^{31}P NMR Analysis of African Tropical Savanna Herbivore Manure

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Introduction

In Africa tropical savanna large herbivores are a major ecosystem driver. Phosphorus (P) is one the major limiting nutrients in this ecosystem, which limits plant productivity and influences the availability and quality of forage for herbivores (Augustine 2003). Herbivore grazing accelerates P cycling through the deposition of organic P in manure thus promoting soil fertility and plant productivity. The objective was to determine the forms and stability of organic P in manure deposited by herbivores with different grazing habits.

Experimental

Fresh vegetation and manure were sampled at MRC during the dry season. Vegetation included Acacia and grass. Herbivores included browsers (giraffe, *Giraffa camelopardalis*; camel, *Camelus dromedaries*), mixed feeders (elephant, *Loxodonta africana*; impala, *Aepyceros melampus* and grazers (cattle, *Bos indicus*; zebra, *Equus burchellii*). Orthophosphate and organic P were determined from an NaOH extract using ^{31}P nuclear magnetic resonance (NMR) using Avance III 500 MHz at McKnight Brain Institute, University of Florida. Total P was determined using ashing method.

Results and Discussion

The organic P forms of manure are similar for all of the animals regardless of the source of forage or digestion process (Figure 1). The decrease in NMR signal corresponds to a decrease of manure TP (Table 1).
The manure NMR spectra are dominated by an orthophosphate signal. Forms of organic P are phosphomonoester > pyrophosphate > DNA (Figure 1). All forms of organic P compounds in the manure are labile in respect to P cycling.

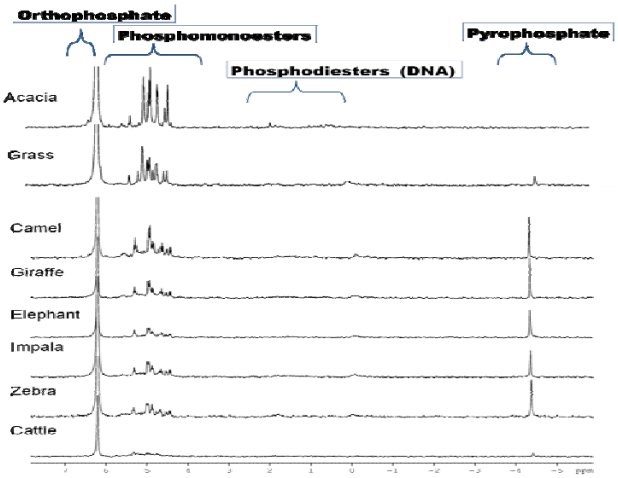

Figure 1. ^{31}P NMR spectra of vegetation and herbivore manure.

Table 1.Total P recovery from NaOH extraction

	TP	NaOH - P	Ortho-P	Monoester	DNA	Pyro-P
	g P kg^{-1}	% of TP	% of TP			
Acacia	1.8	89	77.0	20.0	3.0	ND
Grass	1.0	†	75.0	20.0	3.5	1.5
Camel	5.6	95	69.8	25.9	1.7	2.6
Giraffe	4.9	88	62.7	29.3	3.1	4.9
Elephant	2.5	88	64.0	23.4	2.6	9.9
Impala	6.8	92	76.8	17.9	1.8	3.5
Zebra	3.0	91	72.7	18.2	2.2	5.8
Cattle	1.8	†	66.3	30.0	0.9	2.8

† - TP analysis of NaOH extract exceeded TP of manure; ND – not detected.

Conclusions

High TP values, dominance of orthophosphate, and presence of labile organic P compounds provide short term P availability to plants.

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References

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