African Journal of Biotechnology Vol. 8 (4), pp. 699-702, 18 February, 2009
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2009 Academic Journals

Full Length Research Paper

Haematological characteristics and performance of West African Dwarf Goats fed crude oil contaminated forage

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Accepted 15 January, 2009

The effects of feeding crude petroleum contaminated forage on haematological characteristics and performance of 36 young West African Dwarf (WAD) goats was investigated in order to simulate the impact of real crude oil spillage on livestock and game. Graded levels (0.0, 1.5 and 3.0 g per kg forage) of stabilized "Bonny Light" crude oil was incorporated into predetermined quantities of a grass legume silage and fed to the animals. Results showed that blood cell profile was drastically altered with packed cell volume (PCV), granular leucocytes (neutrophils, eosinophils and basophils) increasing linearly ($p<0.05$) and the lymphocytes and monocytes reducing linearly ($p<0.05$) as crude oil ingestion increased. Feed intake, feed conversion efficiency and final body weight decreased linearly ($p<0.05$) as the level of crude oil contamination increased. Signs of ill-health and high mortality were observed in the crude oil contaminated diets. It was concluded that crude oil administered at levels of 1.5 and 3.0 g per kg forage to young WAD goats adversely affected blood cell profile, performance and survival rates.

Key words: Crude oil, forage, goat, haematology, performance.

INTRODUCTION

Crude petroleum is considered as a complex of hydrocarbons together with organic compounds of sulphur, nitrogen, oxygen with vanadium, sodium and other metals present in small amounts (Baker, 1970). The toxic effects of crude oil on bioorgansims are largely associated with the aromatics (Hartung, 1967; Blumer, 1970). Notable among the aromatics are benzene, naphthalene and anthracene which are known to exert severe haematological changes in animals (Saita, 1974).

There were as many as 784 incidences of oil spills in Nigeria between 1980 and 1996, resulting in a total spillage of over 56.1 million barrels of crude oil into both the aquatic and terrestrial ecosystems (Awobajo, 2000). Several more spillages have occurred since then, particularly in Bayelsa State of Nigeria. Such spills are more frequent and almost endemic in spite of publicly avowed corporate safety measures and standards in their operations (Berepubo et al, 1994).

The prominent goat production systems practiced in Bayelsa State are the extensive and semi-intensive systems. Contamination of forage/pasture by crude oil from spillages may expose goats to the consumption of such pasture. The West African Dwarf (WAD) goat is a commercially valuable animal in Nigeria's Niger Delta because of its importance in meat production. Monsi et al. (1987) and Berepubo et al. (1994) in their studies, showed the deleterious effects of crude oil on poultry and rabbits respectively. However, there is a paucity of information on the effects of crude oil toxicity on goats in available literature. Since oil spills are becoming unavoidable, there is the need to evaluate the effect of crude oil hydrocarbons on goats, because they are at the risk of exposure to toxicity via farmlands, feed crops, water and natural pastures. The study was therefore designed to evaluate the effects of crude oil contaminated forage on haematological characteristics and performance of young WAD goats.

MATERIALS AND METHODS

Management of animals

Thirty-six, 17 weeks old, young WAD goats, weighing 4.03 kg average body weight were used for the study. The animals were

housed in conventional and environmentally adapted goat house with pens of 0.9 m^2 floor spaces in the University's Teaching and Research farm. The goats were tagged and kept in pens for easy sampling. The goats were allowed an equilibration period of one week during which they were fed fresh, uncontaminated mixture of grass (*Panicum maximum*) and legume (*Centrosema pubescens*), which was later ensiled according to standard preparation methods suggested by Sastry and Thomas (1980). A proprietary grower's ration (Table 1) containing 16% crude protein was purchased and fed as supplement for the forage diet.

Experimental design and procedure

The tagged goats were weighed and randomly assigned to three (A, B, C) dietary treatments. Each treatment had twelve goats and was replicated six times to contain two goats per replicate. "Bonny Light" crude oil was procured and exposed in shallow pans for 24 h to allow for stabilization by vaporization (White, 1975).

Graded levels (0.0, 1.5 and 3.0 g per kg forage) of the stabilized crude oil was incorporated into predetermined quantities of the grass/legume silage and fed to the animals. Incorporation of the measured quantities of crude oil was by simple mixing and homogenization for at least 2 h prior to feeding to ensure imbibition and to reduce the chance of selection by the goats. The grower's ration was fed as a supplement to the animals after most or all the measured and treated quantities of the silage have been consumed. Feed and water were given *ad libitum* for a period of 8 weeks. Feed intake and weight gain data were computed on daily and weekly basis respectively. A total of 18 goats (1 per replicate) were sampled out of the 36 goats. Blood was aspirated from their jugular veins and analyzed for packed cell volume (PCV), differential white blood cell counts and total white cell counts (TWC), as suggested by Benjamin (1961). Mortality was recorded and the health of the animals in the three treatments was closely observed. Data were subjected to analysis of variance and the treatment means separated by orthogonal contrast (Gill, 1978).

Table 1. Composition of proprietary grower's ration fed to the experimental goats.

Ingredients	Percentage (%)
Maize	58.00
Groundnut cake	8.00
Fish meal	3.00
Wheat bran	23.00
Brewer's dried grain	5.00
Bone meal	2.25
*Vitamin/mineral premix	0.25
Salt	0.50
Calculated analysis	
Crude protein	16.00

* Composition of premix/kg: Vitamin A. 800,000 IU, vitamin D 1,500 IU, vitamin E 400,000 IU,
vitamin K 3000 mg, vitamin B_1, 2000 mg, vitamin B_2 4000 mg, vitamin B_6 15 mg, vitamin B_{12} 15 mg, vitamin C 10000 mg, folic acid, 1200 mg, Mn 60,000 mg, Zn 60,000 mg, Cu 5000 mg, Fe 25,000 mg.

RESULTS

Haematological characteristics

Data on the effects of crude oil contaminated forage on some haematological characteristics in the experimental animals are presented in Table 2. Significant ($p<0.05$) PCV values were observed to be linear. The PCV values were highest in treatment A - the control - (26%), and lowest in treatment C (18.6%). The data on differential white blood cell counts are also presented in Table 2. A significant ($p<0.05$) difference in neutrophil values was observed, with treatment C having the highest value. Significant ($p<0.05$) differences were similarly observed in the eosinophil, basophil and monocyte values, with the highest values of eosinophil and basophil in treatment C, which also had the lowest monocyte value. Lymphocytes and TWC were found to be significantly ($p<0.05$) most depressed in treatment C.

Performance

The performance of the test goats fed graded levels of crude oil contaminated forage is presented in Table 3. Data on feed intake showed a significant ($p<0.05$) difference between treatments. Feed intake decreased with increasing concentrations of crude oil in the diet. Weight gain and feed conversion efficiency also showed significant ($p<0.05$) differences between treatment groups. Mortality rate increased with increasing levels of crude oil ingestion.

DISCUSSION

The effects of crude oil contaminated forage on haematological characteristics of animals have been reported by other investigators. An environmental stressor such as crude oil has been found to change blood chemistry and cause antibody depression, alter white blood cell counts, including lymphatic involution among other effects, via the ACTH and glucocorticoids in stressed animals (Brown, 1961; Thaxton and Siegel, 1973; Thompson and Lippman, 1974; Siegel, 1980; Sudakov, 1992).

The observed linear ($p<0.05$) reduction of PCV values showed that they decreased with increasing levels of crude oil administration. The results suggested an anaemic condition which was particularly observed in the goats in treatment C. Any adverse effect of crude oil toxicity may be attributed to naphthalene, toluene and benzene (Rice et al., 1977). Benzene has been found to induce anaemia due to bone marrow hypoplasia (Hiraq, 1972; Saita, 1974). This phenomenon may be explained by the ingested crude oil which imposed a physiological stress on the goats and therefore caused the release of glucocorticoids which have been found to deplete erythrocytes (Siegel, 1980), probably via involution of bone marrow (Wilson et al., 1975), hence the observed reduced PCV in this study.The blood cell counts of the neutrophils, basophils, eosinophils, monocytes and lymphocytes were all significantly altered in this study, thus indicating that crude oil ingestion at levels of 1.5 and

Table 2. Haematolgoical characteristics of goats fed crude oil contaminated forage.

Group	Crude oil (g/kg forage)	Neutrophils	Basophils	Eosinophils	Lymphocytes	Monocytes	PCV (%)	TWC (mm^3)
A	0 (Control)	74.6^{a}±3.93	10^{a}±0.243	3.43^{a}±1.75	17^{a}±3.57	3.5^{a}±1.02	26^{a}±3.7	8329.3^{a}±8.39
B	1.5	77.56^{b}±1.03	0.6^{b}±0.643	4.8^{b}±0.38	15.3^{b}±1.43	2.4^{b}±0.08	23.3^{b}±0.00	7998.3^{b}±508
C	3	83.5^{c}±4.97	2.1^{c}±0.887	7.3^{c}±2.12	8^{c}±5.43	1.5^{c} ± 0.95	18.6^{c}±3.7	6143.3^{c}±1347

TWC: Total white cell counts.
^{abc}Means within the same column with different superscripts are significantly different ($p < 0.05$).

Table 3. Performance of goats fed crude oil contaminated forage.

Parameter	Experimental diet		
	0 g/kg forage (control group, A)	1.5 g/kg forage (B)	3.0 g/kg forage (C)
Initial body weight (kg)	4.04	4.05	4.00
Final body weight (kg)	10.40^{a} ± 3.25	6.70^{b} ± 0.45	4.35^{c} ± 2.80
Total body weight (kg)	6.36^{a} ± 3.24	2.65^{b} ± 0.047	0.35^{c} ± 2.72
Average weekly weight gain (kg)	0.795^{a} ± 0.405	0.331^{b} ± 0.059	0.044^{c} ± 0.32
Average daily weight gain (kg)	0.113^{a} ± 0.058	0.047^{b} ± 0.008	0.006^{c} ± 0.049
Average weekly feed intake (kg)	2.10^{a} ± 0.73	1.05^{b} ± 0.27	0.84^{c} ± 0.47
Average daily feed intake (kg)	0.30^{a} ± 0.11	0.15^{b} ± 0.04	0.12^{c} ± 0.047
Feed conversion efficiency (FCE)	2.64^{a} ± 5.66	3.16^{b} ± 5.14	19.09^{c} ± 10.79
Mortality (%)	0	4	6

^{abc}Means within the same row with different superscripts are significantly different ($p < 0.05$).

3 g per kg forage adversely affected the blood profile of the test goats.The observed linearly ($p<0.05$) increased granulocyte values in this study confirmed that the ingested crude-oil-imposed stress on the goats elicited a defense response (Selye, 1963). The increased leucocytes values were in response to the observed outward appearance of ill health in the goats fed the crude oil contaminated forage. This observation agreed with the report that leucocytes manifest moderately or highly; as a result of bacterial infections, inflammatory disorders, physical and emotional stimuli, systemic infections, poisoning with carbon monoxide, drugs and other types of toxicity by organic or inorganic compounds (Saita, 1974; Tijkian et al., 1979; Ross and Wilson, 1982). All of these agents elicit hypercorticolism which increases the granular leucocytes but has dramatic catabolic effect on lymphoid tissues, manifested by lymphoid and thymic atrophy and reduction of the granular leucocytes (Spain, 1975).

The observed linearly ($p<0.05$) reduced monocytes and lymphocytes could be attributed to the effect of the crude oil hydrocarbons on lymphoid tissues such as spleen which was found to be atrophied in this study. This effect of crude oil have been found to cause antibody depression, lymphatic involution, impair migration of phagocytic cells, alter total white blood cells, lower resistance to viruses and foreign bodies (Bhattacharya and Sarkar, 1968; Siegel, 1968).

The observed linear ($p<0.05$) reduction in TWC values may be due to stress (imposed by the crude oil hydrocarbons), the subsequent probable action of the glucocorticoids and the outward ill health which have been similarly reported (Tijkian et al., 1979).

The performance of the WAD goats were adversely affected by the crude oil contaminated forage. The higher concentrations of crude oil inclusion in treatments B and C significantly ($p<0.05$) depressed feed intake. The reduced feed intake associated with crude oil ingestion could adversely affect certain physiological activities in the body, which may result in poor performance. Gupta et al. (1968) observed similar detrimental effects in calves when Dichloro Diphenyl Trichloroethane (DDT) was included in their diets at levels of between 500 – 700 ppm, while lower concentrations did not exert any such adverse effect on feed intake. Heywood (1981) reported that the suppression of body weight gains by toxic components is often or commonly associated with reduced feed intake. Crude oil ingestion in one form or another, during the critical development stages is known to depress growth (Rolling et al., 2002). The rumen contains myriad of microbial species which are involved in the degradation of fibrous feedstuffs (Sastry and Thomas, 1980). There is the possibility therefore, that the crude oil hydrocarbons might have exerted toxic effects on the microbial population of the rumen at the 1.5 and 3 g per kg forage crude oil inclusion levels. Herwaldt (2001) made

similar observations in *in vitro* studies with microbial species under aerobic and anaerobic conditions, where the toxicity manifested in form of growth inhibition, organelles and cell membrane dissolution, resulting in mortality. The higher values of feed conversion efficiency in treatments B and C was an indication that the animals could not convert the consumed diet to body tissue efficiently, probably because of the quality of feed or the physiological status of the goats. This study showed that crude oil was an environmental stressor which might have stimulated ACTH and glucocorticoid synthesis in the goats to elicit these effects that are characteristic of the stress hormones; increased neutrophils, basophils and eosinophils and depressed lymphocytes and monocytes. Feed intake, body weight gain, feed conversion efficiency and the survival rate of goats were adversely affected by crude oil contaminated forage.

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