Where forests have not yet been destroyed the author shows it is possible to put them under a form of management by which they will yield a continuous supply of timber. Where the existing stand is sufficiently valuable this form of development may be secured without investing fresh capital. It does, however, require restraint in the exploitation of the existing forests, and the economics of this type of development is rather different from that of afforestation. In the last chapter, which is entitled "The Economics of Sustained Yield," the comparative economics of devastation and conservative forest management is discussed, with special reference to America, and tendencies are traced towards a more constructive view of company management being adopted.

The profitableness of forestry will be greatly affected by any change in prices. Questions of timber resources and consumption are dealt with, both as regards Europe and America, and price movements are traced for nearly ninety years. These prices have been corrected for changes in the purchasing power of money, so that movements in real prices may be observed. It is interesting to note that, although the real price of sawn softwoods imported in Britain rose rapidly from 1871 to 1900, there was a subsequent fall lasting till the great war and present real prices are little, if any, higher than in 1900.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

FRUIT AND VEGETABLE PIGMENTS AS INDICATORS

A few years ago a study was made of the coloring matter of certain European grapes by Willstätter and Zollinger,[1] and of several American varieties by Anderson and Nabenhauer.[2, 3] All the pigments were found to be chemically similar, being composed of the monoglucoside oenin in the case of the European grapes, and in the case of the American of anthocyanin, which is similar to oenin but with a smaller percentage of methoxyl. It was noted that solutions of some derivatives of anthocyanin turned bright red when acidified and blue or bluish-green when made alkaline, the pigment decomposing in a short time if left in alkaline solution. It does not appear that these workers investigated the indicator values of grape pigments, and Clark does not list any of the products of grapes or of grape skins among the indicators he describes in his book on hydrogen ions.[4] Industrially, however, advantage is taken of the color changes of grape pigments by wine manufacturers, "since red wine is very commonly titrated for total acidity, using the color change from red to green as an endpoint."[5]

After noting the color change in grape-juice while working on a problem in dietetics and recalling that Clark's list of indicators includes the extract of red cabbage,[4] it occurred to us that the pigments of other fruits and vegetables might exhibit similar characteristics. We accordingly began to study such varieties as were readily obtainable, testing for the presence of pigments showing a color change, for the pH range of such color changes as were observed and for the practical value of the pigments for use where liquid indicators or test papers might be needed.

Apricots, carrots, peaches, pears, persimmons and tomatoes failed to yield pigments with indicator characteristics. The pigment of red beets remained red throughout the acid range and into the alkaline range at least as far as pH 13.0. On the other hand, red apples, blackberries, blueberries, prickly pear cactus fruit, black cherries, cranberries, dewberries, grapes of all colors from red to black, loganberries, Satsuma plums, pomegranates, black and red raspberries and strawberries proved to contain pigments of more or less indicator value.

In all cases we at first made decoctions of the fruits or vegetables. Of grapes and apples we used only the skins. The test material was simmered for about fifteen minutes in as little water as practicable, then the colored solution was separated from the pulp by straining through several layers of cheesecloth. We found later that with blackberries, cactus fruit, black cherries, dewberries, pomegranates, raspberries and strawberries a better solution could be obtained by crushing the raw fruit and pressing out the juice. To clear and preserve the solutions we added half their volume of 95 per cent. alcohol, let them stand for several hours and then filtered them.

A series of standard buffers was used in testing the pH range covered by the color changes. The following table shows what we found in the case of ten pigments.

The pigments from all colors of grapes were found to be similar as to indicator characteristics, the only

[1] R. Willstätter and E. H. Zollinger, *Ann. Chem.*, 408: 83, 1915; 412: 195, 1916.
[2] R. J. Anderson, *J. Biol. Chem.*, 57: 795, 1923; 61: 685, 1924.
[3] R. J. Anderson and F. P. Nabenhauer, *J. Biol. Chem.*, 61: 97, 1924.
[4] W. M. Clark, "Determination of Hydrogen Ions," pp. 84–98, 1923.
[5] S. R. Benedict, personal communication.

difference being that the darker the color of the grapes the more concentrated the solution of pigment obtainable from their skins. The same is true of the class of fruits consisting of blackberries, dewberries, loganberries and raspberries. We have not had time to purify these fruit pigments and study their chemical composition, but from the colors they show and the pH range they cover we judge that most of them are derivatives of anthocyanin or similar compounds.

Fruit source	Color change	pH range
Apples	Red to yellowish-green	6.2– 7.2
Blackberries	Red to dark grayish-blue	6.0– 7.4
Blueberries	Reddish-purple to greenish-purple	6.2– 7.2
Cactus	Red to faint purple	9.0–12.0
Cactus	Faint purple to reddish-brown	12.0–13.0
Cherries	Red to bluish-purple	6.0– 7.2
Cranberries	Red to yellowish-green	6.2– 7.2
Grapes	Red to purple	5.0– 6.6
Grapes	Purple to green	6.6– 7-6
Plums	Red to yellowish-green	6.2– 7.2
Pomegranates	Red to purple	6.0– 6.8
Pomegranates	Purple to green	6.8– 7.6
Strawberries	Red to yellowish-green	6.2– 7.2

Any of the pigment solutions, except that of cactus fruit, can be used in the titration of acids. As kept in the form of alcohol preserved solutions, they have stood for several months without showing any signs of deterioration. They can not be used in titrating bases, for in a solution which is no more than moderately alkaline they soon decompose, all of them producing a brown color which does not change when acid is added. The faint purple and reddish-brown colors of the cactus pigment are comparatively resistant to alkalis, but the pH range of the color change is too far over on the alkaline side to make the pigment of much use in titration work. Since, however, it is not poisonous, has but little odor or taste and holds its deep red shade over so wide a pH range, one can easily see why certain housewives in parts of the United States where prickly pear cactus grows have found it so satisfactory a coloring agent in jelly-making.

The most practical use that we have found for these indicators is in making test papers. Soaking a cheap grade of thin filter-paper in the crude decoctions—it is not necessary to clear with alcohol for this purpose—and then drying the paper, gives a satisfactory neutral-tinted product in most cases. The natural acid of apples, cranberries, plums and pomegranates is sufficient to cause the production of red papers. When such papers are dry it is best to wet them with .2 per cent. ammonium hydroxide, rinse quickly and dry again. This treatment changes the color to a neutral tint. The fact that these fruit pigment test papers have a definite neutral tint, as well as an acid tint and an alkaline tint, is an advantage. Their color changes, however, are in some cases a bit different from those of the corresponding pigment solutions. For this reason we add a brief table to show what may be expected of the papers.

Fruit source	Neutral tint	Acid tint	Alkaline tint
Apples	Grayish-purple	Red	Green
Blackberries	Purple	Red	Bluish-green
Blueberries	Purple	Red	Blue
Cherries	Reddish-purple	Red	Bluish-green
Cranberries	Faint purple	Red	Light green
Grapes	Purple	Red	Bluish-green
Plums	Faint purple	Red	Light green
Pomegranates	Purple	Red	Bluish-green
Strawberries	Reddish-purple	Red	Light green

SUMMARY

(1) Solutions of many fruit pigments act as indicators.

(2) These solutions are easily prepared and stable, and the pH range of their color changes is in most cases conveniently near the neutral point.

(3) As liquid indicators they can be used in titrating acids, but not bases.

(4) Their greatest usefulness depends upon the fact that very satisfactory test papers can be made with them in a simple and inexpensive way.

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THE SPOTTING METHOD OF WEED ERADICATION

IN the eradication of ragwort, reported by Grimmett,[1] mention is made of placing about an ounce of dry mixture of equal parts of finely crystallized sulphate of iron and sodium chloride on the crown of the individual plants. A later examination of the area so treated showed 100 per cent. killing. The plants were rotted and could be pulled out easily. In no case did regrowth occur from the roots. In most cases a ring of grass from a few inches to a foot in diameter was also killed.

Some years ago the writer, while considering methods of eradicating plantain and dandelion in a young blue grass lawn, conceived the idea of using a fer-

[1] B. E. R. Grimmett, "Chemical Eradication of Ragwort," *N. Z. Jour. of Agr.*, 34, 4: 256.