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Physical and Chemical Properties of Utah and Idaho Honeys

Raymond C. Rhees

PHYSICAL AND CHEMICAL PROPERTIES OF UTAH AND IDAHO HONEYS

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A thesis submitted in partial fulfillment of the requirements

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Approved:

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Major Professor

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For English Department

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Dean of the School

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Chairman of Committee on Graduate Work

I wish to express appreciation to the Superior Honey Company for the use of their Pfund honey grader and for a number of the honey samples used in this study. I also wish to express my appreciation to the many beekeepers throughout Utah and Idaho who have been cooperative in contributing honey samples. I am grateful for the suggestions and help of Professors Lloyd Malm and Sherwin Maeser during the course of this study and the preparation of this thesis.

Raymond C. Rhees

PHYSICAL AND CHEMICAL PROPERTIES OF UTAH AND IDAHO HONEYS

Even though honey is one of the oldest known sweets, there is a general lack of knowledge concerning its chemical and physical properties. This is particularly true of those honeys produced in the intermountain region. Beekeepers of this region have long felt that their product was sweeter than those honeys produced in other sections of the country. This, of course, implies that honey produced in the intermountain area is higher in sugar concentration and lower in percent moisture. The present study was made in order to supply some data concerning honeys of this area.

Most of the honey produced in Utah and Idaho is in the extracted or liquid state. It is produced for the most part by commercial beekeepers in apiaries located on waste ground on or near irrigated sections of land. Many of these apiaries are located in obscure places and for this reason the importance of beekeeping in Utah and Idaho is generally not recognized. According to Oertel (12), Idaho is fourteenth and Utah is twenty-first in rank as honey producing states. Idaho has about 70,000 colonies of bees producing 4,340,000 pounds of honey and Utah has about 60,000 colonies producing 3,030,000 pounds annually. This estimate was made in 1939 and it is the author's opinion that the number of colonies has not changed appreciably since then.

The honey is gathered by the bees from the nectaries of various honey producing plants. Studies made by Kenoyer (7), Park (14, 15), Vansell (19), and Caillas (2) indicate that the chemical composition and amount of nectar available in various plants differ not only with

the plant but also with environmental factors such as temperature, moisture, rate of honey flow, and number of bees per colony. Vansell gives the sugar concentration of the nectar for 76 western plants. Those of particular interest in Utah and Idaho are as follows:

Floral source	Total sugars %
Sweetclover, yellow	51.6
Dandelion	51.2
Mustard	50.0
Cherry	50.0
Clover, crimson	47.7
Clover, alsike	43.3
Alfalfas, several	41.1
Milkweed	37.2
Sweetclover, white	35.8
Linden, American	33.6
Clover, strawberry	33.3
Sunflower, annual	31.6
Peaches	30.0
Catnip	28.7
Apricots, several	12.0
Pear	4.0 - 30.0

The manner in which honey is ripened has been studied by a number of investigators. Park (14, 15) observed that the honey gathered by the field bees was given to the house bees. The house bees manipulated the nectar with their mouthparts in such a manner that nectar containing 45% sugar when brought into the hive was found to contain

approximately 60% sugar when first deposited in the comb. He also found that the combs of "green" honey left in the hive but screened from the bees advanced in concentration from 65 to 80% within three days.

The combs of ripe honey are removed from the hive, the cells of which are uncapped by the beekeeper with a heated knife and the honey removed by centrifugal force in a machine so constructed that the combs can be reused. The extracted honey is separated from wax and other foreign materials by methods varying with the individual beekeeper. In general the producer makes use of some system of strainers and settling tanks. Strainers are employed to remove particles of comb, after which the honey is passed into large settling tanks where it remains for several days to allow air bubbles and fine foreign particles to rise to the surface. The honey is then drawn from the tanks into containers for wholesale or retail trade. Heat is often applied to facilitate straining and to retard granulation.

The Service and Regulatory Announcements of the Food and Drug Administration, United States Department of Agriculture (18) gives the following definition of honey:

1. Honey is the nectar and saccharine exudations of plants gathered, modified, and stored in the comb of honeybees (apis mellefica and apis dorsata), is levorotatory and contains not more than 25 per cent of water, not more than 0.25 per cent of ash, and not more than 8 per cent of sucrose.

2. Comb honey is honey contained in the cells of the comb.

3. Extracted honey is honey which has been separated from the uncrushed comb by centrifugal force or gravity.

4. Strained honey is honey removed from the comb by straining or other means.

A few samples of Utah and Idaho honey have been analysed in connection with other studies but no extensive analysis has been undertaken. In fact very few regional analyses have been made on U. S. honeys. Eckert and Allinger made an extensive study of the chemical and physical properties of California honeys (4); Ellegood and Fischer studied honeys of the Pacific Northwest (5); and Fraps made some study of Texas honey (6).

The samples used in this study were collected in the Fall of 1941. An attempt was made to obtain samples which were as nearly representative of the area as possible. It was not possible to secure samples representative of a given floral source. This was due mainly to the fact that the honey flow for the years concerned was very light, thus the samples obtained contained honey gathered during the whole honey producing season. Samples of honey produced in 1940 and 1941 were the only ones used in this study. Oertel (12) lists alfalfa, sweetclover, white clover, and alsike clover as being the most important honey producing plants of this region. Also of importance for early sources of honey is the dandelion, fruit blooms, willow, and mustard. This honey is used by the bees for the Spring build up and it is seldom that a surplus is obtained.

The samples were collected by mail as it was not possible to collect them personally. Information as to the floral source, date

extracted, average yield per colony for the year in which the sample was produced, methods used in clarifying the honey, rate of honey flow, and heat treatment, if any, was requested of the contributing beekeepers. Response to this request for information was incomplete and for this reason the influence of the above mentioned factors on the properties of the honey could not be determined. In all cases where information was obtained the source of the honey was from alfalfa or sweetclover or both. No difference was noted between honeys of known and those of unknown floral source. The yields reported for the years analysed varied from 2.5 to 90% of normal, most beekeepers reporting yields under 50% of normal for 1941. Yields for 1940 were reported as low but in only a few cases were estimates given. No special heat treatment was reported.

It was not possible to analyze the samples until the Summer of 1942. Until that time the samples were kept in airtight containers.

At the time of analysis appearance and amount of granulation was noted but no correlation could be observed between granulation and the properties studied. The condition of the sample at the time of analysis depends much on the past history of the honey. It was impossible to gather the samples personally and the manner and extent of processing varies with the producer. In some cases the honey had been heated for the express purpose of retarding granulation.

All samples were heated in a water bath at 60 C. for 48 hours. Those that were liquid at the end of that time were removed and the remainder were left until all crystals had dissolved. The samples were kept in airtight containers until needed.

The United States standard honey grader (Pfund color grader) was used in the determination of color. The color is compared with an amber colored wedge. The graduated scale of the instrument is divided into seven divisions as follows: water white, 0 to 8; extra white, 9 to 16; white, 17 to 33; extra light amber, 49 to 84; amber, 85 to 113; and dark, 114 to 140. Some samples were rather turbid and slightly off shade which made accurate grading difficult.

The weight per gallon was determined by using an Abbe' refractometer according to methods and tables given by G. H. Marvin (10). The moisture content was determined using an Abbe' refractometer following methods and tables described by Chataway (3). Moisture was also determined by chemical methods.

All other determinations were made according to the recommendations of the Association of Official Agricultural Chemists (17).

The data in tables 1, 2, 3, and 4 are arranged according to state, county, and year produced. Table 5 contains the averages according to state and year produced and also the grand average for all samples analysed. Table 6 gives the averages found by this study in comparison to those obtained by other investigators of U. S. Honeys.

Due to the smallness of samples no. 36, 44, and 65, it was impossible to make a complete analysis on them.

The color of the samples analysed varied from white with a Pfund reading of 25 in sample no. 6 to amber, Pfund reading 102, in sample no. 67. By far the majority of the samples were light amber. No significant difference was found between samples produced in Utah and Idaho. The average color grade is probably lower than would be true

Table 1. Physical and Chemical Properties of Idaho Honeys Produced in 1940

Part 1 Physical Properties

County in which produced and sample no.	Refractometric equivalents				Polarization constant at		Pfund reading	Color
	Refrac. tive index	Moist- ure	Total solids	Weight per gallon	20 C.	87 C.	mm	
		%	%	lbs.				
Canyon								
no. 34	1.4968	15.4	82.5	11.91	-18.3	7.0	77	Light Amber
no. 35	1.5017	13.5	84.4	12.02	-19.0	7.1	74	Light Amber
no. 36	1.4980	14.9	83.0	11.94	-- -	- -	77	Light Amber
no. 37	1.5087	*10.8	*87.0	*12.17	-18.2	7.5	102	Amber
Cassia								
no. 65	1.5030	13.0	84.9	12.05	-17.5	10.1	60	Light Amber
Elmore								
no. 37	1.5027	13.1	84.8	12.04	-16.3	10.1	73	Light Amber
no. 38	1.5031	12.9	84.9	12.05	-19.3	9.8	67	Light Amber
no. 39	1.5015	13.5	84.3	12.01	-15.7	10.9	88	Amber
Franklin								
no. 62	1.4968	15.4	82.5	11.91	-16.1	10.0	66	Light Amber
Jerome								
no. 66	1.5030	13.0	84.9	12.05	-16.5	10.3	65	Light Amber
Payette								
no. 29	1.5084	*10.9	*86.9	*12.16	-19.7	6.8	97	Amber
no. 32	1.5080	*11.1	*86.8	*12.16	-19.6	7.4	92	Amber
Average	1.5026	13.1	84.7	12.39	-17.8	8.9	78	Light Amber

* These values were obtained by extrapolation as the tables used did not give values for honeys with such high refractive indices.

Table 1. Continued

Part 2 Chemical Properties

County in which produced and sample no.	Moisture	Invert sugar	Sucrose	Total sugars	Ash	Undetermined	Levulose	Dextrose	L/D
	%	%	%	%	%	%	%	%	
Canyon									
no. 34	15.8	74.68	1.97	76.65	0.08	7.47	41.2	33.5	1.23
no. 35	13.3	77.06	1.76	78.82	0.06	7.82	42.4	35.7	1.19
no. 36	15.2	73.75	3.30	77.05	0.08	7.67	----	----	----
no. 37	12.2	77.57	3.34	77.05	0.08	6.81	41.8	35.8	1.17
Cassia									
no. 65	14.0	77.06	0.78	77.84	----	8.16	45.0	32.1	1.40
Elmore									
no. 37	13.6	77.06	2.73	79.79	0.07	6.54	43.0	34.1	1.26
no. 38	12.6	77.31	3.72	81.03	0.06	6.31	47.4	29.9	1.59
no. 39	14.0	77.06	3.43	79.49	0.06	6.45	43.3	32.8	1.32
Franklin									
no. 62	16.3	73.07	1.93	75.00	0.10	8.60	43.8	29.3	1.50
Jerome									
no. 66	13.7	76.06	1.61	77.67	0.07	8.56	43.7	32.4	1.35
Payette									
no. 29	11.7	78.86	1.56	80.42	0.08	7.80	43.0	35.9	1.20
no. 32	11.7	78.60	2.92	81.52	0.08	6.90	43.8	34.8	1.26
Average	13.7	76.43	2.42	78.85	0.07	7.42	43.5	33.3	1.31

Table 2. Physical and Chemical Properties of Idaho Honeys Produced in 1941

Part 1 Physical Properties

County in which produced and sample no.	Refractometric equivalents				Polarization Constant at		Pfund reading	Color
	Refractive index	Moisture	Total solids	Weight per gallon	20 C.	87 C.		
		%	%	lbs.			mm	
Ada								
no. 1	1.4977	15.1	82.9	11.93	-20.8	3.9	68	Light amber
no. 2	1.4982	14.8	83.1	11.94	-20.8	4.1	68	Light amber
Bannock								
no. 6	1.4968	15.4	82.6	11.91	-18.4	5.8	25	White
Bingham								
no. 5	1.4959	15.8	82.2	11.89	-19.6	5.0	60	Light amber
Canyon								
no. 63	1.5003	14.0	83.9	11.99	-17.0	9.8	72	Light amber
no. 64	1.5008	13.8	84.0	12.00	-19.1	7.9	70	Light amber
Cassia								
no. 4	1.5012	13.7	84.2	12.01	-19.8	5.1	54	Light amber
no. 7a	1.5003	14.1	83.9	11.99	-16.8	7.4	96	Amber
no. 7b	1.5024	13.2	84.7	12.04	-15.8	7.1	144	Extra lt. amber
no. 7c	1.5030	13.0	84.9	12.05	-17.5	5.6	105	Amber
no. 7d	1.5000	14.1	83.8	11.98	-19.4	4.9	64	Light amber
no. 7e	1.5015	13.5	84.3	12.01	-17.7	7.4	49	Extra lt. amber
no. 7f	1.5016	13.5	84.4	12.02	-17.7	6.8	56	Light amber
no. 68	1.5067	*11.6	*86.3	*12.13	-15.8	10.1	68	Light amber
Elmore								
no. 41	1.5070	*11.4	*86.4	*12.13	-17.6	10.1	72	Light amber
no. 42	1.5040	12.6	*85.3	12.07	-17.3	9.8	68	Light amber

Table 2. Continued

Part 1 Continued

County in which produced and sample no.	Refractometric equivalents				Polarization constant at		Pfund reading	Color
	Refractive index	Moisture	Total solids	Weight per gallon	20 C.	87 C.		
		%	%	lbs.			mm	
Jerome								
no. 3	1.4987	14.7	83.3	11.96	-21.1	3.4	60	Light amber
Oneida								
no. 23	1.4953	16.0	82.0	11.88	-22.4	4.3	48	Extra lt. amber
no. 24	1.4950	16.1	81.8	11.88	-20.8	6.0	47	Extra lt. amber
no. 25	1.4937	16.6	81.4	11.85	-17.0	7.1	58	Light amber
no. 26	1.4946	16.3	81.7	11.87	-21.2	5.4	51	Light amber
no. 27	1.4950	16.1	81.8	11.88	-21.2	4.8	45	Extra lt. amber
no. 28	1.4947	16.2	81.7	11.87	-20.1	6.1	39	Extra lt. amber
Payette								
no. 31	1.5018	13.4	84.4	12.02	-19.3	6.9	65	Light amber
Twin Falls								
no. 8	1.5010	13.7	84.1	12.00	-20.1	4.9	55	Light amber
no. 9	1.5001	14.1	83.8	11.99	-20.2	5.0	60	Light amber
no. 19	1.5002	14.1	83.8	11.99	-21.8	4.4	54	Light amber
no. 20	1.4977	15.0	82.9	11.93	-22.0	4.3	56	Light amber
no. 21	1.5011	13.7	84.2	12.01	-19.7	6.0	82	Light amber
Average	1.4995	14.3	83.6	11.97	-19.2	6.2	61	Light amber

Table 2. Continued

Part 2 Chemical Properties

County in which produced and sample no.	Moisture	Invert sugar	Sucrose	Total sugars	Ash	Undetermined	Levulose	Dextrose	L/D
	%	%	%	%	%	%	%	%	
Ada									
no. 1	15.7	75.40	0.59	75.99	0.06	8.25	39.9	35.5	1.12
no. 2	15.3	75.88	0.13	76.01	0.13	8.56	40.2	35.7	1.13
Bannock									
no. 6	15.8	75.64	0.36	76.00	0.05	8.15	39.3	36.3	1.08
Bingham									
no. 5	16.4	73.75	1.93	75.68	0.09	7.83	40.0	33.8	1.18
Canyon									
no. 63	15.2	75.16	2.80	77.96	0.05	6.84	43.7	31.5	1.39
no. 64	15.3	76.56	1.11	77.67	0.09	6.92	43.8	32.8	1.34
Cassia									
no. 4	14.1	75.56	1.26	77.82	0.06	8.02	40.5	36.1	1.12
no. 7a	15.4	74.68	3.04	77.72	0.09	6.79	39.3	34.4	1.14
no. 7b	14.5	75.40	3.33	78.73	0.08	6.69	37.2	38.2	0.97
no. 7c	13.9	75.40	2.23	77.63	0.09	8.38	37.5	37.9	0.99
no. 7d	15.4	75.64	1.53	77.17	0.08	7.35	39.3	36.3	1.08
no. 7e	14.3	74.68	2.92	77.60	0.09	8.01	40.8	33.9	1.20
no. 7f	15.0	75.16	2.94	78.10	0.08	6.82	39.8	35.4	1.13
no. 68	12.6	78.08	1.38	79.46	0.06	7.88	42.2	35.9	1.18
Elmore									
no. 41	12.0	77.57	3.27	80.84	0.09	7.07	45.1	32.5	1.39
no. 42	13.3	77.82	2.52	80.34	0.03	6.33	44.2	33.6	1.32
Jerome									
no. 3	15.5	75.64	1.53	77.17	0.07	7.26	39.6	36.0	1.10

Table 2. Continued

Part 2 Continued

County in which produced and sample no.	Moisture	Invert sugar	Sucrose	Total sugars	Ash	Undetermined	Levulose	Dextrose	L/D
	%	%	%	%	%	%	%	%	
Oneida									
no. 23	16.6	75.40	3.46	78.86	0.06	4.48	43.3	32.1	1.35
no. 24	16.7	74.68	3.52	78.20	0.06	5.04	43.5	31.2	1.40
no. 25	17.0	74.45	1.26	75.71	0.05	7.24	39.1	35.4	1.11
no. 26	16.9	76.56	1.25	77.81	0.06	5.23	43.1	33.5	1.29
no. 27	17.0	76.31	0.54	76.85	0.05	6.10	42.0	34.3	1.23
no. 28	16.6	75.64	0.70	76.34	0.06	7.00	42.5	33.1	1.28
Payette									
no. 31	13.6	76.31	2.72	79.03	0.10	7.27	42.5	33.8	1.26
Twin Falls									
no. 8	14.5	75.88	2.76	78.64	0.08	6.78	40.5	35.4	1.14
no. 9	15.8	75.40	2.48	77.88	0.09	6.23	41.0	34.4	1.19
no. 19	14.6	75.64	3.48	79.12	0.08	6.20	42.4	33.2	1.28
no. 20	15.8	75.64	2.61	78.25	0.05	5.90	42.5	33.1	1.29
no. 21	15.0	75.16	3.82	78.98	0.07	5.95	41.7	33.5	1.25
Average	15.2	75.69	2.12	77.78	0.08	6.92	41.3	34.1	1.20

Table 3. Physical and Chemical Properties of Utah Honeys Produced in 1940

Part 1 Physical Properties

County in which produced and sample no.	Refractometric equivalents				Polarization constant at		Pfund reading	Color
	Refractive index	Moisture	Total solids	Weight per gallon	20 C.	87 C.		
		%	%	lbs.			mm	
Box Elder								
no. 53	1.5055	12.0	*85.8	12.10	-18.8	7.9	65	Light amber
no. 55	1.5020	13.4	84.5	12.03	-18.2	8.4	63	Light amber
Cache								
no. 58	1.4997	14.3	83.6	11.97	-21.8	5.5	67	Light amber
Juab								
no. 59	1.5060	*11.8	*86.0	12.12	-20.6	7.2	70	Light amber
no. 60	1.5043	*12.5	*85.4	12.08	-21.4	6.9	69	Light amber
no. 61	1.5073	*11.3	*86.5	*12.14	-21.0	7.7	59	Light amber
Millard								
no. 56	1.4990	14.5	83.4	11.96	-14.0	13.1	31	White
Sevier								
no. 49	1.4990	14.5	83.4	11.96	-20.2	7.7	71	Light amber
no. 50	1.5041	12.6	*85.3	12.07	-20.2	7.7	71	Light amber
no. 51	1.5024	13.2	84.7	12.04	-20.2	7.1	68	Light amber
Utah								
no. 43	1.5012	13.7	84.2	12.01	-18.8	7.9	81	Light amber
Weber								
no. 47	1.5069	*11.5	*86.4	*12.13	-16.5	10.9	84	Light amber
no. 48	1.5043	12.5	*85.4	12.08	-16.7	11.0	70	Light amber
Average	1.5032	12.9	85.0	12.05	-19.1	8.4	67	Light amber

Table 3. Continued

Part 2 Chemical Properties

County in which produced and sample no.	Moisture	Invert sugar	Sucrose	Total sugars	Ash	Undetermined	Levulose	Dextrose	L/D
	%	%	%	%	%	%	%	%	
Box Elder									
no. 53	12.7	78.08	2.98	81.06	0.07	6.17	43.3	34.8	1.24
no. 55	13.3	78.34	2.52	80.86	0.06	5.78	43.3	35.0	1.24
Cache									
no. 58	15.8	97.31	1.40	78.71	0.07	5.42	44.3	33.0	1.34
Juab									
no. 59	12.2	78.60	2.49	81.09	0.04	6.67	45.1	33.5	1.35
no. 60	13.1	78.08	2.78	80.86	0.06	5.98	45.9	32.2	1.42
no. 61	11.8	80.20	1.90	82.10	0.05	6.05	45.6	33.6	1.39
Millard									
no. 56	15.4	73.75	3.32	77.07	0.02	7.51	44.3	29.5	1.50
Sevier									
no. 49	14.8	77.06	3.24	80.30	0.10	4.80	45.3	31.8	1.42
no. 50	13.0	78.08	2.53	80.61	0.06	6.33	45.3	32.8	1.38
no. 51	13.9	78.08	2.53	80.61	0.08	5.41	44.3	33.8	1.31
Utah									
no. 43	13.8	77.31	1.64	78.95	0.09	7.16	43.3	34.0	1.27
Weber									
no. 47	12.7	77.31	1.40	78.71	0.09	8.41	44.6	32.7	1.37
no. 48	13.4	77.31	1.14	78.45	0.09	8.06	45.2	32.1	1.41
Average	13.5	77.65	2.30	79.95	0.07	6.44	44.7	33.0	1.35

Table 4. Physical and Chemical Properties of Utah Honeys Produced in 1941

Part 1 Physical Properties

County in which produced and sample no.	Refractometric equivalents				Polarization constant at		Pfund reading	Color
	Refractive index	Moisture	Total solids	Weight per gallon	20 C.	87 C.		
		%	%	lbs.			mm	
Box Elder								
no. 10	1.4965	15.5	82.4	11.91	-21.8	3.7	67	Light amber
no. 11	1.4954	16.0	82.0	11.88	-24.1	1.9	81	Light amber
no. 12	1.4972	15.2	82.7	11.92	-21.9	4.2	67	Light amber
no. 13	1.4966	15.5	82.5	11.91	-21.4	4.6	57	Light amber
no. 14	1.4968	15.4	82.6	11.91	-21.5	5.4	55	Light amber
Cache								
no. 57	1.4965	15.5	82.4	11.91	-21.3	5.8	40	Extra lt. amber
Emery								
no. 54	1.4930	16.9	81.1	11.83	-21.8	5.1	46	Extra lt. amber
Iron								
no. 18	1.4957	15.8	82.1	11.89	-21.9	5.4	62	Light amber
Juab								
no. 15	1.4955	15.9	82.0	11.89	-19.7	6.6	39	Extra lt. amber
Millard								
no. 30	1.4930	16.9	81.1	11.83	-18.9	7.1	68	Light amber
no. 40	1.5064	*11.7	*86.2	*12.12	-17.3	9.9	69	Light amber
no. 44	1.4980	14.9	83.0	11.94	-15.5	10.5	65	Light amber
Piute								
no. 16	1.4932	16.8	81.2	11.84	-20.5	5.7	50	Extra lt. amber
Sanpete								
no. 22	1.4974	15.2	82.8	11.93	-13.5	12.6	83	Light amber
no. 52	1.4937	16.6	81.4	11.85	-20.8	6.2	78	Light amber

Table 4. Continued

Part 1 Continued

County in which produced and sample no.	Refractometric equivalents				Polarization constant at		Pfund reading	Color
	Refractive index	Moisture	Total solids	Weight per gallon	20 C.	87 C.		
		%	%	lbs.			mm	
Sevier								
no. 17	1.4936	16.7	81.3	11.85	-21.0	7.6	75	Light amber
Uintah								
no. 45	1.5030	13.0	84.9	12.05	-20.3	7.4	57	Light amber
no. 46	1.5045	12.4	*85.5	12.08	-20.3	7.1	65	Light amber
Utah								
no. 33	1.4985	14.7	83.2	11.95	-19.5	7.6	54	Light amber
Average	1.4970	15.3	82.7	11.92	-20.1	6.5	62	Light amber

Table 4. Continued

Part 2 Chemical Properties

County in which produced and sample no.	Moisture	Invert sugar	Sucrose	Total sugars	Ash	Undetermined	Levulose	Dextrose	L/D
	%	%	%	%	%	%	%	%	
Box Elder									
no. 10	16.6	75.88	2.26	78.14	0.09	5.17	41.2	34.7	1.19
no. 11	16.6	74.45	2.90	77.35	0.10	5.95	41.9	32.6	1.29
no. 12	16.3	75.64	1.89	77.53	0.08	6.09	42.4	33.2	1.28
no. 13	15.3	75.40	1.87	77.27	0.07	7.36	42.0	33.4	1.26
no. 14	15.8	75.16	2.58	77.74	0.08	6.38	43.5	31.7	1.37
Cache									
no. 57	15.3	74.68	1.60	76.28	0.08	8.34	44.0	30.7	1.44
Emery									
no. 54	17.6	75.40	0.59	75.99	0.03	6.38	43.6	31.8	1.39
Iron									
no. 18	16.7	74.21	2.65	76.86	0.10	6.34	44.3	29.9	1.52
Juab									
no. 15	16.6	74.68	0.73	75.41	0.08	7.91	42.7	32.0	1.34
Millard									
no. 30	17.6	73.52	2.38	75.90	0.07	6.43	42.2	31.3	1.35
no. 40	11.7	78.34	3.40	81.74	0.07	6.49	44.3	34.0	1.28
no. 44	15.1	75.16	1.25	76.41	- --	8.49	42.4	32.8	1.29
Piute									
no. 16	17.3	71.72	2.76	74.49	0.21	8.00	42.5	29.2	1.46
Sanpete									
no. 22	16.2	71.73	3.96	75.69	0.23	7.88	42.7	29.0	1.47
no. 52	16.7	75.40	2.69	78.09	0.05	5.16	43.8	31.6	1.39
Sevier									
no. 17	17.8	74.68	0.19	74.87	0.12	7.21	46.4	28.3	1.64
Uintah									
no. 45	13.5	78.60	1.52	80.12	0.08	6.30	42.4	36.2	1.17
no. 46	12.6	77.82	3.03	80.85	0.09	6.46	44.5	33.3	1.34
Utah									
no. 33	15.6	75.40	2.96	78.36	0.10	5.94	44.0	31.4	1.40
Average	15.8	75.15	2.17	77.32	0.09	6.75	43.2	32.0	1.36

Table 5. Physical and Chemical Properties of Utah and Idaho Honeys (Averages)

Part 1 Physical Properties

State and year	Refractometric equivalents				Polarization constant at		Pfund reading	Color
	Refractive index	Moisture	Total solids	Weight per gallon	20 C.	87 C.		
		%	%	lbs.			mm	
Idaho 1940	1.5036	13.1	84.7	12.39	-17.8	8.9	78	Light amber
Idaho 1941	1.4995	14.3	83.6	11.97	-19.2	6.2	61	Light amber
Average Idaho	1.5011	13.7	84.2	12.18	-18.5	7.6	70	Light amber
Utah 1940	1.5032	12.9	85.0	12.05	-19.1	8.4	67	Light amber
Utah 1941	1.4970	15.3	82.7	11.92	-20.1	6.5	62	Light amber
Average Utah	1.5001	14.1	83.9	11.99	-19.6	7.5	65	Light amber
Idaho 1940	1.5036	13.1	84.7	12.39	-17.8	8.9	78	Light amber
Utah 1940	1.5032	12.9	85.0	12.05	-19.1	8.4	67	Light amber
Average 1940	1.5029	13.0	84.9	12.22	-18.5	8.7	73	Light amber
Idaho 1941	1.4995	14.3	83.6	11.97	19.2	6.2	61	Light amber
Utah 1941	1.4970	15.3	82.7	11.92	20.1	6.5	62	Light amber
Average 1941	1.4983	14.8	83.2	11.95	19.7	6.4	62	Light amber
Average all samples	1.5001	14.1	83.7	12.00	-19.2	7.1	65	Light amber

Table 5. Continued

Part 2 Chemical Properties

State and Year	Moisture	Invert sugar	Sucrose	Total sugars	Ash	Undetermined	Levulose	Dextrose	L/D
	%	%	%	%	%	%	%	%	
Idaho 1940	13.7	76.43	2.42	78.85	0.07	7.42	43.5	33.3	1.31
Idaho 1941	15.2	75.69	2.12	77.78	0.08	6.92	41.3	34.1	1.20
Average Idaho	14.5	76.06	2.27	78.32	0.08	7.17	42.4	33.7	1.26
Utah 1940	13.5	77.65	2.30	79.95	0.07	6.44	44.7	33.0	1.35
Utah 1941	15.8	75.15	2.17	77.32	0.09	6.75	43.2	32.0	1.36
Average Utah	14.7	76.40	2.24	78.64	0.08	6.60	44.0	32.5	1.36
Idaho 1940	13.7	76.43	2.42	78.85	0.07	7.42	43.5	33.3	1.31
Utah 1940	13.5	77.65	2.30	79.95	0.07	6.44	44.7	33.0	1.35
Average 1940	13.6	77.04	2.36	79.40	0.07	6.93	44.1	33.2	1.33
Idaho 1941	15.2	75.69	2.12	77.78	0.08	6.92	41.3	34.1	1.20
Utah 1941	15.8	75.15	2.17	77.32	0.09	6.75	43.2	32.0	1.36
Average 1941	15.5	75.42	2.15	77.50	0.09	6.89	42.3	33.1	1.28
Average all samples	14.8	76.03	2.21	78.25	0.08	6.87	42.7	33.3	1.29

Table 5. Comparative Averages of Several U. S. Honeys

Part 1 Physical Properties

	Refractometric equivalents				Polarization constant at		Pfund reading	Color
	Refractive index	Moisture	Total solids	Weight per gallon	20 C.	87 C.		
		%	%	lbs.			mm	
Utah and Idaho	1.5001	14.1	83.7	12.00	-19.2	7.1	65	Light amber
California	1.4964	16.39	82.10	11.88	- 7.2	5.2	49	Extra lt. amber
Pacific Northwest (fireweed honey)	--	--	--	--	--	--	--	-- --
Texas	--	--	--	--	--	--	--	-- --
Browne's average for 99 samples of U. S. honeys	--	--	--	--	-13.02	10.81	--	-- --

Part 2 Chemical Properties

	Moisture	Invert sugar	Sucrose	Dextrin	Total sugars	Ash	Acid	Levulose	Dextrose	L/D
	%	%	%	%	%	%	%	%	%	
Utah and Idaho	14.8	73.03	2.21	--	78.25	0.08	--	42.7	33.3	1.27
California	16.50	74.95	2.53	0.91	77.53	0.21	0.16	40.41	34.54	1.17
Pacific Northwest (fireweed honey)	13.91-17.56	70.73-74.62	2.65-7.40	0.49-0.99	--	0.04-0.05	0.03-0.04	--	--	--
Texas	18.51	75.71	1.17	--	--	0.23	--	--	--	--
Browne's average for 99 samples of U. S. honeys	17.59	74.41	1.98	--	--	0.23	--	--	--	--

for honey produced during a normal year. This is understandable as the color is affected not only by the floral source, mineral constituents, colloidal material and temperature but also by such factors as yield and rate of honey flow. The average grade for the 73 samples studied was 65 or light amber.

The flavor of all honeys studied was noted at the time of analysis. Although the flavor of the individual honeys varied all were mild in flavor and agreeable in taste. Small amounts of strong flavored honey is produced in Utah and Idaho but nearly all honey produced is suitable for table use.

The moisture content as determined chemically gave results consistently higher than those obtained with the refractometer. The chemical method gave results which averaged 0.7% higher in moisture than refractometric methods.

It has been suggested that the sand method for the determination of moisture as given by A. O. A. C. is a poor one for honey. Marvin and Wilson (11) compared results obtained by using sand, glass plate, blotter, asbestos, and refractometer. The refractometer gave higher results than the A. O. A. C. method. Their refractometric method made use of standard sugar tables in obtaining the results. Other workers noted that the standard sugar table consistently gave results higher than those obtained by drying in sand. Chataway (3) revised the sugar tables so that the results obtained with the refractometer would agree favorably with the results by the A. O. A. C. method. Chataway's tables, however, gave results lower in the present study than the A. O. A. C. method.

The moisture content of Utah and Idaho honeys was considerably lower than that for most other U. S. honeys. The average for 73 samples is 14.8% as compared to an average of 16.39% for California honey (4); 13.91 to 17.56% for Pacific Northwest honey (5); 18.51% for Texas honey (6); and 17.59% for 99 samples of American honeys (1). Decreased production in 1940 and 1941, which insured thorough ripening in the hive before extraction, and the dry climate of Utah and Idaho are the principal contributing factors to the lower moisture content. Several investigators (8, 9) found that honey tends to form an equilibrium in water content with air moisture. Browne (1) pointed out that samples from Utah, Nevada, Arizona, and Colorado averaged 15.60% moisture while samples from Minnesota, Wisconsin, Illinois, Missouri, and Iowa averaged 18.88% moisture.

It should also be noted that the average for 1940 is 13.6% moisture while the average for 1941 is 15.5%, a difference of 1.9%.

Samples showed a variation in moisture content from 11.7% in samples no. 29 and 32 to 17.8% in sample no. 17.

The weight per gallon of Utah and Idaho honeys is high. This is to be expected as the moisture content is low. Thus Utah and Idaho honey contains more sugar per gallon than the average of other honeys studied.

The percentage of invert sugars ranged from 73.07% in sample no. 62 to 80.20% in sample no. 61 with an average value of 76.03% invert sugar.

The percentage of sucrose ranged from 0.13% in sample no. 2 to 3.96% in sample no. 22 with an average value of 2.21% sucrose. All

samples contained less than half of the 8% limit specified by the Food and Drug Administration.

Total sugars varied from 74.49% in sample no. 16 to 81.74% in sample no. 40 with an average of 77.50%.

The per cent of ash varies from 0.02% in sample no. 56 to 0.23% in sample no. 22 with an average of 0.08%. No sample exceeded the limit set by the Food and Drug Administration. Several investigators have shown that there is a correlation between color and per cent ash (4, 16). In this study, however, not enough variation in color exists to produce a significant variation in ash.

Undetermined materials averaged 6.87% and ranged from 5.04% in sample no. 24 to 8.60% in sample no. 62. The undetermined materials are composed of dextrins, organic acids, wax particles, pollen grains, and other materials of unknown character.

The levulose content of Utah and Idaho honey was high, 42.7% as compared to 40.41% for California honey, while the dextrose content is somewhat below that for California, 33.3% for Utah and Idaho and 34.56% for California. An increase in levulose content, expressed as the levulose : dextrose (L/D) ratio, tends to retard granulation.

Conclusions

Utah and Idaho honeys for the years analysed contained a high percentage of sugars and a low percentage of moisture. This may be due to several factors but more particularly due to a short honey crop and due to the low humidity of this region.

Differences exist in the physical and chemical properties of the

individual honeys of the two states and for that matter in the honeys of the different counties within the state. In general, however, it is to be noted that the physical and chemical properties of the honeys of the region studied are similar. This is shown in the averages in table 5. The similarity is to be expected as the climate and honey producing plants are common to the whole region studied.

In order to complete the study of the honeys of this region an analysis should be made on samples from honeys produced in years in which the yield of honey is average or above.

Summary

1. Because of the lack of actual data concerning the physical and chemical properties of Utah and Idaho honeys, forty-one samples of Idaho honey and thirty-two samples of Utah honey were analysed. These honeys were produced in 1940 and 1941.

2. The analytical results show that Utah and Idaho honeys are low in moisture content and higher than average in sugar content. This likely is due in part to the decreased production of honey in 1940 and 1941.

3. No sample analysed exceeded the limits specified by the Food and Drug Administration.

4. No significant difference was found between Utah and Idaho honey.

5. There is a difference in the properties of honey from year to year.

6. The average values for the 73 samples analysed are as follows: refractive index, 1.5001; moisture, (determined from refractive index) 14.1%; moisture, (determined chemically) 14.8%; total solids, 83.7%;

weight per gallon, 12.00 lbs.; polarization constants, at 20 C. -19.2, at 87 C. +7.1; color, light amber; invert sugar, 76.03%; sucrose, 2.21%; total sugars, 78.25%; ash, 0.08%; levulose, 42.7%; dextrose, 33.3%; L/D ratio, 1.29%.

Literature Cited

1. Browne, Chemical Analysis and Composition of American Honeys, U.S.D.A., Bureau of Chemistry, Bull. 110 (1908).

2. Caillas, Composition and Changes in Nectar, Amer. Bee Jourl., 66 (5), 226 (1926).

3. Chataway, Determination of Moisture in Honey, Can. J. Research, 6, 532 (1932).

4. Eckert and Allinger, Physical and Chemical Properties of California Honeys, Calif. Agr. Expt. Sta. Bull., 631, (1939).

5. Ellegood and Fischer, Composition of Fireweed Honey, Food Research 5, 559 (1940).

6. Fraps, The Chemical Composition of Texas Honey and Pecans, Texas Agr. Expt. Sta. Bull., 272 (1927).

7. Kenoyer, Environmental Influences on Nectar Secretion, Iowa Agr. Expt. Sta. Research Bull., 37, 219 (1916).

8. Lynn, Englis, and Melum, Effect of Processing and Storage on Composition and Color of Honey, Food Research, 1, 255 (1936).

9. Martin, The Hygroscopic Properties of Honey, J. Econ. Entomol., 32, 660 (1939).

10. Marvin, Methods of Determining the Weight Per Gallon of Honey, Amer. Bee Jour., 73 (11), 426 (1933).

11. Marvin and Wilson, Determination of Honey by Several Methods, J. Econ. Entomol., 24, 603 (1931).

12. Oertel, Honey and Pollen Plants of the United States, U.S.D.A., Circular 554 (1939).

13. Park, The Storing and Ripening of Honey, Amer. Bee Jour. 64, (7), 330 (1924).

14. Park, The Rate at Which Honeybees Ripen Honey, J. Econ. Entomol. 26, 188 (1933).

15. Park, Studies on Nectar in Relation to Honey Production, ibid., 21, 789 (1928).

16. Schuette and Huenich, Mineral Constituents of Honey, Food Research 2, 529 (1937).

17. Skinner, Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, Washington, D. C., Association of Official Agricultural Chemists, Fifth ed. p. 509-512.

18. United States Department of Agriculture, Food and Drug Administration, Definitions and Standards for Food Products, U.S. Dept. Agr. Food and Drug Service Regulatory Announc., F. D. 2:11, Fifth rev. Nov., 1936.

19. Vansell, The Sugar Concentrations of Western Nectars, J. Econ. Entomol., 32, 666 (1939).