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A chemical study of apple twigs

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A CHEMICAL STUDY OF APPLE TWIGS.

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At the suggestion of the Director, with whom the idea originated, I have made a short study of apple twigs with the object of learning whether there exist, in mid-winter, any differences in composition between the new growth of those varieties of apple which are *hardy* and those which are *non-hardy* in the climate of Central and Northern Iowa.

Four varieties of twigs were studied, namely, Duchess of Oldenburg, Borovinca, Ben Davis and Boiken—the two first named being regarded as hardy and the two latter as non-hardy varieties. The twigs were taken from the trees, and the work done during January just passed. The Ben Davis twigs were from a single large tree*—the only one available—the Duchess from four large trees, the Boiken and Borovinca each from a number of nursery trees, three to five years from the graft; all were apparently well matured.

The time required for making thorough proximate analysis of the twigs could not be afforded at the present time, in justice to other interests; therefore it was thought best in this bit of chemical exploration to take a short-cut through the regular analytical methods, even at some sacrifice of accuracy and detail information. For it was believed that if the several samples were treated exactly alike, this course would be likely to reveal, or at least to give a clue to, any marked differences which might exist in their composition—and this, rather than a minute knowledge of detail, was the object of the study.

Therefore the course pursued was as follows: (1). Three inches of the extreme ends of the twigs were taken for extraction; (2) the next next 4 inches for estimating moisture and protein; (3) the next 1½ inches for specific gravity; (4) the next 2 inches were held as reserve, and (5) the next 2 inches were used in determining the ash. The numbers of twigs from which these samples for analysis were taken, were of Duchess 45, of Borovinca 65, of Ben Davis 32 and of Boiken 42.

The portions used for extraction were, without drying, chipped very fine with a knife, extracted five times with hot water (on steam bath for two hours

*Some of the results given further on, as well as certain appearances during analysis, indicate that this Ben Davis tree was not in a healthy condition.

each time), each extraction was evaporated separately, and slowly, to near dryness and the residue thoroughly exhausted with absolute alcohol (acting for several hours with frequent trituration). The alcoholic solution was made to a definite volume, from which measured portions were taken for the various determinations. The residue undissolved by alcohol was (after removal of the last trace of that solvent by heat) dissolved in water, the solution made to a fixed volume. and from it portions were taken for analysis.

The first of these two solutions will be designated as the Alcoholic Extract, the second as the Water Extract.

A WORD OF WARNING.

It must be stated that in evaporating the first aqueous extracts "to near dryness"—as stated above—it was found impossible to be sure of treating the varieties exactly alike *in respect to the amount of water left unvaporated*, as the work was done upon the several varieties on different days and comparison was impossible. Now a difference here might affect in varying degrees the solvent action of the absolute alcohol, allowing it to dissolve more freely in one case than another; therefore I wish to caution the reader against drawing conclusions (other than merely tentative ones) from differences shown in *either* the water or the alcoholic extract *separately*. No such possibility of error, however, attaches to the *totals* from *both* the extracts, and these may be taken as representing absolute facts.

RESULTS.

All results, excepting those on Moisture, Acidity and Specific Gravity, are stated in percentage on the DRY SUBSTANCE *of the twigs.*

1. EXTRACTIVES.

[From the terminal 3 inches of the twigs.]

[a.] Total Solids extracted.

	DUCHESS.	BOROVINCA.	BEN DAVIS.	BOIKEN.
Alcoholic Extract	14.48	14.13	16.78	18.08
Water Extract	13.16	14.56	12.24	13.12
Totals	27.64	28.69	29.02	31.20

[b.] Sugars, Dextrin, Glucosides and any other soluble matters convertible into Glucose (or other reducing body) by heating with dilute acid. Results calculated as Glucose.

	DUCHESS.	BOROVINCA.	BEN DAVIS.	BOIKEN.
Alcoholic Extract	4.68	4.52	4.18	4.84
Water Extract	4.70	4.94	2.92	3.38
Totals	9.38	9.46	7.10	8.22

[c.] Acidity—showing the number of cubic centimeters of $\frac{1}{10}$ normal alkali required to neutralize the acid from 100 grammes of the *Dry Substance* of the twigs.

	Duchess.	Borovinca.	Ben Davis.	Boiken.
Alcoholic Extract	265.1	278.9	321.1	358.3
Water Extract	122.1	124.8	162.2	126.3
Totals	387.2	403.7	483.3	484.6

[d.] Pectins. [In water extract only.]

Duchess.	Borovinca.	Ben Davis.	Boiken.
2.20	2.46	3.38	3.70

[e.] Dextrin. [In water extract only.]

Duchess.	Borovinca.	Ben Davis.	Boiken.
7.74	6.51	5.11	5.86

[f.] Organic Matters precipitated (thrown out of solution) by neutral Lead Acetate.

[The alcohol of the alcoholic extract was replaced with water previous to precipitation.]

	Duchess.	Borovinca.	Ben Davis.	Boiken.
Alcoholic Extract	1.95	1.55	3.13	lost.
Water Extract	2.82	3.00	2.34	3.92
Totals	4.77	4.55	5.47	

[g.] Organic Matters precipitated by Cupric Acetate.

[The alcohol of the alcoholic extract was replaced with water previous to precipitation.]

	Duchess.	Borovinca.	Ben Davis.	Boiken.
Alcoholic Extract	1.26	.64	1.38	lost.
Water Extract	1.81	2.44	2.52	2.70
Totals	3.07	3.08	3.90	

[h.] Extractives Undetermined.

Adding together the above results on the extractives which were separately determined, (after calculating the acidity into

percentages of anhydrous oxalic acid), omitting [g] as being included in [f], and assuming the total for Boiken in [f] to be the same as for Ben Davis, we have as the sums,

Duchess.	Borovinca.	Ben Davis.	Boiken.
25.83	24.77	23.23	25.43

deducting these from the Total Solids extracted [a], viz:

27.64	28.69	29.02	31.20

we have as the Extratives Undetermined (in percentages on the dry substance of the twigs)

1.81	3.92	5.79	5.77

2. MOISTURE [In second cutting from tips.]

Percentages on original samples.

	Duchess.	Borovinca.	Ben Davis.	Boiken.
Moisture.	46.55	48.92	46.42	45.31

The figures on Ben Davis and Boiken are probably a trifle low, as these samples lay in the cellar a week after cutting from the trees before the analyses were begun.

3. CRUDE PROTEIN (i. e. total nitrogen $\times 6\frac{1}{4}$.)

[In second cutting from tips of twigs.]

	Duchess.	Borovinca.	Ben Davis.	Boiken.
Crude Protein	6.29	7.06	4.94	8.60

These rather surprising figures are the means of closely agreeing duplicates.

4. SPECIFIC GRAVITY.

[On the third cutting from tips.]

The results obtained were

	Duchess.	Borovinca.	Ben Davis.	Boiken.
Sp. gr.	1.059	1.049	1.006	1.023

On account of the possible loss of moisture from the Ben Davis and Boiken samples, I had little confidence in these figures. Therefore fresh samples were obtained direct from the trees, and the third cutting from the tips gave, respectvely,

Sp. gr.	1.077	1.025	1.032	1.031

The gravity of a dozen or more individual twigs was then taken, separately, at different distances from the tips, the results showing in each variety a wide range, as for instance in the Duchess from .93 to 1.07 and in Ben Davis from .98 to 1.07.

As might have been expected, the density usually increased with the distance from the tips, although a number of exceptions to this were found.

The differences in density appeared to depend mainly upon the relative proportion of the bark and pith to the wood, and as that is a question purely of structural botany, far removed from the chemist's domain, the subject was pursued no farther.

5. CRUDE ASH.

[In fifth cutting from tips of twigs.]

	DUCHESS.	POROVINCA.	BEN DAVIS.	BOIKEN.
Crude Ash	3.94	3.99	3.79	3.77

Determination of other constituents was deferred until time can be spared for more thorough investigation of the subject.

SUMMARY.

The results of this short study show that of the samples examined—for no conclusions reaching beyond these can be deduced from so scant data—

1st. The tender varieties contained somewhat more of extractable matters than did the hardy

2d. The tender varieties contained a smaller total of sugars, dextrin and other water-soluble substances, convertible into glucose by dilute acids.

3d. The tender varieties contained more free acids than did the hardy.

4th. The tender varieties contained more soluble pectins and less dextrin than did the hardy.

5th. Of extractive matters undetermined, the tender varieties contained the most.

6th. Protein showed wide variations in the different samples, but not on the lines of tender and hardy. Ash was nearly the same in all.

CONCLUSION: The results as a whole certainly do not negtative the idea that chemical analysis may yet aid in dis inguishing between hardy and tender varieties, and perhaps even lend it some slight encouragement; moreover they distinctly point out certain lines for future study.

Could the end aimed at be fully attained, so that tender and hardy varieties could be absolutely distinguished from each other by means of chemical tests, and farmer and horticulturist be saved the years of trial now so often ending in dismal failure, the gain to all classes would be inestimable.