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A Chemical Examination of the Loganberry

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FOREWORD

This bulletin deals with the chemistry of the Loganberry. A knowledge of the principles of chemistry, especially in its relation to foods, is essential to understand and appreciate fully some portions of it. Since all phenomena of animal and plant life such as growth, well-being, activity, and disease are based on chemical changes, no apology is made for the use of simple chemical terms.

Acknowledgment. A word of appreciation is here extended to Professor H. V. Tartar, Chemist of the Oregon Experiment Station, for securing samples of Loganberry juice. It was at his suggestion that the investigation of the acid content of Loganberry juice was undertaken.

HISTORICAL

The Loganberry is a comparatively new fruit. At the time of its discovery by J. H. Logan of Santa Cruz, California, in 1884, it aroused considerable interest among horticulturists in various parts of the United States. A number of the experiment stations gave the Loganberry a trial, but for the most part reported unsatisfactory results. By some it was regarded as a curiosity.

Green of the Minnesota Station (Bulletin 45, p. 321) gave the following report: "This is a novelty among fruits . . . . it reclines on the ground and is increased by layers about as easily as the dewberry . . . . The fruit is of a red color, rather lacking in flavor, but not unpleasant. The plants have been grown two seasons at the University Farm and came through the winter of 1894-95 without injury, although covered with earth as it is customary with us to treat all our raspberries. It has so far been only moderately productive and, while worthy of trial in a small way, is not anything promising. We regard it with very much interest as a curiosity, and as a possible forerunner of something good."

Taft and Lyon of the Michigan Station (Bul. 169, p. 141) state that the Loganberry failed to fruit. Quoting them, "Even if it should prove hardy and productive, the appearance and texture of the fruit are likely to prevent its ever being of any value for general planting."

The results at the Wisconsin Station were somewhat similar. Goff (Wis. Sta. Bul. 72, p. 37) says: "My impressions were that . . . . it is of interest chiefly as a hybrid and as a novelty . . . . The fruit is too poor in quality to become popular."

At the Pennsylvania Experiment Station (Agri. Bul. 111, p. 65) Butz reported that the Loganberry was not hardy enough to withstand the winters. "This is the common experience in the eastern states. The fruit is as large as a blackberry, but is too soft for shipping, therefore not adapted for commercial planting. The flavor is a peculiar one which is not universally liked."

In marked contrast to these reports from the central and eastern sections of the United States are the results obtained by Wickson and recorded in the California Exp. Station Report, 1892-1894, p. 340. Here

is what he says in his description of the berry: "Its splendid size, prolific bearing, and notable excellence as a table fruit when thoroughly ripened, convinced us of its unique character and exceptional value as a new fruit. . . . The Logan berry is an exceedingly robust grower and has unique foliage and cane growth as well as fruit . . . [which] is strikingly large and handsome, and a laden cane is a sight not to be forgotten. The fruit is sometimes an inch and a quarter long with the shape of a blackberry. Its flavor is unique and peculiar, and gives to many tastes suggestions of the combination of blackberry and raspberry flavors."

Writing for the Oregon Farmer (1913) Lewis says of the Loganberry: "Canned it is most excellent, being splendid for pies, makes a fine jelly, and its juice by many people is thought to be superior to that of the grape. The berry is adapted to only a few Pacific Coast localities, and in Western Oregon reaches its highest degree of perfection . . . . It is a crop which can be combined very nicely with prune production, as it can be easily evaporated in the same buildings that are used for the drying of prunes."

ECONOMIC IMPORTANCE

A few years ago the true value of the Loganberry was unknown. Discussed at length, as we have observed in agricultural journals, used to some extent by housewives, and advertised in a limited manner, it is just now coming into its own. The development of the Loganberry industry is a direct result of the expansion of the canning trade, the discovery that the berries would keep well when dried, and the further fact that the juice is a by-product which finds a ready and nation-wide market. Single orders of ten carloads of juice have been shipped out of the State. The juice is found aboard battleships, and in every cantonment. The pulp is being made into jam for the soldiers.

Yield. Approximately three and one-half tons of berries or three hundred 24-pound crates to the acre is considered a moderate yield, whereas the average yield is placed at five tons, and on rich lands from six to seven tons of berries, or five hundred to six hundred crates to the acre.

The pressing plants are offering four cents a pound, which means $80.00 a ton, or a total of $400.00 an acre, based on the average yield of five tons.

In 1915 the total sales of Loganberry juice for all companies amounted to less than $60,000; in 1916 to less than $200,000, whereas in 1917 the total sales amounted to something in excess of $1,000,000. By the consolidation of the Pheasant Fruit Juice Company and Northwest Fruit Products Company, the two largest manufacturers of Loganberry products, with an extensive advertising system and with representative salesmen in some of the larger commercial cities, still greater market is assured and overproduction is unlikely.

Colby of the California Experiment Station was the first to study the composition of the Loganberry, but he made no attempt to study the acid content. Results dealing with specific gravity, total acidity, and sugar content of berries of varying degrees of ripeness were reported by Tartar(1) of the Oregon Experiment Station.

(1) Lewis & Brown, Oregon Sta. Bul. 117 (1914), 18.

Jones and Colver analyzed three samples of irrigated and one sample of non-irrigated berries and reported their results in the Idaho Experiment Station Bul. 75 (1912), 47.

EXPERIMENTAL

The results reported here are confined to the analysis of one fourteen-pound sample of fresh, ripe, whole berries and to an examination of the juice, pulp, and oil.

Table I. Composition of the Fresh, Ripe, Whole Berry

	Percent.
Total Solids	20.74
Moisture	79.26
Citric Acid (anhydrous)	1.52
Invert Sugar	7.15
Sucrose	Absent
Protein (N x 6.25)	4.55
Fat (ether extract)	6.13
Crude Fiber	1.38
Ash	0.571
Calories per pound	237.00

This sample of herries was gathered at the close of a uniformly dry season (1917). The percentage of solids reported here is higher than would be expected under normal conditions of rainfall and much higher than reported by Jones and Colver for the non-irrigated berry. Owing to the drouth, the Loganberry season, which usually extends over a period of five or six weeks, was of about three weeks duration.

LOGANBERRY JUICE

From the commercial standpoint the chief value of the Loganberry is in its juice. A chemical examination of the juice shows the following results:

Table II. Composition of the Juice

Sample No.	I	II	III	IV
Date of Collection (1917)	July 18	July 25	July 28	August 7
Specific Gravity (25° C.)	1.0526	1.0548	1.0565	1.0599
Total Acidity*	1.904	1.60	1.515	1.54
Citric Acid (anhydrous)	1.82	1.521	1.511	1.54
Volatile Acids (Acetic)	.....	0.048	0.025	.....
Total solids	.....	12.84	12.49	14.74
Invert sugar	8.55	8.80	9.06	8.74
Protein (N x 6.25)	.....	0.871	0.497	0.37
Ash	.....	0.499	0.45	0.39
Calorific value per liter	.....	405.00	403.00	386.00

*Calculated as anhydrous citric.

The first three samples of juice were pressed from 4 to 5 lbs. of berries purchased in the open market. The berries were ground in a food chopper and then pressed in a small fruit press lined with doubled bird's-eye cotton cloth. Sample IV was obtained in a similar manner in a larger press from 14 lbs. of berries after removing the sample for the analysis given in Table I. The specific gravity readings were made by the pycnometer method on the juice which was kept in a constant temperature bath at 25° C.

The results given in Table III were obtained by following the directions given in the "Official and Provisional Methods of Analysis," Bul. 107 (Revised).

Table III. Analysis of Loganberry Juice

Sample No.	I	II	III
Sp. Gr. (16° C.)	1.0523	1.0477	1.0508
Percent Acidity as Citric	2.396	3.084	2.199
Percent Acidity as Sulfuric	1.678	2.159	1.54
Water	88.96	89.13	90.548*
Total Solids	11.04	10.87	9.452
Percent Ash	0.4139	0.5785	0.4226
Alkalinity (as K_2CO_3)	0.4130	0.5075	0.288
Protein (N x 6.25)	0.3226	0.731	0.7375
Sugar (as invert sugar)	6.56	5.37	8.39
Alcoholic Precipitate	0.502	0.872	0.4008
Calorific Value, per liter	290.00	207.00	385.00

*The results beginning at this point were obtained by Miss Ierne Ahern.

Sample I was raw unsweetened juice bottled by the Pheasant Fruit Juice Company of Salem, Oregon, during the summer of 1915. Sample II was collected from fresh berries by subjecting them to pressure with a Yale press, July 10, 1916. Sample III was obtained in the same manner as II, but later in the season; viz., August 8, 1916. The higher moisture content and lower total solids of Sample III are due to the fact that the sample was dried in a steam oven, whereas I and II were dried in vacuo at 70° C.

Windisch and Schmidt state that the ash of all fruit juices has an alkalinity of 10 to 12 for each gram of ash, and sometimes, though rarely, a very little more or less. The alkalinity of one gram of ash of I and II was found to be 12.70 and 12.71, respectively. This alkalinity represents the number of cc. of normal acid solution required to neutralize 1 gram of ash.

The following analyses of Loganberry juice were made by N. Uyei of the Oregon Experiment Station Chemistry department in 1916.

Table IV. Analysis of Loganberry Juice

Sample No.	I	II	III	IV
			(second pressing)	
Acidity (as H_2SO_4)	1.40	1.15	1.15	.90
Moisture	87.40	89.28	94.08	88.789
Total solids	12.60	10.718	5.919	11.211
Ash	0.494	0.430	0.32	0.416
Alkalinity (as K_2CO_3)	0.3375	0.423	0.245	0.375
Protein (N x 6.25)	0.454	0.850	0.314	0.813
Sugar (reducing sugar)	9.32	6.17	3.13	7.575
Alcoholic Precipitate	1.07	1.416	1.33	1.669

The above samples of unsweetened juice were prepared by two different companies in the State. When Loganberry juice is sweetened its sale price and volume are increased sufficiently to pay for the addition of sugar. Thirteen and three-tenths pounds of sugar added to a gallon of juice doubles its volume. Besides it helps to overcome the possibility of loss by fermentation.

A study of the acid content of the Loganberry and its juice has been made. Citric was found to be the chief acid, with traces of tartaric and volatile acids. Malic acid was absent. Citric is the acid found in lemons and limes.

Although the Loganberry season lasts only about six weeks, yet during that time some of the juice factories handle 2000 tons of berries for the juice alone. They yield an average of 180 gallons of juice to the ton, or approximately 1560 pounds. In order to express the juice the berries are ground and macerated, after which they are spread in layers of from 2 to 3 inches deep on canvas, or special cloth, the ends and sides of which are folded over to prevent the mixing of the pulp with the escaping juice. From twelve to sixteen of these layers, separated by lattice layer boards, are placed in the press and subjected to a pressure of 1600 to 1800 lbs. to the square inch.

PULP

When a factory handles 2000 tons of berries in juice manufacture there results an approximate loss of 438 tons of pulp which is either dumped into a stream, used in the preparation of jam, spread upon the fields, or allowed to mold. Attempts have been made to feed this pulp to hogs, which eat it sparingly, or not at all. The chief reason for this is not hard to find. Owing to the acidity of the pulp, farm animals refuse to eat it. It is suggested here that the addition of a calculated quantity of sodium carbonate, as determined by chemical analysis, may overcome this feature.

Table V. Percentage Composition of Loganberry Pulp

	Moist Pulp.	Dried Pulp A.	Dried Pulp B(*)
Moisture	70.97	.....	.....
Total Solids	29.03	.....	.....
Protein (N x 6.25)	3.727	12.81	14.80
Fat (Ether extract)	3.799	13.089	15.07
Carbohydrate (Nitrogen-free Ext.)	11.06	38.11	32.82
Crude Fiber	8.389	28.89	33.88
Ash	0.695	2.394	3.43
Acid (as citric)	1.367	4.706	.....
Calories (per lb.)	426.00	1458.00	1567.00

(*) Dried Pulp B was analyzed by B. Pilkington of the Experiment Station Chemistry department.

An examination of the dried pulp above shows that one pound of it is equal in calorific value to six pounds of apples, eight pounds of string beans, one and one-fifth pounds of white bread, three pounds of broiled chicken, or four pounds of potatoes. The crude fiber content, which is high, as well as the presence of citric acid, impart an undesirable taste to muffins made from equal parts of finely ground pulp and flour. The acid taste was overcome by adding calculated amounts of baking soda.(2)

(2) Miss Ahern conducted a few baking tests. It is believed that proper milling of the dried pulp would remove the crude fiber which is made up chiefly of seed hulls and that the flour thus produced would, when combined with wheat flour, make a war bread palatable to the taste and satisfactory as a food so far as calories are concerned.

To 500 grams, or a little more than a pound of pulp was added 150 cc. of water and the combination boiled for 30 minutes in a double boiler. The juice expressed from this pulp, when cooked with an equal volume of sugar, produced a jelly of good color, flavor, and texture. The pulp is rich in pectin, an essential jelly-forming constituent of most fruits, besides sufficient acid to produce the desired result.

As a fertilizer the pulp may be of some value, for it not only adds organic matter or humus, but also mineral constituents. Miss Ahern of this laboratory found 1.01% phosphorus and 0.47% sulfur.

LOGANBERRY OIL

When the fat is first extracted from the ground pulp it is a pale yellowish, mobile liquid, with a characteristic odor. After standing a few days in a stoppered bottle it forms a surface film and becomes semi-solid. At the expiration of six months it is completely transformed into a leathery mass. As judged by the following chemical examination, it would make a good substitute for linseed oil.

The constants of the oil extracted from the finely ground dried pulp by means of petroleum ether, boiling point 44-65° C., are as follows:

Specific Gravity (15.5° C.)	Refractive Index (15.5° C.)	Solidifying Temperature	Iodine No.	Saponification No.
0.9260	1.4811	—33° C.	158.32	179.8

Comparing this oil with other drying oils, it lies between hemp seed oil and tung oil as judged by its iodine value and specific gravity. Its refractive index is high—near that of linseed oil.

CONCLUSIONS

1. Attention has been called to a comparatively new and rapidly growing industry of the Pacific Coast.
2. Citric acid is the chief acid of the Loganberry.
3. The ash of the Loganberry juice has a high alkalinity.
4. Dried ground Loganberry pulp has a calorific value of 1458 calories a pound, nearly as high as four.
5. The pulp may be used in the manufacture of jelly or jam.
6. Loganberry seed oil has marked drying properties.
7. Loganberry pulp may have some value as a fertilizer.

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