.56±12.76 kg and average milk yield of 5.67±0.29 kg/d were used for conducting the lactation trial. They were divided into three groups in completely randomized design (CRD). All the animals were housed in well ventilated katcha shed under uniform managemental conditions. Three total mixed rations and clean drinking water were offered *ad libitum* for four times a day. The diets were moistened before feeding to prevent dustiness and faster consumption. Control TMR (T_1–Control) was formulated using dried maize fodder (roughage source) and concentrate feed ingredients (maize grain, deoiled soybean meal, urea, molasses, mineral mixture and salt). All the ingredients were ground in a chaffer cum grinder. Detoxified neem cake (dNC) and detoxified karanja cake (dKC) were incorporated in the rations replacing 50% of protein content of soybean meal. Thus, dNC was used at 3.78% of TMR (T_2-dNC), whereas dKC was used at 5.85% of TMR (T_3–dKC). In T_2–dNC, soybean meal was substituted at 13.2% with detoxified neem seed cake and in T_3-dKC, soybean meal was substituted at 18% with detoxified karanja cake. Therefore, three types of TMR were prepared for the entire duration of the experiment.

A 90 days lactation feeding trial was conducted on lactating crossbred cows to study the effect of feeding complete rations on milk yield and composition. Animals were completely machine milked twice daily at 4.00 a.m and 4.00 p.m throughout the experimental period and daily milk yield was recorded. Representative samples of milk were collected in sterile milk sample bottles once in a week throughout the experiment.

Animal body weights were calculated from their heart girth and body length measurements by Shaffer's formula (Sastry *et al.* 1982). Body weight (lb) = (G2×L)/300 where, G is heart girth and L is the body length from shoulder point to pin bone in inches. The factor 0.4536 was used to convert these body weights into kilogram. Milk samples were analyzed for milk fat by Gerber's method (ISI 1977 IS: 1224 Part I), SNF by Gravimetric method (ISI 1982 IS: 10083), total solids by the addition of fat and SNF content, 4% FCM (NRC 2001), milk protein by Kjeldahl method (AOAC 2010).

The fecal egg count (FEC) was determined as eggs per gram (EPG) taken by the Stahl's method described by

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Solesby (1982). As the animals were maintained in an organized farm, periodical rotational deworming was followed to keep the parasitic load to a minimum. The fecal samples were collected at the beginning as well as end of the trial and they were studied for FEC.

Data from individual animals were averaged for each parameter and the values were subjected to statistical analysis (Snedecor and Cochran 1989) using SPSS. Statistical significance among groups was determined using two way ANOVA and Tukey's post-hoc test was employed to assess statistical significance. For milk yield and compositional parameters, treatment, period and interactions were found out using SPSS. The values were expressed as mean±SE. Differences were considered significant if $P<0.05$.

The initial and final body weight of cows during the period of 90 days of lactation study in all treatments remained same ($P>0.05$). However, there was improvement in body weight irrespective of the groups. The body weights increased over a period of 90 days indicating that all the rations had positively influenced the body weights and differences were non-significant. The average initial body weights of animals in T_1–control, T_2–dNC and T_3-dKC were 331.44, 334.51 and 337.72 kg, respectively. After 90 days of feeding trial, the body weights for T_1–control, T_2-dNC and T_3-dKC were 359.88, 364.66 and 360.62 kg, respectively. The percent CP was made around 12% to meet the nutrient requirements as per ICAR (1998) taking into consideration the dry matter intake as well as milk yield and stage of lactation. The fecal egg count as eggs per gram was studied at the beginning and the end of the experiment by collecting dung samples from all the 18 animals and found negative. This was probably due to periodical rotational deworming of the animals.

Milk yield (kg/day) and FCM yield (kg/day) was found to be more in dNC compared to dKC groups (Table 1). Over a period of 90 days feeding, both milk yield (kg/day) and FCM yield (kg/day) increased in all the groups. The average milk fat was found to be lower ($P<0.05$) in T_3-dKC group (5.03±0.21) compared to T_1-control (6.13±0.25). With the progression of experiment, milk fat remained equivalent among all treatment groups. However, total fat yield (g/d) was found to be higher ($P<0.05$) in T_2-dNC. Similarly, compared to initial values, total fat yield increased ($P<0.05$) in all the treatment groups. The average milk SNF was found to be equivalent among all three groups and as experiment progressed, milk SNF also remained same in all the groups. Total solids was found to be lower ($P<0.05$) in T_2-dNC and T_3-dKC groups compared to T_1-control. Total solids (%) among different groups remained similar during different fortnights. Total solid yield (g/d) was found to be higher in T_2-dNC compared to T_3-dKC and T_1-control. Total solid yield (g/d) was increased from initial to final stage of experiment across all the treatments. Density and milk protein was found to be equal among dNC and dKC groups compared to T_1-control. Milk density, milk protein also remained same across all the fortnights. DMI (kg) required for kg FCM was found to be same ($P>0.05$) in all the groups (Fig. 1). Significant improvements in milk yield and FCM yield were recorded in neem seed cake containing group compared to control and karanja cake fed groups. This was probably attributed to better protein availability from neem

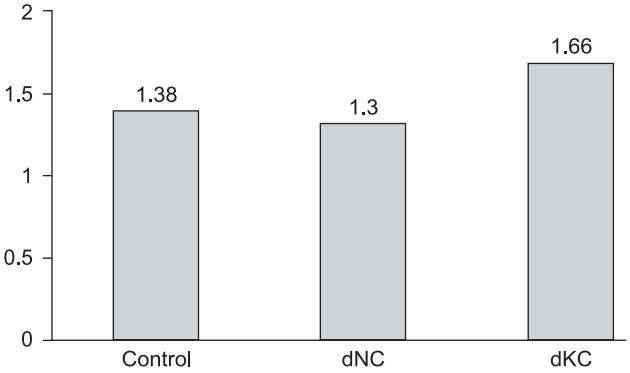

Fig. 1. Efficiency of milk production (kg DM per kg FCM) of different groups: (T_1-Control), with soybean meal as sole protein supplement; (T_2-dNC), detoxified neem cake was used at the expense of 50% of soybean meal protein; (T_3-dKC), detoxified karanja cake was used at the expense of 50% of soybean meal protein.

Table 1. Milk yield and composition in treatment groups

Attributes	T_1 (Control)	T_2 (dNC)	T_3 (dKC)	SEM	Trt	Period	Trt*Period
Milk yield (kg/d)	4.95^{b}	6.23^{a}	5.11^{b}	0.15	0.001	0.014	0.972
4% FCM yield (kg/d)	6.46^{ab}	7.47^{a}	5.91^{b}	0.20	0.004	0.003	0.921
Fat (%)	6.13	5.33	5.03	0.14	0.006	0.280	0.985
Fat yield (g/d)	291.99	332.60	257.52	10.26	0.008	0.003	0.935
SNF (%)	9.37	9.00	9.24	0.09	0.208	0.918	0.350
SNF yield (g/d)	465.10	559.83	471.50	14.54	0.011	0.016	0.994
Total solid (%)	15.50	14.33	14.26	0.17	0.003	0.244	0.610
Total solid yield (g/d)	763.09	892.43	729.84	22.88	0.006	0.003	0.969
Milk density	30.84	31.18	31.25	0.16	0.578	0.878	0.764
Milk protein	3.66	3.68	3.60	0.01	0.096	0.525	0.992

Values bearing different superscripts in a row (a,b) differ significantly ($P<0.05$). (T_1, Control), with soybean meal as sole protein supplement; (T_2, dNC), detoxified neem cake was used at the expense of 50% of soybean meal protein; (T_3, dKC), detoxified karanja cake was used at the expense of 50% of soybean meal protein.

seed cake. Rangaiah *et al.* (2004) fed water washed neem seed cake to lactating Murrah buffaloes and observed similar milk yield and quality when compared to control. In the present study, even though all the three rations were iso-nitrogenous, the inclusion of neem seed cake showed better conversion efficiency into milk yield without showing any adverse effects. The milk production of dairy cows can be increased by manipulating post ruminal digestibility of rumen degradable protein and amino acid balance rather than rumen degradable protein alone (Noftsger and St-Pierre, 2003). Palmquist and Beaulieu (1993) had discussed various feed factors like grain intake, undegradable protein intake, fat supplements and energy intake which influence milk fat composition. Thus, the differences in milk yield and composition observed in the present study were attributed to quality and quantity of degradability of protein supplements and minor changes in composition of TMR. The detoxification process used in this study can be very well integrated with existing neem/karanja oil factories and the resultant cake can be cheaper alternative for soybean meal thus there will be economic benefits to the feed companies which in turn pass on the benefit to the customers. The results pertaining to the milk yield, milk fat, SNF, milk protein, total solids, density and milk production efficiency revealed that the 50% replacement of soybean meal with neem seed cake and karanja cake did not show any adverse effect for a period of 90 days.

SUMMARY

In the present study, neem seed cake (51.55% CP) and karanja seed cake (37.91% CP) were used as a partial replacement of soybean protein cake. Three iso-nitrogenous total mixed rations (TMR) were prepared namely T_1-control where soybean meal was incorporated at 9.6% of TMR, in T_2-dNC and T_3-dKC, the cakes were incorporated at 3.85 and 5.85% of TMR and fed to eighteen crossbred cows in three groups for 90 days. Milk yield (kg/day) and FCM yield (kg/day) was found to be higher in dNC compared to dKC groups. After 90 days of feeding, both milk yield (kg/day) and FCM yield (kg/day) increased in all the groups. The average milk fat was found to be lower in ($P<0.05$) in T_3-dKC group (5.03) compared to T_1-control (6.13). Total solids was found to be lower in T_2-dNC and T_3-dKC groups compared to T_1 control. DMI (kg) required for kg FCM was same in all the groups (1.38 in T_1-control; 1.30 in T_2-dNC and 1.66 in T_3-dKC). It was concluded that detoxified neem cake (dNC) and detoxified karanja cake (dKC) can be included in total mixed rations of medium producing dairy cattle (5–8 liters of milk per day) replacing standard soybean meal without adversely affecting milk composition and milk production efficiency.

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