

present striking differences not only in climatic and physical features, but also in the quality of the live-stock, the cattle on the hilly wet regions of the west coast where green grass is available practically throughout the year being notoriously poor in quality both in size and milk yield compared to those on the dry eastern plains; a mineral deficiency in the soil caused by the heavy rains and reflected in the composition of the herbage provides an extremely probable explanation of the poor quality of the Malabar cattle.

The Madras grasses were obtained from the outskirts of the City and the Malabar samples either from Kollengode (a hilly tract near Palghat or from Calicut. The samples were cut in the months of August and September immediately after the grasses had come to flower. Identification was kindly carried out by Prof. K. Ekambaram of the Presidency College, Madras.

The following constituents were determined on nine common grasses and two varieties of straw: silica-free ash, iodine, chlorine, calcium, phosphorus, iron, sodium and potassium. Determinations of nitrogen were carried out at the same time as the protein content is also known to be a factor dependent on the state of the soil.

The methods of analysis were those of the Association of official Agricultural Chemists (1935) with the following exceptions: iodine was determined by von Fellenberg's method as described by Harington⁷, nitrogen according to Pregl, and phosphorus according to Fiske and Subbarow.⁸

CONCLUSIONS

Taking into consideration only the most important constituents, viz., calcium, phosphorus, potassium, sodium, silica-free ash and nitrogen for which standards of comparison are available, it is obvious from Table I that all grasses

analysed are poor in quality, only one of the samples, viz., *Panicum ramosum* from Madras showing a mineral content even approximately equivalent to that of good quality natural British pasture. This species contain adequate amounts of silica-free ash, calcium, phosphorus and chlorine, but is deficient with respect to potassium, sodium and protein. The deficiencies in *Setaria verticillata* are such that this grass would be a suitable supplement to *Panicum ramosum*.

Comparing the grasses from the two localities with each other the west coast varieties are seen to be very much inferior in essential minerals to those grown in Madras; this is strikingly brought out in the case of the two species *Cyanodon dactylon* and *Panicum ramosum* which are common to both groups. The Malabar grasses are particularly deficient in calcium, phosphorus, iodine and protein.

The two kinds of rice straw from Malabar are characterised, as was to be expected, by a mineral content which is extremely low compared even to the grasses from the same locality.

¹ Hall, Sir A. D., *The Feeding of Crops and Stock*, (John Murray, London), 1937.

² Orr, Sir J. B., *Minerals in Pastures* (Lewis, London), 1929, p. 112.

³ Aiyer and Kayasth, *Agriculture and Live-stock in India*, 1931, 1, 526.

⁴ Warth, Iyer and Ayyar, *Ind. J. of Vet. Sci. and Anim. Husb.*, 1932, 2, 325.

⁵ Iyer and Krishna Ayyar, *ibid.*, 1934, 4, 108.

⁶ Ramiah, P. V., *ibid.*, 1933, 3, 65.

⁷ Harington, *The Thyroid Gland*, Oxford University Press, 1933.

⁸ Fiske and Subbarow, *J. Biol. Chem.*, 1925, 66, 375.

Effective Phosphates in Cane Juices

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ALTHOUGH the importance of the phosphate content of juices in determining their behaviour towards clarification is generally recognised, the exact phosphate requirements reported by different authors vary within wide limits (Walker,¹ McAllep and Bomanti²). Some have concluded (Lanier³) that the initial colloid content is more responsible for the efficiency of clarification than the phosphate content itself.

In Natal, where the juice colloids are high and the soil deficient in phosphates, the P_2O_5 content of juices is raised to 0.05–0.06 per cent.⁴ to secure good clarification. The work of Keane and Hill⁵ on the filtrability of raw cane sugars, of Carrero⁶ on P_2O_5 contents P.O.J. 2878 juices, of Beater⁷ on South African juices and of McRae⁸ on the nature of the phosphates present, shows

that the entire phosphorous in the juices is not available for clarification. The authors believe that it is only the phosphate which is in true solution or which gets into solution on heating which reacts with the added lime to form the calcium phosphate precipitate; this portion of the phosphate is known as the effective phosphate.

The Separation of 'effective' and 'non-effective' phosphates.—The 'effective' phosphate was dialysed out through a cellophane membrane, at 80° C. against distilled water, employing a muslin-filtered sample of juice (50 c.c.) obtained by crushing in a three roller vertical mill, under moderately heavy pressure. 50 c.c. of the juice is then separately analysed for total phosphates.

The dialysate in the beaker is collected and

TABLE I

	Variety	Total P_2O_5 gm./litre juice	Dialysable P_2O_5 (Effective P_2O_5)	
			P_2O_5 gm./litre	% Total P_2O_5
I (a)	CO. 312 ..	0.5350	0.5446	93.09
(b)	CO. 331 ..	0.4284	0.4149	96.85
II (a)	CO. 312 ..	0.5874	0.5754	97.96
(b)	CO. 331 ..	0.4751	0.4648	97.83
III (a)	CO. 312—			
	Top ..	0.6076	0.5861	96.46
	Bottom ..	0.8150	0.7875	96.63
	Whole ..	0.6942	0.6761	97.36
	CO. 331—			
	Top ..	0.5116	0.4984	97.42
	Bottom ..	0.7505	0.7370	98.20
	Whole ..	0.6130	0.5998	97.85

replaced by fresh distilled water daily in the initial stages and later on, on alternative days. The dialysis was continued for 7 days, with daily changes of water; all the dialysate was collected, concentrated, evaporated to dryness with a few drops of calcium acetate, ashed and the P_2O_5 estimated gravimetrically by precipi-

tation as ammonium phosphomolybdate. The results obtained with two varieties, on different dates, on the whole juice and juices from top and bottom portions are given in the table.

The above figures reveal that in the varieties examined the effective phosphate is more than 95 per cent. of the total phosphate. This is in disagreement with the results of most of the earlier workers, who obtained by their methods 50–70 per cent. of the total phosphates as possibly being available for defecation. It will also be noticed that the effective phosphate is more in the bottom juice than in the top juice. Whether these differences are common to all the Indian varieties and at different periods of growth or due to milling conditions or to defects in the methods of determination—these are factors now under investigation.

¹ Walker, H., *Ind. Eng. Chem.*, 1923, 15, 104.

² McAllep and Bomanti, *Hawaiian Planters' Record*, 26, 122.

³ Lanier, "Process," 4th Annual Conf. of Association Sug. Tech., Cuba, p. 93.

⁴ Farnell, *Int. Sug. Jour.*, 1929, p. 149.

⁵ Keane and Hill, *Ind. Eng. Chem.*, 1931, 23, 421.

⁶ Carrero, *Rept. Agric. Expt. Station*, Puerto Rico, Mayaguez, 1931, p. 11.

⁷ Beater, *Proc. South African S. Tech. Association*, 1937, p. 82.

⁸ McRae, *ibid.*, 1929, p. 54.

Chemical Reactions Involving Solids

THE structural elements of matter in a solid possess but little mobility at ordinary temperatures, compared to a fluid state, so that one would on superficial considerations even hesitate to regard solids, as such, to be involved in chemical reactions. Indeed this concept prevented for a remarkably long time any appreciable interest being taken in the chemistry of the solid state, although technical processes and particularly work on metallography had shown that under favourable conditions solids do possess a characteristic reactivity. This chemical reactivity of a solid is in particular evident when the other reacting component is a fluid, as in the combustion of carbon, reactions of graphite, reduction of oxides, etc. Reactions in which solid phases are exclusively taking part are also not uncommon: only, these cases are to be met with in different regions of chemical studies such as metallography, solid solutions, and Industrial Chemistry, and thus they escaped a general correlation. Consequently the principles underlying the reactions of solid bodies are very much less known and understood than those relating to reactions in the gaseous phase. The first important monograph on chemical reactions involving solids, "Diffusion und Chemische Reaktion in Festen Stoffen" by Prof. W. Jost, appeared in 1937. The 86th Symposium* organised by the Faraday Society in April 1938 has now helped to bring together various aspects of the subject, for a general discussion.

* *Trans. Farad. Society*, Part 8, 1938, pp. 821, 1085.

It is but natural that the general physical principles underlying these reactions should come up first for consideration. In the first two papers by N. F. Mott and J. C. Slater, the energy levels in crystal lattices, and the motion of electrons and of "positive holes" are discussed, and it is explained how the "excitation" can be transmitted over finite distances by the transfer of energy from one atom to the next. Succeeding papers deal with the conduction, diffusion, and chemical changes in solids. In the phenomena of electric conduction, and in a number of reactions involving diffusion processes, it is interesting to study the mechanism of the movement of the material ions. It is generally regarded that these movements are possible when there are deviations from the strict order of an ideal lattice. According to Wagner, some ions can exist interstitially within the normal lattice, and some positions of the normal lattice may be vacant. Motion is then possible by the jumps of the ions into the neighbouring vacant points or into the neighbouring interstitial positions. When the temperature is not too low, there is a thermodynamic equilibrium of the interstitial ions and the vacant places with the whole lattice. The energy of disorder in the ionic crystals has been discussed by W. Jost. In another interesting paper by J. D. Bernal, on the geometrical factors in reactions involving solids, it has been emphasised that the one common principle which runs through the whole field of such reactions, is the tendency to preserve crystal orientation