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CHEMICAL DEPARTMENT,

Oregon Agricultural Experiment Station,

CORVALLIS, OREGON.

CHEMICAL STUDIES OF OREGON FRUITS.

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CHERRIES.

G. W. SHAW, A. M.

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## INTRODUCTION.

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This bulletin is intended merely as a report of progress in the chemical study of Oregon fruits which was entered upon two seasons ago, the report of the first work having been presented in Bulletin 45. These analyses are to be continued from season to season, and the results presented below should in no sense be taken as conclusive and final as to the physical and chemical merits or demerits of the varieties discussed. Such final results can only be obtained from a long series of analyses covering a number of seasons.

G. W. SHAW, Chemist.

# CHEMICAL STUDIES OF OREGON FRUIT.

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## CHERRIES.

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WITH all the investigations by horticulturists upon the growing of cherries, and the development of new varieties, it seems somewhat strange that no more work has been done upon the chemistry of this favorite fruit. So far as I am able to discover there has been no work published by any of the experiment stations except in California along the chemical side of the subject. There has been a wonderful improvement in the size and quality of the cherry brought about through the application of the principles of selection by horticulturists, and through the untiring efforts of Mr. Seth Lewelling several of the most highly prized varieties have had their origin in our own State. That this is so seems most appropriate, for I believe no more luscious cherries can be grown in the world than in some portions of this State. It is not the province of this paper to discuss these locations. That question is a purely horticultural one, while that before us has to deal with the physical and chemical characteristics of the fruit itself. Such examinations of fruits are of value both from a scientific and a practical standpoint, (1) giving a comparison of different varieties; (2) furnishing a point of departure for the development of other new varieties along desired lines; (3) contributing to our knowledge of the average composition of the fruit; (4) and representing the degree of improvement over wild fruit.

### THE FRUIT USED.

The cherries upon which these results were obtained were grown in the college orchard. The trees were eight years of age and the crop was the third the trees had borne. The soil upon which this orchard is located is the ordinary gray basaltic loam of the Willamette valley and inclined to be heavy. The average composition of such soils is as follows:

## AVERAGE COMPOSITION OF SOIL.

## ANALYSIS OF FINE EARTH.

Insoluble matter .....	64.72
Soluble silica.....	4.39
Potash (K <sub>2</sub> O).....	.24
Soda (Na <sub>2</sub> O).....	.18
Lime (CaO).....	.83
Magnesia (MgO).....	.81
Manganese (Mn <sub>2</sub> O <sub>4</sub> ).....	.08
Iron (Fe <sub>2</sub> O <sub>3</sub> ).....	17.15
Alumina (Al <sub>2</sub> O <sub>3</sub> ).....	
Sulfuric Acid (SO <sub>3</sub> ).....	.03
Phosphoric Acid (P <sub>2</sub> O <sub>5</sub> ).....	.19
Water and Organic Matter.....	10.57
Total.....	99.19
Humus.....	1.66

*These soils are rich in phosphoric acid, well supplied with humus and lime, but weak in potash. It should be remarked that the lime is in a form which will probably render it of small agricultural value.*

The fruit used for analysis was carefully selected as representing fully ripe fruit. The samples were taken during June and represent thirteen varieties.

## COMPOSITION OF THE CHERRY.

Chemically, the cherry contains, besides water:

DRY MATTER	{	Sugar,
		Acids,
		Albumenoids,
		Pectose,
		Cellulose,
		Ash.

**THE SUGAR.**—This exists in cherries as grape and fruit sugar. It is one of the chief food constituents of the cherry as well as of the other fruits.

**THE ACIDS** present in cherries are principally malic and citric, the former constituting the chief sour principle of the fruit. These are accompanied by a smaller quantity of tartaric acid. These same acids exist in most of the other common fruits and berries.

**THE ALBUMENOID.**—This is a class of bodies which contains about 16 per cent of nitrogen and which is commonly estimated by a determination of the nitrogen. It is the function of this class of bodies and of this class alone to form flesh or muscle in the animal body. The character of the albumenoids is best represented by the white of an egg.

**PECTOSE** is the substance which on proper boiling yields jelly. In the cherry it is present in relatively small quantities, hence this fruit is not considered a good jelly fruit.

CELLULOSE, or vegetable fibre, occurs in all parts of all plants. It is this which gives strength and toughness to vegetable matter and forms the vegetable framework. The substance is well represented by fibre of cotton, hemp, and flax.

THE ASH represents the mineral matter removed from the soil. It comprises various salts consisting of potassium, sodium, magnesium, iron, calcium, etc., combined with phosphoric, sulfuric and hydrochloric acids.

#### METHOD OF ANALYSIS.

The fully ripe, selected cherries were brought to the laboratory and there at once subjected to the following analysis:—

AVERAGE WEIGHT.—A convenient number—never less than 40—without stems, were weighed. From the result thus obtained the average weight of the single berry was calculated as well as the number required to weigh one pound.

FLESH AND PITS.—The pits were then removed from these cherries, and after being carefully freed from all adhering flesh, were weighed. The difference between the original weight and the weight of pits being taken as that of the flesh.

JUICE AND PULP.—One hundred grams of the flesh thus obtained was weighed into a counterpoised wet linen cloth and subjected to great pressure in a juice press so long as juice could be obtained. The material remaining in the cloth was weighed as *pulp*.

WATER AND DRY MATTER.—About 20 grams of the fresh flesh was thinly sliced from several of the cherries and dried on a watch glass in an air bath, at first at a temperature of about 95° C, and finally at a temperature of 105° C.

ACIDITY.—Fifty grams of the fresh flesh was thoroughly bruised in a mortar and by means of 350 cc of cold distilled water transferred to a beaker where it was allowed to remain for 20 minutes, during which time it was thoroughly stirred several times. The pulp was then filtered out by means of a pump and the filtrate made to 500 cc. It was necessary to decolorize the solution quite carefully for the coloring matter was found sensitive to alkali used in the titration, and the color was in a measure restored by that agent, rendering the end reaction in titration dim. For determining acidity 50 cc of the above solution was titrated with tenth-normal potassium hydrate using phenolphthalein for an indicator.

SUGAR.—This was obtained by Fehling's method. For this pur-

pose 100 cc of the solution prepared above was treated with 10 cc concentrated hydrochloric acid and kept at a temperature of 69° C for 10 minutes. The solution was then neutralized with sodium carbonate. Fifty cubic centimeters of this solution was then made to 100 cc and treated with Fehling solution as follows: Ten cubic centimeters of the Fehling solution was diluted to 50 cc and heated to boiling and the solution of cherry juice run in from a burette. The mixture was then boiled exactly one minute and tested for copper. This operation was repeated till the minimum amount was found which would precipitate all the copper.

**NITROGEN**—The official Kjeldahl method was used for this determination; using ten grams of the flesh.

**ASH**.—This was obtained by buring in a muffle furnace a convenient weight of the flesh till a white ash remained. It was found that an excellent ash was obtained much more easily in the case of the cherry than with most of the other fruits.

TABLE I.  
Showing Physical Analysis of Cherries, 1898.

Lab. number...	VARIETY.	DATE	Average weight in grams.....	Number per pound.....	Per cent of flesh	Per cent of pits	Flesh.	
							Per cent of juice	Per cent of pulp.
1347	Lincoln .....	June 14..	4.40	103	95.45	4.55	89.53	10.47
1348	Windsor.....	June 14..	5.50	83	95.27	4.73	87.98	12.02
1349	May Duke.....	June 14..	4.15	109	94.46	5.54	88.90	11.10
1352	Black Tartarian.....	June 20..	5.64	80	94.86	5.14	85.55	14.45
1353	Early Richmond.....	June 20..	4.19	108	96.42	3.58	91.73	8.27
1354	Seedling.....	June 20..	2.85	159	91.23	8.77	88.99	11.01
1355	Transparent .....	June 20..	5.36	84	95.90	4.10	91.13	8.87
1356	Centennial.....	June 25..	5.12	89	92.78	7.22	80.00	20.00
1357	Governor Wood.....	June 25..	5.94	76	.....	.....	.....	.....
1358	Elton .....	June 26..	5.74	79	90.90	10.10	.....	.....
1361	Lewelling .....	June 29..	4.79	94	92.31	7.69	86.00	14.00
1563	Rockport Bigarreau..	June 30..	7.79	58	93.35	6.65	80.00	20.00
1364	Royal Ann .....	June 30..	7.26	62	94.13	5.87	86.00	14.00
Average.....			5.29	85	93.92	5.32	86.35	13.09

NOTES ON THE SAMPLES.

1347. *Lincoln*.—An Oregon seedling originated by Seth Lewelling, Milwaukie, Ore. A large, black, sweet cherry with purple flesh. "It is a firm fruit and a long keeper."

1348. *Windsor*.—A dark cherry; large and tart.
1349. *May Duke*.—A juicy, dark red cherry with a sub acid flavor.
1352. *Black Tartarian*.—A very large, purplish black cherry. The flesh is thick, purple and juicy.
1353. *Early Richmond*.—A red, acid cherry of medium size.
1354. *A Seedling*.—A small, red cherry of fine texture and fair flavor.
1355. *Transparent*.—Amber colored and slightly mottled on one side.
1356. *Centennial*.—A cherry "splashed" with crimson on a pale yellow ground; of exceptionally firm texture.
1357. *Governor Wood*.—Light yellow in color and somewhat spotted with red; juicy and sweet.
1358. *Elton*.—A yellow cherry mottled with red, and possessing a fine flavor.
1361. *Lewelling*.—Another cherry of Oregon stock. Color, dark cherry; flesh firm and fine flavored.
1363. *Rockport Bigarreau*.—Amber and red in color, and sweet to the taste. A very large cherry.
1364. *Royal Ann*.—Had the characteristic markings of this well known variety. It was of normal size.

#### NOTES ON THE PHYSICAL CHARACTERISTICS.

SIZE OF CHERRY.—This is indicated by the weight in grams and the number required to weigh one pound. I think the cherries were typical of the varieties as usually found growing in orchards. The trees on which the cherries grew had a fair crop but were not at all overloaded. An examination of the tables shows that of the varieties analyzed the largest cherries were Rockport Bigarreau, 7.79 grams, as against the seedling, 2.85 grams. The Rockport averaged half a gram heavier than the favorite Royal Anns, requiring 58 to the pound against 62 of the latter, and 23 less than the average number required. When this is taken into account with the fact that it is an attractive cherry and that the flesh is exceptionally firm, as shown in the fact that it carries 20 per cent of pulp, it would seem to be a most excellent fruit for long distance shipping. Both the Rockport and the Royal Ann ranged considerably heavier than the other varieties, the latter being about 40 per cent heavier than the average.



Comparing the Royal Anns of our sample with the average of those samples analyzed by the California Station (1894), we find they stand 62 to the pound against 54.4 for the California product. If we compare the Black Tartarian variety with the same variety there grown and reported in the same publication, we find our analyses shows 80 to the pound against an average of three samples of 62.7 for the California cherries. We can find no literature giving analyses of the other varieties appearing in our table. I have no means of knowing what number of cherries composed the sample reported in the California bulletin, but those reported in our table consisted of 40 cherries each and I believe them to be fair specimens of the varieties grown in the Willamette valley.

**PROPORTION OF PITS TO FLESH.**—The percentage of pits ranges from 3.58 in Early Richmond (1353) to 10.10 in Elton (1358). Thus the former carries the greatest per cent of flesh and the latter the least. The average indicates that cherries contain about 17.5 times as much flesh as pits. It is well also to note that the Early Richmond also is a juicy cherry. The average of California analyses shows a little over one per cent more flesh, but since the number of analyses there reported is smaller than here presented and only three varieties are included, this may not be taken as indicating a greater per cent of flesh as the condition to be expected. However, it should be remarked that the same condition was found in the case of prunes\* as shown in a previous publication. If this be taken in connection with the fact that our soils are exceptionally well supplied with phosphoric acid, and the well known tendency of this constituent to produce a high development of seed, it is, perhaps, significant and worthy of attention. This is all the more noteworthy since if a comparison be made between the same varieties, Royal Ann and Black Tartarian, we find that in each case those grown on the California soils rich in potash gave a higher flesh content than those grown on the phosphatic soils of Oregon.

**PROPORTION OF JUICE TO PULP.**—The largest proportion of pulp is shown in Rockport (1363) and in the Centennial (1356). These lead the other varieties by several per cent, thus indicating firm dry fruits and a good shippers. The most juicy sample examined was Early Richmond (1353) to which Transparent (1355) was a close second. The proportion existing between the average juice and

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\*Composition of Oregon Prunes, Ore. Bul. 45, G. W. Shaw.

TABLE II,  
Showing Chemical Analysis of Cherries, 1898.

Laboratory number	VARIETY.	DATE.	Sugar.			Acid in Juice, Terms of SO <sub>3</sub> .....	Nitrogen in Flesh.	Albumenoids in Flesh (N x 6.25).....	Crude Ash	Proximate Analysis of Flesh.			
			In Fresh Flesh	In Juice	In Fresh Fruit.					Water	Organic Matter	Crude Ash	Total
1347	Lincoln	June 14	8.83	9.81	8.43			.73	82.35	16.02	.73	100	
1348	Windsor	June 14	7.74	9.31	7.37	.48		.58	82.62	16.82	.62	100	
1349	May Duke	June 14	7.73	8.64	7.30			.58	84.45	14.83	.62	100	
1352	Black Tartarian	June 20	11.62	13.55	11.02	.32	.170	1.05	83.57	15.86	.57	100	
1353	Early Richmond	June 20	10.43	11.36	10.05	.64	.181	1.13	83.78	15.82	.62	100	
1354	Seedling	June 20	11.40	12.81	10.40	.16	.166	1.08	86.80	14.65	.65	100	
1355	Transparent	June 20	11.10	12.18	10.64	.28	.124	.78	86.65	13.54	.65	100	
1356	Centennial	June 25	13.17	16.44	12.22	.60	.120	1.00	76.91	22.09	1.00	100	
1357	Governor Wood	June 23	12.42			.70	.192	.71	81.01	18.21	.71	100	
1358	Elton	June 26	12.53		11.43	.16	.156	.60	79.00	20.49	.60	100	
1361	Lewelling	June 29	12.31	14.30	11.36	.16	.166	1.00	74.72	*25.28		100	
1363	Rockport	June 30	12.62	15.77	11.78	.24	.435	.84	78.65	20.69	.66	100	
1364	Royal Ann	June 30	13.76	16.00	12.85	.82	.141	.68	81.29	19.03	.68	100	
Average			11.21	12.29	10.40	.43	.145	.91	81.25	18.22	.53	100	

\*Includes ash.

pulp is 6.6 to 1, while the California average was 5 to 1,\* thus indicating the Oregon cherry grown in the Willamette valley to be more juicy than that of California. This is further shown by comparing the average of the three California analyses of the Royal Ann, showing a ratio of 4.2 to 1, with the same variety in Oregon showing a ratio of 6 to 1.

#### NOTES ON CHEMICAL CHARACTERISTICS.

SUGAR.—As previously stated the sugar in fruits is mostly fruit or grape sugar. In cherries this seems to be the only sugar present (as the term is commonly understood). Tests by titrating with Fehling solution followed by inversion, and again titrating failed to show any increase due to cane sugar.

In the flesh there is a wide range extending from 7.73 per cent in May Duke (1349) to 13.76 per cent in Royal Ann (1364). The average of all results shows 11.21 per cent sugar in the fresh flesh, which is 3.48 per cent less than the sugar content of the Royal Ann. If this be compared with the organic matter in the fruit it appears that about two-thirds of it is sugar; however, there are some varieties in which not more than one-half is sugar. If we compare our average with the analyses presented in the California publication (Report of 1894-1895), we find 10.96 per cent sugar in the flesh for the California fruit against an average of 11.21; and if compared with European analyses † we find their average to be 10.24 per cent, thus being very close to our fruit in this important ingredient.

The average acid content of the cherries, .43 per cent, is about the same as that of Oregon prunes, .46. ‡ The ratio between the acid and sugar in the cherry flesh is 1 to 26, while in the case of the prune it is 1 to 31. It is interesting to here note that Fresenius gives as the ratio for *sweet cherries* 1 to 11.16 and for *sour cherries* 1 to 6.85, *calculated as malic acid*. This would indicate a considerable improvement to have taken place in those grown on the Pacific coast over those examined by him so far as the proportion of sugar is concerned.

ALBUMENOIDS.—This is a class of bodies which contains about 16 per cent of nitrogen, and which in all ordinary analyses is determined from the nitrogen content by multiplying it by 6.25. It is

\*Cal. Station Report. 1894-1895.

†Vol. II, König. ‡Composition of Oregon Prunes, Bul. 45, G. W. Shaw.

the function of this class of bodies, and of this class alone, to form flesh or muscle in the animal body. So far as we know none of this material is elaborated in the body, but must all be obtained from external sources, hence the great importance of the albumenoids in any article of food.

Referring to the table the maximum per cent, 1.20, is found in the Governor Wood variety (1357) and the minimum, .70 per cent, in Centennial (1356). The average of all results was .91 per cent, which is somewhat lower than the average presented by California and higher than the European results.

ASH.—The average ash per cent was found to be .53, ranging from a maximum of 1.00 per cent to a minimum of .46 per cent.

#### FOOD CONSTITUENTS.

In the following table the results are averaged to show the food constituents of the average berry determined in the analysis:

FOOD CONSTITUENTS.	
Water .....	81.25
Dry Matter .....	18.75
Total .....	100.00
Sugar .....	11.21
Albumenoids .....	.91
Fat and Carbohydrates .....	5.67
Acid .....	.43
Ash .....	.53
Total .....	18.75

It is evident from the above that the cherry carries considerable nutritive matter, the proportion of dry matter to water being about 1:4.5 and of the dry matter about two-thirds is sugar. The fruit should make an excellent dried product and deserves for this purpose more attention than it at present receives in this State.