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REVIEW ARTICLE

A STUDY ON NUTRITIONAL ASPECTS OF FORAGES

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A Study on Nutritional Aspects of Forages

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INTRODUCTION

A major constraint to the use of legumes as a livestock feed is the presence of toxic and antinutritional constituents. These constituents have different but adverse effects on animal performance including loss of appetite and reductions in dry matter intake and protein digestibility. Tannins inhibit the utilization of nutrients through astringency, enzyme inhibition and reduced forage digestibility (Onwuka, 1983). Phytates chelate several mineral elements, especially Ca, Mg, Fe, Zn and Mo, and interfere with their absorption and utilization (Ologhobo, 1980). Oxalates affect Ca and Mg metabolism (Oke, 1969) and react with proteins to form complexes which have an inhibitory effect on peptic digestion (Oboh, 1986). The saponins act on the cardiovascular and nervous systems as well as on the digestive system. Large doses of legume juices containing saponins cause distention of the rumen (Gestetner et al, 1986). Cyanogenic glycosides impart a bitter taste, reduce palatability and cause toxicity. Intact plants contain little, if any, free hydrogen cyanide but this may be formed rapidly under the influence of ß-glucosidase in cells injured by freezing, drying or maceration.

There are no data on nitrate, phytate and some other antinutritional contents of perennial forage legumes in Nigeria. Some data on tannic acid are available for some perennial forage grasses and browse species (Offiong and Awah 1988; Onwuka, 1983). This paper provides information on the mineral elements and antinutritional toxic factors in some Nigerian forage legumes.

MATERIALS AND METHODS

Samples of 25 forage legume eaten by goats were collected at 5 sites in Nigeria. Samples were mowed with a scythe at various heights above the ground, chopped and wilted in the field. Grab samples of the wilted forage were taken, oven-dried at 70°C for 48 hr. cooled and milled in a Christy-Norris grinder. Ground samples of about 500 g were sealed in cellophane bags and stored at 4°C until required for analysis.

Contents of Mg, Zn, Cu. Fe and Mn were determined using the Parkin-Elmer atomic absorption spectrophotometer. A flame photometer was used for Na, K and Ca: P and Se were determined by standard methods (AOAC, 1975). All of tannin (Burns, 1963; Dalby and Shuman, 1978), saponin (Walls et al, 1952; Segal et al, 1966), phytin - as physic acid and phytin-phosphorus (Young and Greaves, 1940) -oxalate (AOAC, 1975), hydrocyanic acid (Wood, 1965; Tewe, 1980) and nitrate (Jackson, 1958) were determined by standard methods. Determinations were made on a dry weight basis.

RESULTS AND DISCUSSION

The mean P content was 0.25 ± 0.02%. All the legumes for which P was determined contained more than the 0.15% recommended for livestock. The highest level (0.42%) occurred in*Indigofera hirsuta* and *Teramus labialis*. The Ca content ranged from 0.40% to 1.57% with a mean value of 1.03 ± 0.06%. These values compare favourably with other Nigerian results (Onwuka, 1983; Agishi, 1985; Ifut, 1987). All the forage legumes contained more than 1.6 g/kg DM, the level generally recommended for non-lactating goats (NRC, 1981). Results obtained for Mg are lower than those found elsewhere in Nigeria (Offiong and Awah, 1988). This could result from the season in which the forage legumes were collected coupled with the fact that most soils in southern Nigeria are predominantly acidic. Ratios of Ca/P were higher than the recommended range of 1 to 2 (NRC, 1981) in most of the samples except for *Cajanus cajan* and *Crotolaria retusa.*

Mean values of Na and Cl were 0.05% and 0.02%. Based on the dietary values of 0.5% recommended for goats (NRC, 1981), Na was deficient in all the legumes.

Levels of K were high in *Calopogonium mucunoides* (2.55%), *Crotolaria retusa* (2.85%), *Desmodium scorpiurus* (2.44%), *Stylosanthes bojeri* (2.56%), *Stylosanthes guyanensis* (2.70%) and *Teramus labialis*(2.10%). The levels of K in all the forages with the exception of *Cajanus cajan* (0.72%),*Centrosema plumieri* (0.30%), *Centrosema pubescens* (0.25%), *Clitoria ternatea* (0.70%), *Dolichos lablab* (0.78%) and *Peuraria phaseoloides* (0.65%) were above the 0.80%

recommended for lactating goats (NRC, 1981). The K levels in *Centrosema plumieri* and *Centrosema pubescens* were lower than the maintenance requirement of 0.5% for non-lactating goats (NRC, 1981).

A mean value of 240.3 ± 39.64 ppm was obtained for Fe, the range being 60-633 ppm. Most legumes contained less than the 350 ppm recommended for goats (NRC, 1981). The level of 45 ppm of Zn recommended for goats (Mba, 1981) was not found in any of the samples. The mean for Mn was 90.92 ± 6.52 ppm in the range 43 to 146 ppm. Only 12 legumes had Mn values above the recommended 90 ppm (NRC, 1981). The mean value for Cu was 7.79 ± 0.63 ppm and the range 3.5 to 14.5 ppm. Based on the 10 ppm recommended for goats (Mba, 1981), the Cu levels in all legumes except *Centrosema plumieri* (14.5 ppm), *Centrosema pubescens* (14.0 ppm), *Desmodium ramosissimum* (10.5 ppm), *Indigofera hirsute* (10.5 ppm), *Indigofera retroflexa* (10.2 ppm) and *Peuraria phaseoloides* (14.0 ppm) were below the recommended value.

TOXIC AND ANTINUTRITIONAL FACTORS

Phytin content ranged from 89.2 mg/g in *Cajanus cajan* to 316.4 mg/g in *Vigna marina*. The corresponding phytin-phosphorus ranged from 24.8 to 92.5 mg/g with an overall mean of 61.25 ± 3.51 mg/g. These values compare with those reported elsewhere for leafy vegetables (Taylor, 1979) and for cowpea and limabean (Ologhobo, 1980) where phytin is the major phosphorus store.

Mean tannin content was 5.05 ± 0.75% in the range 0.00% to 10.72%. The wide variation in tannin contents suggests considerable differences in the nutritional quality of the different species. The level of tannin which adversely affects digestibility in sheep and cattle is between 2% and 5% (Diagayete and Huss, 1981). Goats are known to have a threshold capacity of about 9% dietary tannin (Nastis and Malachek, 1981). With the exception of *Dolichos lablab* (10.13%), *Indigofera hirsuta* (10.43%), *Indigofera suffrutiscosa* (9. 35%), *Stylosanthes gracilis* (10.72%) and *Tefrosia vogelli* (10.03%), it would appear that most of the forage legumes analysed in this study contained tannin at levels tolerable to goats.

Saponin levels were low, as found in other studies (Gestetner et al, 1966). From the levels obtained in this study, it is not likely that the saponin content of forages will affect their nutritional potentials to any significant extent.

Oxalate contents were similar in all samples. Values ranged between 0.52 mg/100 g and 0.82 mg/100 g, with a mean of 0.67 ± 0.02 mg/100 g. Oxalates affect Ca and Mg metabolism (Onwuka, 1983) but ruminants, unlike monogastric animals, can consume considerable amounts of high-oxalate plants without adverse effects, due principally to microbial decomposition in the rumen (Oke, 1969).

Hydrocyanic acid contents were low due to the high drying temperature employed during sample preparation (Ologhobo and Fetuga, 1984). Iodine and protein deficiency syndromes might be the sole etiological factors in a number of endocrine and neurological anomalies observed during cyanide toxicity in animals (Tewe, 1980).

Nitrate values ranged from 0.13% in *Centrosema pubescens* to 0.51% in *Dolichos lablab* with an overall mean of 0.32 ± 0.02%. On a compararative basis the nitrate contents were high in *Crotolaria retusa*, *Crotolaria spectabilis*, *Dolichos lablab* and *Teramus labialis*. Contents in *Centrosema pubescens*, *Clitoria ternatia*, *Tefrosia vogelli* and *Vigna unguiculata* were low. The low nitrate contents seem to augur well for animal nutrition, since a high concentration of nitrate is known to be toxic. Nitrate LD_{50} is about 45 g/100 kg body weight when given to cattle and 25 g/100 kg when given to goats (Crawford et al, 1966). A recent study (Apata, 1987) has established that nitrate per se may not be toxic to animals but may be reduced by rumen bacteria to nitrite which then causes poisoning through combination with haemoglobin to form a brown pigment, methaemoglobin, which is incapable of transporting oxygen to body tissues. The nitrite is further reduced to ammonia to be utilised by the ruminant.

It is not likely that the nitrate levels obtained in this study are high enough to produce adverse effects on animal performance. The validity of this statement needs to be verified by appropriate feeding trials to investigate the actual levels of antinutritional factors that are toxic, the fate of the absorbed substances and their cumulative effects on the animal. For the animal to fulfill its potentialities, the effects of factors which not only reduce dry matter intake and digestibility but also decrease nutrient utilization and cause metabolic disorders should be reduced or eliminated.

These investigations have demonstrated the considerable variability among plants in their contents of antinutritional factors. This may be of potential importance for breeding studies in selecting for improved forage legumes with zero antinutritional content and high nutrient quality.

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