Effect of lignosulfonate supplementation on carryover of monocrotophos to milk in lactating crossbred goats

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Abstract This study was conducted to investigate the effect of lignosulfonate supplementation on carryover of monocrotophos to milk in crossbred (Alpine×Beetal) lactating goats. Study was conducted in two phases: In phase-I, an in vitro experiment was conducted in two sets to observe the effect of different levels of monocrotophos (MCP) on in vitro digestibility parameters (trial 1) and calcium lignosulfonate (LIG) as ameliorant (trial 2). Based on result obtained in in vitro experiment, 25 mg MCP/kg and 2.5% LIG (DM basis) were tested for in vivo experiment in phase II. For in vivo study, twenty lactating goats were randomly distributed into four treatments of five animals in each. The dietary treatments consisted of basal ration devoid of supplemental LIG and MCP (control) or were supplemented with LIG (2.5%, DM basis), MCP (25 ppm, DM basis) or both LIG (2.5%) and MCP (25 ppm). Goats were raised for 60 days and daily feed intake and milk yield was recorded. At 0, 15, 30, 45 and 60 days, milk samples were analysed for its composition and carryover of MCP. In the present findings, MCP intoxication did not affected (P>0.05) intake of DM, DCP and TDN. Milk yield (ranged 1.30-1.38 kg/day) and its composition was similar in control, LIG and MCP group but in MCP with LIG supplemented goats had significantly (P<0.05) lower milk yield, fat, FCM, energy corrected milk and milk energy corrected value. The content of protein, lactose, total solid and SNF varies over time. The supplementation of lignosulfonate as mechanical antidote in MCP intoxicated goats lowered its carryover to milk but its palatability of must be increased in diet either as total mixed ration or as pelleted feed.

Keywords: Carryover, goats, milk, lignosulfonate, monocrotophos, nutrient intake

Introduction Monocrotophos (MCP) is an organophosphate insecticide and acutely toxic but used in agriculture, as a relatively cheap pesticide (Agnihotri, 2000). It has been banned in the U.S. and many other countries. But the use of this organophosphorus (OPP) compound has increased considerably in India due to their low toxicity and low persistence in the mammalian system compared to organochlorine pesticides (Kamath and Rajini, 2007). Feed and fodders are often contaminated with different pesticide residues (Chowdhury et al. 2014; Nag and Raikwar, 2011; Rai et al. 2008, Sharma et al. 2005). The feeding of these contaminated feed and fodders by the animals is main source of entry of pesticides into the animal body (Prasad and Chhabra, 2001; Mohan and Singh, 2013). After entering in blood, pesticide residues are distributed to different organs, tissues and excreted via urine, faeces and milk in lactating animals (Cecchi et al. 2012; Huen et al. 2012; Muhammad et al. 2013). MCP being a highly polar OPP compound is highly hazardous effect on human due to its contact, systemic and residual mode of action (Kumar et al. 2007; Kazemi et al. 2012b). It is also very potent anti-acetyl cholinesterase compound and toxixenobiotics that adversely affect the biological system (Kazemi et al. 2012a; Kumar et al. 2013). The MCP exposure resulted in weight loss in affected animals (Skripsi and Loosli, 1994). The presence of MCP residue in ruminant milk is of immense human health concern. Its occurrence in milk is primarily due to its carryover from the feeds and water after passing through the "Blood-Mammary" barrier. Further, a higher absorption rate from gut and reduced body metabolism may...
The mechanical antidotes like activated charcoal or bentonite have been used to reduce the toxicity of pesticides in ruminants (Singh, 2004; Kumar et al. 2005 & 2007; Kazemi et al. 2012b) with viable success. The use of commercial activated charcoal is difficult because of its high cost. Therefore, lignosulfonate (LIG) as an alternative to activated charcoal was tried in present study due to its binding capacity to various pesticides under simulated gastro-intestinal conditions (Ta et al. 1999). Moreover, its available cost effectively as lignosulfonate, a by-product of paper and pulp industry. Therefore, present study was conducted to investigate the effect of lignosulfonate supplementation on carryover of monocrotophoso milk and its effect on milk composition in crossbred lactating goats. The part of the study containing nutrient utilization and blood biochemical profile has already been reported (Kumar et al. 2013).

Materials and Methods

Present study was conducted in two phases: Phase I as in vitro experiments and Phase II as in vivo study. The concentrate mixture used in present study consisted of maize 33, de-oiled rice bran 11, mustard cake 12, wheat bran 20, groundnut cake 21, mineral mixture 2 and common salt 1 parts.

In vitro experiments

Strained rumen liquor (SRL) was collected from available two fistulated crossbred bull (HF × Sahiwal) fed concentrate mixture, berseem and wheat straw to meet the nutrient requirement as per NRC (2001). The in vitro experiments were conducted using 100 ml syringes with six replicates for each treatment as per method of Menke and Steinigass (1988). A0.2g of substrate (concentrate: berseem 40:60 ratio) was taken into each syringe except for negative control. In trial 1, different treatments were incubated to evaluate the effect of MCP at 25, 50, 100 and 150 ppm (DM basis) against control (0.2g basal ration, without MCP) for 24 h in vitro. In trial 2, based on result obtained in trial 1, a 150 ppm MCP level was incubated for 24 h with 1.0, 1.5, 2.0 and 2.5% calcium lignosulfonate (DM basis) in vitro. The total gas (ml/0.2 g), in vitro dry matter digestibility (IVDMD), in vitro organic matter digestibility (IVOMD) was estimated after 24 h incubation. For volatile fatty acids (VFA) estimation, 5 ml of supernatant was stored overnight at 4°C with 1 ml meta-phosphoric acid (25%) before estimating VFAs using gas chromatograph (Nucon 5700, India). Total VFA concentration was estimated as per method described by Barnett and Reid (1957). The content of three syringes was used for true degradability of dry matter (IVTD) estimation after 24 h incubation as per the method outlined by Goering and Van Soest (1970).

In vivo experiment

The experiment was conducted at National Dairy Research Institute (NDRI), Karnal, India. It is situated on an altitude of 250m above mean sea level, latitude and longitude position being 29° 42’ N and 79° 54” E, respectively.

Animals, feeding and management

Twenty, 37.20±0.1 kg body weight, 1-2 lactation cross bred (Alpine×Beetal) goats were selected from the herd of NDRI, Karnal. Deworming of all the animals was done before the start of the experiment. The goats were randomly assigned to four treatment groups (n=5), on body weight and milk yield basis. The four dietary treatments consisted of the basal diet devoid of supplemental calcium lignosulfonate and MCP (control) or were supplemented with calcium lignosulfonate (2.5% DM basis), MCP (25 ppm) or both calcium lignosulfonate (2.5% DM basis) and MCP (25 ppm). Experimental feeding was continued for a period of 60 days. The nutrient requirements of goats were met by feeding concentrate mixture and lucerne fodder (Medicago sativa) (Ranjhan, 1998). The chemical composition of the feeds offered is presented in Table 1. Basal diet was free from monocrotophos. A premix was prepared by mixing analytical grade MCP (Sigma Aldrich, USA) with maize grain flour. The premix and calcium lignosulfonate were mixed with concentrate just before feeding. Feed offered and residue left were weighed daily and a representative samples were preserved for further chemical analysis.

Lactation study

Lactation study was conducted for a period of 60 days. During this period daily feed intake and milk yield of individual animal was recorded. The DM content of feeds and ort left was determined at weekly intervals. The body weight of individual animals was recorded prior to feeding at weekly intervals for two consecutive days after the morning milking. The milk samples of individual animal were collected at fortnightly intervals from morning and evening milking and pooled proportionately for the analysis. The pooled aliquots of milk were processed and analysed for composition and pesticide residues same day.

Milk composition analysis

Representative samples were analysed for its fat, protein, lactose and SNF using pre-calibrated milk analyser (Lacto Star, FUNKE GERBER, Article No 3510, Berlin). The analysis of milk for total solids was carried out using recommended methods of AOAC (2005).

(a) ECM was calculated following the equation of Abu-
Ghazaleh et al. (2002):

\[ ECM = (0.3246 \times MY) + (12.86 \times F) + (7.04 \times P) \]

Where,

\[ ECM = \text{Energy corrected milk (kg/day)} \]
\[ MY = \text{Milk yield (kg/day)} \]
\[ F = \text{Fat yield (g/kg)} \]
\[ P = \text{Protein yield (g/kg)} \]

(b) MEV was also calculated according to the equation given by Baldi et al. (2002):

\[ MEV = 203.8 + (8.36 \times \text{Fat \%}) + (6.29 \times \text{CP\%}) \]

Where,

\[ MEV = \text{Milk energy value (kcal/kg)} \]
\[ CP = \% \text{crude protein in milk} \]

c) The correction of milk production to 4% fat was made according to NRC (2001), by using the formula:

\[ FCM = 0.4 \times MY + 15 \times F \]

Where

\[ FCM = \text{fat corrected milk at 4\% fat} \]
\[ MY = \text{Milk yield (kg/day)} \]
\[ F = \text{Fat yield (kg/day)} \]

Chemical analysis

Samples of the feed offered and ort left were collected daily in polyethylene sachets and pooled at weekly intervals for analysis of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fibre (CF), and total ash (AOAC, 2005). Detergent method was used for estimation of neutral detergent fibre (NDF) and acid detergent fibre (ADF) in feed offered and ort left (Van Soest et al. 1991).

MCP determination

Determination of MCP residues in concentrate, lucerne and milk was done in three steps i.e. sample extraction, cleaning up and quantification using HPLC (WATERS, USA, C18μ Bondapak column {300mm×39mm, 10μm particle size}) as per method described by Singh (2004). Acetonitrile was used for extraction of grounded samples of concentrate mixture, lucerne and milk. For cleaning up of milk samples solid phase extraction cartridges (Discovery C18, 3.0 ml, 500 mg, Supelco, Sigma-Aldrich) were conditioned over vacuum manifold assembly (Visciprep 12DL, Supelco) thrice with methanol and thrice with acetonitrile. For cleaning up of feed samples Dual Layer Envi carb II/PSA solid phase extraction cartridge (500 mg/500 mg/6 ml Supelco) were conditioned thrice with acetonitrile. After cleanup, samples were evaporated to dryness under gentle stream of nitrogen and vacuum and reconstituted with 1ml acetonitrile (HPLC grade). Finally, samples were analyzed using HPLC. Percent residual MCP content in milk was calculated by dividing MCP concentration in milk with total dietary MCP intake.

Statistical analysis

Data of in vitro trial was subjected to analysis of variance using the General Linear Model (GLM) procedure of the SPSS (Var.20; SPSS Inc., Chicago). The effect of treatments on IVDMD, TVFA, VFA, and true degradability were tested using the following model:

\[ Y_{ij} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ij} \]

Where, \( Y_{ij} \) = Measurements of the variables, \( \mu \) = Common mean, \( \alpha_i \) = Effect of the \( i^{th} \) treatments (MCP levels; 25, 50, 100 and 150 ppm or 1, 1.5, 2 and 2.5% LIG), and \( e_{ij} \) = Residual error.

The data on nutrient intake, body weight, milk yield and its composition parameters were statistically analysed by using MIXED using repeated measure analysis (SPSS, 20) with day of sampling as repeated measure and treatment group as between subject as variance. Statistical model consisting of treatment, sampling time, and treatment × time interaction as fixed effects with animal as the random effect. The following statistical model was used in analysis:

\[ Y_{IJK} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ij} \]
Where,

\( \mu \) is the overall mean; \( \alpha_i \) effect of treatment \( i \); \( \alpha_j \) effect of time \( j \); \((\alpha \beta)_{ij}\) interaction of \( i^{th}\) treatment and \( j^{th}\) time and \( \varepsilon_{k(ij)} \) is as residuals error. Homogenous subsets were separated by Tukey's HSD test (\( P<0.05 \)).

**Results and Discussion**

*In vitro* rumen fermentation

There was no significant difference in total gas (ml/200 mg feed/24 h), DM, OM and molar VFA concentration (\( P>0.05 \)) in MCP supplemented goats (trial 1) and lowest was in 150 ppm MCP levels indicating a shift in the fermentation pattern (Table 2). Similarly, IVDMD and IVTD were lowest in 150 ppm of MCP indicating an adverse effect on rumen fermentation. Acetate/propionate (A/P) ratio was similar in four treatment group. The propionate was found lowest in 150 ppm MCP treatment.

LIG at levels of 1.0, 1.5, 2.0 and 2.5 percent (DM basis) with 150 ppm MCP (trail 2) (Table 3) could not improve toxic effect of MCP (150 ppm) *in vitro*. TVFA, molar proportion of VFA and A/P ratio were similar all groups. This might be due to fact that MCP bind to LIG but remain in fluid content in fluid content in

### Table 2 Effect of monocrotophos on *in vitro* gas production, dry matter and true digestibility and molar proportion of VFAs

<table>
<thead>
<tr>
<th>Parameters</th>
<th>C(^1)</th>
<th>MCP(^2) (ppm)</th>
<th>SEM</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>25</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Total gas (mL/0.2g)</td>
<td>36.0</td>
<td>37.3</td>
<td>35.0</td>
<td>37.6</td>
</tr>
<tr>
<td>IVDMD (%)</td>
<td>60.2</td>
<td>61.2</td>
<td>61.6</td>
<td>60.7</td>
</tr>
<tr>
<td>IVOMD (%)</td>
<td>63.5</td>
<td>63.7</td>
<td>64.1</td>
<td>62.4</td>
</tr>
<tr>
<td>IVTD (%)</td>
<td>81.4</td>
<td>78.1</td>
<td>79.2</td>
<td>77.0</td>
</tr>
<tr>
<td>TVFA (mM/L)</td>
<td>39.6</td>
<td>56.4</td>
<td>90.9</td>
<td>72.8</td>
</tr>
<tr>
<td>VFA (molar proportion %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetate</td>
<td>74.7</td>
<td>74.9</td>
<td>73.7</td>
<td>73.7</td>
</tr>
<tr>
<td>Propionate</td>
<td>19.0</td>
<td>19.1</td>
<td>19.9</td>
<td>21.2</td>
</tr>
<tr>
<td>Butyrate</td>
<td>6.2</td>
<td>5.9</td>
<td>6.2</td>
<td>5.0</td>
</tr>
<tr>
<td>A/P ratio</td>
<td>3.9</td>
<td>3.9</td>
<td>3.7</td>
<td>3.5</td>
</tr>
</tbody>
</table>

\(^{NS}\) Means are not significantly different (\( P>0.05 \)).

Abbreviation: C\(^1\): control having 200 mg of concentrate and berseem (40:60), MCP\(^2\): monocrotophos IVDMD: *in vitro* dry matter digestibility, IVOMD: *in vitro* organic matter digestibility, IVTD: True degradability, TVFA: total volatile fatty acids, A/P: acetate to propionate ratio.

### Table 3 Effect of lignosulfonate on rumen fermentation parameters against monocrotophos *in vitro*

<table>
<thead>
<tr>
<th>Parameters</th>
<th>C(^1)</th>
<th>MCP(^2) (150 ppm)</th>
<th>LIG(^3) %</th>
<th>SEM</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>IVGP (ml/0.2g)</td>
<td>36.2</td>
<td>32.5</td>
<td>32.7</td>
<td>32.6</td>
<td>33.0</td>
</tr>
<tr>
<td>IVDMD (%)</td>
<td>60.4</td>
<td>54.0</td>
<td>54.4</td>
<td>54.3</td>
<td>51.5</td>
</tr>
<tr>
<td>IVOMD (%)</td>
<td>63.9</td>
<td>58.4</td>
<td>57.4</td>
<td>59.2</td>
<td>53.4</td>
</tr>
<tr>
<td>IVTD (%)</td>
<td>82.3(^a)</td>
<td>77.6(^ab)</td>
<td>76.9(^a)</td>
<td>75.8(^ab)</td>
<td>72.1b</td>
</tr>
<tr>
<td>TVFA (mM/L)</td>
<td>45.2</td>
<td>56.0</td>
<td>62.0</td>
<td>75.6</td>
<td>78.4</td>
</tr>
<tr>
<td>VFA (molar proportion)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Acetate</td>
<td>74.4</td>
<td>74.8</td>
<td>74.9</td>
<td>75.0</td>
<td>75.6</td>
</tr>
<tr>
<td>Propionate</td>
<td>18.7</td>
<td>18.6</td>
<td>19.2</td>
<td>18.3</td>
<td>18.0</td>
</tr>
<tr>
<td>Butyrate</td>
<td>6.2</td>
<td>6.3</td>
<td>5.9</td>
<td>6.7</td>
<td>6.4</td>
</tr>
<tr>
<td>A/P ratio</td>
<td>4.0</td>
<td>4.0</td>
<td>3.9</td>
<td>4.1</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Means with different superscripts in a row differ significantly \( P<0.05 \). Abbreviation: C\(^1\): control having 200 mg of concentrate and berseem (40:60), MCP\(^2\): monocrotophos @150 ppm (DM basis), LIG\(^3\): lignosulfonate was supplemented @ 1.0, 1.5, 2.0 and 2.5 % (DM Basis) + MCP 150 ppm, Other abbreviations see Table 2.
syringe inflicting a toxic effect on rumen microbes (Singh and Singh, 2003; Awal and Malik, 1992; Sandhu and Singh, 1989).

**In vivo** study

For **in vivo** study, 2.5% LIG (DM basis) was taken as ameliorant. It did not adversely affect rumen fermentation and 25 ppm MCP was considered for **in vivo** study as in previous study in our laboratory a toxic effect was visible on goats with daily 50 ppm MCP supplementation (Singh, 2004) and ethical issues.

**Nutrient intake and body weight**

The total DM intake was not affected due to feeding of LIG or MCP (Table 4, Figure 1). The total DM intake in kg or kg/100 kg BW was similar in all groups. There was linear decline in concentrate intake over time (P<0.001) in LIG groups. The DCP and TDN intake as g or g/100 kg BW or g/kg W0.75 were not affected due to LIG or MCP alone or their combination. Intake of DM, DCP and TDN indicate goats were fed on similar protein and energy levels. Present findings were in agreement with previous studies (Singh, 2004; Awal and Malik, 1992). Table 4 shows average daily intake of nutrients in different experimental groups by lactating goats.

**Table 4** Average daily intake of nutrients in different experimental groups by lactating goats

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Treatment groups</th>
<th>SEM</th>
<th>Treatment (T)</th>
<th>Period (P)</th>
<th>T×P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weights, kg</td>
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<tr>
<td>Total DM intake, kg</td>
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<tr>
<td>DM intake, kg/100 kg BW</td>
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<tr>
<td>DM intake, g/kg W0.75</td>
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<tr>
<td>DMI through lucerne, g</td>
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<tr>
<td>DMI through concentrate, g</td>
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<tr>
<td>Total DCP intake, g</td>
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<tr>
<td>DCP intake, g/100 kg</td>
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<tr>
<td>Total TDN intake, g</td>
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<td>TDN intake, kg/100 kg BW</td>
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<tr>
<td>TDN intake, g/kg W0.75</td>
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</table>

Means with different superscripts across a row differ significantly (P<0.05)

- FCM 4% (kg day-1) = 0.4 x milk (kg day-1) + 15 x fat (kg day-1) (NRC, 2001)
- ECM = (0.3246 × milk yield) + (12.86 × fat yield) + (7.04 × protein yield), (AbuGhazaleh et al., 2002)
- MEV = 203.8 + (8.36 × fat%) + (6.29 × CP%), (Baldi et al., 2002)

**Table 5** Milk composition parameters of lignosulfonate and monocrotophos supplemented lactating goats

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Treatment groups</th>
<th>SEM</th>
<th>Treatment (T)</th>
<th>Period (P)</th>
<th>T×P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield, kg/d</td>
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<tr>
<td>Fat %</td>
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<td>Protein %</td>
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<tr>
<td>Lactose %</td>
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<tr>
<td>Total solid %</td>
<td></td>
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<tr>
<td>Solid not fat %</td>
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<tr>
<td>4% fat corrected milk1</td>
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<tr>
<td>Energy corrected milk, kg/d</td>
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<tr>
<td>Milk energy value, kcal/kg²</td>
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</table>

Means with different superscripts across a row differ significantly (P<0.05)

Significance: P<0.05, Treatment (T): monocrotophos @25ppm (DM basis), Period (P): weekly DM intake and body weight. Lignosulfonate (2.5%, DM basis) and Monocrotophos (25 ppm, DM basis)
agreement earlier intoxication study on 50 ppm MCP to goats (Singh, 2004) and 25 ppm chlorpyriphos to calves (Kumar et al., 2005). Nutrient intakes were similar to earlier studies on goats (Patra et al., 2002; Saluja et al., 2006; Kushehawa and Rai, 2011). Weekly body weights were not affected due to MCP or LIG supplementation. Regression analysis of body weight and weekly data showed a decline in body weight over time in all groups (Figure 2). A decline in body weight over time may be due to advancement of lactation (Singh and Ludri, 2002). In earlier finding a decline in body weight was reported at higher doses of monocrotophos (Skripsky and Loosli, 1994; Singh, 2004).

Milk yield and composition

Milk yield (kg/day) in MCP and LIG supplemented group was lower (P<0.03) than control, LIG or MCP group alone (Table 5, Figure 3). The milk composition was monitored at fortnightly intervals upto 60 days of experiment (Table 5). The average fat percent in milk was significantly (P<0.05) lower in MCP and LIG group. The protein, lactose, total solids, solid not fat content was similar in four treatment groups. Similar to fat, 4% fat corrected milk, energy corrected milk (ECM) and milk energy values were significantly lower (P<0.05) in MCP and LIG supplemented group as compared to control, LIG or MCP group alone.

Lower milk yield (kg/day) in MCP and LIG supplemented group might due to a synergistic adverse effect of MCP and LIG (Singh, 2004; Petit et al., 1999). Although in present study a 25 ppm monocrotophos did not affected milk yield significantly but finding leads to decline in milk yield on higher levels of pesticides have been reported in goats (50 mg MCP/kg, Singh, 2004) and cows (Johnson, Jr. et al. 1971).
The lower milk fat in MCP and LIG group might be due to their effect on digestibility (Singh, 2004; Petit et al., 1999). Similarly, 4% fat corrected milk, energy corrected milk (ECM) and milk energy values were significantly lower (P<0.05) in MCP and LIG supplemented group might be due to adverse effect of MCP or LIG on rumen microflora (Sandhu and Singh, 1989). The similar protein, lactose, total solids, solid not fat content in four groups was in agreement to earlier findings on lactating goats fed 50 ppm MCP (Singh, 2004) and normal milk composition reported in different studies for crossbred lactating goat (Singhal and Mudgal, 1984; Saluja et al., 2006; Abdel Rahman et al., 2013).

Carryover of monocrotophos in milk

On body weight basis, the intake of MCP in supplemented groups was 0.95 mg/kg BW/day (34 mg/animal/day). The percent residual MCP content in milk of goats in MCP alone and MCP with LIG group have been presented in Figure 4. Carryover of MCP to milk increased up to 3rd fortnightly (45th day) in MCP group and then decline in last fortnight. This might be due to adaptation of rumen microbes (Kambiranda et al., 2009; Dr.rer.nat., 2013) due to continuous daily intoxication of chronic dose of MCP and degradation of MCP by rumen microbes (Singh and Chhabra, 2005). The catabolic genes for pesticide degradation located on plasmids, transposons or chromosomes can be rapidly transferred among the bacterial populations through vertical gene transfer or more often, by horizontal genetransfer (Heuerand Smalla, 2012). The supplementation of LIG lowered MCP carryover to milk by adsorbing and favouring their excretion in the faeces (Smith- Barbaro et al., 1981; Kumar et al., 2013). The percent carryover from feed to milk was in range (0.1 to 20%) for OPP (Blaethgen, 2000).

Conclusions

The carryover of monocrotophos (25 ppm, DM basis) to milk increase with continuous supplementation without affecting nutrient intake, body weight, milk yield and its composition. Levels of monocrotophos residue in milk were above MRL for milk (0.002 ppm) to cause a potential health hazards. However, the supplementation of lignosulfonate @ 2.5 percent of DM in the diet decreased monocrotophos excretion in milk but its effect on rumen fermentation and microbial population need to be further studied.

References

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