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# Intake, nutrient utilization and growth performance of lambs fed detoxified *Jatropha curcas* meal

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ABSTRACT

The study assessed the effect of dietary supplementation of detoxified *Jatropha* meal (DJM) on feed intake, nutrient utilization and growth performance of lambs. Growing lambs (24) of similar age and body weight (15.76±1.92 kg) were selected for this study. The experimental lambs were allocated in four groups i.e. control group (CG) without DJM and replacing soybean meal (SBM) of CG with DJM on iso-nitrogenous basis in treatment groups (TG) by 12.5% (T1), 25% (T2) and 37.5% (T3). The feeding cum growth trial was conducted for a period of 180 days. The intake of dry matter (DM), organic matter (OM) and digestibility coefficients of DM, OM, CP, NDF and ADF were comparable between CG and TGs. Nutrient intake, DCP, TDN, Nitrogen (N) intake, excretion and retention were comparable between CG and TGs. Replacement of SBM with DJM even up to 37.5% did not show any significant impact on urinary excretion of total purine derivatives (PD), creatinine (C) and their ratio. Microbial N synthesis (g/d) and efficiency of microbial N synthesis of CG were comparable irrespective of DJM%. The initial and final body weights (BW) of lambs between CG and TGs were also comparable. Total BW gain (kg), average daily gain (ADG; g $d^{-1}$) and feed conversion ratio (kg DM/kg gain) by lambs did not differ significantly between CG and TGs. The study concluded that SBM in the diet of lambs could be replaced by DJM up to 37.5% without any adverse impact on nutrient intake, digestibility, rumen microflora and growth of the lambs.

**Key words**: *Jatropha*, Lambs, Nitrogen, Protein supplement, Purines

One of the major constraints in the progress of livestock sector in India is shortage of feed and under performance. In order to meet the future projections (Dikshit and Birthal 2010), country has to explore alternative feed resources. Oil from the seeds of *Jatropha curcas L.* (Jongschaap *et al.* 2007) are used for industrial production of biodiesel and it is estimated that 33 million tonnes of oilseed meal (OSM) is available as byproduct (Ramchandran *et al.* 2007). *Jatropha* seed meal (JSM) can be obtained by decortications, grinding and de-fattening of *Jatropha* seeds which contains about 58–62% crude protein and amino acid profile comparable to soybean meal apart from good proportion of carbohydrates (Makkar *et al.* 1998). Despite good nutrient profile of *Jatropha* OSM, presence of toxic substance (phorbol esters) and anti-nutritional substances (lectin, phytic acid, saponins and trypsin inhibitors) restricts its use in animal feed production (Makkar *et al.* 2008). Makkar and Becker (1999) reported that phorbol esters are major concern for the ill-effects of JSM rather than other factors which are present at tolerable levels. The concentration of phorbol esters is the major distinction to demark toxic and non-toxic varieties of *Jatropha*. Consequently, it can be assumed that proper detoxification of phorbol esters can make JSM safe and potential feed for livestock. The objective of present study was to evaluate the effect of inclusion of different level of detoxified *Jatropha* meal (DJSM) on feed intake, nutrient utilization, microbial nitrogen supply and growth in lambs.

## MATERIALS AND METHODS

*Experiment, animals and diets:* The experiment was conducted at animal experimentation shed of Division of Animal Nutrition, ICAR-Indian Veterinary Research Institute, Bareilly (Latitude 28°.40 N, longitude 79°.43 E and Mean sea level 237.44), India. Growing lambs (24) of 4 month age and mean BW of 15.76±1.92 kg were randomly allocated to 4 groups i.e., control group (CG) without detoxified *Jatropha* meal (DJSM) but soybean meal (SBM) as protein source and SBM was replaced with DJSM in treatment groups (TG) on iso-nitrogenous basis by 12.5% (T1), 25% (T2) and 37.5% (T3). Ingredient composition of concentrate supplement fed to CG and TGs is detailed in Table 1. All the lambs were dewormed prior to experiment and reared under uniform managemental conditions for period of 180 days.

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Table 1. Ingredients and chemical composition of feeds without detoxified *Jatropha* seed meal (DJSM)

| Attribute | Dietary treatment | | | | Green oat | Wheat straw |
|---|---|---|---|---|---|---|
| | CG | T1 | T2 | T3 | | |
| *Ingredients (%)* | | | | | | |
| Maize | 25 | 25 | 25 | 25 | - | - |
| Wheat bran | 50 | 50 | 50 | 50 | - | - |
| Deoiled soybean meal | 22 | 19.2 | 16.4 | 13.6 | - | - |
| DJSM* | 0 | 2.8 | 5.6 | 8.4 | - | - |
| Mineral mixture | 2 | 2 | 2 | 2 | - | - |
| Common salt | 1 | 1 | 1 | 1 | - | - |
| *Chemical composition* (% DM basis) | | | | | | |
| OM | 92.56 | 91.75 | 91.62 | 91.42 | 92.5 | 94.08 |
| CP | 20.32 | 20.72 | 20.46 | 20.14 | 8.56 | 3.38 |
| Ash | 7.44 | 8.25 | 8.38 | 8.58 | 7.50 | 5.92 |
| NDF | 37.26 | 34.26 | 34.29 | 34.20 | 70.18 | 85.40 |
| ADF | 11.65 | 11.40 | 11.43 | 11.71 | 41.09 | 57.92 |
| Phorbol esters | Nil | Nil | Nil | Nil | - | - |

*Detoxified *Jatropha* meal

All the lambs were housed in well ventilated shed having provision for individual feeding. Concentrate supplement (CS) for respective groups was offered daily in the morning at 9.30 AM to meet the nutrient requirements of lambs for maintenance and growth as per Kearl (1982). All the lambs were offered a basal diet of wheat straw *ad lib.* and 100 g green oat fodder as source of vitamin A. Fresh water was offered *ad lib.* twice daily. Initial and final BW was recorded at fortnightly interval by averaging two measurements on consecutive days before feeding and watering. Feed refusals were collected, weighed, and recorded daily before the next feeding to quantify DM intake (DMI). The ration schedule was adjusted fortnightly after recording the body weights of each animal.

*Digestion trial and chemical analysis:* A metabolism trial for 6 d was conducted after 120 days of feeding the experimental diets to assess the nutrient intake, digestibility and nitrogen (N) retained. Daily faeces and urine voided (24 h) by each lamb were measured for 6 d at 7.00 AM, thoroughly mixed and a part of fecal sample of 10% from each lamb was sprayed with 10% (w/v) sulfuric acid (to prevent ammonia loss) and kept for N analysis by Kjeldhal procedure (AOAC 2000) while other part was dried in a forced-air oven at 55°C for at least 72 h, and ground in a Wiley Mill to pass through a 1 mm screen for subsequent analyses of OM, CP, ether extract, NDF and ADF (AOAC 2002). Dietary samples of offered and refusals were also pooled during the trial for chemical analysis.

Urinary PD including allantoin, uric acid, xanthine and hypoxanthine were quantified separately by the colorimetric method of Chen and Gomes (1995). Estimation of urine creatinine was done by the method of Folin and Wu as described by Hawk *et al.* (1976). The microbial nitrogen (N) synthesis in rumen was calculated mathematically (Chen and Gomes 1995, IAEA 1997).

*Statistical analysis*: The results obtained were subjected to analysis of variance using SPSS software (v11.0) and treatment means were ranked using Duncan's multiple range tests. Significant variance between treatments were measured at $P<0.05$. Statistical analyses were carried as for the procedures of Snedecor and Cochran (1994).

## RESULTS AND DISCUSSION

*Feed intake, digestibility and growth:* CP content of CSs was 20% (Table 1) usually recommended for supplementary feeds to be used for efficient feed utilization and which can sustain optimum growth rate by lambs on straw based diets (Tripathi *et al.* 2001). Replacement of SBM by DJSM did not change CP% in CS since both OSM had comparable CP contents. The chemical composition of oat green and wheat straw used in the experiment was comparable with

Table 2. Effect of feeding graded levels of DJSM on intake and nutrient utilization, growth and feed conversion ratio in lambs

| Attribute | Treatment | | | | SEM | P-value |
|---|---|---|---|---|---|---|
| | CG | T1 | T2 | T3 | | |
| Body weight (kg) | 19.46 | 18.12 | 18.83 | 17.26 | 1.570 | 0.881 |
| Metabolic size (kg) | 9.08 | 8.66 | 7.76 | 8.82 | 0.817 | 0.867 |
| *DM intake* | | | | | | |
| $gd^{-1}$ | 665.37 | 656.76 | 697.26 | 600.99 | 28.39 | 0.711 |
| $gkg^{-1}W^{0.75}$ | 72.51 | 75.95 | 76.24 | 72.67 | 1.060 | 0.456 |
| *OM intake* | | | | | | |
| $gd^{-1}$ | 621.80 | 611.80 | 649.15 | 558.50 | 25.32 | 0.704 |
| $gkg^{-1}W^{0.75}$ | 67.00 | 69.84 | 72.07 | 66.49 | 0.900 | 0.088 |
| *Digestibility coefficient* | | | | | | |
| DM | 56.96 | 54.98 | 55.03 | 55.08 | 1.080 | 0.658 |
| OM | 59.69 | 58.21 | 57.94 | 58.40 | 1.070 | 0.752 |
| CP | 64.13 | 67.25 | 64.73 | 66.36 | 0.970 | 0.136 |
| NDF | 55.27 | 53.01 | 53.25 | 52.10 | 1.010 | 0.261 |
| ADF | 48.62 | 47.08 | 47.18 | 44.73 | 1.380 | 0.344 |
| *Nutrient intake* ($gkg^{-1}W^{0.75}$) | | | | | | |
| DOM | 40.43 | 41.64 | 42.92 | 43.85 | 3.075 | 0.171 |
| TDN | 41.98 | 42.68 | 43.80 | 40.62 | 0.932 | 0.171 |
| DCP | 4.74 | 5.10 | 5.02 | 4.97 | 0.105 | 0.147 |
| *Nutrient density* (%) | | | | | | |
| TDN | 58.55 | 56.94 | 56.64 | 56.98 | 3.352 | 0.662 |
| DCP | 6.62 | 6.80 | 6.49 | 6.97 | 0.132 | 0.151 |
| *Body weight* (kg) | | | | | | |
| Initial BW (kg) | 16.52 | 15.52 | 15.51 | 15.51 | 1.83 | 0.985 |
| Final BW (kg) | 27.66 | 26.88 | 27.01 | 26.33 | 2.27 | 0.965 |
| Total BW gain | 11.14 | 11.35 | 11.50 | 10.81 | 0.94 | 0.965 |
| ADG ($g\ d^{-1}$) | 61.88 | 63.09 | 63.89 | 60.09 | 5.22 | 0.961 |
| *Voluntary feed intake* ($g\ d^{-1}$) | | | | | | |
| Concentrate | 335.09 | 323.53 | 323.29 | 308.16 | 30.71 | 0.264 |
| Oat green | 21.2 | 21.2 | 21.2 | 21.2 | 0.00 | - |
| Wheat straw | 326.12 | 349.09 | 349.66 | 311.97 | 32.28 | 0.015 |
| Total | 682.41 | 693.83 | 694.16 | 641.33 | 67.44 | |
| FCR | 11.37 | 11.13 | 11.09 | 11.07 | 0.87 | 0.962 |

*After 180 days. ADG, average daily gain; FCR, feed conversion ratio (kg DMI/kg gain).

the values reported by earlier workers (Patra *et al.* 2006, Dey *et al.* 2008, Pathak *et al.* 2013).

Daily intake ($gd^{-1}$, $g^{-1}kgW^{0.75}$) of DM and OM did not differ significantly among treatment groups. The digestibility coefficients of DM, OM, CP, NDF and ADF were comparable between CG and TGs. DCP and TDN was also comparable between CG and TGs (Table 2). DMI (72.5–76.0 g/kg $W^{0.75}$) of lambs observed in this study was within the suggested range (Kearl 1982) suggesting equal palatability of control and test diets. Phorbol esters are principle secondary plant metabolite in *Jatropha* meal which are toxic and clinical signs include inappetite and gastro-intestinal irritation leading to diarrohea (Ahmed and Adam 1979). Many workers reported negative effect on feeding *Jatropha curcas* on palatability, DMI and nutrient utilization because of unpleasant smell, taste, texture and high concentration of phorbol esters (Makkar *et al.* 1998, Belewu *et al.* 2010, Pasaribu *et al.* 2010, Berenchtein *et al.* 2013). However, in the present study, phorbol esters were completely removed by detoxification process to reduce its negative effects.

*Nitrogen* (*N*) *balance and microbial N supply:* The daily N intake and its faecal or urinary excretion did not differ significantly ($P>0.05$) between CG and TGs irrespective of level of DJSM (Table 2). N retained ($g\ d^{-1}$) by the lambs in CG and TGs were comparable. Kasuya *et al.* (2013) also observed comparable N balance and biological value in Alpine goats given diet having bio-detoxified (*P. ostreatus*) *Jatropha* seed cake.

The absence of any detectable adverse effect on the health of experimental animals (nutrient intakes in terms of DCP and TDN) suggested that replacement of SBM with DJSM did not affect plane of nutrition. Abd El-Rahman *et al.* (2011) fed goats with 10, 20 and 30% (JSM) replacing cumin seed meal and found analogous TDN in all experimental rations and slightly higher DCP with increasing level of JSM.

The urinary excretion of allantoin, xanthine, hypoxanthine, uric acid, total PD, creatinine and PD:C ratio was comparable between CG and TGs. PD absorption ($mmol\ d^{-1}$), microbial N synthesis ($gd^{-1}$) and efficiency of microbial N synthesis were also not significantly different between CG and TGs (Table 4). In the present study, the excretion of purine derivatives in the urine of growing lambs was inconsistent with the results of Chen and Gomes (1995). Efficiency of microbial N synthesis observed in this study was within the reported range of 10–70g N/kg DOMR (Van Nevel and Demeyer 1977, Dey *et al.* 2008).

*Growth and feed conversion efficiency* (*FCE*)*:* The fortnightly BW changes by lambs under different dietary treatments are depicted in Fig. 1. The initial BW (kg), final BW (kg), total gain (kg) and ADG ($g\ d^{-1}$) were comparable between CG and TGs irrespective of level of DJSM. Similarly, FCE (kg DM/kg gain) by lambs did not differ significantly ($P<0.05$) irrespective of dietary treatments (Table 5).

Study concluded that soybean meal could be replaced with detoxified *Jatropha* meal up to 37.5% in lamb's diets with comparable growth, feed intake, nutrient digestibility, feed conversion efficiency and N retention and microbial protein synthesis in rumen.

Table 3. Effect of feeding graded levels of DJM on N-retention and urinary excretion of purine derivatives and microbial N supply to lambs fed on DJSM by lambs

| Attribute | Treatment | | | | SEM | P value |
|---|---|---|---|---|---|---|
| | CG | T1 | T2 | T3 | | |
| *N-intake* ($gd^{-1}$) | | | | | | |
| Total | 11.01 | 10.63 | 11.21 | 10.14 | 0.865 | 0.967 |
| $g\ kg^{-1}\ W^{0.75}$ | 1.17 | 1.22 | 1.22 | 1.21 | 0.031 | 0.505 |
| *N-excretion* ($gd^{-1}$) | | | | | | |
| Faeces | 3.99 | 3.47 | 3.95 | 3.44 | 0.372 | 0.688 |
| Urine | 4.32 | 4.44 | 4.21 | 4.11 | 0.380 | 0.942 |
| Total | 8.99 | 7.98 | 6.86 | 7.53 | 0.972 | 0.850 |
| *N-retention* | | | | | | |
| $gd^{-1}$ | 2.70 | 2.71 | 3.04 | 2.58 | 0.350 | 0.815 |
| % of intake | 24.54 | 25.52 | 27.20 | 25.24 | 2.212 | 0.860 |
| % of Abs. | 38.17 | 37.76 | 41.86 | 37.92 | 2.910 | 0.735 |
| *Urinary excretion of PD* ($mmol\ d^{-1}$) | | | | | | |
| Allantoin | 4.61 | 4.48 | 4.4 | 4.53 | 0.015 | 0.095 |
| Uric acid | 0.21 | 0.23 | 0.21 | 0.2 | 0.15 | 0.430 |
| Xanthine | 0.26 | 0.5 | 0.75 | 0.3 | 0.07 | 0.160 |
| Hypoxanthine | 0.25 | 0.46 | 0.28 | 0.17 | 0.13 | 0.321 |
| Total | 5.14 | 5.66 | 5.46 | 5.02 | 0.9 | 0.442 |
| Creatinine | 1.39 | 1.38 | 1.3 | 1.25 | 0.08 | 0.412 |
| PD:C | 3.84 | 2.78 | 2.83 | 3.54 | 0.13 | 0.234 |
| PD Absorption ($mmol\ d^{-1}$) | 5.79 | 6.37 | 6.26 | 5.68 | 0.90 | 0.974 |
| Microbial N supply ($gN\ d^{-1}$) | 4.21 | 4.63 | 4.55 | 4.13 | 0.75 | 0.944 |
| *Efficiency of microbial nitrogen synthesis* | | | | | | |
| $gNkg^{-1}$ DOMI | 12.41 | 13.02 | 12.26 | 14.41 | 4.07 | 0.852 |
| $gNkg^{-1}$ DOMR | 16.54 | 17.36 | 16.35 | 19.22 | 3.33 | 0.952 |

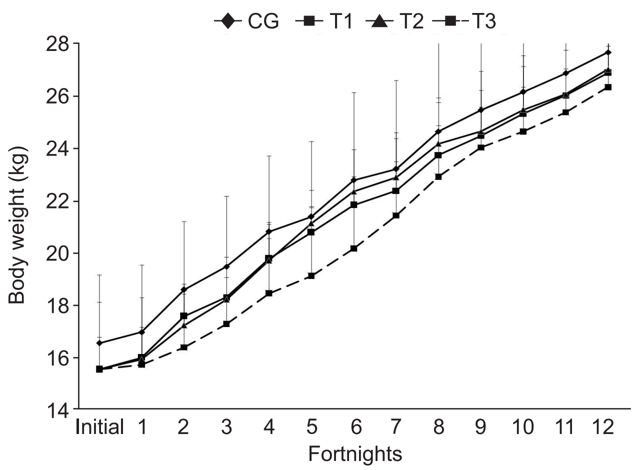


Fig. 1. Effect of feeding DJM on fortnightly body weight changes.

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