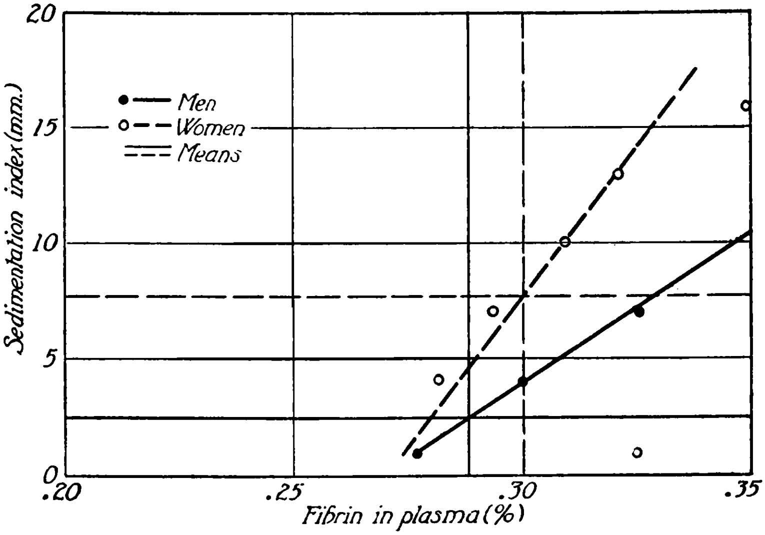

For women $F = .27099 + .0038S$
For men $F = .26984 + .00763S$

FIG. 1.

The difference between the correlation coefficients for the 2 sexes is only .016±.120. Since the difference is less than its probable error, it cannot be considered significant.

3983

Interrelationship of Certain Physico-Chemical Constants of Plant Saps.*

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Increasing attention is being paid to the physico-chemical properties of plant saps. Earlier studies were devoted almost exclusively to the problems of the osmotic concentration of the plant saps, particularly as related to environmental conditions. Dixon and Atkins[1] pointed out that in order to secure uniform samples of

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[1] Dixon, H. H., and Atkins, W. R. G., *Sci. Proc. Roy. Dublin Soc.*, (n. s.) 1913, xiii, 422.

sap the plant tissues must be made permeable by freezing. They used liquid air for freezing the material, and later Gortner and Harris[2] modified this method by using a simple salt and ice bath. Since that time a voluminous literature has accumulated[3] in regard to the influence of geographical environment and climate on the osmotic properties of plant saps. In most of the work carried out by Harris, and Harris and Gortner the electrical conductivity of the tissue fluids has been recorded, in addition to osmotic concentration, but it is only recently that a new factor has been shown to be of importance.

Newton and Gortner[4] devised a technic for the measurement of "bound water" *i. e.,* the water which appears to be associated with hydrophilic colloids and consequently is differentiated from the free water which is free to dissolve organic and inorganic solutes. Newton[5, 6, 7] has demonstrated that a measurement of bound water content is of great importance in the study of winter hardiness of plants, and in similar unpublished work Newton has likewise demonstrated that measurements of bound water are of importance in studying problems of drought resistance. Robinson[8, 9] showed bound water to be a factor in ecological problems of insects. Gortner[10] has called attention to some of the relationships involving free and bound water as affecting biological problems.

Recently Meyer[11] has made a study of the physico-chemical properties of plant saps from a series of mesophytic plants from Ohio. He records the % of water in the fresh leaves, the amount of sap yielded by 100 gm. of fresh leaves under a pressure of 5,000 pounds to the square inch, the % of total water expressed from the leaves, the osmotic concentration of the expressed sap, the total solids in the expressed sap, and the bound water in the expressed sap determined by the method of Newton and Gortner.

[2] Gortner, R. A., and Harris, J. A., *Plant World*, 1914, xvii, 49.

[3] For representative publications see the bibliography in the paper by Harris, J. A., Gortner, R. A., *et al., J. Agr. Res.*, 1924, xxvii, 893.

[4] Newton, R., and Gortner, R. A., *Bot. Gaz.*, 1922, lxxiv, 442.

[5] Newton, R., *J. Agr. Sci.*, 1922, xii, 1.

[6] Newton R., *J. Agr. Sci.*, 1924, xiv, 178.

[7] Newton, R., University of Alberta, Coll. of Agr. Research Bull. No. 1, 1923, p. 53.

[8] Robinson, William, *J. Econ. Entomol.*, 1927, xx, 80.

[9] Robinson, William, Colloid Symposium Monograph, Vol. V, Chemical Catalog Co., N. Y., 1928, p. 199.

[10] Gortner, R. A., "Adsorption and Vital Phenomena," in Mayo Foundation Lectures on Biologic Aspects of Colloidal and Physiologic Chemistry, Saunders and Co., Philadelphia, 1927, p. 133.

[11] Meyer, B. S., *Ohio J. of Sci.*, 1927, xxvii, 263.

Inasmuch as there are but few data on bound-water determinations and most of these data are on a limited number of plant types, it seemed worth while to ascertain whether or not there was any direct relationship between the bound-water content of the plant saps studied by Meyer and any of the other values which he records.

We have accordingly calculated the coefficients of correlation, using the formula suggested by Harris,[12] for all of the various combinations possible from Meyer's data. In some instances, one or another of the values was lacking, which explains why the "number of determinations" varies from set to set. We have likewise calculated the coefficients of correlation for the ligneous forms and for the herbaceous forms separately, inasmuch as Harris, Gortner, Lawrence, *et al*[13, 14, 15] have shown that ligneous forms may differ markedly from herbaceous forms in regard to the magnitude and relationship of the physico-chemical constants of the plant saps.

Table I shows the coefficients of correlation which were obtained between the various physico-chemical constants of the plant saps, as listed in Table I of the paper by Meyer.[11] It is unnecessary to discuss this table at length.

It will be noted that there is no significant relationship between the osmotic pressure and bound water, although in the ligneous forms there appears to be a slight tendency toward an increased bound-water content with increased osmotic pressure. However, this is less than twice its probable error, and in the herbaceous forms the reverse relationship occurs, although here again the coefficient is only slightly more than twice its probable error. Combining both forms, there is no appreciable correlation.

Essentially the same relationships hold when we consider the total solids in the sap, and bound water, a positive correlation in the ligneous forms which is barely more than its probable error, a slightly larger negative relationship in the herbaceous forms, and a positive correlation nearly 3 times its probable error when both forms are combined.

When we consider the total solids in the sap, and the osmotic pressure, we find, as one would expect, a high correlation. Inasmuch as the osmotic pressure is due to dissolved solutes, one should find a perfect correlation, providing all of the dissolved solutes

12 Harris, J. A., Am. Nat., 1910, xliv, 693.

13 Harris, J. A., Gortner, R. A., and Lawrence, J. V., *J. Phys. Chem.*, 1921, xxv, 122.

14 Harris, J. A., Lawrence, J. V., and Gortner, R. A., *Physiol. Res.*, 1916, ii, 1.

15 Harris, J. A., Gortner, R. A., Hoffman, W. F., Lawrence, J. V., and Valentine, A. T., *J. Agr. Res.*, 1924, xxvii, 893.

were contributing to the osmotic pressure. The correlation in this case is considerably higher for ligneous forms than for the herbaceous forms.

TABLE I.

The coefficients of correlation between certain physico-chemical constants of plant saps.

	Ligneous forms		Herbaceous forms		Both ligneous and herbaceous forms	
	No. of determinations	Coefficient of correlation	No. of determinations	Coefficient of correlation	No. of determinations	Coefficient of correlation
Osmotic pressure and bound water	23	+0.227±0.133	15	—0.345±0.153	38	+0.172±0.106
Total solids in sap, and bound water	23	+0.175±0.136	14	—0.289±0.165	37	+0.274±0.103
Total solids in sap, and osmotic pressure	25	+0.806±0.047	14	+0.546±0.127	39	+0.781±0.042
% of total water expressed and bound water	22	+0.373±0.124	10	—0.322±0.191	32	—0.013±0.119
% of total water expressed and total solids in sap	24	+0.044±0.137	10	—0.044±0.213	34	—0.207±0.111
% of total water expressed and osmotic pressure.	25	—0.144±0.132	10	+0.319±0.191	35	—0.176±0.110
% of total water expressed and moisture content of leaves	31	+0.482±0.093	11	—0.658±0.115	42	+0.423±0.085
Water content of leaves and bound water	22	+0.318±0.129	15	+0.268±0.162	37	+0.011±0.111
Water content of leaves and osmotic pressure	25	—0.216±0.129	15	—0.703±0.088	40	—0.600±0.068
Water content of leaves and total solids in sap	24	—0.379±0.118	14	—0.732±0.084	38	—0.672±0.060

The relationship between % of total water expressed and bound water yields a positive correlation approximately 3 times its probable error for ligneous forms, a negative correlation slightly more than twice its probable error for the herbaceous forms, and with both forms combined a correlation of essentially no value. It would appear that in this case, as the amount of total water expressed increases, the bound water increases for the ligneous forms, indicating that the true protoplasmic contents may increase in the last portions of water from the ligneous plants, whereas the first portions of water expressed from the herbaceous plants may be richer in the true protoplasmic contents. In any event, the 2 forms are sharply differentiated by this comparison.

Considering the % of total water expressed in relation to the total solids in the sap, we find no significant correlation for either ligneous or herbaceous forms, although for both forms combined we have a negative correlation approximately twice its probable error.

For % of total water expressed and osmotic pressure there is a negative correlation for the ligneous forms which is not significant, a positive correlation nearly twice its probable error for herbaceous forms, and a slight negative correlation, probably statistically insignificant, for both forms combined.

For the percentage of total water expressed and the original moisture content of the leaves there is a significant positive correlation for the ligneous forms, a somewhat higher negative correlation for the herbaceous forms, and a significant positive correlation for both forms combined. These values indicate that the percentage of total water expressed increases with the increase of the moisture content of the leaves for ligneous forms, but decreases with increased moisture content of the leaves for herbaceous forms. This is rather surprising, and further data are desirable on this point.

For the relationship of the water content of the leaves and bound water we have in all cases a slight positive correlation, indicating that as the water content of the leaves increases, there is a tendency for the bound water to increase. In the case of the ligneous and the herbaceous forms separately the correlation is less than 3 times the probable error. For both forms together the correlation becomes insignificant.

For the water content of the leaves and the osmotic pressure of the expressed sap, there is a slight negative correlation, which is probably not significant, in the case of the ligneous forms, the correlation being less than twice its probable error. In the case of the herbaceous forms, however, there is a large negative correlation, and for both forms together a significant negative correlation. This indicates that in the herbaceous forms an increase of moisture content in the leaves causes a marked decrease in osmotic pressure, whereas for the ligneous forms the decrease, if it occurs, is relatively slight.

For the water content of the leaves and the total solids in the sap we have again a negative correlation, both for the ligneous and for the herbaceous forms, as well as for the 2 forms combined. Here again, the ligneous forms show a much lower correlation than do the herbaceous forms, indicating that physiologically the 2 forms differ to a very marked extent.

It will be noted that in none of the series in which bound water is a factor do we find high coefficients of correlation. This justifies the labor necessary for making these calculations, inasmuch as it demonstrates that the measurement of bound water in a plant sap is the measurement of a factor which is essentially independent of the properties which have previously been measured, and that the bound-water values cannot be obtained from any of the ordinary measurements. Consequently these data can be taken as indicating that measurements of bound water may prove helpful in studying the properties of plant saps as related to geographical distribution.

Another point brought out by the table has already been referred to, namely, the marked differences which are shown in certain of the relationships, when one compares ligneous with herbaceous plant forms. It should be obvious that there is a marked difference in the physico-chemical properties of the plant saps of these two forms, as has already been pointed out.[13, 14, 15]

3984

Improved Method for the Extraction of Melanin from Human Urine.

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The futility in expecting to obtain an unaltered metabolic product of a complex character like human or animal melanin after prolonged boiling with caustic or concentrated mineral acids, was pointed out by Gortner[1]. The method of isolation of urinary melanin by direct precipitation of the urine either with basic lead acetate or with barium hydroxide suffers from the disadvantage

[1] Gortner, R. A., *J. Biol. Chem.*, 1910, viii, 341.