

**MINERAL STATUS OF BROWSING GOATS IN THE NORTH WESTERN
PROVINCE OF SRI LANKA AS INFLUENCED BY FEEDS, SOILS AND
SEASONS**

By

MEERASAIBU MOHAMED MAHUSOON

Thesis

Submitted in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY



ExPhD11



Thesis
Library - EUSL

in the

POSTGRADUATE INSTITUTE OF AGRICULTURE

of the

UNIVERSITY OF PERADENIYA

PERADENIYA

JANUARY 2006



PROCESSED
Main Library, EUSL

ABSTRACT

A series of studies were carried out to investigate the mineral status of free browsing goats as related to soil, forage and seasons in the North Western Province of Sri Lanka. The first study was conducted to determine the macro- and micromineral status of soil, forage and goats. Cross-bred male and female goats (Jamnapari X Indigenous, Saanen X Indigenous, Jamnapari X Saanen, Boer X Indigenous and Jamnapari X Kottukkachiya) at different physiological conditions viz; suckling (<6 month), growing (6-12 month), matured (>1 year), pregnant (>1 year), lactating and non-lactating does reared under the extensive management systems in three different agro-climatic zones (dry, intermediate and wet) in the North Western Province of Sri Lanka were used. Soil organic matter, pH, calcium (Ca), magnesium (Mg) and potassium (K) were higher in the dry zone compared to other two zones. Mean Ca and Mg contents in soil were adequate in all three zones. Mean soil K content was adequate in dry and intermediate zone while deficient in wet zone. Soil phosphorus (P) and sodium (Na) were the most likely deficient minerals in soils.

No deficiency levels were indicated in forage Ca, Mg and K in all the zones. Forage P and Na were all higher in shrub, herb and vines. Deficiency levels were indicated for P and Na in tree leaves and grasses. It appears that ration formulation for range goats in the North Western Province should include Na and P. Plasma analysis has shown that Ca levels were lowest in milking and adult animals in all three zones. Phosphorus was lower in young animals than old. Magnesium levels increased with the age. Plasma K levels were similar in all status in the dry region but male and female

suckling in the intermediate zone and milking and non-lactating does in the wet zone indicated below the critical value. Plasma Na levels decreased progressively with the age. High correlations were found between macromineral contents of soil and forage in the diets and plasma of the animals.

The microminerals of soils revealed that soil copper (Cu), zinc (Zn), iron (Fe) and manganese (Mn) were adequate in all three zones and found to be high in wet zone. The highest range of Cu was found in trees non-leguminous fodder while highest concentration of Zn was observed in trees leguminous fodders and shrubs. Iron and Mn contents were higher than the dietary requirement. Blood plasma Cu levels were found to be increased with the age but plasma Zn concentration was observed in vice-versa. Plasma Cu level increased with age could be associated with its role to oestrogen level. Zinc levels of plasma found to be higher in young animals that could be related the high Zn-binding enzyme necessary for growth and development. The concentration of plasma Fe recorded higher among the pregnant animals. Plasma Mn level was found to be high in adult animals. Goats maintained under free range browsing systems showed no deficiency in microminerals.

The second study was carried out to examine Mo supplementation on nematode infection and weight gain as related to season. Four treatments consisting of 10 goats each were used as control - free grazing only (T_0); free grazing plus mineral block without Mo (T_1); free grazing plus mineral block with molybdenum of 2 mg Mo kg^{-1} block (T_2) and free grazing plus mineral block with molybdenum of 10 mg Mo kg^{-1} block (T_3). The study continued during rainy and dry seasons for one year. The experimental results showed that the concentrations of minerals in forage were higher during the rainy season.

Calcium, Mg, K, Fe and Mn contents in all forages were above the recommended levels during both rainy and dry seasons. During the rainy season 23% and 32% forage samples were deficient in Na and P while in dry season the respective deficiencies were 91% and 100%. Forage Cu and Zn contents were inadequate during both rainy and dry seasons. Mineral concentrations in plasma increased due to mineral supplementation. Plasma Ca, Mg, K, Zn, Fe and Mn contents were above the critical level recommended during both seasons, while 20% and 33% of plasma samples were deficient in P and Cu, respectively. Molybdenum supplementation reduced the nematode egg count and improved haematocrit value, hemoglobin concentration and body weight gain of goats suggesting beneficial effects of molybdenum.

A final experiment was carried out to evaluate the effects of three different sources of phosphorus supplements on growth performance, nutrient utilization, mineral balance, nitrogen retention, rumen parameters, blood biochemical profile and plasma mineral contents of goats. The experimental diets were prepared using three different sources of phosphorus i.e., dicalcium phosphate (DCP), highly soluble Eppawele rock phosphate (HERP) and Eppawele rock phosphate (ERP). Twelve young growing male cross-bred (Saanen x Jamnapari) goats were divided into four groups and each group was undergone into four treatments. The treatments were: control (T_0) –without any phosphorus supplementation; phosphorus supplemented with DCP (T_1); phosphorus supplemented with HERP (T_2) and phosphorus supplemented with ERP (T_3). The experimental results revealed that phosphorus supplementation increased feed intake, weight gain and nutrient digestibility. Mineral balances and nitrogen retention were improved by supplementing phosphorus sources. Rumen parameters and blood biochemical profile were also

improved by phosphorus supplementation. Plasma mineral contents were higher while adding phosphorus sources. Among the phosphorus supplemental diets, highly soluble Eppawele rock phosphate showed the highest responses to the above mentioned parameters. Therefore, highly soluble Eppawele rock phosphate (HERP) could be used as phosphorus supplementation instead of dicalcium phosphate which is expensive and low availability.

Therefore it was concluded that macro- and microminerals of Ca, Mg, K, Cu, Zn, Fe and Mn were adequate while Na and P were deficient in soil of dry, intermediate and wet zone of the North Western Province of Sri Lanka. Plasma macro- and microminerals of goats reflected the physiological status of the animal. Most of the forage showed adequate levels of all micronutrients, which were also reflected in animals. Inclusion of Mo at 10 mg kg⁻¹ block was beneficial to goats for improving blood parameters, suppression of worm infestation and live weight gain. Supplementation of HERP significantly increased feed intake, weight gain and nutrient digestibility while mineral balances and nitrogen retention, rumen parameters and blood biochemical profile were also improved.

CONTENTS

	Page No.
ABSTRACT	I
ACKNOWLEDGEMENT	V
LIST OF TABLES	XII
LIST OF FIGURES	XV
1. INTRODUCTION	01
2. LITERATURE REVIEW	05
2.1 Importance of dietary minerals	05
2.2 Minerals in soils	05
2.2.1 Soil macrominerals	08
Calcium	08
Phosphorus	08
Magnesium	10
Sodium	10
Potassium	11
2.2.2 Soil microminerals	11
Iron	11
Manganese	12
Copper	12
Zinc	12
2.3 Mineral nutrition of forage	13
2.3.1 Macrominerals in forage	15
Calcium	15

Phosphorus	15
Magnesium	17
Sodium	17
Potassium	17
2.3.2 Microminerals in forage	18
Iron	18
Manganese	18
Copper	19
Zinc	19
2.4 Mineral nutrition of goats	20
2.4.1 Macrominerals	20
Calcium	20
Phosphorus	24
Magnesium	27
Sodium and Potassium	30
2.4.2 Microminerals	33
Iron	33
Manganese	34
Copper	34
Zinc	36

3. MACROMINERAL STATUS OF SOIL, FEEDS AND GOATS IN THE NORTH WESTERN PROVINCE OF SRI LANKA.	38
3.1 Justification	38
3.2 Materials and Methods	39
3.2.1 Study area	39
3.2.2 Sample collection	41
3.2.2.1 Blood	41
3.2.2.2 Forage	41
3.2.2.3 Soil	41
3.2.3 Sample analysis	43
3.2.3.1 Forage and plasma analysis	43
3.2.3.2 Soil analysis	43
3.2.4 Data analysis	43
3.3 Results and Discussion	44
3.3.1 Soil analysis	44
3.3.2 Forage distribution	46
3.3.3 Forage analysis	48
3.3.4 Plasma analysis	52
3.3.5 Interrelationship of soil-forage-animal macromineral contents	57

4. MICROMINERAL STATUS OF SOIL, FEEDS AND GOATS IN THE NORTH WESTERN PROVINCE OF SRI LANKA.	59
4.1 Justification	59
4.2 Materials and Methods	60
4.2.1 Study area and sample collection	60
4.2.2 Sample analysis	60
4.2.3 Data analysis	60
4.3 Results and Discussion	61
4.3.1 Soil analysis	61
4.3.2 Forage analysis	63
4.3.3 Plasma analysis	69
4.3.4 Interrelationship of soil-forage-animal micromineral contents	75
5. EFFECT OF MOLYBDENUM SUPPLEMENTATION ON NEMATODE INFECTION AND BODY WEIGHT GAIN IN GOATS AS RELATED TO SEASON	77
5.1 Justification	77
5.2 Materials and Methods	78
5.2.1 Location and period of the study	78
5.2.2 Experimental diets	78
5.2.3 Experimental animals and procedure	78
5.2.4 Sample analysis	80

5.2.5 Data analysis	80
5.3 Results and Discussion	80
5.3.1 Forage mineral content	80
5.3.2 Plasma mineral content	83
5.3.3 Indices of nematode infection	87
5.3.4 Mineral supplement consumption and live weight gain of the goats	89
6. EFFECT OF DIFFERENT SOURCES OF PHOSPHORUS SUPPLEMENTS ON GROWTH PERFORMANCE, NUTRIENT UTILIZATION, BLOOD PARAMETERS AND MINERAL BALANCE IN GOATS	91
6.1 Justification	91
6.2 Materials and Methods	92
6.2.1 Location and periods of the study	92
6.2.2 Experimental diets	92
6.2.3 Experimental animals and procedure	92
6.2.4 Sample analysis	94
6.2.5 Data analysis	95
6.3 Results and Discussion	95
6.3.1 Proximate composition of the basal and test diets	95
6.3.2 Dry matter intake and weight gain of the goats	97
6.3.3 Nutrient digestibility of goats	99