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Status of Carbohydrates in the Acid Hydrolysates of Soils and Humic Acids of Dehra Dun Forests (Uttar Pradesh)

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The study of the content and composition of the soil carbohydrates of Dehra Dun forests revealed that glucose, galactose, mannose, xylose, arabinose and rhamnose are the six sugars which are present in soil as well as their humic acid samples with the glucose as the dominant sugar. The content of total carbohydrate varied with the content of organic matter irrespective of the vegetation cover. The miscellaneous forest soils had higher proportions of hexoses, whereas sal forests soils had more of humic acid-carbohydrates.

Key Words: Soil Carbohydrates, Dehra Dun forests

Carbohydrates in soils are mainly derived from the materials of vegetative and animal origin and slime of the micro-organisms. They provide energy for the humus formation and favour formation of crumb structure in soils. Some of them are also converted into humus substances (Gupta et al. 1963). Many studies have been made in the past on its pentoses, hexoses, galactouronic acids contents etc. in certain temperate soils of other countries (Stevenson et al. 1952, Johnston 1961, Oades et al. 1970; Ogner 1970). However, studies in this respect on Indian soils have been few (Singh & Singhal 1974, Singhal & Dev 1977). Hence in order to characterise these soils for their carbohydrate status, the present study was taken up on some soils of Dehra Dun forests which have 'sal' (*Shorea robusta*) alone or in association with other species.

Experimental

Study Area

This study was carried out in the moist deciduous forests of East and West Dehra Dun Forest Divisions of Uttar Pradesh which have already been described elsewhere (Sharma 1982). Sal (*Shorea robusta*) is the main species of these forests but at places it is completely absent and instead there is a mixed stand of other species. The mean annual rainfall of the area is 2050 mm and the mean maximum and minimum temperature is 26.9°C and 2.7°C respectively. Ten representative soil profiles, five each under sal and miscellaneous forests were examined for the purpose and samples collected for various investigations. A brief description of the soils is as given in (table 1).

Table 1 *Physico-chemical properties of the soils*

Profile No.	Location	Soil Type	Depth (cm)	Colour (dry)	Organic carbon %	Texture	Clay (%)	*p*H
			UNDER SAL FORESTS					
I	Dharmawala Comptt. No. 10 (Timli Range)	Udic Haplustoll	0–26	10 YR 4/3	2.81	L	16.1	6.2
			26–40	10 YR 5/3	0.48	L	13.5	5.8
II	Jhajra Comptt. No. 4 (Jhajra Range)	Udic Haplustoll	0–27	10 YR 5/3	1.45	SiL	19.8	5.7
			27–64	10 YR 5/6	0.78	SiCL	32.5	5.5
III	Mohabewala Comptt. No. 1 (Asarori Range)	Udic Haplustall	0–28	10 YR 4/3	1.55	L	14.6	6.0
			28–68	10 YR 5/6	0.41	L	12.8	6.0
IV	Bahera Comptt. No. 8a (Kansrao Range)	Fluventic Haplumbrept	0–25	10 YR 5/4	1.48	SL	8.9	5.8
			25–62	10 Y R 5/6	0.20	LS	9.9	5.6
V	Lambirao Comptt. No. 55 (Thano Range)	Fluventic Haplumbrept	0–23	10 YR 4/3	3.88	L	18.0	5.9
			23–47	10 YR 5/4	1.62	L	20.3	5.9
			UNDER MISCELLANEOUS FORESTS					
I	Lachhiwala Comptt. No. 2 (Lachhiwala Range)	Udic Arguistoll	0–30	10 YR 5/4	1.66	SiL	18.3	5.9
			30–50	10 YR 5/4	1.02	SiL	20.3	5.8
II	Suswa Comptt. No. 5 (Motichur Range)	Udic Argiustoll	0–10	10 YR 5/3	4.02	SiL	17.1	6.8
			10–29	10 YR 6/4	0.66	SiL	14.1	6.8
III	Bibiwala Comptt. No. 9c (Barkot Range)	Udic Argiustoll	0–40	10 YR 5/4	1.66	SiL	20.8	5.9
			40–58	10 YR 6/4	0.80	SiL	22.8	6.1
IV	Sahansra Comptt. No. 1b (Malhan Range)	Udic Argiustoll	0–20	10 YR 5/3	1.70	SiL	7.2	6.1
			20–60	10 YR 5/4	0.75	SiL	10.4	6.9
V	Karwapani Comptt. No. 4a (Asarori Range)	Lithic Haplustoll	0–18	10 YR 4/3	2.68	L	11.8	6.1
			18–50	10 YR 7/4	0.48	S	3.4	6.4

The extraction of carbohydrates was carried out according to the method of Gupta (1967) by treating the samples with 72% H_2SO_4 at low temperature for 2 hr and refluxing for 16 hr. The carbohydrates in these hydrolysates were measured by reacting with arthrone and reading the green colour at 625mμ on Systronics Spectrophotometer (Model MK 106) as per the method advanced by Morris (1948), modified by Brink et al. (1960) and earlier adopted by Singhal and Dev (1977) for similar soils. Their absorption spectra were also recorded between the wavelength 400–800 mμ.

The determination of individual sugars was carried out with the help of thin layer chromatography (Stahl 1965) on a homogenous buffered silica gel impregnated with .02N CH_3COO Na. The chromatogram was run in ascending order with n-butanol-acetic acid-water (3 : 1 : 1) and the spots were developed with anisaldehydesulphuric acid. The quantity of individual sugars was measured with the help of Systronics Spectrophotometer (Model MK 106).

The above sugars were further confirmed with the help of Gas Liquid Chromatography using aldol acetates of few samples (Oades et al. 1970) on Model Varian Aerography Moduline Series 2800 under the conditions mentioned overleaf.

Column : Apiezon—M of 1.22 m length and 6.3 mm O D

Detector : Thermal conductivity

Carrier Gas : $H/_2$; flow rate 120 ml/min

Temperature : Column– 200°C, detector 250°C and injection port—275°C

Chart Speed : 0.5 cm/min

Results and Discussion

It can be seen that all the soils and their humic acids contain same set of six sugars, viz., glucose, galactose, mannose, rhamnose, xylose and arabinose and their contents vary from site to site depending upon the content of organic matter and other factors as discussed below:

(*i*) *In Soils :* The amount of sugars in soils vary significantly with their contents of organic matter, irrespective of the vegetation cover (r=.98 under sal cover, r=0.99 under miscellaneous forest). Within the profile, however, the content of carbohydrates is more in the surface than subsurface (table 2) to indicate greater microbial activity on the plant material at the surface (Sowden & Ivarson 1962).

The variation in the absorption pattern is on account of difference in the vegetation of each site. Under the miscellaneous forests they have a maxima at 625 mμ and minima at 500 mμ and 900 mμ and resemble the spectra of glucose, whereas under the sal forest there is no minima at 500 mμ and hence no resemblance with glucose. The content of hexoses is also higher in the former than in the latter (table 2). Amongst the sugars present, the content of glucose (40–50% of the total sugars) is maximum followed by galactose, mannose, arabinose, xylose and rhamnose.

(*ii*) *In Humic Acids:* The composition of carbohydrates in humic acids resembles

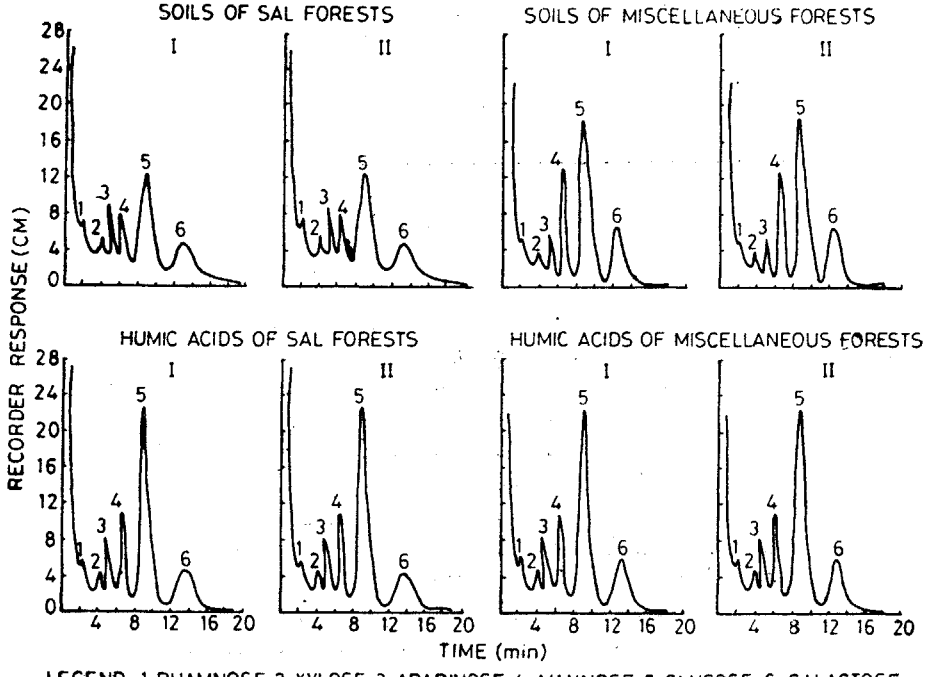

Figure 1 Gas chromatograms of Aldol acetates of Sugars Soil sand their humic acids

Table 2 *Carbohydrates in acid hydrolysates of (a) soils and their (b) humic acids*

Profile	Depth (cm)	Total carbohydrates (mg/100 g)		Monosaccharides (mg/100 g)											
				Glucose		Galactose		Mannose		Arabinose		Xylose		Rhamnose	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
							SAL FORESTS								
I	0–26	602	35220	242	17020	110	8184	99	5026	85	3212	50	1450	16	208
	26–49	105	31200	43	14820	20	7020	14	4720	12	2945	8	1505	5	150
II	0–27	356	34800	145	16920	65	7602	52	4850	50	3240	30	1612	12	140
	27–64	168	31000	70	14660	32	7020	24	4685	22	2830	11	1375	6	120
III	0–28	390	34700	157	16920	70	7665	60	5120	60	3180	27	1475	12	290
	28–68	100	30600	41	14560	16	7030	15	4526	12	2850	8	1390	4	214
IV	0–25	368	34100	152	16600	70	7705	57	4820	50	3205	28	1450	8	270
	25–62	50	30800	21	14700	8	6850	8	4328	6	3002	4	1530	—	230
V	0–23	750	34050	302	16050	140	7708	112	5002	110	3380	62	1670	20	160
	23–47	325	29900	140	14010	60	7013	48	4684	45	2600	26	1353	10	150
							MISCELLANEOUS FORESTS								
VI	0–30	350	30070	173	14020	89	6805	60	5004	16	2851	7	1240	—	100
	30–50	245	26000	120	12405	65	5920	45	3915	10	2420	4	1200	—	75
VII	0–10	788	30000	390	14400	200	6806	138	4564	36	2800	13	1225	5	107
	10–29	150	26010	73	12470	39	5940	28	4008	6	2320	—	1162	—	70
VIII	0–40	372	30000	184	14560	98	7022	66	4400	12	2740	8	1218	—	125
	40–58	162	25800	80	11800	44	6000	28	4120	6	2440	—	1230	—	90
IX	0–20	378	30600	180	14800	95	7110	69	4950	15	2385	9	1145	—	130
	20–60	150	26400	75	12260	36	6060	30	4150	7	2460	—	1270	—	95
X	0–18	570	31000	280	14800	145	7005	100	4776	26	2840	12	1390	4	118
	18–50	95	26080	46	12410	24	5880	15	4006	4	2384	—	1170	—	80

with those of soils (table 2). Their contents, however, vary with the type of vegetation from which they have originated and the amount of organic carbon present. The content of carbohydrates was higher in samples of sal forests than of miscellaneous forests. Glucose is once again the main constituent of these carbohydrates followed by other sugars. Their absorption pattern also resembles except that the peaks are more sharp and higher in the case of sal as compared to miscellaneous probably on account of higher carbohydrate contents in the former as also evident by the correlationships between the carbohydrate content and humic acid carbon (r=.90 in sal forest and r=0.86 in miscellaneous forests).

The variation in the composition of sugars in acid hydrolysates of soils as well as their humic acids under sal and miscellaneous species can be accounted for by the variation in the composition of litter under two vegetation types (Sowden & Ivarson 1962), since the carbohydrates in soils are largely dependent upon the constitution of litter and thus varies from species to species.

The results of gas-liquid chromatography corroborate with those of thin-layer chromatography and the six peaks of the above-mentioned six sugars are well expressed in the samples under investigation (figure 1). The difference in the content of hexoses and pentoses in the soils under sal and miscellaneous forests is also well expressed as exhibited by the difference in their respective peak areas.

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