A pilot study on effect of feeding castor (Ricinus communis) oil on milk yield and composition in lactating Kankrej cows

PC Joshi, MM Pawar, YM Gami, SS Patil, MP Patel and HH Panchasara

Abstract
Functional oils, such as castor oil are chemical substances extracted from various plants which provide health benefits besides their nutritive properties. A pilot study was conducted to assess the effect of feeding castor oil (Ricinus communis) on milk yield and composition in lactating Kankrej cows. Thirty two lactating Kankrej cows (21 days in milk; average 9.74 kg/d of milk yield) were assigned randomly into four treatments having 8 cows each. The four treatments were: T1: control group (without castor oil); T2: 5 ml/d castor oil; T3: 10 ml/d castor oil and T4: 15 ml/d castor oil supplementation for a period of 21 days. The average milk yield, 4% fat corrected milk (FCM) and energy corrected milk (ECM) yield was increased numerically by 7.6, 9.2 and 9.8%, respectively in T4 group as compared to control. The percentage of milk fat and lactose were similar among the different treatments. Milk total solids, solid-not fat and protein were significantly (P<0.05) higher in group T4 than the group T1 and comparable to both in the groups T3 and T1. It is concluded that dietary inclusion of castor oil at the rate of 15 ml/d has improved milk yield and modified the milk composition in lactating Kankrej cows.

Keywords: Castor oil, feed additive, functional oil, Kankrej cow, milk yield

Introduction
India is the largest producer of milk in the world with the increase in production from 17.0 million tonnes in 1950-51 to 155.49 million tonnes in 2015-16 (BAHFS, 2015). Currently, the Indian dairy market is growing at an annual rate of 7%. Milk yield in dairy animals can be improved by factors such as genetic selection of animals for traits like higher milk yield, balanced feeding and other management practices. However, after exploring genetic potential of animal, improved production can only be supported by use of balanced ration and feed supplements/additives such as functional oils. Functional oils, such as castor oil are chemical substances extracted from various plants by distillation, compression or using solvents, providing health benefits besides their nutritive properties (Murakami et al., 2014; Ferreira de Jesus et al., 2016) [10, 5]. Data on effects of dietary functional oil supplementation in dairy cows performance are still scarce in literature.

Materials and Methods
Location of study
The experiment was carried out at Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat. It is located in semi arid region of Banaskantha District of North Gujarat having latitude of 24.35° North and longitude of 72.59° East and at an elevation of 189 meters above the mean sea level.

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Experimental Animals and Design
Thirty two lactating Kankrej cows (21 days in milk; average 9.74 kg/d of milk yield) were assigned randomly into four treatments (8 cows per treatment) stratified on the basis of live body weight and milk production. The four treatments were: T₁: control group (without castor oil); T₂: 5 ml/d castor oil; T₃: 10 ml/d castor oil and T₄: 15 ml/d castor oil supplementation for a period of 21 days. Castor oil was mixed into a portion of the concentrate thoroughly and provided once daily during the experimental period. The animals were fed as per ICAR (2013) feeding standards to meet the nutrient requirements. All the experimental animals were reared under standard management practices with free access to fresh and clean drinking water. The feeds and fodder used in the experiment were as analyzed for chemical composition viz. dry matter, crude protein, crude fibre, ether extract and total ash (AOAC, 2007) [12].

All cows were milked twice a day (morning 4:00 a.m. and evening 4:00 p.m.) and individual milk yield of each cow was recorded daily by using electronic weighing balance. For analysis of milk constituents, milk samples were collected at weekly interval. Milk fat, solid not fat (SNF), protein and lactose were determined by using EKOMILK Ultra Pro Milk Analyzer (Everest Instruments Pvt. Ltd.). The 4% fat corrected milk (FCM) and energy corrected milk (ECM) yield were calculated as:

\[
4\% \text{ FCM} = \text{Milk yield (kg)} \times 0.4 + \text{Fat yield (kg)} \\
\text{ECM} = 0.327 \times \text{Milk yield (kg)} + 12.95 \times \text{Fat yield (kg)} \\
+ 7.20 \times \text{Protein yield (kg)}
\]

Statistical analysis
The data obtained was statistically analyzed as per the method of Snedecor and Cochran (1994) [17]. Analysis of variance of the data obtained in the experiment was conducted based on a completely randomized design (CRD) using the general linear model procedure of SPSS (SPSS 16.0). The differences in the means was compared by Least Significant Differences (LSD) at 5% level (P<0.05).

Results and Discussion
The chemical composition of feeds and fodders fed to experimental animals is given in Table 1. The crude protein content in concentrate mixture, green maize and jowar hay was 19.15, 6.16 and 3.29%, respectively.

The data of milk yield in lactating Kankrej cows fed graded levels of castor oil is presented in Table 2. Initial milk yield was similar among the different treatment groups. The average milk yield (kg/day) during experimental period was 9.58±0.69, 9.62±0.88, 9.43±0.72 and 10.31±1.19 in T₁, T₂, T₃ and T₄ groups, respectively, which was not significantly (P>0.05) affected by supplementation of castor oil among the treatments.

Table 1: Chemical composition (on % DM basis) of feeds and fodders

<table>
<thead>
<tr>
<th>Composition (%)</th>
<th>Concentrate mixture</th>
<th>Green maize</th>
<th>Jowar hay</th>
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<tbody>
<tr>
<td>Dry matter</td>
<td>94.92</td>
<td>15.64</td>
<td>89.73</td>
</tr>
<tr>
<td>Crude protein</td>
<td>19.15</td>
<td>6.16</td>
<td>3.29</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>6.38</td>
<td>27.43</td>
<td>37.58</td>
</tr>
<tr>
<td>Ether extract</td>
<td>3.07</td>
<td>1.16</td>
<td>0.98</td>
</tr>
<tr>
<td>Total ash</td>
<td>7.88</td>
<td>8.56</td>
<td>10.51</td>
</tr>
<tr>
<td>Nitrogen free extract</td>
<td>63.52</td>
<td>56.69</td>
<td>47.64</td>
</tr>
</tbody>
</table>

The 4% FCM and ECM yield was not influenced significantly (P>0.05) by the dietary addition of different levels of castor oil. However, the average milk yield, 4% FCM and ECM yield were numerically improved in T₄ (15 ml/d castor oil) group as compared to the T₁ (control) group by 7.6, 9.2 and 9.8%, respectively. An increase in milk yield was expected as castor oil increase the molar proportion of propionate in rumen. Propionate is the most important substrate for hepatic gluconeogenesis (accounting for 60–74% total substrate), which is highly associated with milk yielding in cows. In line with our findings, Parente et al. (2018) [12] observed that addition 30 g FA/kg DM of castor oil in ewes had no effect on milk production. In contrast, Gandra et al. (2014) [6] observed significant (P<0.05) increase in milk yield (22.47 vs. 24.16 kg/d) in lactating Simmental dairy cows fed with 2 g of ricinoleic acid from castor oil/animal/day in an experiment carried out for 42 days divided into two trials of 21 days. Ferreira de Jesus et al. (2016) [5] also reported that feeding of 500 mg/kg DM of functional oil (cashew nut shell oil and castor oil) in lactating Holstein cows for 21 days increased (P<0.001) milk yield (25.9 vs. 27.1 kg/d), but the FCM yield was not affected (p = 0.188) by the treatments. The data of milk composition in lactating Kankrej cows fed graded levels of castor oil is presented in Table 3. The average fat content in Kankrej milk was ranged from 4.55 to 4.69%. Earlier other authors were recorded similar range of fat percentage in Kankrej cows (Patel et al., 2017; NBAGR, 2018) [13,11].

Table 2: Effect of feeding castor oil on milk yield in lactating Kankrej cows (n=32)

<table>
<thead>
<tr>
<th>Milk yield (kg/d)</th>
<th>Treatments</th>
<th>P value</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>T₁</td>
<td>T₂</td>
</tr>
<tr>
<td>Initial</td>
<td>9.72±0.69</td>
<td>9.79±0.87</td>
</tr>
<tr>
<td>d-7</td>
<td>9.85±0.78</td>
<td>9.53±0.86</td>
</tr>
<tr>
<td>d-14</td>
<td>9.46±0.70</td>
<td>10.00±0.92</td>
</tr>
<tr>
<td>d-21</td>
<td>9.30±0.70</td>
<td>9.16±0.97</td>
</tr>
<tr>
<td>Average</td>
<td>9.58±0.69</td>
<td>9.62±0.88</td>
</tr>
<tr>
<td>4% FCM</td>
<td>10.39±0.77</td>
<td>10.55±0.92</td>
</tr>
<tr>
<td>ECM</td>
<td>11.16±0.79</td>
<td>11.50±1.01</td>
</tr>
</tbody>
</table>

FCM: Fat corrected milk; ECM: Energy corrected milk
The percentage of milk fat and lactose were similar among the different treatment groups. The milk total solids, solid not fat and protein were significantly (P<0.05) higher in group T2 than the group T1 and comparable to both in the groups T3 and T4. Ferreira de Jesus et al. (2016) 10 found that feeding of 500 mg/kg DM of functional oil (castor oil) in lactating Holstein cows for 21 days did not have any influence on milk fat percentage, but milk protein and lactose level were increased (P<0.05). Parente et al. (2018) 12 reported that castor oil supplementation increased milk fat content, while Pereira et al. (2010) 13 reported decrease in milk fat level of goats supplemented with castor oil.

**Conclusion**

Based on the findings, it is concluded that dietary inclusion of castor oil at the rate of 15 ml/d improved milk yield and modified milk composition in lactating Kankrej cows. Further long term studies with castor oil supplementation in dairy cows could contribute to understanding its effect on milk yield and composition.

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