



Influence of Abrus Precatorious Crude Oil Supplementation on Growth Performance, Nutrient Digestibility Rumen Fermentation and Microbial Population of Malabari Bucks

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ARTICLE INFO

Keywords: Abrus Precatorious, Goats, Microbial Population, Performance, Rumen Fermentation

Received : 5 May

Revised : 23 June

Accepted: 23 July

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ABSTRACT

This experiment was conducted to determine the influence of Abrus precatorious crude oil supplementation on growth performance, nutrient digestibility rumen fermentation and microbial population of Malabari bucks. 40 Malabari bucks of about 7 months of age 30.55 ± 0.12 kg initial body weight was used for this experiment. Animals were grouped into four treatments based on their weight. Each treatment consists of 10 animals and individually housed in an already disinfected semi-open pens. Basal diet was compounded to meet the requirement of goats according to NRC (2007). Goats in treatment A (TA; control) received basal diet only while those in TB, TC and TD were given basal diet supplemented with Abrus precatorious oil at 0.2, 0.4 and 0.6 mL per kg. A completely randomized experimental design was adopted and the study lasted for 60 days. Abrus precatorious crude oil supplementation increased ($P < 0.05$) the final body weight, apparent digestibilities of dry matter, organic matter, crude protein, non-structural carbohydrates, acid detergent fibre and neutral detergent fibre. Dietary supplementation of Abrus precatorious oil also decreased ruminal pH, ammonia nitrogen, methane and protozoal counts, and increased the concentrations ($p < 0.05$) of total volatile fatty acids, acetate, propionate, valerate, bacteria and fungi counts. Conversely, butyrate, isobutyrate and isovalerate concentrations were not affected by the treatment ($p > 0.05$). In conclusion, crude Abrus precatorious oil supplementation at 0.6 mL oil/kg DM feed improved final body weight, nutrient digestibility and also had positive effect on rumen fermentation, and microbial population without causing any detrimental effect on the performance of goats

INTRODUCTION

Plants have an immense capacity to synthesize secondary metabolites. These metabolites or bioactive compounds includes, tannins, flavonoids, terpenoids, saponins and alkaloids have shown to be safe, effective, eco-friendly and has no withdrawal period (Alagbe, 2024; Shittu et al., 2022). Essential oils are plant extracts obtained through extraction with organic solvents and subsequent distillation. These extracts are a combination of different molecules because the way they are extracted will carry a general group of chemicals with specific characteristics (Agubosi et al., 2022). Pharmacological properties of essential oils have shown that it possesses antimicrobial, antifungal, anti-helminthic, anti-cancer, immune-modulatory, antidiabetic, anti-diarrhea, antiviral, antioxidant, cytotoxic, gastro-protective, hepato-protective, antiseptic, anti-inflammatory amongst others (John, 2024c). Essential oils have recently been reported as natural alternative to replace antibiotic growth promoters, improve production levels and reduce environmental waste. In ruminants especially it has been shown that essential oils can beneficially work by inhibiting the activities of pathogenic organisms in the rumen (John, 2024d). Among the potential underexplored plant oil is the essential oil from *Abrus precatorius*.

Abrus precatorius is a perennial, herbaceous creeping plant belonging to the family Leguminosae (Jahan et al., 2009; Adedapo et al., 2007). The plant commonly known as Rosary pea is native to tropical and subtropical regions of the world (Bhatt et al., 2007; Bhakta et al., 2019). The leaves, seeds, flowers and stems have been reported be loaded with tripenoids, alkaloids, flavonoids, saponins, glycosides, tannins and steroids which possess antimicrobial (John, 2024b), anti-fertility (Khairnar et al., 2011; Gbolade, 2009), anti-tumor, anti-diabetic (Anant and Maitreyi, 2012), anti-serotonergic, anti-tumor (John, 2024a; Osabede et al., 2004), anti-malarial (John, 2024c), anti-migraine (Jouad et al., 2001), gastro-protective (Shittu et al., 2024; Saganuwan and Onyeyili, 2010), immune-stimulatory (Omokore and Alagbe, 2019), anti-inflammatory (John, 2024d), cytotoxic, analgesics (John, 2024e; Shivam and Mittal, 2022) and antioxidant effects (Choudhari et al., 2011; Kulkarni, 2005). Aqueous extracts from *Abrus precatorius* have been traditionally used in the treatment of fever, jaundice, ulcer, wound, snake bite, gastrointestinal infection, eye defects, sexually transmitted diseases, malaria amongst others (Choudhari et al., 2011).

According to Shivam (2022), *Abrus precatorius* oil contains 3-Pyridinol (1.30 %), 4H-Pyran-4-one, 2, 3, -diyddro-3,5-dihydroxy-6-jmethyl (2.07 %), Benzofuran (3.82 %), Isosorbide (6.26 %), 2-methoxy-4-vinaylphenol (6.81 %), Methylparaben (2.46 %), D-allose (10.98 %), Octanal,2-(phenylmethylene) (1.02 %), Hexadecanoic acid, Methyl ester (4.67 %), n-Hexadecanoic acid (8.25 %), Dibutyl phthalate (1.92 %), Abrusoside B (1.63 %), Abrusoside D (4.25 %) and Abrusoside E (2.81 %).

Previous studies have shown that essential oils have been used to manipulate ruminal metabolism and selectively inhibit rumen methanogenesis (Patra, 2011), reduce harmful microbes and promote the beneficial ones which include *Lactobacillus* spp, as they stabilize the activities of enzymes (Hart et al., 2008), enhance efficiency of digestion (Simitzis, 2017), inhibits the hyper-

ammonia producing bacteria in the rumen (Beenchaar et al., 2008). However, not giving the appropriate dose to animals could lead to toxicity. Therefore caution needs to be exercised in order to boost livestock production, sustainability and food safety. There is also scanty information on the dietary supplementation of *Abrus precatorius* on the performance of goats.

LITERATURE RIVIEW

Study Area, Experimental Animals, Diet and Design

This study was approved by the ethics Committee at the Department of Animal Production and Health, Gandhi College of Agriculture, Rajasthan India (approval number: 2024/099612/0A). All procedures for animal management was done in accordance to the guidelines outlined by Indian Society of sheep and goat production.

The study was carried out at the Small ruminant section, Gandhi College of Agriculture, Rajasthan, India. 40 Malabari bucks of about 7 months of age 30.55 ± 0.12 kg initial body weight was used for this experiment. On arrival of goats, they were quarantined for 14 days before they were grouped into four treatments based on their weight. Each treatment consists of 10 animals and individually housed in an already disinfected semi-open pens measuring 1.5 square meters equipped with cylindrical feeders and iron buckets for water. Basal diet was compounded to meet the requirement of goats according to NRC (2007). Animals were fed twice daily between 8:00 H and 14:00 H, those in treatment A (TA; control) received basal diet only while those in TB, TC and TD were given basal diet supplemented with *Abrus precatorius* oil at 0.2, 0.4 and 0.6 mL per kg. To ensure that animals received the accurate dose, 500 g of basal diet was mixed with the essential oil during the early hour feeding. A completely randomized experimental design was adopted and the study lasted for 60 days. Fresh clean water was offered ad libitum and other management practices were strictly observed. Body weight was done weekly using digital sensitive scale. Feed intake of each goat was calculated as the difference between the feed offered and left over from the previous day.

Analysis and Extraction of Abrus Precatorius Crude Oil

Abrus precatorius leaves were collected from Gandhi Teaching and Research farm in Rajasthan, India and sent to the department of Taxonomy, Sumitra Research Institute, Gujarat for proper identification before it was assigned a voucher number (DT/008D/2022). Collected leaves were shade dried for 6 days and pulverized using an electric blender before extraction. Extraction of oil was done using hydro-distillation method earlier outlined by (Alagbe, 2024). Briefly, 300 g *Abrus precatorius* powder was measured into a round bottom flask, placed on a heating mantle and heated at 70°C for 20 minutes the steam produced is collected in a glass condenser then into a round bottom flask. Mixture of oil and water was separated using a laboratory separator to obtain *Abrus precatorius* oil.

Analysis of bioactive compounds in *Abrus precatorius* oil was done using DAF Triple gas chromatography and mass spectrometry (GC-MS ADF/08/20), China). To obtain precision in results, the machine was set at a

control range between 0 to 300 mL/min (N₂), ionization energy (0-240 eV), ion source temperature (50 to 350 °C) and transfer line temperatures of 50 to 400 °C. Identification of bioactive components in the oil was based on comparison with their retention time and mass spectra by matching with those of the National Institute of Standard and Technology (NIST, 2011) database.

Chemical Analysis of Basal Diet

Chemical analysis of basal diet was analyzed according to AOAC (1997). Acid detergent fibre and Neutral detergent fibre were determined using alpha amylase and sodium sulphite and each parameter was expressed exclusive of residual ash. Organic matter, cellulose, hemicellulose, lignin and non-structural carbohydrates were calculated using the formula below:

$$\text{Organic matter (g/kg DM)} = 1000 - \text{ash content}$$

$$\text{Non-structural carbohydrate (g/kg DM)} = 1000 - (\text{Crude protein} + \text{ether extract} + \text{ash} + \text{NDF})$$

$$\text{Hemicellulose} = \text{Neutral detergent fibre} - \text{acid detergent fibre}$$

$$\text{Cellulose (g/kg DM)} = \text{Acid detergent fibre} - \text{lignin}$$

$$\text{Lignin (g/kg DM)} = \text{Acid detergent fibre} - \text{cellulose}$$

Rumen Liqor Collection and Processing

Rumen liqor was collected on the last day of the experiment from each goat in the morning 3 hours after feeding by inserting a stomach tube and pump. The pressure created by a suction pump makes it easier to collect 50 mL ruminal fluid. After collection, pH of the sample was immediately collected using a glass electrode pH meter. Samples were placed in a closed sided warmer and transferred to the laboratory for further test. Ammonia nitrogen (NH₃-N) concentrations were measured by using the micro diffusion method while total and proportional volatile fatty acid concentrations were conducted by using Press roltax auto-gas chromatography (model XV/BN004/20-BA, Germany). Population of rumen microorganism was carried out using Fost Auto-Microbial analyzer model HO200-A China. To ensure precision in results, all operations on the kit was done according to the manufacturers' recommendation.

METHODOLOGY

In Statistical Analysis for Social Sciences (SPSS), data on growth performance and rumen fermentation were subjected to analysis of variance. To test the significant differences Duncan multiple range test was employed where p<0.05 level was declared significant.

RESULT

Table 1. Ingredient and Chemical Composition of Basal Diet (G/Kg Of DM)

Components	Quantity (g/kg DM)
Corn (900 g/kg CP)	300.0
Corn barn	260.0
Cowpea husk	235.0
Soybean meal (480 g/kg CP)	200.0
Growers Mineral/Vitamin Premix	1.50

Limestone	2.00
Salt	1.50
Total	1000.0
Chemical composition (g/kg dry matter - DM)	
Dry matter	910.0
Organic matter	930.0
Crude protein	165.0
Ether extract	28.11
Ash	70.00
Non-structural carbohydrate	350.40
Acid detergent fibre	221.00
Acid detergent lignin	300.00
Neutral detergent fibre	371.00
Cellulose	191.00
Hemicellulose	15.00
Energy (Kcal/kg)	2600.7

Grower's Mineral and Vitamin premix Each 2.5 kg consists of: Vit A 8,000, 000 IU; Vit D3, 3000, 000 IU; Vit. E. 20g; Vit k3 6 g; Vit B1, 2500 mg; Vit B2, 100g; Vit B6, 300 g; Vit B12, 50 mg; Pantothenic acid, 100 g; Niacin, 85 g, Folic acid, 1900 mg; Biotin, 100 g; Choline Chloride, 660 mg, Fe, 60 g; Mn, 120 g; Cu, 3.7 g; Co, 250 mg; Si, 180 mg and Zn, 96 g

Table 2. Major Bioactive Compounds Identified in Abrus Precatorious Oil

Compounds	Reaction time (min)	Concentration (%)
γ -Terpinene	12.19	7.93
β -Caryophyllene	12.54	5.14
Methylparaben	13.07	0.40
3- Pyridinol	13.48	5.90
Dibutyl phthalate	13.92	1.61
α -Terpineol	14.05	2.08
D-allose	14.98	31.06
Limonene	15.30	3.80
α -Pinene	15.59	0.95
Terpinene-4-ol	15.80	1.15
p-Cymene	16.17	10.06
n-Hexadecanoic acid	16.30	14.50
1-Hexadecyne	19.08	0.58
Octadecanoic acid ethyl ester	19.41	0.02
2-methoxy-4-vinylphenol	19.79	9.72
Di-hydroxypropyl ester	21.65	0.07
9,17-Octadecadienal	21.75	2.03
Oleic acid	23.50	1.41
2-Heptadecanone	23.66	0.96
Stearic acid	23.91	0.04

β -Citronella	25.84	0.26
Geranyl acetate	25.91	0.77
Trans-linalool oxide	26.07	0.35
1-Octanol, 2-butyl	27.10	1.82

Table 3. Growth and Apparent Nutrient Digestibility of Goats Fed Diet Supplemented with *Abrus precatorious* Crude Oil

Growth parameters (kg)	T ^A	T ^B	T ^C	T ^D	SEM
Average initial body weight	35.12	35.09	35.10	35.01	0.04
Average final body weight	38.95 ^b	42.07 ^a	43.11 ^a	43.18 ^a	0.02
Average feed intake	15.66 ^b	18.60 ^a	18.73 ^a	18.81 ^a	0.06
Apparent digestibility (g/kg DM)					
Dry matter	640 ^b	719 ^a	723 ^a	748 ^a	0.92
Organic matter	628 ^b	710 ^a	730 ^a	733 ^a	1.38
Crude protein	556 ^b	670 ^a	685 ^a	692 ^a	1.45
Ether extract	600 ^b	664 ^a	672 ^a	680 ^a	2.78
Non-structural carbohydrates	520 ^b	630 ^a	639 ^a	642 ^a	1.92
Acid detergent fibre	586 ^b	621 ^a	629 ^a	631 ^a	2.40
Neutral detergent fibre	537 ^b	602 ^b	611 ^a	615 ^a	1.63
Cellulose	592 ^b	643 ^a	645 ^a	650 ^a	1.08
Hemicellulose	600 ^b	661 ^a	668 ^a	672 ^a	1.10

Means with different superscripts in a row are significantly different ($P < 0.05$); TA: basal diet with no oil (control); TB: basal diet with *Abrus precatorious* oil at 0.20 mL/kg diet; TC: basal diet with *Abrus precatorious* oil at 0.40 mL/kg diet; TD: basal diet with *Abrus precatorious* oil at 0.6 mL/kg diet; SEM: standard error of mean.

Table 4. Ruminal Fermentation of Goats Fed Diet Supplemented with Different Levels of *Abrus precatorious* Crude Oil

Parameters	T ^A	T ^B	T ^C	T ^D	SEM
Ph	6.81 ^a	6.13 ^b	6.09 ^b	6.02 ^b	0.03
Ammonia Nitrogen (mg/dL)	87.61 ^a	75.52 ^b	75.02 ^b	74.86 ^b	0.61
Acetate (mol/100 mol)	50.82 ^b	56.67 ^a	57.03 ^a	58.03 ^a	0.47
Propionate (mol/100 mol)	20.09 ^b	27.02 ^a	27.03 ^a	27.11 ^a	0.11
Acetate/Propionate (mol/100 mol)	2.52 ^a	2.09 ^b	2.10 ^b	2.14 ^b	0.02
Butyrate (mol/100 mol)	13.00	13.08	13.11	13.15	0.18
Iso-butyrate (mol/100 mol)	2.11	2.07	2.08	2.03	0.02
Valerate (mol/100 mol)	3.79 ^b	4.12 ^a	4.19 ^a	4.25 ^a	0.01
Iso-valerate (mol/100 mol)	2.51	2.79	2.88	2.92	0.01
Total volatile fatty acid (mol/l)	94.84 ^b	107.8 ^a	108.4 ^a	109.6 ^a	8.77
Methane (CH ₄) (mol)	23.00 ^a	19.30 ^b	19.27 ^b	19.18 ^b	1.61

Means with different superscripts in a row are significantly different ($P < 0.05$); TA: basal diet with no oil (control); TB: basal diet with *Abrus precatorious* oil at 0.20 mL/kg diet; TC: basal diet with *Abrus precatorious* oil at 0.40 mL/kg diet; TD: basal diet with *Abrus precatorious* oil at 0.6 mL/kg diet; SEM: standard error of mean.

Table 5. Rumen Microbiome of Goats Fed Diet Supplemented with Different Levels of *Abrus Precatorious* Oil

Parameters	T ^A	T ^B	T ^C	T ^D	⁴ SEM
Total bacteria count ($\times 10^{10}$ cfu/ml)	4.27 ^b	6.22 ^a	6.38 ^a	6.51 ^a	0.02
Total fungi count ($\times 10^5$ cfu/ml)	1.44 ^b	2.37 ^a	2.50 ^a	2.81 ^a	0.01
Total protozoa count ($\times 10^6$ cell/ml)	6.02 ^a	4.18 ^b	4.03 ^b	4.00 ^b	0.01

Means with different superscripts in a row are significantly different ($P < 0.05$); T^A: basal diet with no oil (control); T^B: basal diet with *Abrus precatorious* oil at 0.20 mL/kg diet; T^C: basal diet with *Abrus precatorious* oil at 0.40 mL/kg diet; T^D: basal diet with *Abrus precatorious* oil at 0.6 mL/kg diet; SEM: standard error of mean.

Major bioactive compounds identified in *Abrus precatorious* crude oil is presented in Table 2. D-allose (31.10 %), n-hexadecanoic acid (14.50 %), p-Cymene (10.06 %), 2-methoxy-4-vinaylphenol (9.72 %), γ -Terpinene (7.93 %), 3-Pyridinol (5.90 %) and β -Caryophyllene (5.14 %) were the most abundant compounds.

Growth and apparent nutrient digestibility of goats fed diet supplemented with *Abrus precatorious* crude oil is presented in Table 3. Average final body weight and feed intake were lower ($p < 0.05$) in T^A (38.95 kg; 15.66 kg) than in T^B (42.07 kg; 18.60 kg), T^C (43.11 kg; 18.73 kg) and T^D (43.18 kg; 18.81 kg) respectively. Dry matter, organic matter, crude protein, ether extract, non-structural carbohydrates, acid detergent fibre, neutral detergent fibre, cellulose and hemicellulose values varied from 640 - 748 (g/kg), 628 - 733 (g/kg), 556 - 692 (g/kg), 600 - 680 (g/kg), 520 - 642 (g/kg), 586 - 631 (g/kg), 537 - 615 (g/kg), 592 - 650 (g/kg) and 600 - 672 (g/kg DM) respectively. Values recorded in this experiment was higher in T^B, T^C and T^D than in T^A ($p < 0.05$).

Table 4 revealed the average values of pH, ammonia nitrogen, total volatile fatty acid and methane production. Dietary supplementation of *Abrus precatorious* crude oil affected ($p < 0.05$) the pH (6.02 - 6.81), ammonia nitrogen (74.86 - 87.61 mg/dL), concentration of acetate [(50.82 - 58.03 (mol/100 mol)], propionate [(20.09 - 27.11 (mol/100 mol)], valerate [(3.79 - 4.25 (mol/100 mol)] and methane production [(19.18 - 23.00 (mol)]. Goats fed diet supplemented with *Abrus precatorious* crude oil showed better volatile fatty acid ($p < 0.05$) compared to the control. Values obtained for butyrate [(13.00 - 13.15 (mol/100 mol)], isobutyrate [(2.03 - 2.11 (mol/100 mol)] and iso-valerate [(2.51 - 2.92 (mol/100 mol)] were similar ($p > 0.05$) across the treatments.

Rumen microbiome of goats fed diet supplemented with different levels of *Abrus precatorious* crude oil is presented in Table 5. Total bacteria count was higher ($p < 0.05$) in T^B [(6.22 ($\times 10^{10}$ cfu/ml)], T^C [(6.38 ($\times 10^{10}$ cfu/ml)], T^D [(6.51 ($\times 10^{10}$ cfu/ml)] than T^A [(4.27 ($\times 10^{10}$ cfu/ml)]. Similarly, total fungi count was lower ($p < 0.05$) in T^A [(1.44 ($\times 10^5$ cfu/ml)] than in T^B [(2.37 ($\times 10^5$ cfu/ml)], T^C [(2.50 ($\times 10^5$ cfu/ml)] and T^D [(2.81 ($\times 10^5$ cfu/ml)]. Conversely, protozoal count of goats fed T^B [(4.18 ($\times 10^6$ cfu/ml)] and T^C [(4.03 ($\times 10^6$ cfu/ml)] was similar ($p > 0.05$) to those which received T^D [(4.00 ($\times 10^5$ cfu/ml)] but significantly lower ($p < 0.05$) than T^A [(6.02 ($\times 10^6$ cfu/ml)].

DISCUSSION

The presence of bioactive compounds in *Abrus precatorious* crude oil suggests that it possess numerous medicinal properties such as, anti-inflammatory, antifungal, antiviral, anti-helminthic, immune stimulatory, gastro-protective, antioxidant, antimicrobial, antidiarrheal, anti-cancer, amongst others (Singh et al., 2022; Alagbe, 2023). These compounds have highly efficacy, environmental friendly and could possibly serve as natural alternative to antibiotics (Adewale et al., 2021). The result obtained in this experiment is in line with the reports of (Anant and Maitreyi, 2012). However, Shivam and Mittal (2022) recorded a lower concentration of 6.81 %, 8.25 % and 10.98 % for 2-methoxy-4-vinylphenol, n-hexadecanoic acid and D-allose in *Abrus precatorious* leaf extract. The variation in this results could be attributed to processing methods, geographical location and age of plant (Musa et al., 2020).

Results on the growth performance showed that *Abrus precatorious* crude oil significantly increase final body weight suggesting that they are capable of modulating the activities of rumen microbes and decreasing the population of pathogenic organisms compared to animals fed control diet (). *Abrus precatorious* oil have also shown its ability to improve the palatability of the diet resulting in increased dry matter intake of goats. The result obtained in this study is in consonance with the report of Cardozo et al. (2006) when alfalfa extract, anise, capsicum, and a mixture of cinnamaldehyde and eugenol was fed to beef heifers. Similarly, Shabban et al. (2021) reported a significant effect on final weight gain of barki lambs fed diet supplemented with thyme and cerery. However, Kholif et al. (2021) recorded that supplementation of crude coriander oil in the diet of lactating goats did not enhance their feed intake.

Variation in these results may be attributed to dose, duration of experiment as well as the chemical composition of bioactive compounds (). Dietary supplementation of *Abrus precatorious* crude oil elevated the population of bacteria and fungi leading to an increased dry matter, crude protein, organic matter, acid detergent fibre, neutral detergent fibre, cellulose and hemicellulose digestibility (Busquet et al., 2005; Chaves et al., 2008). The proliferation of these ruminal microbes improves fermentation to produce energy for maintenance and weight gain compared to animals fed control diet (Bodas et al., 2012). Ruminal pH recorded in this study were within the 6.00 - 7.00 reported by Shaaban et al. (2021); Zhou et al. (2019) when oregano essential oil was supplemented in the diet of sheep. This suggests the non-distortion in the activities of rumen microbes. Dietary supplementation of *Abrus precatorious* crude oil also increased propionate and reduction in ruminal protozoa population which favours protein degradation and reduce activities of methanogens (Kim et al., 2019; Hristov et al., 2013). Higher concentration of volatile fatty acid observed among goats fed diet supplemented with *Abrus precatorious* crude oil suggests an increase in available energy for production and growth.

The amount and proportion of volatile fatty acid produced in the rumen depends directly on the profile of the microbial population fermenting the feedstuff (Kim et al., 2019). Lower concentration of ammonia nitrogen especially among animals fed different levels of *Abrus precatorious* crude oil indicates its

ability to influence protein degradation. The result obtained aligns with the results of Thao et al. (2014) when eucalyptus crude oil was supplemented in the diet of swamp buffaloes.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, *Abrus precatorius* crude oil has numerous therapeutic properties including antimicrobial, antioxidant and inflammatory. Dietary supplementation of the oil at 0.6 ml per kg DM diet was capable of modulating rumen microbes, improving growth performance and fermentation without causing any deleterious effect on the health status of goats.

FURTHER STUDY

This study still has limitations related to it, so it is necessary to conduct further research on the topic of the Effect of *Abrus Precatorius* Crude Oil Supplementation on Growth Performance, Digestibility of Rumen Fermented Nutrients and Malabari Bucks Microbial Population in order to perfect this study and increase insight for readers.

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