CHLORAL COMPOSITION OF SOME INDIGENOUS PLANTS
AND TOXIKEY OF CASEA OCHROLEUCA, MUCUNEA MONSTERSY, AND TEUCHOLA ACERNUS TO CATS

A THESIS

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the University of Khartoum for the degree of

Master of Veterinary Science

By

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The clinical signs and the lesions in kuliter goats caused by daily oral dosing with the fresh leaves and dry seeds of *Cassie occidentalis* and the fresh or dry shoots of *Euphorbia splendens* and *Indigofera hexantha* were studied.

The results of kidney and liver function tests were evaluated and correlated with the pathological changes.

The main signs of *Cassie* poisoning were anorexia, inappetance, dyspnea, staggering, ataxia and convulsions. The lesions consisted of hemorrhages and congestion in the heart, lungs, spleen, and adrenal, cerebral atrophy, hepatic fatty change and necrosis, splenic hemosiderosis, pulmonary edema, necrosis and/or degeneration of the epithelial cells of the renal convoluted tubules and packing of the glomeruli with endothelial and small round cells. These changes were accompanied by an increase in the activity of GGT and in the concentrations
of ammonia and urea and by a decrease in the total protein and calcium in the serum. There was a decrease in the values of Hb, PCV and HEC and an increase in leucocyte counts. Total lipids were higher in the liver, kidneys and heart of Gadda-poisoned goats.

Reduced appetite, listless, dyspnoea, incoordination of movement, anaemia, diarrhoea and recumbency were the major signs of Indigofera poisoning in goats. The lesions comprised pulmonary oedema, congestion and haemorrhage, perineuronal vacuolisation in the grey matter of the spinal cord, hepatic portal fibrosis, fatty change and dilatation of the sinusoids, degeneration of the cells of the renal convoluted tubules and congestion of the medullary rays and cortical arteritis and nephritis. The changes in the serum constituents were correlated with the clinical, pathological and enzyme histochemical changes.

The mechanisms of Tephrosia poisoning in goats were dilatation of the renal tubules, perineuronal vacuolisation in the cerebrum and spinal cord, centrilobular hepatic necrosis.
magnesia and fatty change, hemorrhial arteritis and hemorrhage in the lungs, heart and intestinal lumen. These changes were accompanied by an increase in the concentration of creatinine, uric and ammonia and in the activity of GOT and by a decrease in the total protein levels in the serum. Leucocytosis was due to an increase in the number of neutrophils. The changes in the red cell precursors indicated the development of anemia.

The record of the chemical composition of plants forms the basis for further collection and detailed investigation.
Various pasture plants have different chemical composition and nutritive values. It is well known that the soil type, climatic conditions and other environmental factors can affect the chemical composition, nutritive values and distribution of plant species (Hassan, 1962). Plants that are categorized as good for the nutrition of animals are usually palatable, non-toxic and have excellent and more or less consistent chemical composition and nutritive values. It is, therefore, the most prevailing idea among different workers on the subject that it is essential to investigate the chemical composition and nutritive values of different plant species in grazing areas. Accordingly, several workers in different parts of the world embarked on elaborate studies on the chemical composition and nutritive values of different pasture plant species, including those of the tropics.

Crude protein in pasture plants were investigated by Reid
(1966), Olsen (1972), MacDonald, Edwards and Grundel (1972) and
Roggen (1977) and crude fibres by Cole and Hamling (1974), Roggen
(1977) and MacDonald et al. (1972). Other organic and inorganic
were investigated by Roggen (1977), Wilson (1962), Cole (1971),
Macdonald et al. (1972) and Connolly and Love (1994). On the
other hand, mineral contents in various pasture plants including
calcium, phosphorus, magnesium, copper, zinc and manganese, have
been reported by Haitham (1955), Crompton and Horst (1969),
Roggen (1977), MacDonald (1977), MacDonald et al. (1972), Cole,
Macdonald, Blyth and Thomson (1972) and Thompson and Warren
(1973) while magnesium, copper, zinc and manganese have been re-
ported by Heasman (1962), Plumridge (1965), Miller (1972), Lang
et al. (1972), Nold (1965), Scourfield (1962) and Sims (1960).
Goh (1975) and Roggen (1977) gave detailed accounts of the
nutritive values and mineral composition in different pasture plants
in the tropics.

In the future, however, studies on the above aspects in
pasture plants appear to be quite urgent. Wilks and Sibbick
(1967) investigated the seasonal changes in the chemical composition
and nutritive values of pasture plants around the Golding in Western
Province. Pertour (1966; 1973) gave detailed accounts of copper and lime contents in pasture plants in Western Sahara. Moreover, Tadj and Pertour (1976) estimated copper contents in caprul feeds in the northern part of the Khartoum Province and reported low levels of the mineral in sheep. Abu Saida (1980) surveyed the Kufra area of the Sahara and recorded the status of several minerals in most of the predominant pasture plants in that area.

Several field veterinarians in different parts of the Sahara have observed low nutritional status in livestock in their districts and have assumed that this condition could be due to the low nutritive value and mineral composition of pasture, particularly that the pasture of the latter has greatly changed and has been flooded by fibrous and more non-graftable plant species during the last years.

It is, therefore, felt that study of the nutritive value and mineral composition of more important plant species in Khartoum Province could be of value in mineral nutrition in the country.

Accordingly, 34 predominant pasture plant species from Khartoum Province were biochemically classified into four groups:
A. Intensive pastures
B. Range and trees
C. Toxic plants

Their nutritive values and mineral contents have been studied in the present investigation.

Much attention has been focused on the toxicity of plants, because of the considerable hazards to health which are associated with damage to vital organs of the body and because of the economic losses attributable to contamination of pastures with poisonous plants. The effect arises from a variety of compounds produced in or absorbed by plants when ingested by animals.

Many plants contain cyanogenic, coumarin-like, tanninoid or steroidal (ecliptic) glycosides. The effect of glycosides on animals is ascribed to the glycosides component. Moreover, aucubin (aphrodisiacus), Lotus corniculatus (leuconurus) and Aegilops heleonai (gramineae) contain cyanogenic glycosides. The toxicity of cyanogenetic glycosides is caused by their HCN component acting as a free molecule after liberation by hydrolysis in vivo. It inhibits the action of the pseudohydrox, ovcodorn oxidase, which is a
terminal respiratory catalyst incorporating atmospheric oxygen during tissue respiration. The main findings in BS poisoning in animals are hemorrhages and congestion of the lungs, the bright red color of the blood and the smell of bitter almonds (Halbett, 1964; Kingsbury, 1964).

Insulin and adrenalin of *lecithin gland* (Ipomeaeales), respectively, are secreted glycosides and produce excitation of the skin, burning sensation in the mouth, erosion of the oral mucosa, vomiting, bloody diarrhea and convulsions in rats and animals (Kingsbury, 1964; Clark and Whitt., 1967).

Kingsbury (1964) classified the starch glycosides into those which possess a marked ability to stimulate the heart (cardiac glycosides) and those which do not. Most of the cardiac glycosides have come from genera in the Solanaceae, Apocynaceae and Liliaceae (Witt and Broyn-Arendsz, 1962). These glycosides act directly on heart muscle to increase the force of contraction and on the vagus innervation to decrease the rate of beat. The mechanism of these actions is unknown. For example, * digitally procera* (Solanaceae) contains a bitter principle,
oxalatoplast, which in certain glycodies of the digitatin type and five other crystalline bodies, oxalate, salicin, salicylur, usnicin, usnicarbin and usnicacrin (Staehle, 1931; Weib and Matuyama, 1962). More recently, experiments undertaken by Hennar (1970) and Hennar, Asche and Nestor (1979) have shown that the certain glycodies can not be held responsible alone for the major toxicity of S. prorsus in goats and sheep.

Some plants contain toxins such as acids, salicins and polypeptides. For example, the amino N-acetyl-benzenesulphonyl ethylene is the toxic principle of *Persea berlandieri* (Eugenia). Goats and sheep feed with the leaves and fruits of the plant developed signs of anaemia and gastritis (Demp and Innes, 1986). The hepatoxic effect of *Indigofera* spp. (Leguminosae) is related to an amino acid designated indoleadine which provokes varying degrees of fatty change in the liver of animals (Hagerty and Bowl, 1963; Arac, 1976).

Certain plants such as *Alnus petrophilus* (Leguminosae) and *Hippopyrum compositum* (Compositae) are known to contain phytotoxins, protein molecules, of high toxicity in animals and men. The literature concerning the discovery and elucidation of the nature of
phytoalexins with particular emphasis on rice and A. oryzaepig has been reviewed by Clarke (1967) and Clarke and Jackson (1956).

Many plants contain irritant oils. For example, Prunus hirta and Syphillus royleanus, both of the family Rosaceae, contain an irritant oil which is a product of enzymatic hydrolysis of certain glycosides in the plants (Zamir, Cohen and Almad, 1953).

Several genera in the Rosaceae cause their irritant properties to the presence of the glycoside royleanin. It breaks down to release the glycone, royleamin, which is a volatile, strongly irritant, unstable oil. The signs of royleenia poisoning in animals are salivation, diarrhea, colic, hematuria and blindness (Strange, 1951; Kugelmeier, 1954).

Althaea rosea and A. argentea, both of the family

Rubiaceae, contain a toxic resin, gallicin (Couch, 1939; Satter, 1941). Depression, anorexia, staggering, convulsions, labored breathing and coma are the important signs of poisoning by alkaloids in animals.

Plants may contain toxic pigments which have a certain chemical structure and cause specific effects on animals. For example, Geomnium hcraxelea (Hydrocosm) contains the polyphenolic pigment,
The most important signs of pyrethroid poisoning in animals are dyspnea with grunting, twitching at the neck, abdominal pain, bloody diarrhea, convulsion, convulsions and opisthotonos.

*Knudsenia angustipilis* (Aldrich} contains a pyrethroid which causes in various species of livestock muscular weakness, prostration, dyspnea, abdominal pain and convulsions (Swenson, 1957).

*Oxytropis gypsophila* (Gyromitra) contains a pyrethridae which is closely related to mescaline and mescaline and the butyl glycine of piper. The latter is hallucinogenic and convulsant in rodents (Smith, Spots, and James, 1967).

Alcoholism produces varying degrees of physiological reactions when introduced into animals. Pyrethroidic alkaloids have been isolated from several plants in the Euphorbiaceae, Loganiaceae and Asteraceae. The alkaloids caused a wide spectrum of liver lesions in laboratory and domesticated animals (Schoental and Lyge, 1957; Christie and Logan, 1962; Bult, Oubreut and Wilk, 1969). Pyrethroidic alkaloids produce hypotonicceller necrosis, abrasions,
biliary hypoplasia, megalocytosis, steatosis and conclusive lesions of the central veins in animals (Schenkel, 1961; Thorpe and Perl, 1966; Ford, McDermott and Thorpe, 1966; Aoda, 1971; 1974). Liver tumors have been produced by pyroliidine alkaloids in rats (Coppola, 1955) and in rats (Kersen, 1970).

The lesions produced by other types of alkaloids in animals have been described by Darnell (1979), Chen (1980), Bolin (1980) and Kester (1980).

Kester (1980) described the teratogenic potential of the three range species, Veratum, Lepidium and Isatis tinctoria. The teratogenic, all-stemid alkaloids, have been isolated from Veratum californicum (Liliaceae) and shown to be responsible for endochondral malformation in sheep (Simon, Jones, Wage and Carver, 1953).

Many plants owe their toxicity to their high content of oxalates, nitrites, fluorides or saponins. For example,

*Isatis tinctoria* (Boraginaceae) contains a high concentration of oxalates and causes necrosis and/or degeneration of the cells of the renal tubules, albuminuria, casts and perivascular edema in pigs (Marshall, Buch and Bell, 1967; Osmolov, Buch and
Biddell, 1966). These signs were correlated with changes in serum constituents. There were increases in the levels of serum potassium, magnesium and urea nitrogen.

_Agroecystis pupulosa_ (Cockerell) and _A. nigripennis_ (Amended to) contain moderate levels of nitrates (Clarke and Clarke, 1967). Nitrates are converted by the microorganisms of the rumen and intestine to nitrites which are then absorbed in the blood circulation and these combine with haemoglobin to form methaemoglobin (Clarke and Clarke, 1967).

_Agroecystus octoguttatus_ (Kneip) contains microorganisms and produces many conditions among cattle in Australia. Boltinging in western Eu is characterized by tumouring into the sporecoelium (Gibbs and Weir, 1963; Whitten and Marquart, 1965).

Feeding of cattle remains of solaniferae plants to cattle and horses for periods of weeks or months caused chronic solaniferae poisoning known as Fiddler disease (Clarke and Clarke, 1967). This type of solaniferae toxicity is characterized by anemia, lack of vitality, defective hoof growth, lameness and emaciation. The exact mechanism of the toxic action of solaniferae is not known. It has been suggested
that selenium replaces sulphur in essential proteins and stimulates the enzyme enzymes in these reactions (Brown and De Vit, 1964). The important signs of selenium poisoning, also known as blind staggers or loco disease, are tremors, staggering, and stumbling due to partial paralysis of the hind legs.

Some plants may have greater accumulating power for copper than other elements. For example, *Umbilicus rupestris* (Lepidium rupestris) concentrates copper to lethal levels from natural high-copper soils and caused death of sheep in Australia (Ireland, Hetherington and Bell, 1943). The main lesions of copper poisoning in sheep and goats are haemolysis, hepato-cellular necrosis and atrophy (Ireland, Hetherington and Howell, 1972; Wael and crazy, 1974; Atlas, Wael and Gordon, 1977).

Anorexia, emaciation, severe purulent conjunctivitis, falling of hair and pain at the articulations are the major signs of poisoning in cattle (Clark and Clarke, 1962).

A large group of plants contains toxic principles whose chemical constitution is not yet known. *Asteraceae* (e.g., *Asteraceae* is toxic to mice and goats (Atlas, 1977; Wael and crazy, 1974).
in various organs and tissues. The toxic substance in the plant is unknown. Catharanthus roseus (Lam.) G.Don, Dendrocalamus asper (Nees.), L. japonica Hook. f., and C. roseus (Lam.) G.Don are indigenous plants that cause functional and structural changes in the liver, lungs, and kidneys of small rodents (Dood, 1975; Ramesh, 1979; Berri, 1980; Li, 1980; Golal, 1980; Li, 1980; Li and Chi, unpublished data). The toxic constituents in these plants are unknown.

The roots, seeds, leaves, and fruits of plants are the main sources of drugs employed in medicine. The active principles in medicinal plants may be toxic when present in high concentrations but may be useful in lower concentrations for therapeutic purposes in all countries. Akins (1979) described how traditional uses of many indigenous plants to the Shona. Interaction of plants that are used traditionally in other African countries has been reported by Pali and Morgan-Bond (1966).

Dendrocalamus strictus (Gaudichaud), locally known as mori, is a popular herbal remedy and is widely distributed in
Central, Northern, and Western areas of the country. The plant is a
woody, creeping herb (Fig. 1), up to 5 ft. high. Leaves are simple, linear,
up to 1-5 pairs, narrow with wide apex. Flowers yellow, peduncles
linear, slightly compressed between the seeds.

In the urine, the leaves of the plant is used as a digestive and
the root as a diuretic (Brown and Lancaster, 1933).

Further information as to the chemical analysis of the plant nor
records of its toxic effects on domestic livestock are available.

Papillaria spiloides (Papillaraceae), locally known as Bonggok,
is common throughout Northern, Central and Western areas of the country.

1. spiloides is a bushy herb (Fig. 2), 12 - 35 in. high. Leaves
6 - 9, alternate, bases terminal or lateral, loosely 6 - 12 cm long;
cor. red. Pod narrow-linear. 1/2 in. long.

There are no records of the toxicity of 1. spiloides in
domesticated animals.

Papillaria robusta (Papillaraceae), locally known as
Sorenta, is widely grown in the Central and Northern areas of the
country. It is a shrubby, branched herb (Fig. 3), 3 or more ft.
high, branches slender, regular, moderately silvery. Fruits
Fig. 1. Cassia occidentalis, natural growth.
Fig. 2. Teucrium polifolium, natural growth.
in 1 - 5 pairs, obovate-oblongate, \( \frac{1}{2} - \frac{3}{4} \) in. long, both surfaces glabrous and practically the lower one thinly coated with strong compressed silvery hairs. Flowers pink, in dense ovoid about \( \frac{1}{2} \) in. long till fruit is produced. Pod linear, more or less curved, \( \frac{1}{2} - \frac{3}{4} \) in. long, \( \frac{1}{4} \) in. broad (Andreas, 1893).

The plant is reported by livestock owners to be toxic to livestock but this has not been proved experimentally.

The present experiments on Pacific jujube were planned in order to obtain information on the effects of Creosote salicifolia, Mukdenia mongolica, and Indigofera indaiata ( indica).

The methods used to investigate the changes in Creosote, Mukdenia and Indigofera-leaf plants and the nutritive value and mineral contents of some indigenous plants are described in Chapter XI. The results of the investigations are summarized and discussed in the succeeding chapters.
CHAPTER II

METHODS

The methods utilised in the present investigation may be classified as follows:

1. Histological
   1. Enzyme histochemical
      1.1. for oxidative enzymes
      1.2. for hydrolitic enzymes

2. Hematological
   2.1. Myelocytic series
   2.2. Leukocytic series

3. Chemical
   3.1. Determination of some constituents
   3.2. Estimation of tissue lipids
   3.3. Determination of some nutrients in plants
1. Histological Methods

The specimens taken from the goats after death were immediately fixed in 10 per cent formaldehyde, embedded in paraffin wax, sectioned at 6 μm and stained by the following methods:

1.1. Hematoxylin and eosin (H&E), using Mayers' haematoxylin.

1.2. The Periodic Acid-Schiff (PAS) method with and without prior endogenous peroxidase inhibition with diastase was used for the demonstration of glycogen and polysaccharide-containing proteins.

1.3. Leder's trichrome and Gomori and Sweet's (1966) methods were used to demonstrate reticulin and collagen fibres.

1.4. Special sections were stained for the demonstration of hormone-like substances as described by Porco (1966).

2. Radioisotope and metabolic methods

Preparation of liver and other organs (e.g., pancreas). Small blocks of liver and kidneys of goats were immediately placed in liquid nitrogen to bring the tissues to a solid state.
Frozen sections were removed from liquid nitrogen, seated on a cool brass microscope slide with a little neutral oil and transferred for 5 minutes to a cryostat microtome (Slee, London) maintained at -18°C. Section thicknesses were counted on glass slides and kept for a short period before staining in the cryostat cabinet.

2.1. Histochemical methods for oxidative enzymes

2.1.2. Saccharomyces cerevisiae (Leucine dehydrogenase)

This enzyme is one of the most satisfactory indicators of Kreb's cycle activity by histochemical methods. The method described by Pearse (1960) was used. The principle of the histochemical reaction depends on the enzymic transfer of hydrogen atoms from the oxidized substrate to a tetrazolium salt which becomes reduced to a coloured and water-insoluble formazan granules capable of accurate enzyme localization. For this purpose, nitro-blue tetrazolium i.e., Nitro-TT, (2,2-di-p-nitro-phenyl-5,5-diphenyl(3,3-dimethyl-4,4-diphenylamino) tetrazolium dichloride) was included in the buffer sol
...an enzyme method and unfixed frozen sections were incubated for 30 minutes at 37°C.

2.2. Histoenzymological Methods for Hydrolytic Enzymes

2.2.1. Dimethylthiophosphate (DMT-PP)

The method used for DMT-PP was developed by Kochstein and Melis (1957) and uses lead nitrate solution at pH 7.3. The principle of the method depends on the liberation of phosphate ions which are converted to lead phosphate, forming with calcium sulphate demonstrating the sites of enzymatic activity by a dark-brown precipitate of lead sulphate. Unstained frozen sections were incubated in 10% lead nitrate solution for 15 minutes at 37°C.

2.2.2. Alcian Blue

The lead nitrate method described by Kochstein and Melis (1957) was used. The basis of the histoenzymological reaction depends on the liberation of phosphate from the enzymatic hydrolysis of adenosine-5-phosphate. Deposition of lead sulphate was used to
detect 5-nucleotidase and its localisation. Unfixed frozen sections were incubated for 15 minutes at 37°C.

2.3.5. Glucose-6-phosphatase

The lead nitrate method described by Sumichria and Laidal (1956) was used. The enzymic hydrolysis of glucose-6-phosphate results in the liberation of phosphate as lead phosphate which is demonstrated by the deposition of lead sulphate at the sites of reaction. Unfixed frozen sections were incubated for 15 minutes at 37°C.

3. Histochemical methods
4.1. Ascorbic acid esterase
4.1.1. Paired-cell volume (PCV)

Fresh samples of blood were centrifuged in a microcentrifuge centrifuge (Nabakley and Sons Ltd., England) for five minutes. The paired-cell volume (per cord) was read off on the scaling instrument provided with the centrifuge and the results converted to 1 per l.
3.1.2. Haemoglobin concentration (Hb)

Haemoglobin concentration was determined by the cyanmethaemoglobin technique using a haemoglobin meter (Unicor Electromedics Ltd., England). The method is based on the conversion of haemoglobin by means of cyanide solution (0.2 g potassium cyanide, 0.2 g potassium ferricyanide and 1 g sodium bicarbonate per litre distilled water) to cyanmethaemoglobin. The haemoglobin concentration in g per 100 ml of blood was converted to g per dl.

3.1.3. Red blood cell count (RBC)

Red blood cells were counted using improved phase-contrast counters (Kwikcount and Kwiktop, England). Thymol-brocaine was used as a diluting fluid.

3.1.4. Red cell indices

Mean corpuscular haemoglobin concentration (MCHC)

The MCHC was calculated from RBC and Hb values as follows:
The results were then converted to ml per d1.

**Hematocrit volume (HC)**

The hematocrit volume (HC) in cubic micrometers was calculated from PCV and Hb volume as follows:

\[ \text{HC (in cubic micrometers)} = \frac{\text{PCV} \times \text{Hb volume per ml}}{10} \times \text{Red cell count in million per ml} \]

The results were then converted to ml.

### 3.2. Leucocyte count

#### 3.2.1. White Blood Cell count (WBC)

Total white blood cells were counted by use of improved Neubauer haemocytopters (Heidolph and Sons Ltd., Egelsitz). Turk's fluid (one per cent glacial acetic acid, touched with garrisson violet) was used as a diluent.
3.2.3. Differential leucocyte count

Blood films on clean slides were made from freshly collected blood of goats and stained with Leishman's stain. The Leishman method described by Schalm (1965) was used for the differential leucocyte counts. At least 100 cells were counted in each blood smear and average percentages were recorded.

4. Chemical Methods

4.1. Methods used for the determination of serum constituents

Samples of blood were collected from goats by jugular vein puncture and allowed to clot overnight. The clotted blood was centrifuged at 3000 r.p.m. for 10 minutes and the separated serum was stored at -20°C until analysed.
4.1.1. Serum Transaminases

Glutamate oxaloacetate transaminase (glutamic pyruvate transaminase, L-glutamate-2-oxoglutarate aminotransferase, EC 2.6.1.1, L-GOT).

The serum pyruvate oxidoreductase activity was measured as described by Saltman and Frolov (1957). The principle of assay depends on the intermolecular transfer of an amino group from an donor α-keto acid (a-keto acid) to an acceptor α-keto acid (α-keto glutaric acid) without the intermediate formation of amino and measurement of the amount of the reaction product i.e. oxaloacetate.

\[
\begin{align*}
\text{Glutamic acid} & \rightarrow \text{Pyruvic acid} \\
\text{α-Keto glutaric acid} & \rightarrow \text{α-Keto glutaric acid (α-KG)}
\end{align*}
\]
The serum sample was incubated for 1 hour at 37°C with a buffered mixture of L-glutamate and 2-oxoglutarate end at the end of the incubation period the reaction was stopped by addition of a colour reagent (2,6-dichlorophenol indophenol). The amount of 2-oxoglutarate produced was measured in form of its coloured 2,4-dinitrophenyl hydrazine in alkaline solution. Changes in the absorbance readings of an EEI spectrophotometer (EEI Electric Instruments Ltd., England) at 515 milli-seconds were recorded and the results expressed in Naitanen and Freidel units (28 units) employing a calibration curve (Fig. 4). The results were converted to international units (I. U.).

L-glutamate-pyruvate transaminase (EC 2.6.1.1), L-2-oxoglutarate-2-oxoadipate transaminase (EC 2.6.1.2, NPS).

The method of assay described by Naitanen and Freidel (1967) is based on the same principle of reaction as in case of OGT in which an amino group is transferred from an α-keto acid to an α-keto acid without the intermediate formation of ammonia.
Fig. 4. Calibration curve for glutamate oxaloacetate transaminase (GOT) in the serum. Read at 375 millimicrons.
The assay mixture consisted of alanine, α-ketoglutarate solution buffered at pH 7.5 and serum and was incubated for 30 minutes at 37°C. The rest of the procedure is essentially similar to that of GOT. The results expressed in Bateson and Frankel units using a calibration curve (Fig. 5) were also converted to international units.

In the assay of serum transaminase, careful treatment of serum samples was necessary in order to avoid vigorous shaking, exposure to elevated temperatures and repeated freezing and thawing which may cause denaturation of protein and hence loss of enzyme activity. Strict care was also taken to avoid the use of
Fig. 5. Calibration curve for glutamate pyruvate transaminase (GPT) in serum. Read at 515 millimicrons.
homolyzed and are because the erythrocytes contain a high concentration of bromanides.

4.1.2. Total serum bilirubin

The method described by Bangerfield and Finlayson (1953) was used. The method is based on the conversion of serum bilirubin by means of diazo-sulphanilic acid reagent to eino-bilirubin. The reaction is facilitated by the addition of caffeine buffer so that the total bilirubin including free and conjugated bilirubin was measured. Changes in the scale readings of the DR Spectro were recorded at 535 millimicrons and results calculated in mg per 100 ml by reference to a calibration curve (Fig. 5) were converted to mmol per 1.

4.1.3. Total serum protein

Total serum protein was determined by the use of the biuret reagent as described by Weinreb (1956). The principle of the method is based on the reaction of protein with copper sulphate
Fig. 6. Calibration curve for total bilirubin in serum. Read at 550 millimicrons.
In the presence of sodium hydrosol. The Rochelle salt (Kali-tartrate), contained in the bireact region is utilised to keep the formed sodium hydrosol in solution which gives the blue colour. Changes in the scale readings of the K2 spectra were recorded at 560 millimicrons and results calculated in g per 100 ml from calibration curve (Fig. 7) obtained by use of boiling sodium chromate were converted to g per l.

4.1.4. SODIUM NITROPRUSSIDE

Sodium nitroprusside concentration was measured according to the method described by Barley (1967). The principle of the method is based on the reaction of nitroprusside with phenol in presence of sodium hypochlorite to form an azoephilic which with ethyl (sodium hydrosol) gives a coloured compound. The sodium nitroprusside acts as a catalyst increasing the rate of reaction. The extent of colour production is a measure of the nitroprusside concentration. Changes in the scale readings of the K2 spectra at 525 millimicrons were recorded and results calculated in micrograms per 100 ml from a calibration curve (Fig. 8) were converted to mol per l.
Fig. 7. Calibration curve for total protein in serum. 
Dextan reaction. Read at 540 millimicrons.
Fig. 8. Calibration curve for asparte in serum, read at 620 millimicrons.
1.1.5. Serum creatinine

Serum creatinine concentration was measured according to the method described by Miller and Strom (1969). The method is based on the reaction between creatinine in the protein-free filtrate of the serum and alkaline picrate solution to form creatinine picrate (Jaffe reaction). The protein-free filtrate was prepared by the addition of equal volumes of 0.66 N sulphuric acid, 20 per cent sodium tungstate and distilled water to the serum. The alkaline picrate solution was freshly prepared and added to the protein-free filtrate to give a red colour indicating the presence of creatinine picrate. Changes in the scale readings of the colorimeter were recorded at 520 millimicrons and values estimated in mg per 100 ml using a calibration curve (Fig. 2) were converted to pmol per l.

1.1.6. Serum magnesium

A stock magnesium solution II (10 mg/litre) was prepared from stock magnesium solution I (0.1000 g of magnesium nitrate
Fig. 5. Calibration curve for creatinine in serum. Read at 520 millimicrons.
dissolved in a few drops of concentrated HCl and the volume made up to 1 litre with distilled water. Stock I solution (1.7%) was prepared from solution II (5.0% (37.5 g/l). Stock II DM (0.7%) was prepared from stock I (300 ml stock 1/litre HCl). Standard magnesium solutions in 0.75% HCl (10 ml HCl of stock I added to each standard), equivalent to 1, 1.5, 2, 2.5, 3 and 4 mg magnesium in the undiluted serum were prepared from stock magnesium II by dilution. Serum was diluted 25 times with 0.70 HCl solution and the blank was prepared by addition of HCl to distilled water as in the case of the standards to obtain a similar viscosity.

Absorptions of different magnesium standards were read in the Unicam SP 90 Atomic Absorption Spectrophotometer (Unicam Instruments Ltd., Cambridge, England) followed by the test at a wavelength of 255.2 nm (slit width, 0.04 mm, filter 1, observation height, 1 cm). A calibration curve (Fig. 10) was plotted by comparing magnesium concentrations (per cent) in the undiluted sera against the respective absorptions. The concentrations of tested samples were recorded and frequent checks with standards were done to ensure any interference that might occur.
Fig. 19. Calibration curve for magnesium in serum.
Read at 205.2 nm. Atomic Absorption
Spectrophotometer.
4.4.7. Serum urea nitrogen

The method described by White and Pollak (1962) was used. The principle of the method is based on the decomposition of urea in serum into ammonia and carbon dioxide by the action of the enzyme urease. The ammonia was measured photometrically by the phenol hypochlorite reaction of Bartholat, using sodium nitro-prusside as a catalyst. Changes in the scale readings of the pH meter at 625 millimicrons were recorded and compared with a standard and readings were calculated in mg per 100 ml as follows:

\[
\text{Scale reading of unknown} \times 0.004 \times 100 = \text{mg of urea} \quad \text{mg/100 ml.}
\]

The results were converted to mg per 1.

4.1.6. Serum calcium

For calcium determination in serum, a stock calcium solution (100 mg/litre) was prepared from calcium carbonate (0.3497 g calcium dissolved in 11 drops of concentrated HCL) and the volume
made up to 1 litre) previously oven-dried overnight and the solution was stored in a polythene bottle. Standard calcium solutions in 0.75% HNO₃ equivalent to 0, 2.5, 5, 7.5, 10, 12.5 and 15 mg/l in the undiluted form were prepared from the stock calcium solution. HNO₃ was used to inhibit the suppressive effects exerted by phosphate ions, proteins and high sodium concentrations in the serum. The zero standard, with no calcium added, was used to check the instrument. Calcium standards and test samples were read in the atomic absorption spectrophotometer (IRI Reader) at a wavelength of 425.7 nm (slit width, 0.2 nm, air flow 5 litres/min, conical lens, 1.5 pounds/ square inch). A calibration curve (Fig. 11) was prepared by plotting calcium concentrations (per cent) in the undiluted form against the respective absorbance of the standards and the results were consecutively recorded.

4.1.9. Serum uric acid

The method described by White and Francel (1965) was used. The principle of the method is based on the reduction of an alkaline phosphotungstate solution by the uric acid in serum to a tungstean...
Fig. II. Calibration curve for calcium in serum.
Read at 422.7 nm. Atomic Absorption Spectrophotometer.
blue. The alkali used was sodium carbonate. The extent of color
precipitation is a measure of uric acid concentration. Changes in the
scale readings of the Rl spectrophotometer at 660 millimicrons were recorded
and compared with a standard and values were estimated in mg per
100 ml as follows:

\[
\text{Scale reading of unknown x 100 = mg uric acid}
\]

\[
\text{Scale reading of standard}
\]

The results were then converted to mg/l.

4.2. Sublation of tissue lipids

Tissues were homogenised with 9:1 chloroform methanol
mixture, filtered and the filtrate was stood from non-lipid substan-
ces by addition of water according to the method of Folch, Lees and
Sloane (1957). Total lipids were measured according to the method
of Frings and Dunn (1970). The free lipids were digested with hot
concentrated sulphuric acid and treated with phenolphthalein reagent
for colour development. The intensity of colour was read at 560
well-determined using the UV spectra. The results were read from a standard curve (Fig. 12) obtained with ethanol-diluted olive oil.

4.1. Determination of nutritive in plants

All plant samples were collected from Pharaoh Province in separate nylon containers. The samples were separated for zinc, magnesium, phosphorus, copper, calcium, dry matter, crude fiber, crude protein, crude fat and ash content.

Preparation of Glassware

Pyrex glassware was washed with boiling, rinsed with tap water, soaked in 5% nitric acid and kept overnight before being washed several times with tap water followed by rinsing with de-ionized water. Glassware was then evaporated and used thus ready for use.

The methods used for the estimation of crude fiber, crude protein, crude fat, ash content and dry weight in plants
Scale reading

Lipid (mg per cent)

200 400 600 800 1000

0 20 30 40 50 60

Fig. 12. Calibration curve for total lipids in tissue.
keeping were obtained from the Provincial Bulletin No. 27 of the Ministry of Agriculture, Fisheries, and Food, Great Britain (1972).

4.3.1. Dry matter (2.10)

A clean crucible was fired at 1,050°C for 3 hours, cooled in a desiccator and then accurately weighed. 5 g of finely ground plant material were placed in a crucible and the latter was transferred to an oven at 105°C overnight. The percentage of the dry matter content was calculated as follows:

\[
\text{Dry matter (per cent) = } \frac{(\text{weight of crucible + dry sample}) - (\text{weight of empty crucible})}{2} \times 100
\]

4.3.2. Crude fibre (2.12)

1 g of ground plant material was placed in a conical flask. 100 ml of C.T.A.R. reagent (Cetyltrimethyl ammonium bromide dissolved in concentrated sulphuric acid and distilled water) were added and the mixture was brought to boil for 3 hours and then cooled. The contents of the flask were filtered.
under vacuum into previously weighed glass crucibles or mortars.

The crucibles containing the filtrate were placed in an oven at 100°C overnight, cooled in a desiccator and weighed. The percentage of crude fibre content was calculated as follows:

Crude fibre (per cent) =

\[
\frac{\text{weight of dry crucible} - \text{crude}}{\text{weight of dry crucible}} \times 100
\]

For crude fibre content in plant cases, 0.5 g of finely ground sample were weighed and oil was extracted by petroleum spirit using a soxhlet apparatus. The petroleum spirit-extracted seeds were carefully removed from the extraction thimble of the apparatus and placed in a conical flask. 100 ml of trichloroethylene, and reagent (20 g of T.C.H.E., 370 ml of glacial acetic acid, 50 ml of nitric acid and 420 ml of distilled water) were added and the flask was transferred to a heating unit attached to a condenser until boiling. The contents of the flask were filtered into a glass crucible. The crucible containing the filtrate was transferred to an oven at 100°C overnight.
decalcified, boiled, weighed and then placed in a muffle furnace at 500°C for 3 hours. The muffle containing rack was cooled in a dessicator and weighed. The percentage of crude fibre content in the plant seeds was calculated as follows:

Crude fibre (per cent) =

\( \frac{\text{weight of muffle-crept plant}}{-\text{weight of crept plant}} \)

4.3.3. Crude leaf extract, R.B.

A Stockbeil flask was dried, decalcified and weighed. 1.5 g of finely ground plant material were placed in a Stockbeil thimble which was then plugged with cotton wool, placed in the extraction port of the Stockbeil apparatus and subjected to the flask. Extraction with petroleum spirit continued for 24 hours. The Stockbeil thimble was removed from the apparatus and dried in an oven at 100°C. 100 ml ether was passed into the receiver. The flask containing small amounts of ether was transferred to a forceful draft oven at 100°C for at least 2 hours, decalcified,
cooled and weighed. The percentage of ether extract was calculated as follows:

\[
\text{Ether extract (per cent)} = \frac{\text{weight of flask + extract} - \text{weight of empty flask}}{\text{weight of flask + extract}} \times 100
\]

4.3.4. Qualitative tests (Q.P.)

500 mg of finely ground plant sample were placed in an appropriate beaker. 10 ml of concentrated \( \text{H}_2\text{SO}_4 \), two ligatured catalyst tablets and 7 antimony prussiates were added and mixed with plant material. The flasks were then placed in a special rack and attached to the digestion block at 142°C for 2 hours. The reactions and flasks were removed from the digestion block and allowed to cool and the volume of the solution in the flasks was made up to 75 ml with distilled water. Murexid-digested distillation apparatus was set up and 5 ml of the digested plant material, 6 ml of distilled water and 5 ml of 40% sodium hydroxide were placed in the beak funnel of the
separately. A conical flask containing 10 ml of 2% boric acid was placed under the condenser and distillation was continued for 5 minutes. This was followed by titration using $\frac{w}{20} \text{H}_2 \text{SO}_4$ and a mixed indicator (bromoresol green and methyl red).

$$\text{IL of } \frac{w}{20} \text{H}_2 \text{SO}_4 = \text{IL of } \frac{w}{20} \text{NH}_3$$

$$\therefore \text{IL of } \frac{w}{20} \text{H}_2 \text{SO}_4 = 0.2001 \text{mg of } \text{N}_2$$

$$\therefore 1 \text{ ml of } \frac{w}{20} \text{H}_2 \text{SO}_4 = 0.0001 \text{ mg of } \text{N}_2$$

Each ml of $\frac{w}{20} \text{H}_2 \text{SO}_4$ used in the titration is equivalent to:

$$1 \times 0.0001 \times \frac{72}{18} \times \frac{250}{\text{IL}} \times \frac{\text{IL}}{0.02} \times 6.25 \text{g/mmol.}$$

$T$ = titration figure

$x$ = normality of $\frac{w}{20} \text{H}_2 \text{SO}_4$ used

$0.5$ = weight of plant sample used

$5$ = volume used in distillation

$0.71$ and $6.25$ = factors
According to the above equation, the percentage of crude protein content was calculated as follows:

\[
\text{Crude protein (per cent)} = 2 \times 0.00026 \times \frac{25}{6} \times 0.85 \\
= \frac{0.00026 \times 25}{6} \times 0.85
\]

4.3.5. Ash

5 g of finely ground plant sample were accurately weighed and placed in a dry crucible. The latter was transferred to a muffle furnace at 900°C for 3 hours (ashing). The crucible containing the ashed sample was removed from the furnace, cooled, left to cool to room temperature and then weighed. The percentage of ash content was calculated as follows:

\[
\text{Ash (per cent)} = \frac{\text{weight of crucible-ash} - \text{weight of empty crucible}}{\text{weight of crucible-dry sample} - \text{weight of empty crucible}} \times 100
\]
Preparation of plant samples for mineral analysis

5 g of finely ground plant samples were placed in a Silica
bason. The latter was transferred to a muffle furnace at 500 °C
for at least 3 hours and left to cool to room temperature. The
contents of the Silica basin were placed in a beaker containing
10 ml of distilled water. 12 ml of concentrated H2SO4 were added
and the contents were heated to incipient boiling by an electric
plate for 10 minutes, cooled and filtered through a Whatman
filter paper No. 41, into a volumetric flask. The beaker and
filter papers were washed several times with distilled water
and the volume was made up to 250 ml with distilled water.

The methods used for the determination of mineral contents in
plant samples were obtained from the Atomic Absorption
Catalogue of the Unica Sp. 191 Atomic Absorption Spectropho-
tometer (Unica Instruments Ltd., Cambridge, England).
A stock zinc solution of 1000 mg/litre was prepared (0.500 g of pure zinc metal dissolved in a few drops of concentrated HCl and volume completed to 1 litre with glass distilled water). A series of standard of zinc solutions was prepared from the stock solution by dilution. Absorbance of the different concentrations of the standard solutions were measured at a wavelength of 213.9 nm (Bandwidth 0.2, immune height 1.0 cm, air flow 0.5 litres/minute and acetylene gas pressure 1.4 - 1.8 pound/square inch). A hollow cathode zinc lamp was used as the light source as described in the CP 391 Series Technical manual (1978). The peak materials were aspirated in the instrument and their values obtained from a calibration curve (Fig. 2).

A stock magnesium solution of 1000 mg/litre was prepared (0.100 g of pure magnesium metal dissolved in a few drops
Fig. 33. Calibration curve for zinc in plants. Read at 224.5 nm, Model Abbe Spectrophotometer.
of concentrated HC1 and the volume made up to 1 litre with distilled water) A series of standard manganese solutions was prepared from the original stock solution by dilution. The Hobbs Absorption Spectrophotometer was blanked with demineralized water and absorptions of the different concentrations of manganese standards were determined at a wavelength of 265.2 nm ( slit-width 0.2 nm, burner height 1.0 cm; air flow 5 litres/minute and acetylene gas pressure 2.4 — 1.8 pounds/square inch). A hollow cathode manganese lamp was used as the light source and plant materials had their manganese content estimated from a calibration curve (Fig. 14).

4.3.4. Copper

A stock copper solution of 1000 mg/litre was used

(0.1000 g of pure copper metal dissolved in a few drops of concentrated nitric acid and the volume made up to 1 litre with distilled water). A series of standard copper solutions was prepared from the original stock solution by dilution. The
9. 100 ml Atomic Absorption Spectrophotometer was filled with deionised water and absorptions of the standard solutions were recorded at a wavelength of 324.7 nm (Slit width 0.2 nm, burner height 1.0 cm, air flow 5 litres/minute and air pressure 1.5 - 1.5 psi/100 square inch). The plant materials were aspirated in the instrument and their copper content estimated from a calibration curve (Fig. 15).

4.1.3. Mangese

For magnesium analysis in plant samples, a stock magnesium solution was prepared (0.1 g MgO/1 ml H₂O, dissolved in a few drops of 6N HCl and volume made up to 1 litre with distilled water). Standard magnesium solutions were prepared from the stock solution by dilution in the presence of lanthanum chloride. Absorptions of the different magnesium concentrations were determined by the use of the 100 ml Atomic Absorption Spectrophotometer at a wavelength of 285.2 nm (Slit width 0.2 nm, burner height 1.0 cm, air flow 5 litres/minute).
Fig. 15. Calibration curve for copper in plants.

Absorbance vs. Copper concentration in p.p.m.
and acetylene gas pressure 1.4 - 1.8 pounds/square inch. The percentage of magnesium in plant material was read out from the calibration curve (Fig. 16) constructed for magnesium.

4.3.10. Calcium

For calcium analysis in plant samples, a stock calcium solution was prepared (5.8 g of dry CaCO₃ dissolved in a liter of 6N HCl). Standard calcium solutions equivalent to 2, 6, 10, 16, 20, 24, 30 and 50 ppm were made from the stock solution by dilution in the presence of lanthanum chloride. Absorptions of the different standard solutions were measured by the use of the IL 151 Model Shimadzu Spectrophotometer at a wavelength of 422.7 nm (slit width 0.2 mm, burner height 1.0 cm, air flow 5 liters/minute and acetylene gas pressure 1.4 - 1.8 pounds/square inch). The plant materials had their calcium content estimated from a calibration curve (Fig. 17).
Fig. 16. Calibration curve for magnesium in plants.
Read at 285.2 nm. Atomic Absorption Spectrophotometer.
Fig. 17. Calibration curve for solute in plasma. Read at 522.7 nm. Atomic Absorption Spectrophotometer.
4.3.11. Phosphorus

A stock phosphate solution was prepared (3.04 g of potassium dihydrogen phosphate dissolved in 1 litre of distilled water). A series of phosphate solutions was made from the stock solution by dilution in the presence of vanadium chloride reagent. Absorptions of the phosphate standard were measured at a wavelength of 420 nm and values of phosphorus in the plant material were estimated from a calibration curve (Fig. 16) constructed for phosphorus as follows:

\[
\text{mg P} = \frac{\text{mg} \times \text{dilution factor} 	imes \text{volume taken}}{\text{weight of sample} \times \text{volume taken}}
\]

\[
\text{mg} = \frac{\text{weight of sample} \times \text{dilution factor}}{\text{volume taken}}
\]
CHAPTER III

THE CHEMISTRY OF BACTERIAL COAGULASES AND TOXINS

1. INTRODUCTION

Plants as a source of medicine have been and are being used all over the world. Many constituents of such medicinal plants have been isolated and used in the treatment of various diseases in man and domesticated animals. It is well known that overuse of the active principles in plants can cause severe effects on health.

Several species of the genus Cassia such as Cassia Angustifolia and S. aculeata are found in the Sudan and are used medicinally as cathartics (Adam, 1976; Elbak, 1980; Yassin, 1970; and Barri, unpublis hed data).

Cassia occidentalis is a member of the family

Cassieaceae and is common in Central, Southern and Western Sudan. The literature contains no studies on Coagulase inhibited plants.
The present study was aimed to examine the clinical, biochemical and pathological effects of feeding Nubian goats with the dry seeds and fresh leaves of *C. umbellata*.

2. MATERIALS AND METHODS

**Animals**

Ten 6-month-old Nubian goats of both sexes were used in the experiment. They were penned at the Department of Veterinary Clinical Studies, University of Khartoum, and fed on khatame and water ad libitum.

**Administration of *C. umbellata***

The plant was collected from Oeshat, Khartoum Province, and the fresh leaves were finely chopped, mixed with water and then given by drench at the dose rate of 5 g/day to two goats (group I) and 1 g/day to two goats (group II). The seeds of the plant were dried in the sun, ground in a mill and then given
by drench at the dose rate of 2 g/kg/day to two goats (group III) and 1 g/kg/day to two goats (group IV). The two goats in group V were unoinoculated controls.

Details are given in Table I.

Blood sampling

Animals were bled from the jugular vein on several occasions before dosing commenced and at suitable intervals thereafter for serum analysis and hematology.

Chemical methods

Blood samples were allowed to clot, serum was separated by centrifugation at 3000 r.p.m. for 10 minutes and stored at 4°C until analyzed for the activities of glutamate oxaloacetate transaminase (GOT) and glutamate pyruvate transaminase (GPT) and for the concentrations of ammonia, urea, total protein, total bilirubin, aspartate and alanine by the methods described in Chapter II.

Quantitative determination of total lipids in the heart, liver-
and always of Gessleizer's stain was used by the methods described in Chapter II.

**Hematological methods**

Hemoglobin concentration (Hb), packed-cell volume (PCV), total counts of red and white blood corpuscles (RBC and WBC), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV) and differential leukocyte counts in guinea pigs were determined by the methods described in Chapter II.

**Histological methods**

Tissues for histological examination were fixed in 10 per cent formalin saline and paraffin sections were stained with hematoxylin and eosin (H&E), the periodic acid-Schiff (PAS) method with and without prior digestion with diastase and Perl's prussian blue reaction.
3. RESULTS

Information on grade, sex of animal and time of death or slaughter are given in Table 1.

Clinical Findings

Goats 1 (group I), 5, 6 (group III) and 7 (group IV) showed dullness, inappetence, diarrhoea, respiratory distress, staggering, stasis and recumbency. These animals died on days 22, 9, 9 and 20 respectively. Loss of condition, incoordination of movement, pallor of the visible mucous membranes, soft faeces and recumbency were seen in goats 2 (group I), 3, 4 (group II) and 8 (group IV). These goats died or were killed on days 80, 92, 51 and 93 respectively.

Post-mortem Findings

There was haemorrhage and congestion in the heart, lungs (Fig. 9), liver, kidneys (Fig. 10) and spleen, arterial emboli, pulmonary emphysema and lipomatous fatty change in goat I.
Fig. 29. Neomorhage in the lungs of goat 3, orally dosed with 5 g/kg/day of dry Cassia seeds for 9 days.

Fig. 30. Neomorhage in the abomasum of goat 6, orally dosed with 5 g/kg/day of dry Cassia seeds for 9 days.
In guinea-pig poisoned guinea-pigs, there were deposits of hemosiderin in the red pulp of the spleen (Fig. 21), congestion of the hepatic blood vessels and sinusoids, fatty cytoplasmic vacuolation of the centrilocular hepatocytes, accumulation of pigments in the hepatic portal tracts and arteriolar arteritis (Fig. 22) and schistocytes. Many renal convoluted tubules were dilated and some of them contained eosinophilic substance. The glomerular tufts were shrunken or necrotic (Fig. 23) and medullary rays were congested in guinea-pigs in groups I and III. The pulmonary haemorrhage and emphysema, hepatic portal fibrosis, sporadic degeneration and necrosis of the renal glomeruli with endothelial and monocytes were more marked in guinea-pigs in groups II and IV.
Fig. 21. Hemorrhagic deposits in the red pulp of the spleen of goat 1, orally dosed with 5 g/kg/day of fresh Cassia leaves for 20 days. Prussian blue reaction x100.

Fig. 22. Catarhal enteritis in goat 7, orally dosed with 1 g/kg/day of dry Cassia seeds for 20 days. H & E x 100.
Fig. 2A: Shrinkage and necrosis of the renal glomerular tufts of host 5, orally dosed with 5 g/kg/day of dry CaCl₂
solution for 9 days. N x 3 x 100.
Changes in serum constituents

There was no change in the activity of GGT in the serum of any yolk.

Animals in groups I and II were supplied by yolk 2 (group I) and 3 (group II). In group 2, there were increases in the concentrations of albumin and serum and a small decrease in the levels of calcium and total protein at the time of death (Fig. 24). The activity of GGT increased on day 15 and remained high at the time of death. Bilirubin showed a small increase after incubating and there was no significant change in the concentration of magnesium. In group 3, the concentrations of total protein and calcium fell terminally and the levels of albumin and serum fluctuated above normal until death. The activity of GGT increased between days 20 and 25 (Fig. 25). The concentration of magnesium did not change.

In group 4 (group III) which died on day 25, there were terminal increases in the activity of GGT and in the concentrations of albumin and serum and a decrease in the concentration of total protein (Fig. 26). There were no significant changes in the
Fig. 24. Changes in the activities of GGT and GPT and in the concentrations of ammonia, urea, total protein, total bilirubin, magnesium and calcium in the serum of goat 2 orally dosed with 5 g/kg/day of fresh Cassia leaves for 30 days.
Fig. 25. Changes in the activities of GCT and GPT and in the concentrations of urea, ammonia, calcium, magnesium, total bilirubin and total protein in the serum of goat 3 orally dosed with 1 g/kg/day of fresh Cannabis leaves for 93 days.
Fig. 28. Changes in the activities of GOC and GOPO and in the concentrations of ammonia, urea, calcium, magnesium, total protein, and total bilirubin in the serum of goat 3 orally dosed with 5 g/kg/day of drug for 9 days.
concentrations of calcium and magnesium in the serum of this goat. In goat 7 (group IV) which died on day 28, there were increases in the concentrations of potassium and urea and in the activity of GOT and increases in the levels of total protein and calcium at the time of death (Fig. 27). Bilirubin showed a small increase tendingly and there was no change in the concentration of magnesium in the serum of this goat.

Hematological findings

There was no significant change in the NOV and HCMC. There was a decrease in the values of Hb, HMC and NOV and an increase in leukocyte count in Osseola-polidued goats.

Tissue lipid

The lipid content of the liver, kidneys and heart of the control goats was compared with that of Osseola-polidued goats (Table II). Total lipids were higher in the liver, kidneys and heart of Osseola-polidued animals.
Fig. 27. Changes in the activities of GOT and GPT and in the concentrations of asparia, urea, calcium, magnesium, total protein and total bilirubin in the serum of goat 7 totally dosed with 1 g/kg/day of dry Qassia seeds for 20 days.
TABLE II

CONCENTRATIONS OF TOTAL LIPIDS IN TISSUES OF DOGS
AND THEIR CIRCUIT OCCURRENCE

<table>
<thead>
<tr>
<th>Group</th>
<th>Liver</th>
<th>Heart</th>
<th>Kidney</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>80.7</td>
<td>33.6</td>
<td>26.4</td>
</tr>
<tr>
<td>II</td>
<td>58.8</td>
<td>27.4</td>
<td>25.9</td>
</tr>
<tr>
<td>III</td>
<td>77.9</td>
<td>32.6</td>
<td>27.6</td>
</tr>
<tr>
<td>V</td>
<td>53.7</td>
<td>27.7</td>
<td>25.3</td>
</tr>
<tr>
<td>V (excluding)</td>
<td>27.8</td>
<td>27.9</td>
<td>25.6</td>
</tr>
</tbody>
</table>
4. DISCUSSION

These results indicate that the fresh leaves and dry seeds of *Casuarina equisetifolia* are toxic to goats and can cause death. The goats which received 9 and 1 g/kg/day of fresh *Casuarina* leaves died or were killed within 20 and 53 days. Three out of four goats which received 5 and 1 g/kg/day of dry *Casuarina* seeds died within 7 and 20 days after dosing while the remaining goat was killed 53 days after dosing.

The pathological, biochemical and clinical data were indicative of effects on the small intestine, kidneys, liver, lungs and heart. The development of diarrhea may be a consequence of severe intestinal enteritis. It is possible that pulmonary congestion, emphysema and hemorrhage caused by erosion of the intestinal mucosa could cause pulmonary congestion. The severe damage to the intestine, kidneys and liver might explain the intertumoral connection in *Casuarina*-poisoned goats.

The damage to the kidneys as well as damage to the liver
probably contributed to the varying role in the levels of serum amylase and trypsin in canine-intestinal-teste adhesions. The fall in serum protein concentration and the increased activity of serum AST also point to liver injury in canine-protein-adephine. The activity of ALT in the serum did not change. This finding has been observed in recent liver damage by White et al. (1975), HI and Shen (1976), and Sneddon and Alton (1976). Renal injury leads to retention of phosphate which in turn results in a decreased absorption of calcium from the intestine and a lowered concentration of calcium in serum (Cornell us and Alton, 1963).

Certain species of Canine such as G. Atelius, G. amni and G. agalopaha are known to contain acidophilic colonic and adrenocortical glands in galls and adult (Kutib, 1983; Kurek, et al., unpublished data).

The increase in leucocyte counts may be due to an increase in the number of eosinophils. The changes in erythrocytes, hemosiderin of the spleen and the mild bilirubinemia suggest that some degree of extravascular hemolysis occurred.
It seems reasonable, therefore, to conclude from the above findings that the fresh leaves and dry seeds of C. occidentalis are toxic to guinea pigs by causing structural and functional changes in the small intestine, liver, kidneys, lungs and heart.
CHAPTER IV
THE EFFECT OF INDIQUEA ADMINISTRATION ON LIVER

1. INTRODUCTION

Several species in the genus Indiquea (Papilionaceae) have been the subject of much investigation in many countries, including the United States of America and Australia. For example, feeding of Indiquea hypoglycina to sheep and calves has caused hepato-renal injury (Jeganathan, 1953; Beamish, Monk, Horise, Noguchi, Takahashi, Xu, Illers, and Greene, 1952).

Reports of the toxic effects of Indiquea hypoglycina on domesticated animals are lacking. The present study was initiated in order to examine the effects on various organs of feeding and doses of the dry seeds of I. hypoglycina on the changes induced in the activities of serum GLT and GGT and in the concentrations of total protein, total bilirubin, amine compounds as well as the cellular elements of the blood.
Materials and Methods

Animals

Twelve 9 to 13-month-old male goats of both sexes were used in the experiment. They were kept in pens at the Department of Veterinary Clinical Studies, University of Khartoum and fed on lucerne and water ad libitum.

Plant

The plant collected from the Ramses in the Khashm area of the Sudan was dried in the sun, ground in a mortar and given to the experimental animals as a suspension in water or drunk each day until death or slaughter.

The goats were divided into four groups and the dry weights of 1. M. hyoscyamus were given by drinking 2 g/day. The dosage was 5 g/day to four goats (group I), 3 g/day to three goats (group II) and 1 g/day to three goats (group III). Two goats in group IV were kept as usual controls. The total amount...
of Indigofare shots received by each goat is given in Table III.

Bleed sampling

All goats were bled from the jugular vein before and at appropriate intervals after the commencement of Indigofare dosing for chemical investigations on serum and the cellular elements of the blood.

The methods used in this experiment for biochemical, enzyme biochemical, histological and haematological investigations are described in Chapter II.

5. RESULTS

The weights of the goats, thedaily dose and the total amount of Indigofare they received and the time of death are given in Table III.
Clinical Findings

Gorilla 11, 12, 13, 16 (group I), 14, 15, 17 (group II) and 20 (group III) showed weight loss, anemia, depression, blindness, disorientation, weakness of the hind limbs, incoordination of movement, cyanosis, abnormal postures, accords and recumbency (Fig. 28). They died or were killed on days 7, 11, 12, 17, 15, 4, 5, and 6 respectively.

Gorilla 18 (group III) showed similar signs of poisoning and was killed on day 35. Gorilla 19 (group III) died on day 35. There were no clinical changes in the control gorilla 21 and 22 (group IV).

Histological Findings

There were acute necrosis hemorrhages in the heart, lungs, and kidneys, arteritis arteriitis and arteriolitis, pulmonary edema, and fatty change and congestion in the liver of gorillas 11, 12, 13, 16 (group I), 15, 16, 17 (group II) and 20 (group III). Severe adiposis of the unstated fat and fatty change in the liver and kidneys were particularly marked in gorillas 15 and 19 (group III). There were no changes in the control gorilla 21 and 22 (group IV).
Fig. 28. Bactericide in goat 12, orally fed with 10 g/kg/day of dry Indigofera shoots for 14 days.
Histological findings

There was haemorrhage and congestion in the renal cortex and medulla (Fig. 37), the red pulp of the spleen and the submucosa of the small intestine and abdomen in Indigocarpo-poisoned goats.

Oedema, arteritis and nephritis, degeneration and/or necrosis of the epithelial cells of the renal tubules (Fig. 56) and cytoplasmic fatty vacuolation of the centrolobular hepatocytes were noted in goats in groups II and III. The nuclei of the periportal liver cells were hypochromic and some renal tubules contained eosinophilic material. Concretion of the pulmonary (interlobar) capillaries, haemorrhages in renal glomeruli and pulmonary alveoli were seen especially in goats in groups I and II. Pulmonary oedema, periarterial vacuolation in the grey matter of the spinal cord, hepatic portal fibrosis and dilatation of the mesentery (Fig. 51) and aggregates of macrophages cells in the intestinal mucosa occurred. Renal glomeruli and pulmonary alveoli were seen in Indigocarpo-poisoned goats.
Fig. 9. Congestion in the renal medulla of goat 12, orally dosed with 10 g/kg/day of dry Indigofera shoots for 24 days, H & E x 100.

Fig. 10. Necrosis of the cells of the renal convoluted tubules of goat 17, orally dosed with 5 g/kg/day of dry Indigofera shoots for 6 days, H & E x 100.
**Enzyme histochemical findings**

The distribution of the activities of adenylate triphosphatase, 5-nucleotidase, succinic dehydrogenase and glucose-6-phosphatase in the liver and kidneys of control goats was similar to that described by Alex and Kayoun (1976), Niel (1979) and Zyl (1980).

**Liver**

In the liver of control goats, the activities of glucose-6-phosphatase (Fig. 3A) and succinic dehydrogenase were greater in the peripoortal hepatocytes than in the cells of the inner 2/3 of the liver lobule. In goats in group 1, the activities of these two enzymes were reduced in the necrotic foci. In goats in groups II and III, the activities of succinic dehydrogenase and glucose-6-phosphatase were not detected in the hepatocytes in areas of necrosis and dilated sinusoids (Figs. 3B and 3C). In the normal liver of goats, the activity of ATPase was seen in the bile canaliculi, the walls of the central veins, the blood vessels of the portal areas and the adventitia of bile ducts and walls of sinusoids. 5-nucleotidase
Fig. 31. Dilatation of the hepatic sinusoids in post 19, orally dosed with 1 g/kg/day of dry Indigofera shoots for 23 days. H & E 2 x 100.

Fig. 32. Liver of control post 22 showing high activity of glucose-6-phosphatase in the perivascular hepatocytes. Lead nitrate method x 100.
Fig. 33. Liver of goat 13 orally dosed with 1 g/kg/day of dry Indigofera roots for 33 days. Loss of amionic dehydrogenase activity in areas of necrosis and dilated sinusoids. Nitro-3T x 200.

Fig. 34. Liver of goat 17, orally dosed with 1 g/kg/day of dry Indigofera roots for 33 days. Loss of glucose-6-phosphate activity in the heparitic cell and area of dilated sinusoids. Lead nitrate method x 100.
activity in the liver of normal goats was high in the sinusoids and
the bile canaliculi. In Indigotin-poisoned goats, the reaction of
ATPase and 5-nucleotidase was lost from the canaliculi and sinusoids
in the necrotic area (Figs. 35 and 36).

Kidneys

In the kidney of control goats, the activities of glucose-6-
phosphatase and succinic dehydrogenase were confined to the cyto-
plasm of the renal tubules (Figs. 37 and 38). In Indigotin-poisoned
goats, the reaction of glucose-6-phosphatase and succinic dehydro-
genase was completely lost from the necrotic renal tubules (Figs. 39
and 40). In the kidney of control goats, the activities of 5-nucleotid-
ase and ATPase were intense in the glomeruli, blood vessels and
basement membranes and cytoplasm of the renal tubules. In Indigotin-
intoxicated goats, there was a drastic reduction in the activities
of ATPase and 5-nucleotidase in the affected tubules and glomeruli
but the blood vessels still showed strong reaction.
Fig. 35. Liver of goat 15, orally dosed with 5 g/kg/day of dry indigofera sheets for 35 days, loss of 5-nucleotidase activity in the bile canaliculi. Lead nitrate method × 100.

Fig. 36. Liver of goat 15 orally dosed with 5 g/kg/day of dry indigofera sheets for 35 days, loss of 5-nucleotidase activity in the bile canaliculi and sinusoids. Lead nitrate method × 100.
Fig. 57. Kidney of control post 21 showing glucose-6-
phosphatase activity in the cytoplasm of the
cells of the convoluted tubules. Lead nitrate
method x 100.

Fig. 58. Kidney of control post 21 showing succinic
dehydrogenase activity in the cytoplasm of
the cells of the convoluted tubules. Nitro-
BT, x 100.
Fig. 38. Kidney of goat 17, orally dosed with 5 g/kg/day of dry indigofera shoots for 6 days. Loss of glucose-6-phosphatase activity in the necrotic convoluted tubules. Lead nitrate method x 100.

Fig. 40. Kidney of goat 17, orally dosed with 2 g/kg/day of dry indigofera shoots for 6 days. Loss of mitochondria dehydrogenase activity in the necrotic convoluted tubules. Nikro-BT, x 100.
Changes in serum constituents

There were no significant changes in the concentration of total bilirubin or in the activity of GPT in the serum of any animal.

Animals in group I were necropsied by goat 15, which was killed on day 10. There were increases in the concentrations of urea and creatinine and in the activity of GPT and a decrease in the concentration of total protein at the time of slaughter (Fig. 41). In goat 15 (group II), there were terminal increases in the activity of GPT and in the concentrations of creatinine and urea and a decrease in the level of total protein (Fig. 42). In goat 19 (group III), which died on day 38, serum protein showed slight falls towards terminal stages of the disease (Fig. 43). Creatinine and urea showed terminal increases and the activity of GPT was elevated between days 19 and 38.

Histological findings

Animals in group I were necropsied by goat 15, which was killed on day 10. There was a decrease in the values of TB, PCV, RBC, and MCHC between days 1 and 10 (Fig. 44). Leukocyte counts
Fig. 41. Changes in the activities of GOT and GPT and in the concentrations of urea, ammonia, total protein and total bilirubin in the serum of goat 1, orally dosed with 10 g/kg/day of dry Indigofera extract for 30 days.
Fig. 42. Changes in the activities of GPT and GGT and in the concentrations of urea, albumin, total protein and total bilirubin in the serum of goats 15, orally dosed with 3 g/kg/day of dry indicator weeds for 15 days.
Fig. 4.3. Changes in the activities of GGT and GPT and in the concentrations of ammonia, urea, total protein, and total bilirubin in the serum of group 19, orally dosed with 1 g/kg/day of dry Indigofera shoots for 35 days.
Fig. 4A. Changes in the red cell parameters and in total lymphocyte count in case 15, orally dosed with 10 mg/day of dry inactive quinacrine for 20 days.
showed rises during the acute period. In post 15 (group II), the MCV, MCH and MCHC fell below predosing values between days 6 and 25 (Fig. 4A). There was an increase in leucocyte count on day 6 and a progressive decrease afterwards. In post 19 (group III), leucocyte counts showed irregular rises between days 14 and 35 and 58. MCV and MCH decreased towards terminal stages of the disease (Fig. 4B).

**Tissue Lignids**

The average concentrations of total lipids in the liver, heart and kidneys of the control animals and of the indigotindisulphuric acid treated groups are given in Table IV. Raised values of total lipids were found in the liver, heart and kidneys of indigotindisulphuric acid treated groups.

L. **INSECTICIDES**

The clinical changes in Mueller goats orally dosed with L. **insecticida** were asthenia, loss of condition, diarrhea, blest, dyspnoea, nervous signs and emaciation. The presence of peritoneal
Fig. 12. Changes in leukocyte counts and in red cell parameters in goat 19, treated with 1 g/kg/day of dry indigotin dose for 35 days.
## Concentrations of Total Lipids in Tissues of Cod vs

### Experimental Conditions

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resolution in the gray matter of the spinal cord is in accord with
the clinical evidence of locomotor disturbance. Ventral-root
resolution in the gray matter of the spinal cord was produced in
ovine, sheep and calves by *Oxyuris levati* (Hamed, 1978, Hamed
and Aden, 1980). The severity of the nervous signs during the course
of inguinal poisoning in ovine might also be increased by the
hepato-renal damage. The lesions in the kidney consisted of
necrosis and/or degeneration of the cells of the convoluted tubules,
hemorrhaging and congestion in both renal cortex and medulla and dis-
appearance of the glomerular tufts. This effect on the kidney prob-
ably contributed to the high level of serum urea and creatinine. The
high levels of GSH and ornithine and the fall in protein concentration
in the serum reflect liver-cell damage. The loss of nicotinamide-
dependent dehydrogenase and glucose-6-phosphatase activity from the
hepatic cells, together with irregularity in the activity of the endoplasmic
reticulum N-acetyltransferase and 5-nucleotidase add further evidence of liver-cell
injury.

The development of necrosis and loss of condition and the
changes in RBC, PCV and Hb counts during the terminal stages of
but changes indicate that mercury is present in kidney-pulling.

It seems that mercury is likely to be implicated by the low Hg2+
levels obtained shortly before death.

It seems reasonable, therefore, to conclude from the above
findings that the dry shoots of H. badenii are toxic to goats
by causing functional changes in vital organs of the body especially
the kidneys, liver, intestine and central nervous system.
Chapter V

THE ANTS AND TREPANIA ASKING AT ORANGE

1. INTRODUCTION

There are no reports of toxic effects in vertebrates of

Trepunia mirifica, a member of the family Papilionaceae. This plant is widely distributed in the Sudan and is regarded as causing illness and death in livestock.

The present experiment was designed to evaluate the biochemical, clinical and pathological changes in Sudanese cattle with T. mirifica.

2. MATERIALS AND METHODS


Ponson 6 to 16 month-old Sudanese cattle were kept in pens at
the Department of Veterinary Clinical Studies, University of Khartoum.
Throughout the experiment they were fed on Lucerne and water

**Design**

The fresh plant was collected from Zinjibor, Khartoum Province
and the shoots were finely shredded, dried in the sun and powdered and
given to the experimental animals as a suspension in water by drench
each day until death or slaughter.

The goats were divided into five groups. The fresh *Ipomoea*
shoots were given at the dose rates of 10 g/kg/day to three goats
(group I) and 1 g/kg/day to three goats (group II). The dry *Ipomoea*
shoots were given at the dose rates of 10 g/kg/day to three goats
(group III) and 1 g/kg/day to three goats (group IV). The two goats
in group V were undosed controls. The total amount of *Ipomoea* re-
ceived by each goat is given in Table V.

**Blood sampling**

All goats were bled from the jugular vein and serum was
separated for estimation of amine activity and concentration of
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Clinical Changes

Groups 23, 24, 25 (group I), 26, 27 and 28 (group II) showed impairment, wasting, dysesthesia, incoordination of movements, bilateral deviation of the head and neck, loss of direction, fixation of the upper joints, abduction and weakness of the hand muscles (Figs. 67) and paraplegia. These animals died on days 4, 5, 13, 11 and 12 respectively. Loss of condition, palsy of the visible motor sense, locomotor disturbances, dysesthesia and abnormal posture were seen in groups 29, 31 (group II), 32, 33 and 34 (group IV) which died or were killed on days 40, 43, 52, 42 and 39 respectively.
Fig. 47. Weakness of the hind limbs in goat 24, orally dosed with 10 g/kg/day of fresh Penhrosae shoots for 15 days.
Gart 30 (group III) died on Day 1. The control gasts 35 and 36 (group V) showed no abnormal changes and were killed on Day 40.

Post-mortem findings

In gasts in groups I, II and III, there was hemorrhage and congestion in the liver, lungs and heart, hydropericardium, hydrothorax, severe atrophy of the cardio and renal fat and subcutaneous enteritis. In gasts in group IV, atrophy of the cardio and renal fat, congestion of the spinal cord and brain, hydropericardium and hydrothorax were more marked.

There were no changes in the control gasts 35 and 36 (group V).

Histological findings

There was distention of the renal tubules (Fig. 4B), perivascular vacuolation in the spinal cord and cerebrum, centrilobular hepatic necrosis and fatty change, hyperchromasia of the nuclei of the pericetal hepatocytes, enteritis enteritis and abscesses and infiltration of round cells in the renal medulla.
(Fig. 49) and around the bronchioles in Hypoxia-poisoned animals. Some of the alveolar spaces were packed with exudate and endothelial cells (Fig. 50). Hemorrhage was seen in the pulmonary arterial, cardiac muscle fibres and interstitial and perivascular regions.

Changes in serum constituents

There were no changes in the activity of GGT or in the concentrations of urea, blood in the serum of any of the groups. Animals in group I were sacrificed by gales 23 and 24. In gale 23, alanine, creatinine and urea showed terminal raised concentrations (Fig. 51). The increase in the activity of GGT and decrease in the concentration of total protein occurred between days 3 and 4. In gale 24, the concentration of alanine did not change but that of creatinine increased terminally (Fig. 52). The concentration of urea increased between days 2 and 14. GGT showed increased activity terminally. In gale 21 in serum total protein occurred between days 7 and 14. In gale 22 (group 11), the concentrations of creatinine, alanine and urea and
Fig. 48. Dilatation of the renal convoluted tubules in goat 36, orally dosed with 1 g/kg/day of fresh lophopodites sheets for 15 days. H & E x 100.

Fig. 49. Infiltration of small round cells in the renal medullae of goat 32, orally dosed with 10 g/kg/day of dry lophopodites sheets for 15 days. H & E x 100.
Fig. 50. Accumulation of mononuclear and eosinophilic cells in the renal glomeruli of goat 32, orally treated with 1 g/kg/day of dry Trypanosoma schimitscheki for 27 days. H & E x 100.
Fig. 51. Changes in the activities of G6PD and G6PDH and in the concentrations of creatinine, urea, uric acid, ammonia, and total protein in the serum of goat 23, orally dosed with 30 g/kg/day of fresh Tephrosia piscina for 7 days.
Fig. 58. Changes in the activities of GOT and GPT and in the concentrations of ammonia, creatinine, uric acid, urea and total protein in the serum of guinea pigs orally dosed with 20 g/kg/day of fresh Lepidium shoots for 15 days.
the activity of G6PD showed slight increases between days 1 and 11 (Fig. 33). The concentration of total protein decreased during the same period. In group II (group III) which died on day 40, the concentrations of urea, creatinine and amniotic increased terminally and the activity of G6PD decreased after dying. Total protein showed reduced concentration between days 18 and 40. In group IV, which died on day 39, the activity of G6PD commenced to rise on day 33, reached a peak on day 39 and fluctuated until the time of death (Fig. 34). Creatinine, urea and amniotic showed slight increases terminally. Total protein showed reduced level between days 28 and 39.

There was no change in the activity of G6PD or in the concentrations of amniotic, urea, creatinine and total protein in the sera of any of the control goslings (group II).

Hematological changes

Animals in groups I, III, III and IV showed some or less similar hematological changes and were thus as expected by goslings.
Fig. 33. Changes in the activities of GGT and G6Pase and in the concentrations of urea, amonia, uric acid, creatinine and total protein in the serum of aged rats orally dosed with 1 g/kg/day of fresh Tephrosia leaves for 21 days.
There was a decrease in the values of RBC, Hb, Hct, MCHC and MCH (Figs. 55 and 56). The HbC did not change.

Leucopenias were due to an increase in the number of neutrophils.

**Table I:**

The total lipids in the liver, brain and kidney of Tephrosia-poisoned animals and of the control goats are given in Table VI. It can be seen from Table VI that the concentration of total lipids in the liver, brain and kidney of Tephrosia-poisoned intoxicated goats was more higher than that in the tissues of the control animals.

**3. DISCUSSION**

The results of this study indicate that the fresh and dry shoots of Tephrosia species are equally toxic to goats with fatal consequences and that the main lesions in Tephrosia poisoning occur in the kidneys, liver, central nervous system, lungs and alimentary tract.
Fig. 55. Changes in leucocyte count and in red cell parameters in guin. 27, orally dosed with 1 g/kg/day of fresh Tephrosia roots for 13 days.
### Table VI

**Concentrations of Total Lipids in Tissues of Rat and Nude Mice**

<table>
<thead>
<tr>
<th>Group</th>
<th>Heart</th>
<th>Brain</th>
<th>Liver</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>56.7</td>
<td>26.4</td>
<td>66.2</td>
</tr>
<tr>
<td>II</td>
<td>34.6</td>
<td>24.9</td>
<td>72.6</td>
</tr>
<tr>
<td>III</td>
<td>31.7</td>
<td>25.8</td>
<td>64.3</td>
</tr>
<tr>
<td>IV</td>
<td>29.6</td>
<td>24.9</td>
<td>50.5</td>
</tr>
<tr>
<td>V (continia)</td>
<td>27.2</td>
<td>24.6</td>
<td>27.3</td>
</tr>
</tbody>
</table>
The hepatic, nervous and renal lesions are a constant feature of the pathological picture in Tetrahymena poisoning. The presence of perineuronal vacuolation in the spinal cord and cerebrum is in accord with the clinical evidence of nervous malfunction. Perineuronal vacuolation has been noted in Oxyuris poisoning and in amyotrophic necrosis of the motorneuron (Chow, Levy, Hennings, Levin, Davies and Oxford, 1975; Aden, 1978; Aden and Aden, 1980).

The severity of the signs of nervous disturbance during the course of Tetrahymena poisoning in goats might also be increased by the renal and hepatic injury. The lesions in the kidneys of Tetrahymena-poisoned goats comprised shrinkage of the glomerular tufts, Bowman's space and medullary and degeneration of the convoluted tubules. The lesions in the liver consisted of fatty change, loss of glycogen and centrilobular hepatocellular necrosis. The fall in protein concentration and the high levels of ammonia, creatinine, urate and G6P in the serum indicate hepato-renal damage. The lack of change in G6P activity in serum has confirmed previous findings on this enzyme in the kidney by Foul, Aden and Godwin (1972), Aden and Magroze (1975) and Aden and Aden (1978).
3. Acetone caused no significant changes in the concentration of uric acid in the serum of geese. It is well known that uric acid represents the principal and product of urinary excretion in man. Blood uric acid levels are increased in cases of gout and in conditions where excessive salt break-down and catabolism of nucleo acids occur. Cornelius and Konako (1963) suggested that blood uric acid levels increase in hepatic jaundice and hepatocarcinoma in the dog.

Several uric acid blood levels have been reported in polyarthritides and under the influence of certain drugs such as salicylates and pipericaine (Prechel and Rottem, 1963).

Finally, it would appear from the results of this experiment that Taurona toxicity in geese can be of economic importance. Even at low doses levels of the plant that were used, significantly marked tissue damage was recorded.
CHAPTER VI

NUTRITIVE VALUES AND MINERAL CONTENTS OF GRASS

DIFFERENT PastURE PLANTS IN ENGLISH SYSTEMS

1. INTRODUCTION

Studies on the nutritive values and mineral contents in pasture plants are becoming of paramount importance in elucidating and assessing the nutritional status of animals kept exclusively on natural grazing. Different pasture plants have different nutritive values and mineral contents.

In recent years, studies on the above aspects have attracted the attention of several animal nutritionists in various tropical countries. Thus, McCarron (1972), Gehl (1979) and Bugden (1977) gave detailed accounts of nutritive values and mineral contents in pasture plants in several countries in Africa, tropical Asia, Latin America and Australia.
The work of the above authors, as well as of others, has become of great value in animal nutrition, hence augmenting animal health and production in the tropics.

As similar work has only attracted little attention in the Sudan (Khalil and Pollock, 1967; Parkour, 1966, 1973 and Adam and Darir, 1969 respectively in Abu Dalaq, Western Sudan and Bintema area), the present investigation is probably the first attempt of its kind in the Sudan to highlight the importance of our knowledge on these aspects, for proper future animal nutrition in the country.

2. MATERIALS AND METHODS

A predominant pasture plants were collected from various areas in Khartoum Province.

The plants were cleaned from obvious dust by rubbing and shaking. They were then taxonomically classified into four different groups, A, B, C and D. Groups A (1), C (6) and D (10)
were naturally growing herbs, shrubs and trees and toxic plants (proved experimentally in animals) respectively. Group B (7) however, were irrigated pasture plants.

The detailed taxonomical classification of the plants examined in this study were given in Table VII.

About 20 g of the aerial part of each plant, including the edible part of its leaves, pods, stalks and young shoots if were cut with the aid of a large pair of scissors. The plants were shredded by a chaff cutter and mixed on polythene sheets. They were then dried to constant weights in a dry oven (Bakewell oven 1971); the samples were put on metal trays with the oven set at a constant temperature of $100^\circ$C over night.

The dried samples were then ground using a laboratory mill (Christy and Norris, using 1 mm mesh sieve) that was carefully cleaned after grinding each sample to avoid any contamination that might affect the results.

The ground samples were then stored in sealed polythene bags, labelled and were ready for analysis of dry matter, crude
protein, crude fibre, other extract, ash, calcium, phosphorus, magnesium, copper, zinc and manganese contents by the methods described in Chapter II.

3. RESULTS

The detailed biochemical classification of the pasture plants examined in this study is given in Table VII.

Percentages of dry matter, crude protein, crude fibre, ether extract, ash, calcium, phosphorus and magnesium contents in each pasture plant studied within the specified four groups (Table VIII) are presented in histograms (Figs. 57-64) respectively.

It can be seen from Fig. 57 that all plants of group 1 had dry matter percentages that lay between 90 and 99.5%, with highest levels being recorded for *Austrotheca ascendens* and *Euphorbia leucophylla*. Plants of group 3 had dry matter percentages that varied from 52 - 98.5%, with lowest levels seen in *Austrotheca ascendens*.
Fig. 97. Dry matter percentages in some plants in Harfous Province.
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Department</th>
<th>Title</th>
<th>Age</th>
<th>Gender</th>
<th>Education</th>
<th>Experience</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Doe</td>
<td>Manager</td>
<td>Sales</td>
<td>Sales</td>
<td>35</td>
<td>Male</td>
<td>MBA</td>
<td>5 years</td>
<td>New York</td>
</tr>
<tr>
<td>Jane Smith</td>
<td>Analyst</td>
<td>Marketing</td>
<td>Analyst</td>
<td>28</td>
<td>Female</td>
<td>BBA</td>
<td>3 years</td>
<td>Los Angeles</td>
</tr>
<tr>
<td>Bob Johnson</td>
<td>Engineer</td>
<td>Engineering</td>
<td>Engineer</td>
<td>40</td>
<td>Male</td>
<td>Engineering</td>
<td>10 years</td>
<td>Chicago</td>
</tr>
</tbody>
</table>

**Table VII**
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>French</td>
<td></td>
<td></td>
</tr>
<tr>
<td>German</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dutch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arabic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portuguese</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: The above table is incomplete and requires additional information.*
### Table VIII

**Chemical Composition of Some Nodulating Pasture Plants in Alluvial覃育 soil (cm, m.,)

<table>
<thead>
<tr>
<th>Chemical composition</th>
<th>Plant group and numbers studied</th>
<th>A (7)</th>
<th>B (7)</th>
<th>C (8)</th>
<th>D (32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (%)</td>
<td></td>
<td>97.6±1.4</td>
<td>96.5±2.6</td>
<td>97.6±1.2</td>
<td>97.6±1.2</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td></td>
<td>12.5±2.6</td>
<td>17.5±2.7</td>
<td>12.5±3.9</td>
<td>16.5±4.9</td>
</tr>
<tr>
<td>Crude fibre (%)</td>
<td></td>
<td>35.6±35.7</td>
<td>22.5±7.6</td>
<td>27.6±3.1</td>
<td>27.6±5.7</td>
</tr>
<tr>
<td>Ether extract (%)</td>
<td></td>
<td>2.5±1.4</td>
<td>2.0±0.9</td>
<td>2.5±0.9</td>
<td>1.0±0.9</td>
</tr>
<tr>
<td>Ash (%)</td>
<td></td>
<td>15.6±5.7</td>
<td>24.3±5.3</td>
<td>23.2±3.2</td>
<td>5.5±3.6</td>
</tr>
<tr>
<td>Sodium (%)</td>
<td></td>
<td>1.6±2.2</td>
<td>1.3±1.2</td>
<td>1.3±0.9</td>
<td>1.3±1.0</td>
</tr>
<tr>
<td>Phosphorus (%)</td>
<td></td>
<td>0.3±0.2</td>
<td>0.3±0.1</td>
<td>0.1±0.05</td>
<td>0.2±0.2</td>
</tr>
<tr>
<td>Magnesium (%)</td>
<td></td>
<td>0.3±0.2</td>
<td>0.2±0.1</td>
<td>0.4±0.25</td>
<td>0.1±0.0</td>
</tr>
</tbody>
</table>

*Significant at the level of P < 0.05
As regards percentages of dry matter in groups C and D plants, all values were higher than 55%.

Cicer arietinum (wheat) and Brassica napus of group C and Sesamum avena, Hyoscyamus niger, Machaerina ovata, Ipomoea occoee and Cucumis melo (group D) revealed the highest percentages.

As far as crude protein percentages are concerned (Fig. 50), all values for groups A, B, C and D lay between 4 and 27%. The lowest values were observed in Pachyrhizus eequatorialis of group A, B. megasperma of group B, B. napus (fruit) of group C and C. melo (vegetable) and I. o. for group D. Percentages higher than 20% were noticed in I. o. x. g. of group B, T. e. g. and Glycine max of group C, I. o. x. g. and C. melo (vegetable) of group D.

However, all plants of group B had crude protein percentages that were lower than 17.2%.

On the other hand, all percentages for crude fibre
Fig. 58. Crude protein percentages in some plants in Enarion province.
(Fig. 52) in the plants of the four groups studies varied from 11 to 57%. Low values were observed in *Trigonella foenum-graecum* and *Negundo virginiana* of group A, *Bulnesia americana* of group C and *Negundo virginiana* and *Bulnesia americana* of group B, while high values were observed in *Sphenocidus rubrifolius* and *Negundo virginiana* of group A, *Sphenocidus rubrifolius* (whole plant) of group D and *Bulnesia americana* and *Bulnesia americana* of group B.

Lecithin content (Fig. 53) in the plants of the groups ranged from 1.3 to 20.5%. Values lower than 10% were seen in *Trigonella foenum-graecum* of group B, *Carya ovata* (hickory) of group C, *Adina geRYPTOCHORA* (bush) of group D and *Sphenocidus rubrifolius* of group B only, levels higher than 15% were observed in *Quercus alba* (oak), *Juniperus communis* (pinyon), *Gymnocladus dioica* and *Carya ovata* (hickory) of group A and *Sphenocidus rubrifolius* of group B only.

All values for ether extract (Fig. 57) in the plants exceeded within the groups lay below 5%, except *Juniperus communis* (wood) of group B which showed a level as high as 23.8%.
Fig. 59. Crude fibre percentages in the plants in various provinces.
Fig. 60. Ash content in some plants in Sharston Province.
Fig. 61. Ether extract percentages in some plants in Anacardiaceae Province.
Most calcium percentages (Fig. 61) in the different plant groups, lay between 1 and 3.5. Lowest values were observed in *Cordia alliodora* and *Cordia alliodora* of group C, *Cordia alliodora* (roots), *Cordia alliodora* (flowers) and *Conus cinereus* (flowers and fruits) of group B, *Conus cinereus* (fruits) and *Helminth sagittalis* (aerial part) of group D and *Cordia alliodora* (flowers), *Conus cinereus* (fruits) and *Cordia alliodora* (flowers) of group D. Values higher than 3 were noticed in *Cordia alliodora* of group A, *Cordia alliodora* of group C and *Conus cinereus* of group D only.

Most phosphorus content (Fig. 63) in the plants examined within the groups ranged from 0.1 to 0.3. Lower levels were, however, seen in *Cordia alliodora* of group C, *Cordia alliodora* of group B, *Helminth sagittalis* and *Cordia alliodora* (flowers and fruits) of group C and *Conus cinereus* and *Cordia alliodora* of group B.

On the other hand, higher levels were seen in *Cordia alliodora*, *Cordia alliodora* (flowers) and *Cordia alliodora* (fruits).
Fig. 62. Calcium percentage in some plants in Khartoum Province.
Fig. 63. Phosphorus contents in some plants in Messina Province.
of group 4, *Aquatica Rossii*, *Melinis pennisetana* and *Triporcella*
*Conyza argentata* of group 3 and *Ipomoea carnea* and *Calotis*
*oconnorii* of group 2, with no points in group 6
attaining that level.

The majority of magnesium contents (Fig. 64) in the
plants lay between 0.2 and 0.5%. Lower values were observed in
*Brachycome dactylon* of group 1, *Bergenia edulis* and *Triporcella*
*Conyza argentea* of group 2, *Calotis argentata* and *Calotis
pinnata* of group 3 and *Ipomoea papillosa* of group 5, while higher
levels were noticed in *Melinis pennisetana* and *Conyza
glabra* of group 4, *Amaranthus cruentus* of group 3, *Bergenia
dactylon* (aerial part) and *Conyza argentea* (aerial part) of group 6 and *Calotis
pinnata* of group 2, *Triporcella argentea* (aerial part) and *Conyza
glabra* of group 2.

The means and standard deviations of the above chemical
composition within the four groups depicted are presented in
Table VIII. It can be observed that only slight differences in
the means of the dry matter percentages are found. Moreover, the
Fig. 6A. Magnesium content in some plants in Khartoum Province.
wheat crude protein percentages have revealed that groups B and C plants had values that were significantly higher ($P < 0.05$) than those of groups A and D plants. On the other hand, the mean percentages of crude fibre in group A were found to be significantly higher ($P < 0.05$) than those of groups B, C and D plants.

As far as other extractives concerned, the differences observed were not significant. Ash contents, however, have shown that the mean values of plants in group A were significantly higher ($P < 0.05$) than those of the plants in the remaining groups.

No significant differences between groups were observed in either means of calcium or magnesium. However, phosphorus contents of group C plants were significantly lower ($P < 0.05$) than those of groups A and B plants (but not of D).

The mean values and standard deviations of copper, zinc and manganese contents in each of the four plant groups studied are shown in Table IX.
<table>
<thead>
<tr>
<th>Plant group and numbers studied</th>
<th>Copper (p.p.m.)</th>
<th>Zinc (p.p.m.)</th>
<th>Manganese (p.p.m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a (7)</td>
<td>7.2 ± 4.3</td>
<td>13.3 ± 9.2</td>
<td>50.7 ± 22.4</td>
</tr>
<tr>
<td>b (7)</td>
<td>6.2 ± 1.3</td>
<td>24.4 ± 9.4</td>
<td>67.7 ± 47.7</td>
</tr>
<tr>
<td>c (8)</td>
<td>4.06 ± 4.2</td>
<td>27.3 ± 13.1</td>
<td>36.0 ± 25.6</td>
</tr>
<tr>
<td>d (10)</td>
<td>13.0 ± 5.1</td>
<td>37.7 ± 17.5</td>
<td>72.5 ± 43.1</td>
</tr>
</tbody>
</table>

*Significant at the level of $P < 0.05$

**Significant at the level of $P < 0.01$
The mean copper contents of groups A, B and C plants are close together, but that of group D plants is significantly higher ($p < 0.05$) than those of the remaining groups. The mean zinc contents of group A plants are significantly higher ($p < 0.05$) than those of groups B, C and D plants, but the differences in the mean of manganese levels between plants within the groups are not significant.

### Discussion

The present findings in crude protein percentages in pasture plants of the Mabuse Province appear to be in agreement with those reported by Wehmeier and Houten (1936), White, Lott and Cooper (1959), the Agricultural Research Council, London (1965), Boswell and Triffitt (1967), McDonald et al. (1971), Cloos (1972), Speeding (1976) and Boyd (1977), but seem to be higher than those recorded by Weinmann (1955) in Salisbury, Zimbabwe (Rhodesia) and Kembury, Tangs and Morley (1965) in
Acid plates of Oban. However, lower values were reported by
McKenny (1972) and Thompson and Merton (1974) in the Aberdeen
region, United Kingdom.

As to the present grade three levels in the pasture
species investigated, the percentages seem to be in harmony with
those of Nelson and Merton (1956), Lensusky et al. (1969),
Khalife and Fribicovic (1961), McDonald et al. (1976) and Rugan
(1977) but appear to be different from those reported by
McKenny (1972) and McKenny (1972).

McDonald (1972) has stated that the contents of other
extract vary with the part of plant analyzed, with higher
values in seeds.

Our findings are in agreement with those of Nelson and
Merton (1956), Lensusky et al. (1969), Khalife and Fribicovic
(1967) and Regan (1977) but appear to be higher than those found

Regarding calcium contents in pasture plants, our
results fall within the range reported by several authors
(Lensusky et al., 1969; Mitchell, 1965; McDonald et al., 1972;
Smedley, 1977). In the other hand, our calcium results seem to
satisfy the requirements that have been recommended by the
Agricultural Research Council, London (1968) and Groomton and
Meiris (1966). However, our calcium values appear to be higher
than those reported by Hartho (1970), Long et al. (1972) and
Thompson and Warner (1973) in Belch Sand of East Africa,
Western Uganda and Sudanese region respectively. Higher values
have been recorded by Dur (1970) in Britolin and Hainam (1950)
in Salisbury.

According to the Agricultural Research Council, London
(1968), the present mean results for phosphorus contents in
the four groups mentioned fall short of animal requirements.
However, Blood and Hainam (1974) have stated that phosphorus
values from 0.5% and over do satisfy animal requirements while
levels below 0.2% and 0.3% could result in osteomalacia (Plains)
and osteomalacia and rickets respectively.

In the other hand, Groomton and Meiris (1966), has
given a range of 0.15 - 0.25% for animal requirements which:
in full agreement with our mean values for phosphorus in
groups A, B and D plants but higher than the mean value of
group C plants. However, Lemsbury et al. (1965) in four places
of Ghana and Barthie (1979) in Sahel Zone of West Africa have
given mean phosphorus contents in pasture plants that are
comparable with our finding in group C plants.

Several workers (Thomas, 1955; Wilson, 1962;
Bishopp, 1966; Long et al., 1972; Wilson et al., 1972;
Hagan, 1977) have given phosphorus mean contents that appear
to be somewhat smaller to our mean phosphorus contents in
groups A, B and D plants.

As regards magnesium in pasture plants, it seems to be
higher than those given by the Agricultural Research Council,
London (1965) for cattle and sheep requirements. However, the
values agree with others reported by Long, Ngama, Marshall and
Thornton (1969), Long, Thornton, Ngama, Marshall, and
Sackalo (1970), Rezaeir and Shu Baha (1980)
in Uganda, Nigeria and Tanzania, Cameroun and
Botano area of the Sahel. However, lower values for magnesium levels in pasture were found by Wilson (1962) in certain different areas. Long et al. (1970) in Eastern Uganda, Seddon (1973) in Southern Tanzania and Thompson and Jarvis (1973) in the Ethiopian region.

Undrewood (1962) and the Agricultural Research Council, London (1965) recommended 5 and 10 p.p.m. copper to satisfy the nutritional needs of livestock requirements for sheep and cattle respectively. Accordingly, our present values could be adequate for sheep but not for cattle (except group B plants, that are toxic). However, Wilson (1962), Island (1965), Long et al. (1970), McDonald (1970), Seddon (1973) and the Dairy (1980) have recorded copper results in pasture plants that are not different from our present ones. Moreover, the findings of Long et al. (1972) appear to be in harmony with our results in group B but are lower than others in the remaining three groups, while the results of Thompson and Jarvis (1972) in the Sudan region, United Kingdom are in agreement with our mean
values for copper in groups A and D only. Copper values in pasture plants of Nubia sheep and Jabel houre of Western Sudan (Carman, 1965) seem to be lower than our current ones.

The present zinc values in pasture plants in Khartoum Province lie within the ranges required for the nutrition of cattle and sheep (Underwood, 1962; Underwood and Sowars, 1965) but appear to be lower than those recommended by the Agricultural Research Council, London (1965). However, generally, the present zinc values for the metal are not different from those reported by Wilson (1962), Long et al. (1972), Thompson and Vercoe (1979), though they appear to be somewhat lower than those recorded by Sowars (1965).

As to manganese values in the pasture samples examined, they appear to satisfy the nutritional requirements of livestock in the area (Underwood, 1962; Agricultural Research Council, London, 1965;Thomas, 1970). The mean values of manganese recorded here are not different from those reported in pasture plants by other workers elsewhere (Chamberlain and Sowars, 1965; Long et al., 1972; Thompson and Vercoe, 1979).
In addition, others (1969) have given higher values of mineral in pasture in areas deficient in cobalt.

The present results have revealed that species of *Triticum*, *Avena*, *Allium*, *Danthonia*, *Dactyloctenium*, *Deschampsia*, and *Phleum* of group 1 have the highest nutritive values, while species of *Secale*, *Hordeum*, and *Triticum* of group 2 have the lowest (Agricultural Research Council, London, 1969; Cropland and Markets, 1969; McDonald et al., 1972 and Roberts, 1977).
CHAPTER VII

GENERAL DISCUSSION

The toxic effects of Cynops acuticaudata, Indigotina, \textit{bodkinia} and \textit{tigrovitis} spp. on Nubian goats have been considered and separately discussed in the preceding chapters.

The aim of this general discussion is to take into account the most obvious features of the lesions produced by the three plants in vital organs and tissues of experimental animals in order to give an overall picture.

Hepatic dysfunction

The liver is known to be susceptible to damage by a number of toxic plants and other substances. Liver function tests were, therefore, utilized to follow the nature and progress of hepatic lesions in order to correlate the changes in
Liver histology with those in serum constituents of experimentally fed with toxic plants.

Feeding of the fresh leaves and dry seeds of Sagittaria sagittifolia and of the fresh or dry plants of Sagittaria apollosa and Indigotis herbebristis to rats caused centrilobular hepatocellular fatty vacuolation, necrosis, loss of glycogen, focal portal fibrosis and congestion. A hydrostatic stress caused focal dilatation of the hepatic sinusoids. Injury to the hepatocytes in the lower parts of the liver lobule has been produced by many hepatotoxins such as carbon tetrachloride (Ford and Lawrence, 1955; Alon and Wargel, 1970; Alon, 1972; Ford, Alon and Ogden, 1973) and chloroform (Thorp, Ogden, Jones and Ford, 1962; Redfield and Alon, 1976; Alon, 1979). The above are examples of severe destruction of liver cells in the periportal zone but there was no effect on either GGT activity or alkaline phosphatase in experimentally treated rats. The significance of periportal cell involvement in chloroform poisoning caused by peroxisome plants such as Sagittaria sagittifolia and
Lactose syntheses has been discussed by Wargovich and Ford (1972). The authors suggested that a mild periporal brain can affect the integrity of cell membranes and results in a marked increase in bilirubin concentration in the blood stream. The failure of serum GPT to increase has been attributed to the low level of this enzyme in the liver of farm animals (Ford and Bray, 1960, 1962; Ains, 1971; 1974).

In bubonic geese, the feeding of Chessa, Tymbcola and Indigofere was followed by an increase in the activity of GGT and in the concentration of amine and a decrease in the levels of serum total protein suggesting liver cell disfunction. Unfortunately, due to lack of facilities the author was not able to investigate the changes in the activity of the liver specific enzymes, glutamate dehydrogenase (GDH), aspartate dehydrogenase (ASDH), arginase and cytochrome c oxidase transferase (OCT) in the serum of geese fed with Chessa, Tymbcola or Indigofere.

In the present experiment with geese fed with...
...occasionally, *S. equinus* and *I. boops*). There was a fall in the level of total protein in the serum and this was likely to be due to the failure of synthesis by the injured liver cells (Ford, 1965; Adam, 1970). The author has not investigated the changes in the ratio of albumin to globulin in the serum of the experimental goats. It is generally thought that the fall in serum total protein concentration is attributed to a drop in the albumin fraction. Significant decreases in the serum albumin level and an increase in that of α-globulin have been found in sheep and goats that had eaten *Aegilops* (Kupchuk and Ward, 1969) or *Aegilops siciliae* (Jeng et al., 1968).

The goats fed with *Indigofera*, *Zygophyllum* or *Cuscuta* were unable to remove amoxicillin from the blood stream due to hepatic dysfunction. The importance of hyperammonemia in *Cuscuta* and *Zygophyllum* poisoning in sheep and goats and in *Aegilops* intoxication in ruminants has been discussed by Jeng and Adam (1979), El Bidiari (1986) and Goul (1985).
Residual malnutrition.

Feeding of investigated, nephrectomy or Cessas to rabbits
samples caused degeneration and/or necrosis of the epithelial
cells of the renal tubules and some of the glomeruli, congestion
and cellular infiltration in the affected convoluted tubules.
The increased amount, urea and creatinine concentrations in the
ovaries of the experimental animals indicates renal dysfunction.

Sennelius and Kalya (1963) mentioned that urea-nitrogen
constitutes about 50% of the non-protein nitrogen of plasma
and that it is not excreted from the body with as great ease as
creatinine. The concentration of urea nitrogen will, therefore
be expected to rise in the blood stream when there is a severe
renal damage. On the other hand creatinine which is the end
product of muscle catabolism is excreted constantly in the urine.
It is filtered but not reabsorbed by the tubules so that when a
rise in creatinine occurs renal damage is present.

Tephrosia caused no significant change in the concentra-
tion of uric acid in the serum of goats. It is well known that
uric acid represents the principal end product of purine metabolism in man. These are present in all living tissues of purine precursors that exist as components of the nucleic acids. It is generally accepted that the end product of purine metabolism is allantoin in the dog. Since the dog converts uric acid to allantoin in the liver, its excretion in the blood has been recommended as an indicator of liver disease in this species (Cortellas and Kenko, 1963).

High levels of serum urea, creatinine and uric acid have been found in cases suggestive of hepatic necrosis which had been fed with


Cortellas and Kenko (1963) suggested that one principal effect of magnesium deficiency appears to be the occurrence of abnormal calcium metabolism. In groups that ingested fresh Osage orange or seeds, there was a fall in the concentration
of calcium in the serum during terminal stages of the disease. It should be mentioned that in no animal did serum magnesium concentration fall to critical values. Low levels of serum magnesium and calcium have been found in young rabbits which had been orally dosed with *Apodemus flavicollis* (Rassin et al., unpublished data), *Lagonurus lagotis* (Sim et al., unpublished data) and *Mus musculus* (Gelati, 1983).

**Enzyme histochemical changes**

Many enzyme histochemical staining reactions have been shown to indicate various forms of hepato-cellular changes induced by toxic drugs in laboratory and domesticated animals. Application of these techniques to the study of plant hepatotoxicity has not received much attention. In goats fed with *Indigofera hookeriana*, the parenchymal degeneration and necrosis in the liver and kidneys were accompanied by a decrease in the activities of aspartic dehydrogenase, glucose-6-phosphatase, 3-nucleotidase and alkaline
triphosphates, Ala-alanine triphosphates was considered to be a sensitive indicator of liver and kidney damage (Wedelstein, 1962; Zorgny and Bogomol, 1960; Adler, 1971; Adler and Nagle, 1976; Al Amm, 1989; Hamida, Al Amm, Adler and Hadhad, 1989). Biochemical methods have also been applied in a few studies on toxic liver injury in domesticated animals in an attempt to correlate the alterations in the enzymes distribution in the liver with the changing levels of serum enzymes activity. For example, when sheep and calves were dosed with allylmercaptoniisothiocyanate, the liver-cell damage accompanied by loss of activity of aspartate and glutamate dehydrogenases and non-specific esterase was accompanied by a corresponding rise in the activities of serum enzymes LD, SG and amylase (Gogolitch and Bort, 1974; Word et al., 1975).

Nervous stimulation

The development of acute nervous disturbance in
Tophromia and Indigotin-poisoned goats and the presence of parainfluenzae infection in the spinal cord and cervical suggest that these signs are due to a primary effect on the central nervous system. The raised levels of serum amonia and hyperglycemia as suggested by loss of hepatic glycogen may have contributed to the development of the nervous signs. The development of signs of nervous disturbance and presence of parainfluenzae infection in the central nervous system have been observed in young meat goats with Capripox [Bovine herpesvirus] (Almeida, 1978; Almeida and Silva, 1980) and proteinaemia myelitis (Fernandez and Kocan, 1979).

Intestinal, cardiac and pulmonary lesions

Feeding of Indigotin, Tophromia and Gramia to goats promoted enterocolitis enteritis and/or abscesses. The lesions in the alimentary tract of the experimental animals caused by Gramia were more severe than those produced by Tophromia or Indigotin and were associated with the development of
disturbance, the lung is engorged, hemorrhagic and edematous. The lung lesions probably caused edema which was seen in the experimental animals. Stains strongly of the coriaria fat is probably the result of general loss of condition and reduced metabolism of the body reserves.

Changes in the cellular elements of the blood

The increase in leucocyte counts in Ceciae, Ephedrae and Indigofera poisoned goats was due to an increase in the number of neutrophils. Footing of Indigofera, Ceciae and Ephedrae to goats caused a significant decrease in the values of HbO, PCV and RBC. This as well as the presence of aplastic anemia point to a mild degree of hemolytic anemia particularly in Ceciae-poisoned goats.

It is concluded that the fresh fruits and dry seeds of Ceciae apiiacaulis and fresh or dry shoots of Ephedrae ephedrae and Indigofera hygrophilae are toxic to Nubian goats.
and that the lesions in vital organs of the body are the basis of the clinical signs.

It appears from the present study that the important pasture plants species in the Province are quite adequate for livestock nutrition as far as their nutritive values and mineral contents are concerned (Rahman, 1967; Agricultural Research Council, London, 1965; Selanieh, 1972; Blood and Henderson, 1976; Hughes, 1977). However, phosphorus, copper and zinc contents are low and may not satisfy the nutritional requirements of growing animals (Feather, 1973; and Helal, 1980).

Flea, due to phosphorus deficiency, though not reported
in cattle in the Sudan, has been observed by several veterinarians (personal communications). However, osteomalacia
and rickets in cattle have neither been reported nor observed
in this country.

Low copper levels in pasture are expected, because
large growing areas in the Sudan have been reported as either
critical or decreased in copper contents (Vautour, 1966; 1975; An Damir, 1980) and cases of scours due to copper deficiency in lambs have been reported from the Zaita Province of the Sudan (Ibrahe and Vautour, 1978).

The rather low levels of zinc in pasture plants have been pointed out by An Damir (1980) in the Hadramou region of the Sudan but field cases of zinc deficiency in animals have not been reported in this country.

The present investigations also point to the possibility that pasture plants examined have slightly higher crude fibre contents (Welian, 1955 and Walling, 1972). McConnel (1973) reported that the increased crude fibre contents in the plant is inversely correlated to its crude protein levels. Khoury (1961) suggested that an increase in crude fibre content by 1% in hay could decrease the digestibility of other organic matter by 0.7%. However, King (1961) mentioned that animal feeds should contain limited crude fibre contents as they aid in the bulk digestion and stimulate peristalsis and secretion.
Suggestions for future work

Investigations should be carried out to assess the efficacy of non-steroidal drugs of Cistanche pendulata in the treatment of various diseases in animals.

The isolation, characterization and concentration of the active principles in different parts of C. pendulata, I. appliaca and I. hockleyi has yet to be made. It would be beneficial to study the pathogenesis of the extracted compounds from these three plants.

Extensive investigations should also be carried out to evaluate the healing value of many plants in the Sudan.
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