

give the maximum of acetic acid, consists in the production of the maximum of alcohol from the sugar by dominant fermentation with selected yeasts, followed by the conversion of the alcoholic liquor into vinegar by the quick process of vinegar making.

(3) The vinegar obtained is of excellent quality. Its composition is similar to that of cider vinegar, save for its high content of solids, and content of pentosans.

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## THE EFFECT OF SHADE DURING RIPENING ON THE PROXIMATE CONSTITUENTS OF THE WHEAT KERNEL.

BY R. W. THATCHER AND H. R. WATKINS.

Received March 5, 1907.

Within the past few years extensive experiments in growing crops under shade have been carried out. The purpose of these investigations has been, for the most part, to influence the development of the plant in such a way as to adapt it to some market requirement. So far as we can discover, however, very little concerning the effect of the shade upon the chemical composition of the plants has been published. Berthelot<sup>1</sup> reports analyses to show the effect of the shade of an elm tree upon the percentage content of carbon, phosphorus, sulphur, and nitrogen of crested dogtail grass cut at intervals during the growing season. Strakosch<sup>2</sup> investigated the effect of very diffused light upon the formation of carbohydrates in the leaves of the sugar beet. Aside from these, the literature which is available to us contains no reference to the effect of shade during growth upon the nature and the percentage of the compounds which are built up in the plant.

The chemical department of the Washington State Experiment Station is making a thorough study of the conditions which affect the chemical composition and milling qualities of wheat. During the summer of 1906, in connection with these studies, we made some preliminary investigations of the influence of direct sunlight as compared with diffused light upon these properties of the wheat kernel. The results of these experiments are so striking and so suggestive that their publication at this time seems to be warranted.

### DETAILS OF THE EXPERIMENT.

The wheat was all of the Bluestem variety, a white spring wheat. Six rows of grain grown from seed coming from several different wheat-producing districts of the State were used. Just at the time when the plants began to flower, on July 12th, a portion of the plants of each row were shaded by stretching over one end of the plot a cover. This cover was made of heavy, 16-ounce duck canvas, and was stretched just above

<sup>1</sup> Compt. Rend. 128, 139-140, (1899).

<sup>2</sup> Separate from *Oest. Ungar. Z. Zuckerind. und Landw.* 1906, No. 1.

## ANALYSES OF WHEATS GROWN IN SUNLIGHT AND IN SHADE.

	WHEAT No. 1		WHEAT No. 2		WHEAT No. 3		WHEAT No. 4		WHEAT No. 5		WHEAT No. 6	
	Open	Shaded	Open	Shaded	Open	Shaded	Open	Shaded	Open	Shaded	Open	Shaded
	%	%	%	%	%	%	%	%	%	%	%	%
Moisture .....	9.89	9.75	9.71	9.29	9.82	9.16	9.01	9.12	9.28	8.89	9.02	9.26
Dry Matter .....	90.11	90.25	90.29	90.71	90.18	90.84	90.99	90.88	90.72	91.11	90.98	90.74
In Moisture-free Sub.												
Ash .....	3.05	2.93	2.97	2.65	2.35	2.93	2.64	2.89	2.82	3.00	2.75	2.37
Crude Protein .....	22.28	22.41	21.06	24.02	22.28	24.01	21.69	23.57	21.16	24.40	21.87	20.98
Ether Extract .....	1.83	1.82	.....	.....	1.69	2.12	.....	.....	1.50	1.74	1.56	1.55
Starch .....	67.53	62.49	.....	.....	65.56	58.39	.....	.....	67.07	62.38	66.70	62.28
Fibre, etc., by difference	5.30	9.83	.....	.....	8.12	12.54	.....	.....	7.45	9.48	7.12	12.82

the heads of the grain so as to completely cut off all the direct rays of the sun, but to give free access to air and diffused light. Immediately following the placing of this canvas in position there was a period of cloudy weather lasting for six days, during which the cover would, of course, have no effect. After this the weather was cloudless until the grain was ripe, the total period during which the sunshine exercised its effect upon the ripening grain being only ten or twelve days. Owing to the unusually hot weather during July of last season, the grain ripened much more rapidly than it normally does in this section. The kernels were, therefore, light in weight, considerably shrunken, and lower in starch and higher in protein, than they would normally be in this locality. With normal harvest weather the ripening period extends over three or four weeks and the effect of shading during a more prolonged period on a normal year may be still more marked.

After the grain was fully ripe, several plants from the shaded portion of each row were pulled, taking care to get those which had been well under the cover, so that the full length of the stems had been shaded. At the same time a similar number of plants from the unshaded part of the same rows were pulled. The grain from each of the samples thus obtained was threshed out by hand. In every case the kernels from the shaded samples were found to be darker in color than those from the same row which had grown in the open sunlight, and had a slight reddish tinge. The samples were all analyzed according to the methods of the A. O. A. C. In part of the samples the number of plants pulled was too few and the amount of grain brought to the laboratory was too small to permit of all the determinations which would otherwise have been made. The results of the analyses appear in the accompanying table; the percentages of the several proximate constituents being calculated on the basis of moisture-free substance.

The results of the analyses reveal the following facts concerning the effects of shading the grain: the percentage of moisture was not affected, being sometimes lower and sometimes higher in the shaded grain; the same is true of the ash content; the protein content in five cases out of the six is higher in the shaded grain, the average difference being 2.01%, from which it appears that the effect of the shading is to increase the relative amount of nitrogenous material the single exception being probably due to some other cause operating in this case upon the plants grown under the shade; the starch content is decreased by the shading in every case, the difference between the percentage of starch in the shaded and unshaded samples of the same grain varying from 4.42 per cent. to 7.15 per cent.; the percentage of oil, as represented by the ether extract, appears to be increased slightly by shading, although the increase is insignificant in every case but one. From this it appears that

significant effects upon the percentage of protein and of starch in the kernels were produced by shutting off the direct rays of sunlight from the plants during the last ten or twelve days of the ripening period. A careful study of the figures fails to reveal any exact relation between the decreased percentage of starch and the increased proportion of nitrogenous bodies. Hence it appears that the increase in the percentage of crude protein is not due simply to the failure of the plant to build up its normal amount of starch, but to some disturbance of the physiological processes caused by the absence of direct sunlight.

We plan to repeat this experiment during the coming season in considerably greater detail, and to extend the investigation to other grains and to vegetables which store up their reserve of carbohydrate food material in other forms than starch.

WASHINGTON STATE EXPERIMENT STATION,  
Pullman, Wash., Feb. 28, 1907.

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[CONTRIBUTION FROM THE BUREAU OF CHEMISTRY, U. S. DEPARTMENT OF  
AGRICULTURE].

### RIPENING OF ORANGES<sup>1</sup>

BY W. D. BIGELOW AND H. C. GORE.  
Received February 18th, 1907.

In order to obtain some general information regarding the changes in composition of fruit during its growth and ripening, we have found it necessary to so plan our work as to include the examination of varieties of fruit in which certain ingredients or complexes are present in considerable proportion. The error of determinations in proximate organic analyses is relatively so great, and the percentage of certain complexes in certain fruits and the percentage of some of the complexes in all fruits so small, that it is impossible to select a single fruit in which a sufficient number of determinations can be made to give an adequate idea of the changes that take place in fruit during its growing and ripening stages.

In the fruits thus far reported by us, the acid content has been so low that the determination of its rôle in the growth and ripening of the fruits is difficult. The majority of the fruits grown in temperate climates contain a relatively small amount of acid, and it is not an easy matter to select fruits in which the course of the formation and the disappearance of acid may be traced to advantage. Accordingly the orange was selected as a fruit relatively rich in acid. As was pointed out by us in our study of apples<sup>2</sup>, fruits, especially in their green state, suffer changes in composition very rapidly after picking, and a serious error attends the study of the ripening of fruit which is grown at a distance of several days from

<sup>1</sup> Read before the American Association for the Advancement of Science at New Orleans, December, 1905.

<sup>2</sup> U. S. Dept. Agr. Bur. Chem. Bull., 94, p. 51.