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Physico Chemical and Spectroscopic Characteristics of Humin of some Typical soil Groups in Rajasthan

D. C. JOSHI[1] and C. P. GHONSIKAR[2]

Humin extracted from eight profiles representing typical soil groups in Rajasthan was studied for elementary composition, functional groups, spectra under visible ranges and coagulation threshold values. Variation in C, N and S contents and functional groups of humin of different soils were in ranges comparable with those reported elsewhere. Variation in elemental composition of humin appeared to be related with the stage of humification. E4/E6 ratio and coagulation threshold values indicated that humin of Banswara (black) and Kota soils were similar in behaviour to humic acid. Humin of Jaipur, Ganganagar, Sirohi, Udaipur, Banswara (red) and Chittor soils was characterised by wider E4/E6 ratio and higher coagulation threshold values indicating their resemblance to fulvic acid.

Humus, which includes a wide spectrum of organic compounds, can be broadly classified in three fractions viz., humic acids, fulvic acids and humin, depending upon their solubility in alkaline solutions. Humin, the difficultly soluble part, exists in soil in firm linkage with mineral part (Greenland, 1971) and can be extracted only after repeated treatments with alkali. As a result of firm linkage with inorganic fractions, humin is stable in soil and plays important role in soil formation and fertility.

Though some studies on the humic and fulvic acid of Rajasthan soils have been reported (Joshi and Saxena, 1971; Joshi and Ghonsikar 1979, Joshi 1980; Maliwal and Khangarot, 1966) there are no reports on the nature and composition of humin. Present studies report the physico-chemical and spectroscopic characteristics of humin of some typical soils of Rajasthan.

MATERIAL AND METHODS

Soil samples from eight profiles representing typical soil groups were collected. Physico-chemical characteristics of the soils were determined by the usual procedure (Piper, 1950). Humin was extracted, purified and dried according to the methods described by Kononova (1966).

Humin samples were analysed for carbon (Bremner and Jenkinson, 1960) nitrogen by microkjeldahl's method and sulphur by Chaudhary and Cornfield (1966) method. Fuctional groups in humin were determined according to the method of Schnitzer and Gupta (1965). Methods described by Kononova (1966) were followed for recording spectra under visible ranges

1 and 2 Central Arid Zone Research Institute, Jodhpur and Marathwada Agricultural University, Parbhani, Maharastra, respectively.

TABLE I Elementary composition and functional group content of Humins (on ash free basis)

Location and Depth (cm)	Horizon	Humin-C as % of org. Carbon	Elementary composition					Functional groups (me/g)		
			Carbon %	Nitrogen %	Sulphur %	C/N	C/S	Total Acidity	Carboxyl group	Phenolic hydroxyl groups
Jaipur			**Non calcic brown soils**							
0-20	Ap	14.63	42.81	2.67	1.54	16.03	27.80	2.45	1.15	1.30
20-67	C1	25.37	40.61	3.79	1.19	10.68	34.12	1.40	0.90	0.55
67-115	C2	14.46	45.50	4.23	1.15	10.63	37.82	0.35	0.12	0.23
Ganganagar			**Desert reverine soils**							
0-15	Ap	31.29	56.41	4.12	1.81	13.69	31.11	2.25	1.05	1.20
15-60	C1	49.24	53.89	3.11	1.61	17.32	33.47	2.55	1.22	1.33
60-115	C2	39-33	50.14	3.30	1.17	15.19	42.85	2.30	1.30	1.00
Sirohi			**Hilly soils**							
0-20	A1	10.23	43.54	4.05	0.68	10.75	63.38	2.55	1.30	1.25
0-60	B21	12.51	45.01	4.31	0.48	10.44	90.57	2.20	1.10	1.10
60-90	B22	10.42	40.09	4.46	0.46	10.98	86.66	1.68	1.30	0.38
Udaipur			**Grayish brown**							
0-16	Ap	19.74	40.85	2.73	1.45	14.98	28.23	2.30	1.50	0.80
16-42	B21	19.34	55.25	7.88	1.50	7.01	36.63	2.60	1.20	1.40
42-82	B22	19.57	52.25	5.34	1.63	9.87	32.05	1.90	1.70	0.20
82-120	C1ca	14.18	36.14	5.02	1.11	7.25	32.80	1.15	0.40	0.75
Banswara (black)			**Black soils**							
0-27	Ap	8.70	75.46	8.78	1.29	8.58	58.49	2.45	1.30	1.15
27-60	B21	12.49	32.46	3.41	1.27	12.41	33.35	1.45	0.85	0.60
60-100	B22	10.25	35.14	2.42	1.42	14.08	24.85	0·65	0.40	0.25
Kota										
0-11	Ap	12.29	55.25	7.81	1.06	7.07	52.12	2.60	1.15	1.35
11-58	B21	32.36	59.24	5.65	1.11	10.48	53.36	3.10	2.10	1.00
58-100	B22	52.35	63.96	6.40	1.26	9.99	50.76	3.15	1.90	1.25
Banswara (red)			**Red soils**							
0-18	A	25.80	64.94	5.35	1.43	12.14	45.71	2.90	1.50	1.40
18-75	B21	30.66	65.89	4.32	1.39	15.25	47.40	1.55	0.50	1.05
75-200	C	37.30	42.04	4.46	1.14	9.19	37.00	0.90	0.40	0 50
Chittor										
0-13	Ap	10.83	50.02	1.67	1.09	29.95	46.05	4.20	2.00	2.20
13-50	B2	18-06	61.56	3.07	1.10	20.05	55.96	1.65	1.00	0.65
50-100	C	13.75	42.93	1.52	0.56	27.77	77.77	1.70	0.70	1.00

TABLE II Coagulation threshold values and extintion coefficient of humin

Location & depth (cm)	Horizon	Beginning of the Coagulation (m.e $CaCl_2$/lit)	Completion of the coagulation after four hours (m.e $CaCl_2$/lit)	E4/E6 ratio
Jaipur		Non calcic brown soils		
0-20	Ap	No coagulation	No	O.D. very low*
20-67	C1	"	No	"
67-115	C2	"	No	"
Ganganagar		Desert riverine soils		
0-15	Ap	15	40	6.88
15-60	C1	15	40	7.43
60-115	C2	15	40	5.00
Sirohi		Hilly soils		
0-20	A1	15	40	6.50
20-60	B21	10	40	3.40
60-90	B21	10	40	3.30
Udaipur		Grayish brown soils		
0-16	A1	15	40	8.33
16-42	B21	15	40	9.60
42-82	B21	15	40	14.66
82-120	Clca	15	40	13.60
Banswara (Black)		Black soils		
0-27	Ap	15	20	3.80
27-60	B21	15	20	4.11
60-100	B22	15	30	4.26
Kota				
0-11	Ap	10	20	4.25
11-58	B21	15	30	5.51
58-100	B22	15	30	6.60
Banswara (red)		Red soils		
0-18	A	15	60**	6.87
18-75	B21	15	60**	8.33
75-100	C	15	60**	14.33
Chittor				
0-16	Ap	15	60**	7.14
16-50	B2	15	40	8.11
50-100	C	15	40	8.64

* O.D. Optical density

** Coagulation incomplete

and for determination of coagulation threshold values of humin.

RESULTS AND DISCUSSION

Soils were normal to slightly alkaline with respect to pH (7.5 to 8.8) and EC (< 2 mm hos/cm at 25°C). $CaCO_3$ content in these soils was in the range of 0.2 to 3.5 per cent except in Kota soils which contained upto 28 per cent. Jaipur and Ganganagar soils were moderately coarse textured having low amount of organic carbon (0.117 to 0.261%). Sirohi, Banswara and Kota soils were medium (0.170 to 0.463%) whereas Udaipur and Chittor soils were high (0.522 to 1.132%) in organic carbon content and varied in texture from loam to clay loam. Detailed analytical data have been reported earlier (Joshi and Gonsikar, 1979).

Humin obtained from different soils showed wide variation in carbon (32.46 to 78.46%), nitrogen (1.52 to 8.78%) and sulphur (0.46 to 1.81%) contents. These values are comparable to those reported by Kononova (1966) for Russian soils. There was not much difference in the composition of humin (Table I) of different horizons of Ganganagar, Jaipur, Sirohi and Kota black profiles. In Udaipur profile humin of Ap horizon was low in nitrogen and in C_1-ca horizon it was low in carbon content in comparison to B horizons. Humin of B horizon of Banswara black soil was low in carbon and nitrogen whereas in Chittor profile these contents were high in comparison to their adjoining horizons. Variation in the composition of humin in different horizons of the same profile could be attributed to the degree of condensation which affected their mobility in the profile.

Significant correlations between carbon and nitrogen content of humin (0.591) indicated their close association in the formation of humin nuclei. Nitrogen content of humin also showed significant correlations with the nitrogen content of soil ($r = 0.575$) suggesting that humin constitutes a reserve of total nitrogen component of the soil. Kononova (1966) and Schnitzer and Khan (1972) expressed the view that humin served as a potential source of nitrogen in soil.

Total acidity and functional group (carboxyl and phenolic hydroxyl) content of humin generally ranged from 1 to 3, 1 to 2 and 1 to 2.2 me per g of humin respectively. Schnitzer and Khan (1972) reported total acidity, carboxyl and phenolic hydroxyl group in the range of 5, 2 to 3 and 2 me per g of the fraction in Canadian soils and concluded that such low functional groups were due to considerable loss in interaction with mineral part.

Humin of A and B horizon of Ganganagar, Udaipur, Kota and Chittor profiles did not show much variations

in the functional group content but in Jaipur, Sirohi and Banswara profiles, sub-soil horizon humin was low in functional groups as compared to their surface horizons. Kononova (1966) also observed that humic acids isolated from humin had a lower absorption capacity.

Optical density curves of the humin were less steeper and monotonic without any maxima or minima. Decrease in the optical density of humin with depth in Udaipur, Banswara (red and black) and Kota profiles indicated their condensation.

The E4/E6 ratio for Banswara and Kota black soil humin (Table II) ranged between 3 and 5 and indicated their resemblence to humic acid. Wider E4/E6 ratio (7 to 15) in the humin of Udaipur, Banswara (red), Chittor and Ganganagar profiles and low optical density of Jaipur soil humin indicated their similarity to fulvic acid. In general the ratio was slightly wider for sub-soil horizons, which indicated aliphatic characteristics.

Humin of red soils showed initial coagulation at 15 *m e* per litre of $CaCl_2$ (Table II) but coagulation was not complete even after the addition of 60 *m e* per litre of $CaCl_2$. Humin of Jaipur soil also did not coagulate upto the addition of 60 *m e* per litre of $CaCl_2$. Humin of Ganganagar, Sirohi and Udaipur soil coagulated at 40 *m e* per litre of $CaCl_2$. These humin behaved like fulvic acid and were largely aliphatic in character. On the contrary humin of Kota and Banswara black soils completely coagulated by the addition of 20 to 30 *m e* per litre of $CaCl_2$ and to be more condensed. Such humin might show greater dispersion and develop better soil structure.

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