Distribution of hydrolysis products of inositol penta- and hexaphosphates in some humid tropical soils

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The proportions of inositol pentaphosphate (IP_5) and hexaphosphate (IP_6) varied significantly and were found to be related to the organic matter and organic P contents of the soils sampled. Esters of myo + D-chiro IP_6 together accounted for 48 to 81 per cent and scylloinositol represented about 19 to 52 per cent of the total hexaphosphate. Simple correlation revealed that alkaline conditions probably favoured the synthesis of scyllo IP_6 by phytase and multiple correlation suggested that organic matter, organic P and pH were collectively related to the amounts of different inositol polyphosphate fractions in soil samples. The ratio of IP_6 to IP_5 varied between 0·7 and 4·3 and that of myo + D-chiro to scyllo IP_6 between 0·9 and 4·3.

INTRODUCTION

THE PRESENCE of several isomeric forms (myo, scyllo, D-chiro, and neo) of the esters of inositol penta- and hexaphosphates (IP_5 and IP_6) have been reported in soils (COSGROVE, 1963, 1966; ANDERSON, 1967; MCKERCHER and ANDERSON, 1968; ANDERSON and MALCOLM, 1974) but very little work has been done to determine their amounts in soils.

An attempt has, therefore, been made to estimate the relative amounts of isomeric IP_5 and IP_6 in some humid tropic soils of Bangladesh and determine their relationships with soil properties.

MATERIALS AND METHODS

Ten samples of surface soil (0 to 15 cm) representing ten series varying in physical (*Table 1*) and chemical properties (*Table 2*) were collected from different parts of Bangladesh.

Analyses were made for organic carbon by TINSLEY's wet combustion method as described by BREMNER and JENKINSON (1960), pH by the Pye glass electrode method (soil:solution ratio 1:2·5), organic P by the method of MEHTA *et al.* (1954), and inositol penta- and hexaphosphates and the isomers of IP_6 by the methods of MCKERCHER and ANDERSON (1968).

Table 1. Physical characteristics of the soil samples

Soil series	*USDA soil taxonomy*	*General type*	*Parent material*	*Texture*	*Drainage*	*Colour*
Karail	Fluvaquentic Haplaquept	ABC	Madhupur clay alluvium	Clay	Very poor	Grey
Jatrabari	Fluvaquentic Haplaquept	GFS	Madhupur clay alluvium	Clay	Poor	Olive grey
Siddhirganj	Aeric Fluvaquentic Haplaquept	NDGFS	Old Meghna estuarine	Silty clay	Poor	Dark grey
Kajla	Fluvaquentic Haplaquept	NDGFS	Gangetic floodplain	Silty clay	Poor	Grey
Harta	Histosols, undifferentiated	Peat	Peat	Clay	Poor	Black
Magra	Fluvaquentic Haplaquept	NDGFS	Old Meghna estuarine	Silty clay	Poor	Dark grey
Paysa	Typic Haplaquoll	NDGFS	Old Meghna estuarine	Silt loam	Poor	Dark grey
Naldanga	Typic Hydraquent	NDGFS	Tista floodplain	Silt loam	Very poor	Dark grey
Lashkara	Aeric Fluvaquentic Haplaquept	NDGFS	Old Himalayan piedmont	Clay	Poor	Grey
Sarala	Aeric Fluvaquentic Haplaquept	NDGFS	Tista floodplain	Clay loam	Poor	Dark grey

ABC = Acid basin clay; GFS = grey floodplain soil; NDGFS = non-calcareous dark grey floodplain soil.

Table 2. Chemical properties and approximate percentage composition of inositol hexaphosphate fractions in soil samples

							Isomers of IP_6		
Soil series	*pH*	*Organic matter* (%)	*Organic P* (*p.p.m.*)	IP_5 (*p.p.m.*)	IP_6 (*p.p.m.*)	*Ratio* $IP_5 : IP_6$	*Myo + D-chiro* (%)	*Scyllo* IP_6 (%)	*Ratio myo + D-chiro : scyllo* IP_6
Karail	4·3	4·09	205	31·5	53·5	1·7	51	49	1·0
Jatrabari	4·5	4·10	180	30·0	20·0	0·7	72	28	2·6
Siddhirganj	4·6	4·80	250	31·9	78·1	2·5	80	20	4·0
Kajla	4·6	4·63	220	38·0	62·0	1·6	78	22	3·5
Harta	5·8	22·31	560	64·6	275·4	4·3	81	19	4·3
Magra	5·5	6·86	320	37·6	112·5	3·0	79	21	3·8
Paysa	6·6	12·23	450	52·2	174·8	3·2	48	52	0·9
Naldanga	5·9	20·76	530	58·8	221·2	3·8	66	34	1·9
Lashkara	7·3	6·62	300	35·1	94·9	2·1	54	46	1·2
Sarala	7·2	4·40	240	22·5	52·2	2·3	52	48	1·1
Minimum				22·5	20·0	0·7	48	19	0·9
Maximum				64·6	275·4	4·3	81	52	4·3
Mean				39·8	114·5		66·1	33·9	
LSD ($P = 0·01$)				1·80	1·42		2·59	2·59	

RESULTS AND DISCUSSION

The content of IP_5 in the soil samples ranged from 22·5 to 64·6 p.p.m. (mean 39·8 p.p.m.) and that of IP_6 from 20·0 to 275·4 p.p.m. (mean 114·5 p.p.m.) (*Table 2*). These ranges correspond to about 9·4 to 17·3 and 11·1 to 49·2 per cent of the total organic P. The amounts of IP_5 and IP_6 were significantly ($P=0·001$) correlated with organic matter and organic P contents of the soils (*Table 3*).

The IP_6 fraction contained a mean amount of 66·1 per cent (range 48 to 81 per cent) of the myo + D-chiro isomers and 33·9 per cent (range 19 to 52 per cent) of the scyllo isomer (*Table 2*). In most soils the last mentioned isomer was the least abundant.

Table 3. Simple and multiple correlation coefficients between inositol polyphosphate fractions and organic P, organic matter and pH of the soils

	Correlation coefficient (r)		*Correlation coefficient (r)*
IP_5 and organic P	+0·941***	Myo + D-chiro IP_6 and pH	+0·167
IP_5 and organic matter	+0·948***	Scyllo IP_6 and organic P	+0·829***
IP_5 and pH	+0·134	Scyllo IP_6 and organic matter	+0·731**
IP_6 and organic P	+0·988***	Scyllo IP_6 and pH	+0·545*
IP_6 and organic matter	+0·969***	IP_5 and all factors	+0·975***
IP_6 and pH	+0·313	IP_6 and all factors	+0·992***
Myo + D-chiro IP_6 and organic P	+0·918***	Myo + D-chiro IP_6 and all factors	+0·946***
Myo + D-chiro IP_6 and organic matter	+0·936***	Scyllo IP_6 and all factors	+0·866***

*, ** and *** denote significant at P = 0·1, 0·02 and 0·001

Significant correlations were obtained between the constituents of the inositol hexaphosphate fractions and organic P and organic matter at the 0·1 per cent level (*Table 3*). A positive significant relationship was obtained between scyllo IP_6 and pH at the ten per cent level (*Table 3*) and no significant correlation was observed between myo + D-chiro IP_6 and pH. This suggested that alkaline conditions probably favoured the synthesis of scyllo IP_6 by phytase. However, multiple correlation suggested that all the above factors contributed to differing amounts of inositol polyphosphate fractions in the soil samples (*Table 3*). The ratio of IP_6 to IP_5 varied between 0·7 and 4·3 and that of myo + D-chiro to scyllo IP_6 ranged from 0·9 to 4·3. Except for the Jatrabari soil, the IP_6 contents of the soils exceeded those of IP_5.

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