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CHEMICAL COMPOSITION OF TEA LEAF CELL-WALL

R. R. Selvendran and B. P. M. Perera

Despite the fact that 'appearance' and texture of black tea plays an important part in determining the market price of the product,[1] very little work has been done on the cell-wall material of tea shoots and of commercial black tea. This lack of information is not only in striking contrast to the importance attached to such studies with other plant foods,[2,3] but also to the great deal of information available on the soluble constituents of black tea.[4-6] However, biochemists have recognised the importance of the pectic substances contained in the tea leaf[7]. It is to be expected that the contribution of polysaccharides to the texture of a food product will vary with their individual construction, their topographical position and their relative abundance. About 45 per cent of the dry weight of tea is due to cell-wall material, and the relative concentrations of the various structural constituents (polysaccharides and proteins) in tea flush from Clone TRI 2024 from which black tea is manufactured, is now reported.

That part of the cell-wall material of tea leaf which is insoluble in 80 per cent aqueous ethanol was divided into the following arbitrary fractions: hot water-soluble polysaccharides and proteins, ammonium oxalate-soluble pectic acid, sodium, hypochlorite-soluble compounds (lignin and structural proteins), hemicelluloses A and B and α cellulose, by successive extraction with hot water, ammonium oxalate, NaClO and cold alkali.[8,9] The protein content of the hot water-soluble fraction and the hot water-insoluble residue were calculated from nitrogen determinations. It is known, for example, that the hot water-insoluble proteins present in the cell-wall material are destroyed by chlorite oxidation and would contribute to the apparent lignin figure.[8] In tea flush the contribution of the former (which could be structural proteins) to the NaClO-soluble compounds is very high. A correction for this must be made when calculating the lignin content.

The polysaccharide fractions were dissolved in 72 per cent (*w/w*) sulphuric acid diluted to 2N solution with distilled water and heated under reflux for 12h. The sugars were isolated from the hydrolysates after neutralisation with solid barium carbonate.[8]. In most of the fractions a little brown residue remained unhydrolysed. The residues were further hydrolysed with dilute sulphuric acid for 5h, but no sugars were detected in the hydrolysates.

The proteins present in the hot water-soluble fraction and the hot water-insoluble residue were hydrolysed with 6N hydrochloric acid for 24h. The hydrolysates were dried in the frozen state to remove the hydrogen chloride and the liberated amino acids were absorbed on a cation exchange column and eluted with 2N aqueous ammonia.

The mixture of sugars and amino acids were separated on paper chromatograms and estimated colorimetrically [8,10-12]. The sugars produced on hydrolysis of all the arbitrary fractions were somewhat similar and were glucose, galactose, xylose, arabinose, ribose, galacturonic acid, an unidentified uronic acid and rhamnose (a trace). The results of the analyses of the various fractions in tea flush and black tea are given in Tables 1 and 2. In Table 2 each sugar has been designated as a hexosan or pentosan, but this does not imply that they existed as distinct polysaccharides.

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TABLE 1—*Percentage composition of the ethanol-insoluble material of tea flush and black tea (dry weight basis)*

Constituent	*Tea flush*	*Black tea*
Cell-wall material	42.6	46.8
Hot water-soluble polysaccharides and proteins	8.9	9.6
(Hot water-soluble proteins - N x 6.25)	(2.7)	(2.2)
Ammonium oxalate soluble pectic acid	2.5	2.1
(Hot water-insoluble proteins)	(11.6)	(12.1)
NaClO-soluble compounds (lignin and structural proteins)	12.8	14.7
Holocellulose*	15.9	19.2
Hemicellulose A	2.1	2.9
Hemicellulose B	7.5	8.6
α -Cellulose	5.4	6.5

* Holocellulose is the insoluble residue remaining after NaClO treatment

The amino acids produced on hydrolysis of the hot water-soluble fraction and the hot water-insoluble residue were aspartic acid, glutamic acid, serine, glycine, lysine, threonine, histidine, arginine, tyrosine, alanine, hydroxyproline, valine, leucine/isoleucine and proline. Glutamine and asparagine were absent, possibly because these amino acids were destroyed by the hot hydrochloric acid treatment. The basic amino acids such as arginine and proline were present in relatively higher concentrations in the structural proteins.

TABLE 2—*Percentage composition of the polysaccharide fractions extracted from the ethanol-insoluble material of tea flush*

	Polysaccharide fractions				
Polysaccharides present	*Hot water soluble*	*Ammonium Oxalate-soluble*	*Hemicellulose A*	*Hemicellulose B*	*α -Cellulose*
Glucosan	1.8		23.1	45.0	86.5
Galactan	16.8	17.0	6.4	17.5	10.0
Xylan	1.0	3.0	45.7	23.1	2.0
Araban	11.0	29.0	17.8	13.7	
Ribose	0.9				
Polygalacturonic acid	68.0	51.0			
Uronic acid			7.0	0.7	1.0
Rhamnan	0.5		Trace	Trace	Trace

It resulted from the above study that each stage of the extraction procedure removed a complex mixture of polysaccharides and proteins from the cell-wall material, the composition of which is controlled by the previous history of the sample. Tea infusion would contain some of the hot water-soluble polysaccharides and proteins and these compounds are known to influence the creaming characteristics of the liquor [4,13,14]. The structural constituents, because of their ability to absorb moisture, may play an important role in determining the storage characteristics of the black tea. The relative concentrations of the constituents present in the cell-wall material form a useful complement to our knowledge of black tea.

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