

HONEY

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Honey and beeswax are in demand as items of commerce, so beekeepers maintain honeybees at high population levels in most parts of the world. In addition to their important role as producers of honey and beeswax, honeybees are also the most efficient of the insect pollinators. They visit flowers methodically and in large numbers collecting nectar and pollen, and they do not destroy the plants during the inadvertent process of pollination. Honeybee colonies can be readily transported and concentrated seasonally to satisfy pollination requirements. It is estimated that more than \$11.5 billion worth of fruit, vegetable, legume, and oilseed crops are pollinated annually in the U.S. by the honeybee. To guarantee that colony levels are adequate to perform the vital role of pollination, it is essential that honey markets be maintained.

The U.S. Food and Drug advisory definition of honey states that "Honey is the nectar and saccharine exudation of plants, gathered, modified, and stored in the combs by honeybees (*Apis mellifera* and *A. dorsata*); is levorotatory; contains not more than 25% water, not more than 0.25% ash, and not more than 8% sucrose". Although this definition once served a useful purpose, it is considered today to allow much too high a content of water and sucrose and too low a content of ash. The monosaccharides glucose and fructose constitute about 85% of the solids of honey, and the remaining 15% is exceedingly complex and variable. There are 20 additional sugars present, as well as small quantities of vitamins, minerals, amino acids, enzymes, and trace organic acids and carbonyl compounds.

The general characteristics of honey—its sugar composition, color, and flavor—depend primarily upon the kinds of flowers from which it is made by the honeybee. Climate also affects the color and composition of honey from a given floral source.

Honey is the sweet, viscous substance elaborated by the honeybee from the nectar of plants. This definition excludes honeydew honey, which is produced by the bee from honeydew excreted by various plant-sucking insects. The bee harvests, transports, and processes nectar and honeydew to honey, and packages and stores it in the comb. Honey is the only sweetening material that can be stored and used exactly as it is produced in nature. No refining or processing is necessary before consumption. For successful handling in commerce, however, it is commonly heated to destroy yeasts and to delay granulation, and generally is strained or filtered to remove extraneous materials. These operations are conducted after removing the wax capping from the comb cells and centrifugally extracting out the honey from the comb. Most producers of honey sell the bulk of their producton to processors, who prepare it for marketing and package it. Even when processed for commercial use, honey is essentially a natural product and is highly variable in color, flavor, moisture content, and sugar composition.

While honeybees are kept in all 50 states of the U.S. and in almost every country of the world, conditions favorable to commercial beekeeping (honey production) are not as widely available. Changes in agricultural practices and crops influence the value of areas for beekeeping and the quality, quantity, and type of honey produced. Most of the honey produced in the world is used up in maintaining the colonies of bees throughout the year, and the beekeepers' harvest is the surplus to the bees' requirements, between 5 and 40% of the total.

The honey producer may sell his entire crop in bulk 55 gal containers to a packer or

dealer or sell his crop directly to retail stores or the consumer. About two thirds of the honey produced in the U.S. is marketed in bulk, the remainder in smaller packages to retail stores or consumers. Nearly half the crop is produced by about 1200 fulltime beekeepers (400 or more colonies), about two fifths by part-time beekeepers (25 to 400 colonies), and the remainder by hobbyists (less than 25 colonies). Immediately after extraction from the hive, honey is at its best in terms of flavor and color. It is not suitable for large-scale marketing, however, without further processing.

The U.S. and Canada account for about 20% of the annual world honey production of 620,000 tons. The U.S. alone produced over 88,000 tons in 1977 and imported another 31,000 tons, while exporting only 2350 tons. Per capita annual consumption of honey in North America is about 1.5 lb. Of the estimated annual world consumption of 600,000 tons of honey, about 90% is consumed as a spread on bread, biscuits, or crackers, or is used directly to sweeten drinks, fruits, and cereals. The remaining 10% of honey consumed is divided among several minor uses including baking, confectionary, preserves, spreads, and syrups, meat packing, tobacco manufacture, and cosmetics.

See Tables 1 to 24 and Figures 1 and 2.

Table 1
ANNUAL HONEY PRODUCTION AND CONSUMPTION IN THE DIFFERENT
CONTINENTS

	Europe	U.S.S.R.	U.S. and Canada	Australia and New Zealand	South and Central America	Asia	Africa	World total
Area (million square miles)	1.8	8.6	7.6	3.1	8.0	10.8	12.5	52.5
Total honey harvest (1000 tons)	119	101	123	24	100	72	81	620
Average honey harvest per colony (lb)	21	23	58	77	56	27	15	28
Average honey consumption per capita (lb)	0.9	1.1	1.5	1.1	0.2	0.01	0.6	0.4
Average sugar consumption per capita (lb)	79	99	108	126	93	15	24	44

From Crane, E., *Am. Bee J.*, 117(3), 142, 1977. With permission.

Table 2
HONEY: PRODUCTION IN SPECIFIED COUNTRIES,
AVERAGE 1968—1972, ANNUAL 1973—1976² (in 1000 metric
tons)

Region and country	Average 1968—1972	1973	1974	1975	1976
North America					
Canada	21.8	24.8	20.8	21.1	18.6
Cuba	4.0	4.6	5.7	6.0	6.2
Dominican Republic	0.8	1.1	1.2	1.1	1.2
El Salvador	1.0	1.5	1.5	1.6	1.7
Guatemala	2.6	3.2	3.3	3.3	3.4
Jamaica	0.7	1.1	1.1	1.2	1.2
Mexico	33.0	33.0	38.0	40.0	40.0
U.S.	99.9	107.8	84.0	89.1	86.3
Total	163.8	177.1	155.6	163.4	156.6
South America					
Argentina	19.8	21.0	27.0	23.6	22.7
Bolivia	1.0	1.2	1.3	1.2	1.3
Brazil	7.0	4.7	4.5	5.0	5.5
Chile	6.3	6.4	6.4	6.9	7.5
Colombia	9.0	9.4	9.7	10.0	10.2
Total	43.1	42.7	48.9	46.7	47.2
Western Europe					
Austria	5.7	6.1	6.1	6.0	6.0
Belgium-Luxembourg	1.0	1.1	1.2	1.1	1.2
France	10.2	10.5	9.7	9.0	20.0
Germany, West	14.4	10.0	16.5	8.8	15.0
Greece	8.6	8.6	8.6	9.1	9.9
Italy	6.6	6.5	6.0	6.3	6.9
Netherlands	0.4	0.2	0.2	0.2	0.3
Spain	9.2	9.5	9.5	10.3	11.0
Switzerland	1.7	1.8	2.5	3.1	3.8
U.K.	3.8	2.7	4.1	3.7	4.0
Total	61.6	57.0	64.4	57.8	78.1
Eastern Europe					
Bulgaria	6.4	6.4	5.0	5.9	6.2
Czechoslovakia	7.2	7.7	7.9	6.4	6.1
German Democratic Rep.	5.9	6.0	5.9	4.5	4.3
Hungary	7.0	7.9	8.6	7.8	7.6
Poland	9.0	10.4	10.9	7.4	9.6
Romania	7.7	8.4	8.6	9.2	9.8
Yugoslavia	4.4	4.1	4.5	5.0	5.2
Total	47.6	50.9	51.4	46.2	48.8
Total Europe	109.2	107.9	115.8	104.0	126.9
Total U.S.S.R.	106.3	124.7	117.9	117.9	125.0
Africa					
Central African Rep	4.0	5.0	5.0	5.1	5.1
Egypt	5.0	6.7	8.1	7.2	9.3
Ethiopia	17.5	18.1	18.8	19.2	19.4
Malagasy Republic	10.1	10.8	11.0	11.2	11.4
Morocco	1.5	1.8	1.8	2.0	2.1
Tanzania	7.5	7.8	6.2	7.1	7.5
Total	45.6	50.2	50.9	51.8	54.8

Table 2 (continued)
HONEY: PRODUCTION IN SPECIFIED COUNTRIES,
AVERAGE 1968—1972, ANNUAL 1973—1976² (in 1000 metric
tons)

Region and country	Average 1968—1972	1973	1974	1975	1976
Asia					
Afghanistan	2.8	3.1	3.2	3.3	3.5
China, People's Rep. of	17.9	13.6	12.3	17.3	18.8
Iran	4.1	4.5	5.0	5.2	6.0
Israel	1.8	1.8	1.8	1.9	2.0
Japan	7.5	7.6	7.6	6.3	6.2
Turkey	14.4	16.8	17.2	17.1	17.4
Total	48.5	47.4	47.1	51.1	53.9
Oceania					
Australia	18.9	18.1	21.2	20.6	22.8
New Zealand	5.4	5.9	5.0	6.8	7.2
Total	24.3	24.0	26.2	27.4	30.0
World Total	540.8	574.0	562.4	562.3	596.4

Table 3
HONEY: U.S. PRODUCTION, IMPORTS, EXPORTS, CONSUMPTION,
PRICE (1955—1977)^{3,4}

Year	No. colonies (thousands)	Honey yield/ colony (lb)	Production (1000 lb)	Imports (1000 lb)	Exports (1000 lb)	Apparent domestic consumption (1000 lb)	Price (¢)
1955	5,252	48.6	255,200	9,900	20,500	244,600	17.8
1959	5,109	46.3	236,600	4,500	12,500	228,600	17.0
1963	4,849	55.0	266,800	2,600	25,000	244,200	18.0
1967	4,819	46.3	215,800	16,800	11,600	221,000	17.4
1968	4,770	41.9	191,400	16,900	8,100	200,200	16.9
1969	4,762	59.5	267,500	14,700	9,900	272,300	17.5
1970	4,290	51.7	221,800	8,900	8,200	222,500	17.4
1971	4,110	48.0	197,400	11,400	7,600	201,200	21.8
1972	4,068	52.6	214,100	39,000	4,100	249,000	30.2
1973	4,103	57.9	237,700	10,700	17,600	230,800	44.4
1974	4,195	44.1	185,100	24,600	4,600	205,100	51.0
1975	4,181	47.3	196,500	46,400	4,000	238,900	50.6
1976	4,278	46.4	198,700	65,000	4,000	259,700	49.9
1977	4,318	40.9	176,500	63,500	4,700	235,300	53.0

* Preliminary.

Table 4
HONEY: U.S. IMPORTS (1975—1977)³

Continent and country of origin	1975 (Metric tons)	1976 (Metric tons)	1977 (Metric tons)
North America			
Canada	3,295	2,480	6,830
Dominican Republic	333	336	351
El Salvador	62	293	439
Guatemala	193	330	523
Mexico	6,121	14,065	14,839
Other countries	118	372	269
Total	10,122	17,876	23,251
South America			
Argentina	5,644	8,397	4,144
Brazil	1,799	914	1,003
Chile	148	318	20
Colombia	94	172	1
Venezuela	80	146	25
Other countries	191	150	18
Total	7,956	10,097	5,211
Europe			
Belgium and Luxembourg	3	0	18
Germany, Fed. Rep. of	11	18	21
Greece	9	48	31
Netherlands	1	23	1
Spain	53		
U.K.	3	2	6
Other countries	27	62	16
Total	107	153	103
Asia and Oceania			
Australia	2,293	1,205	20
China, People's Rep. of	208	254	289
New Zealand	290	284	35
Other countries	62	92	6
Total	2,853	1,835	350
Africa, total	0	159	66
Total	21,038	30,120	28,981

Table 5
HONEY EXPORTS FROM THE U.S., (1964—1973) (1000 lb)

Country of destination	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
West Germany	2,340	5,464	4,673	4,165	3,499	5,320	3,327	3,599	1,043	6,694
Canada	1,648	3,246	2,800	1,086	67	242	269	80	400	281
Belgium/Luxembourg	584	440	639	482	491	354	408	124	66	520
Netherlands	632	779	656	981	777	761	1,066	365	644	784
U.K.	532	1,086	1,081	1,360	856	875	1,391	1,620	766	3,187
Philippines	36	44	49	40	54	73	46	88	9	77
Switzerland	319	89	66	58	80	57	55	17	28	259
France	702	1,340	2,377	1,972	897	683	174	189	121	820
Austria	0	0	23	0	7	0	1	0	0	0
Italy	0	0	6	14	8	8	10	99	7	7
Other	2,156	1,318	1,963	1,516	1,368	1,495	1,405	1,383	1,018	4,948
Total exports	8,949	13,806	14,333	11,674	8,104	9,868	8,152	7,564	4,102	17,577

From Diehnelt, W. J., in *The Hive and the Honeybee*, Dadant & Sons, Ed., Dadant & Sons, Hamilton, Ill., 1975, 467. With permission.

Table 6
HONEY: COLONIES OF BEES, YIELD PER COLONY, PRODUCTION,
PRICE, BY STATE (1976 and 1977)³

State	No. colonies (thousands)		Yield/colony (lb)		Production (1000 lb)		Price (\$)	
	1976	1977	1976	1977	1976	1977	1976	1977
Alabama	45	49	22	23	990	1,127	0.596	0.616
Arizona	59	60	57	47	3,363	2,820	0.418	0.421
Arkansas	68	70	33	30	2,244	2,100	0.471	0.466
California	525	525	26	26	13,650	13,650	0.407	0.425
Colorado	41	41	61	67	2,501	2,747	0.485	0.523
Connecticut	8	8	23	28	184	224	0.981	1.06
Delaware	1	3	35	30	35	90	0.794	0.879
Florida	360	360	76	40	27,360	14,400	0.424	.442
Georgia	139	150	22	25	3,058	3,750	0.491	0.513
Hawaii	7	7	102	97	714	679	0.505	0.454
Idaho	109	103	39	46	4,251	4,738	0.476	0.480
Illinois	45	44	42	40	1,890	1,760	0.647	0.644
Indiana	80	79	27	39	2,160	3,081	0.695	0.756
Iowa	80	82	83	74	6,640	6,068	0.499	0.512
Kansas	50	52	52	46	2,600	2,392	0.466	0.485
Kentucky	60	53	20	22	1,200	1,166	0.751	0.826
Louisiana	36	36	37	35	1,332	1,260	0.461	0.443
Maine	5	5	22	18	110	90	0.910	0.858
Maryland	13	13	29	22	377	286	0.695	0.772
Massachusetts	12	12	19	22	228	264	1.01	1.03
Michigan	110	105	50	54	5,500	5,670	0.507	0.498
Minnesota	155	150	92	80	14,260	12,000	0.476	0.470
Mississippi	59	59	23	23	1,357	1,357	0.598	0.588
Missouri	110	116	50	48	5,500	5,568	0.599	0.640
Montana	85	96	112	57	9,520	5,472	0.469	0.539
Nebraska	138	144	50	50	6,900	7,200	0.440	0.458
Nevada	9	10	55	55	495	550	0.533	0.572
New Hampshire	4	4	29	28	116	112	1.02	1.04
New Jersey	37	36	28	28	1,036	1,008	0.763	0.825
New Mexico	16	17	59	33	944	561	0.484	0.448
New York	120	120	40	31	4,800	3,720	0.532	0.558
North Carolina	210	205	20	25	4,200	5,125	0.713	0.793
North Dakota	125	120	120	88	15,000	10,560	0.492	0.490
Ohio	107	97	24	26	2,568	2,522	0.574	0.635
Oklahoma	67	65	40	34	2,680	2,210	0.593	0.632
Oregon	48	56	29	37	1,392	2,072	0.481	0.509
Pennsylvania	93	93	31	31	2,883	2,883	0.615	0.656
Rhode Island	1	1	26	30	26	30	0.975	1.08
South Carolina	56	60	19	18	1,064	1,080	0.767	0.805
South Dakota	155	160	58	58	8,990	9,280	0.458	0.450
Tennessee	156	160	24	22	3,744	3,520	0.667	0.802
Texas	200	210	47	43	9,400	9,030	0.458	0.450
Utah	47	48	29	50	1,363	2,400	0.502	0.532
Vermont	7	8	43	24	301	192	0.843	0.886
Virginia	78	80	22	20	1,716	1,600	0.586	0.657
Washington	95	91	25	44	2,375	4,004	0.460	0.530
West Virginia	94	89	19	20	1,786	1,780	0.787	0.939
Wisconsin	117	125	88	77	10,296	9,625	0.508	0.513
Wyoming	36	41	100	64	3,600	2,624	0.454	0.501
Total	4,278	4,318	46.4	40.9	198,699	176,447	29.536	31.101

Table 7
HONEY: EMPLOYMENT AND MAN-HOURS REPORTED
BY U.S. PROCESSORS OF DOMESTIC OR IMPORTED
HONEY (1971—1975)^a

Item	1971	1972	1973	1974	1975
Numbers of employees*					
Average of all employees	443	442	444	417	447
Average of production and related workers	297	284	286	269	290
Man-hours worked in processing, packaging, or marketing domestic or imported honey — 1000 man-hours	554	495	502	488	501

* Excludes supervisory employees (above the working foreman level), clerical staff, salesmen, and general office workers, but may include small numbers of workers packing nonhoney products.

Table 8
HONEY: COLONIES, PRODUCTION, MAN-HOURS, AND
PRODUCTIVITY MEASURES OF 124 U.S. COMMERCIAL
BEEKEEPING FIRMS, BY CATEGORIES OF EMPLOYMENT,
1971—1975^a

Item	1971	1972	1973	1974	1975
Total number of colonies (1000)	229.2	241.0	275.1	278.6	281.3
Total production (million lb.)	15.2	18.4	23.8	18.6	18.7
Yield/c colony (lb.)	66.5	76.4	86.4	66.8	66.6
Production and extraction of honey					
Immediate family members					
Not compensated (1000 man-hr)	246.9	279.6	305.2	294.4	297.9
Compensated	112.6	140.5	132.8	133.5	132.3
Other employees	258.0	286.0	411.8	431.2	460.0
Total honey production and extraction (1000 man-hr)	617.5	706.1	849.8	859.1	890.2
Processing, packaging, and marketing of honey					
Immediate family members:					
Not compensated (1000 man-hr)	12.3	12.8	13.8	16.4	17.7
Compensated (do)	6.9	7.0	7.0	3.7	3.7
Other employees (do)	3.7	4.6	5.2	8.1	11.4
Other employment (e.g., package bee production) (1000 man-hr)	48.7	49.7	65.7	71.5	69.8
Total	689.1	780.2	941.5	958.8	992.8
Productivity measures					
Total man-hr/colony	3.0	3.2	3.4	3.4	3.5
Production and extraction man-hr/colony	2.7	2.9	3.1	3.0	3.2
Honey production/total man-hr (lb)	22.1	23.6	25.2	19.4	18.9
Honey production/production and extraction man-hr (lb)	24.7	26.1	28.0	21.7	21.0

Table 9
U.S. PRICE SUPPORT PROGRAM FOR HONEY (1950—1974)*

Year	Parity price (¢/lb)	Support price (¢/lb)	Support price as a percent of parity	Market price as a percent of parity	Quantity placed under loan (million lb)	Quantity acquired (million lb)
1950	—	9.0	—	—	—	7.4
1951	16.7	10.0	60.0	61.7	—	17.8
1952	16.3	11.4	70.0	69.5	14.3	7.0
1953	15.0	10.5	70.0	77.2	4.1	0.5
1954	17.0	10.2	60.0	80.3	2.2	0
1955	13.2	9.9	75.0	90.2	2.0	0
1956	13.9	9.7	70.0	97.1	1.8	0
1957	13.9	9.7	70.0	95.7	4.1	0.1
1958	13.7	9.6	70.0	86.3	17.5	0.2
1959	13.8	8.3	60.0	88.4	1.4	0
1960	14.3	8.6	60.0	89.6	4.1	0
1961	14.9	11.2	75.0	88.6	10.8	1.1
1962	15.1	11.2	74.0	80.5	3.7	0
1963	16.7	11.2	67.0	85.0	3.2	0
1964	17.2	11.2	65.0	80.2	9.6	2.2
1965	17.8	11.2	63.0	73.7	17.3	3.3
1966	18.6	11.4	61.3	70.4	33.9	4.1
1967	19.5	12.5	64.0	66.7	31.0	5.4
1968	18.7	12.5	66.8	68.6	24.9	0.1
1969	19.5	13.0	66.7	68.7	45.7	3.5
1970	20.4	13.0	63.7	69.6	40.6	—
1971	21.0	14.0	66.7	85.7	22.9	0
1972	22.3	14.0	62.8	121.1	19.8	0
1973	26.7	16.1	60.2	158.1	12.1	0
1974	34.3	20.6	60.0	139.1	12.5	0
1975	42.4	25.5	60.1	107.8	0	0
1976	49.0	29.4	60.0	—	—	—

Table 10
COMMERCIALLY SIGNIFICANT HONEY TYPES
AND NATURAL BLENDS OF THE U.S.

Honey	Area of production
Clover	Central, North-Central, East-Central
Sweet clover	Central, North-Central, East-Central
Sweet clover-alfalfa	Intermountain West
Alfalfa	Central and Mountain West, California
Basswood	Mid-Atlantic to Wisconsin
Buckwheat, wild	California
Cotton	Southwest
Fireweed	Oregon
Gallberry	Southeast
Goldenrod	Northeast
Locust, black	Mid-Atlantic, East Central
Mesquite	Southwest
Orange-grapefruit	Florida, California
Sage	California
Sourwood	Virginia, Carolinas
Spanish needle	Central
Star thistle	California, North Central
Tulip tree	Mid-Atlantic to Indiana
Tupelo	Florida
Vetch	California, Oregon

From White, J. W., Jr., *Advances in Food Research*, Vol. 24, Academic Press, New York, 1978, 291. With permission.

Table 11
NECTAR AND POLLEN PLANTS BY REGION⁷

Plant	Northeast	Northcentral region	Southeast	Plains region	Mountainous region	Southwest	West	Alaska	Hawaii
Alder (<i>Alnus</i> spp.)						X	X	X	—
Alfalfa (<i>Medicago sativa</i> L.)	X	X		X	X	X	X	X	—
Algaroba (<i>Prosopis chilensis</i> (Mol.) Stuntz)									X
Alkaliweed (<i>Hemizonia</i> spp.)							X		—
Almond (<i>Prunus amygdalus</i> Batsch.)							X		—
Amsinckia (<i>Amsinckia</i> spp.)							X		—
Ash (<i>Fraxinus</i> spp.)					X	X	X		—
Aster (<i>Aster</i> spp.)	X	X	X	X		X	X		—
Baccharis (<i>Baccharis</i> spp.)						X			—
Balsamroot (<i>Balsamorhiza</i> spp.)					X				—
Basswood (<i>Tilia americana</i> L.)	X	X	X	X	X		X		—
Bermudagrass (<i>Cynodon dactylon</i> (L.) Pers.)						X	X		—
Bindweed (<i>Convolvulus</i> spp.)					X	X			—
Birdsfoot trefoil (<i>Lotus cornicula-</i> <i>tus</i> L.)	X						X		—
Bitterweed (<i>Helenium amarum</i> (Raf.) Rock)				X					—
Blackberry (<i>Rubus</i> spp.)	X			X			X		X
Black wattle (<i>Acacia</i> spp.)									X
Bladderpod (<i>Lesquerella gordoni</i> (Gray) Wats.)						X			—
Blueberry (<i>Vaccinium</i> spp.)	X		X					X	—
Bluecurls (<i>Trichostema</i> spp.)							X		—
Blue thistle (<i>Echium vulgare</i> L.)	X			X					—
Bluevine (<i>Gonolobus laevis</i> Michx.)			X						—
Blueweed (<i>Cichorium intybus</i> L.)						X			—
Boneset (<i>Eupatorium</i> spp.)				X	X		X	X	X

Boxelder (<i>Acer</i> spp.)				X	X	X			
Broomweed (<i>Gutierrezia texana</i> (DC.) T. & G.)									—
Buckbrush (<i>Symphoricarpos</i> spp.)	X		X			X			—
Buckeye (<i>Aesculus californica</i> (Spach) Nutt)					X				—
Buckwheat (<i>Fagopyrum esculen-</i> <i>tum</i> Moench)	X	X					X		—
Burroweed (<i>Haplopappus tenu-</i> <i>isectus</i> (Greene) Blake ex Benson)				X		X			—
Cacti (Cactaceae family)					X	X			—
Camphorweed (<i>Heterotheca sub-</i> <i>axillaris</i> (Lam.) Britt. & Lusby)				X	X			X	—
Cascara (<i>Rhamnus purshiana</i> DC.)									
Catclaw (<i>Acacia greggii</i> Gray)							X		—
Ceanothus (<i>Ceanothus</i> spp.)						X			—
Cedar elm (September elm) (<i>Ulmus</i> <i>serotina</i> Sarg.)			X	X	X				—
Citrus (<i>Citrus</i> spp.)			X						—
Cleome (<i>Cleome serrulata</i> Pursh)				X		X	X	X	X
Clethra (<i>Clethra alnifolia</i> L.)	X				X	X	X		—
Clover									
Alsike (<i>Trifolium hybridum</i> L.)	X	X			X		X	X	—
Crimson (<i>Trifolium incarnatum</i> L.)			X						—
Red (<i>Trifolium pratense</i> L.)	X	X		X	X				
Sweetclover (<i>Melilotus</i> spp.)	X	X	X	X	X		X	X	X
White (<i>Trifolium repens</i> L.)	X	X	X	X	X		X	X	X
Coffee (<i>Coffea arabica</i> L.)									
Corn (<i>Zea mays</i> L.)		X		X	X	X			X
Cotton (<i>Gossypium</i> spp.)			X	X			X	X	
Cottonwood (<i>Populus</i> spp.)			X	X			X	X	
Cowpea (<i>Vigna sinensis</i> (Torner) Savi)			X		X		X	X	
Cranberry (<i>Vaccinium macrocar-</i> <i>pon</i> Ait.)	X	X						X	—
Creosote bush (<i>Larrea tridentata</i> (D.C.) Coville)						X	X		—

Table 11 (continued)
NECTAR AND POLLEN PLANTS BY REGION⁷

Plant	Northeast	Northcentral region	Southeast	Plains region	Mountainous region	Southwest	West	Alaska	Hawaii
Crownbeard (<i>Verbesina</i> spp.)			X	X		X		X	
Cucurbits									
Cantaloup (<i>Cucumis melo</i> L.)	X	X	X	X		X	X		
Cucumber (<i>Cucumis</i> spp.)	X	X	X	X	X	X	X		
Gourds (<i>Cucurbita</i> spp.)	X	X	X						
Melon (<i>Citrullus</i> spp.)	X	X	X			X	X		
Pumpkin (<i>Cucurbita</i> spp.)	X	X	X		X		X		
Squash (<i>Cucurbita</i> spp.)	X	X	X				X		
Dandelion (<i>Taraxacum</i> spp.)	X	X			X		X	X	X
Eardropvine (<i>Brunnichia cirrhosa</i> Gaertn.)			X						
Elm (<i>Ulmus</i> spp.)	X	X	X	X	X	X			
Eucalyptus (<i>Eucalyptus</i> spp.)						X	X		X
Filaree (<i>Erodium</i> spp.)						X	X		
Fireweed (<i>Epilobium angustifol- ium</i> L.)		X					X		
Fruit bloom									
Apple (<i>Malus</i> spp.)	X	X	X	X	X		X	X	
Apricot (<i>Prunus</i> spp.)					X	X	X		
Cherry (<i>Prunus</i> spp.)	X	X			X		X		
Citrus (<i>Citrus</i> spp.)			X			X	X		X
Peach (<i>Prunus</i> spp.)	X	X	X	X	X	X	X		
Pear (<i>Pyrus</i> spp.)	X	X	X	X	X		X		
Plum (<i>Prunus</i> spp.)	X	X	X	X	X		X		
Gallberry (<i>Ilex glabra</i> (L.) Gray)			X						
Goldenrod (<i>Solidago</i> spp.)	X	X	X	X	X	X		X	
Grape (<i>Vitis</i> spp.)				X					
Greasewood (<i>Sarcobatus vermicul- atus</i> (Hook.) Torr.)					X				
Guajillo (<i>Acacia berlandieri</i> Benth.)						X			

Table 11 (continued)
NECTAR AND POLLEN PLANTS BY REGION⁷

Plant	Northeast	Northcentral region	Southeast	Plains region	Mountainous region	Southwest	West	Alaska	Hawaii
Matchweed (<i>Gutierrezia sarothrae</i> (Pursh) Britt. & Rusby)	—	—	—	—	X	—	—	—	—
Mesquite (<i>Prosopis juliflora</i> (Sw.) DC.)	—	—	—	—	X	—	—	—	—
Mexican clover (<i>Richardia scabra</i> L.)	—	—	X	—	—	—	—	—	—
Milkvetch (<i>Astragalus</i> spp.)	—	X	—	—	X	—	—	—	—
Milkweed (<i>Asclepias</i> spp.)	X	—	—	—	—	—	—	—	—
Mint (<i>Mentha</i> spp.)	—	—	—	—	—	—	—	—	—
Monkeypod (<i>Samanea</i> spp.)	—	—	—	—	—	—	—	—	—
Mountain apple (<i>Eugenia malaccensis</i> L.)	—	—	—	—	—	—	—	X	—
Mule ear (<i>Wyethia</i> spp.)	—	—	—	—	X	—	—	—	—
Mustard (<i>Brassica</i> spp.)	—	X	—	—	X	—	—	—	—
Nohu (<i>Tribulus cistoides</i> L.)	—	—	—	—	X	—	—	—	—
Oak (<i>Quercus</i> spp.)	—	—	X	—	X	—	—	—	X
Ohi'a Lehua (<i>Metrosideros</i> spp.)	—	—	—	—	—	—	—	—	X
Oi (<i>Verbena</i> spp.)	—	—	—	—	—	—	X	—	—
Oregon grape (<i>Berberis nervosa</i> Pursh)	—	—	—	—	—	—	X	—	—
Oregon maple (<i>Acer macrophyllum</i> Pursh)	—	—	—	—	—	—	—	—	—
Painbrush (<i>Castilleja</i> spp.)	—	—	X	—	—	—	—	X	—
Palmetto (<i>Sabal</i> spp.)	—	—	X	—	—	—	—	—	—
Palmetto, saw (<i>Serenoa repens</i> (Bartr.) Small)	—	—	X	—	—	—	—	X	—
Palm trees (Palmaceae family)	—	—	—	—	—	—	—	—	—
Partridgepea (<i>Chamissoa</i> spp.)	—	—	—	—	X	—	—	X	—
Peppervine (<i>Ampelopsis arborea</i> (L.) Koehne)	—	—	—	—	X	—	—	—	—
Persimmon (<i>Diospyros virginiana</i> L.)	—	—	X	—	X	—	—	—	—

Pili (<i>Heteropogon contortus</i> (L.)	—	—	—	—	—	—	—	—	—	X
Beauv. ex Roem. & Schult.	—	—	—	—	—	—	—	—	—	—
Pine (<i>Pinus</i> spp.)	—	—	—	—	—	—	—	X	—	—
Pluchea (<i>Pluchea</i> spp.)	—	—	—	—	—	—	—	—	—	—
Poplar (<i>Populus</i> spp.)	—	—	—	—	—	—	—	—	X	—
Rabbitbrush (<i>Chrysothamnus</i> spp.)	—	—	—	—	X	X	—	—	—	—
Ragweed (<i>Ambrosia</i> spp.)	—	—	X	X	X	X	—	—	—	—
Rape (<i>Brassica napus</i> L.)	—	—	—	X	—	—	—	—	—	—
Raspberry (<i>Rubus</i> spp.)	X	X	—	—	—	—	—	X	X	—
Rattanvine (<i>Berchemia scandens</i> (Hill) K. Koch)	—	—	X	X	—	—	—	—	—	—
Redbud (<i>Cercis canadensis</i> L.)	—	—	X	X	—	—	—	—	—	—
Resinweed (<i>Grindelia</i> spp.)	—	—	—	X	—	—	X	—	—	—
Russian-thistle (<i>Salsola</i> spp.)	—	—	—	X	X	X	X	X	—	—
Safflower (<i>Carthamus tinctorius</i> L.)	—	—	—	—	X	X	X	X	—	—
Sage (<i>Salvia</i> spp.)	—	—	—	—	—	—	—	X	—	—
Saguaro (<i>Carnegiea gigantea</i> (En- gelm.) Britt. & Rose)	—	—	—	—	—	—	X	—	—	—
Sainfoin (<i>Onobrychis</i> spp.)	—	—	—	—	—	X	—	—	—	—
Saltcedar (<i>Tamarix gallica</i> L.)	—	—	—	—	—	X	—	—	—	—
Santa maria (<i>Parthenium hystero-</i> <i>phorus</i> L.)	—	—	X	—	—	X	—	—	—	—
Silky oak (see silver oak)	—	—	—	—	—	—	—	—	—	X
Silver oak (<i>Grevillea robusta</i> A. Cunn.)	—	—	—	—	—	—	—	—	—	X
Smartweed (<i>Polygonum</i> spp.)	X	X	X	X	—	X	X	—	—	—
Snakeweed (see matchweed)	—	—	—	—	X	X	—	—	—	—
Snowvine (<i>Mikania scandens</i> (L.) Willd.)	—	—	X	—	—	—	—	—	—	—
Sorghum (<i>Sorghum</i> spp.)	—	—	—	X	—	X	X	—	—	—
Sourwood (<i>Oxydendrum arbo-</i> <i>reum</i> (L.) DC.)	—	X	X	—	—	—	—	—	—	—
Soybeans (<i>Glycine max</i> (L.) Merr.)	—	X	X	—	—	—	—	—	—	—
Spanish-needles (<i>Bidens bipinnata</i> L.)	—	X	X	X	—	—	—	—	—	X

Table 11 (continued)
NECTAR AND POLLEN PLANTS BY REGION⁷

Plant	Northeast	Northcentral region	Southeast	Plains region	Mountainous region	Southwest	West	Alaska	Hawaii
Sumac (<i>Rhus</i> spp.)	X	X	—	X	—	—	—	—	—
Summer farewell (<i>Petalostemum</i> spp.)	—	—	X	—	—	—	—	—	—
Sunflower (<i>Helianthus</i> spp.)	—	—	X	X	—	X	—	—	—
Tamarix (<i>Tamarix aphylla</i> (L.) Karst.) (<i>Tamarix articulata</i> Vahl)	—	—	—	—	—	X	X	—	—
Tarweed (<i>Hemizonia</i> spp.)	—	—	—	—	—	—	X	—	—
Thistle (<i>Sonchus arvensis</i> L. and <i>Cirsium</i> spp.)	—	—	—	—	X	—	—	—	—
Canadian (<i>Cirsium arvense</i> (L.) Scop.)	—	—	—	—	—	—	X	—	—
Star (<i>Centaurea</i> spp.)	—	—	—	—	—	—	X	—	—
Thyme (<i>Thymus</i> spp.)	X	—	—	—	—	—	—	—	—
Tievine (<i>Convolvulus</i> or <i>Ipomoea</i> spp.)	—	—	X	X	—	—	—	—	—
Titi									
Black (<i>Cliftonia monophylla</i> (Lam.) Britton ex Sarg.)	—	—	X	—	—	—	—	—	—
Spring (<i>Cyrilla racemiflora</i> L.)	—	—	X	—	—	—	—	—	—
Summer (<i>Cyrilla</i> spp.)	—	—	X	—	—	—	—	—	—
Toyon (<i>Photinia arbutifolia</i> Lindl.)	—	—	—	—	—	—	X	—	—
Tulip poplar (<i>Liriodendron tulipifera</i> L.)	X	X	X	—	—	—	—	—	—
Tupelo (<i>Nyssa</i> spp.)	—	—	X	—	—	—	—	—	—
Vervain (<i>Verbena</i> spp.)	—	—	X	—	—	—	—	—	—
Vetch (<i>Vicia</i> spp.)	—	—	X	X	X	—	X	—	X
Vine maple (<i>Acer circinatum</i> Pursh)	—	—	—	—	—	—	X	—	—
Wild alfalfa (<i>Lotus</i> spp.)	—	—	—	—	—	—	X	—	—
Wild buckwheat (<i>Eriogonum</i> spp.)	—	—	—	—	X	X	X	—	—

Wild currants (<i>Ribes</i> spp.)	-	-	-	-	X			
Wild dandelion (<i>Hymenopappus arenosus</i> Heller)	-	-	-	-	X			
Wild snowberry (<i>Symporicarpos</i> spp.)	-	-	-	-	X			
Willow (<i>Salix</i> spp.)	X	X	X	-	X			
Wingstem (<i>Actinomeris alternifolia</i> (L.) DC.)	-	-	X	-	-			
Yellow ginger (<i>Hedychium flavescens</i> Carey)	-	-	-	-	-			X
Yellow-rocket (<i>Barbara vulgaris</i> R. Br.)	X	X	-	-	-			-

Table 12
COMPOSITION OF 490 U.S. FLORAL HONEY
SAMPLES AND 14 U.S. HONEYDEW HONEY
SAMPLES*

	Average (%)	Standard deviation	Range (%)
Floral Honey			
Composition			
Moisture	17.20	1.46	13.4—22.9
Fructose	38.19	2.07	27.25—44.26
Glucose	31.28	3.03	22.03—40.75
Sucrose	1.31	0.95	0.25—7.57
“Maltose”	7.31	2.09	2.74—15.98
Higher sugars	1.50	1.03	0.13—8.49
Undetermined	3.10	1.97	0.0—13.2
Honeydew Honey			
Composition			
Moisture	16.30	1.74	12.2—8.2
Fructose	31.80	4.16	23.91—38.12
Glucose	26.08	3.04	19.23—31.86
Sucrose	0.80	0.22	0.44—1.14
“Maltose”	8.80	2.51	5.11—12.48
Higher sugars	4.70	1.01	1.28—11.50
Undetermined	10.10	4.91	2.70—22.4

Table 13
CARBOHYDRATE COMPOSITION OF COMMERCIALLY IMPORTANT
HONEY TYPES

No. of Samples	Floral type	Glucose (%)	Fructose (%)	Sucrose (%)	“Maltose” (%)	Higher sugars (%)
23	Alfalfa	33.40	39.11	2.64	6.01	0.89
25	Alfalfa-sweetclover	33.57	39.29	2.00	6.30	0.91
5	Aster	31.33	37.55	0.81	8.45	1.04
3	Basswood	31.59	37.88	1.20	6.86	1.44
3	Blackberry	25.94	37.64	1.27	11.33	2.50
5	Buckwheat	29.46	35.30	0.78	7.63	2.27
4	Buckwheat, wild	30.50	39.72	0.79	7.21	0.83
26	“Clover”	32.22	37.84	1.44	6.60	1.39
3	Clover, alsike	30.72	39.18	1.40	7.46	1.55
3	Clover, crimson	30.87	38.21	0.91	8.59	1.63
3	Clover, Hubam	33.42	38.69	0.86	6.23	0.74
10	Cotton	36.74	39.28	1.14	4.87	0.50
3	Fireweed	30.72	39.81	1.28	7.12	2.06
6	Gallberry	30.15	39.85	0.72	7.71	1.22
3	Goldenrod	33.15	39.57	0.51	6.57	0.59
2	Heartsease	32.98	37.23	1.95	5.71	0.63
3	Locust, black	28.00	40.66	1.01	8.42	1.90
3	Mesquite	36.90	40.41	0.95	5.42	0.35
4	Orange, California	32.01	39.08	2.68	6.26	1.23
13	Orange, Florida	31.96	38.91	2.60	7.29	1.40
4	Raspberry	28.54	34.46	0.51	8.68	3.58

Table 13 (continued)
CARBOHYDRATE COMPOSITION OF COMMERCIALLY IMPORTANT
HONEY TYPES

3	Sage	28.19	40.39	1.13	7.40	2.38
3	Sourwood	24.61	39.79	0.92	11.79	2.55
4	Star-thistle	31.14	36.91	2.27	6.92	2.74
8	Sweetclover	30.97	37.95	1.41	7.75	1.40
3	Sweetclover, yellow	32.81	39.22	2.93	6.63	0.97
4	Tulip tree	25.85	34.65	0.69	11.57	2.96
5	Tupelo	25.95	43.27	1.21	7.97	1.11
7	Vetch	31.67	38.33	1.34	7.23	1.83
9	Vetch, hairy	30.64	38.20	2.03	7.81	2.08
12	White clover	30.71	38.36	1.03	7.32	1.56

From White, J. W., Jr., in *Symposium Sweeteners*, Inglett, G. E., Ed., AVI Publishing, Westport, Conn., 1974, 120. With permission.

Table 14
HONEY: MAJOR AND MINOR SUGARS

Trivial name	Systematic name
Glucose	—
Fructose	—
Sucrose	α -D-glucopyranosyl- β -D-fructofuranoside
Maltose	O- α -D-glucopyranosyl-(1 \rightarrow 4)-D-glucopyranose
Isomaltose	O- α -D-glucopyranosyl(1 \rightarrow 6)-D-glucopyranose
Maltulose	O- α -D-glucopyranosyl-(1 \rightarrow 4)-D-fructose
Nigerose	O- α -D-glucopyranosyl-(1 \rightarrow 3)-D-glucopyranose
Turanose	O- α -D-glucopyranosyl-(1 \rightarrow 3)-D-fructose
Kojibiose	O- α -D-glucopyranosyl-(1 \rightarrow 2)-D-glucopyranose
Laminaribiose	O- β -D-glucopyranosyl-(1 \rightarrow 3)-D-glucopyranose
α , β -Trehalose	α -D-glucopyranosyl- β -D-glucopyranoside
Gentiobiose	O- β -D-glucopyranosyl-(1 \rightarrow 6)-D-glucopyranose
Melizitose	O- α -D-glucopyranosyl-(1 \rightarrow 3)-O- β -D-fructofuranosyl-(2 \rightarrow 1)- α -D-glucopyranoside
3- α -Isomaltosylglucose	O- α -D-glucopyranosyl-(1 \rightarrow 6)-O- α -D-glucopyranosyl-(1 \rightarrow 3)-D-glucopyranose
Maltotriose	O- α -D-glucopyranosyl-(1 \rightarrow 4)-O- α -D-glucopyranosyl-(1 \rightarrow 4)-D-glucopyranose
1-Kestose	O- α -D-glucopyranosyl-(1 \rightarrow 2)- β -D-fructofuranosyl-(1 \rightarrow 2)- β -D-fructofuranoside
Panose	O- α -D-glucopyranosyl-(1 \rightarrow 6)-O- α -D-glucopyranosyl-(1 \rightarrow 4)-D-glucopyranose
Isomaltotriose	O- α -D-glucopyranosyl-(1 \rightarrow 6)-O- α -D-glucopyranosyl-(1 \rightarrow 6)-D-glucopyranose
Erlose	O- α -D-glucopyranosyl-(1 \rightarrow 4)- α -D-glucopyranosyl- β -D-fructofuranoside
Theanderose	O- α -D-glucopyranosyl-(1 \rightarrow 6)- α -D-glucopyranosyl- β -D-fructofuranoside
Centose	O- α -D-glucopyranosyl-(1 \rightarrow 4)-O- α -D-glucopyranosyl-(1 \rightarrow 2)-D-glucopyranose
Isopanose	O- α -D-glucopyranosyl-(1 \rightarrow 4)-O- α -D-glucopyranosyl-(1 \rightarrow 6)-D-glucopyranose
Isomaltotetraose	O- α -D-glucopyranosyl-(1 \rightarrow 6)-[O- α -D-glucopyranosyl-(1 \rightarrow 6)],-D-glucopyranose
Isomaltopentaose	O- α -D-glucopyranosyl-(1 \rightarrow 6)-[O- α -D-glucopyranosyl-(1 \rightarrow 6)],,D-glucopyranose

From Doner, L. W., *J. Sci. Food Agr.*, 28 (5), 443, 1977. With permission.

Table 15
VITAMIN CONTENT OF HONEYS

(μg/100 g honey)

Samples	Riboflavin	Pantothenic acid	Niacin	Thiamin	Pyridoxine	Ascorbic acid
29 Minnesota	61	105	360	5.5	299	2400
38 U.S. and foreign	63	96	320	6.0	320	2200
21 U.S. 3—7 years old	22	20	124	3.5	7.6	—
19 U.S. 1—2 years old	26	54	108	4.4	10.0	—
India	12—54	—	442—978	8—22	—	2000—3400

From White, J. W., Jr., *Honey*, Crane, E., Ed., Heinemann, London, 1975, 199. With permission.

Table 16
MINERAL CONTENT OF HONEY¹²

Mineral	Light honey (ppm)	Dark honey (ppm)
Potassium	205	1676
Chlorine	52	113
Sulfur	58	100
Calcium	49	51
Sodium	18	76
Phosphorus	35	47
Magnesium	19	35
Silica	22	36
Iron	2.4	9.4
Manganese	0.30	4.09
Copper	0.29	0.56

From White, J. W., Jr., *Honey*, Crane, E., Ed., Heinemann, London, 1975, 1972. With permission.

Table 17
NUTRIENTS IN HONEY IN RELATION TO HUMAN REQUIREMENTS

Nutrient	Unit	Quantity in 100 g honey	Recommended daily intake, U.S.
Energy equivalent	kcal	304	2800
Vitamins			
A	IU		5000
Thiamine	mg	0.004—0.006	1.5
Riboflavin	mg	0.02—0.06	1.7
Niacin	mg	0.11—0.36	20
B ₆	mg	0.008—0.32	2.0
Pantothenic acid	mg	0.02—0.11	10
Folic acid	mg	—	0.4
B ₁₂	μg	—	6.0
C	mg	2.2—2.4	60
D	IU	—	400
E	IU	—	30
Biotin	mg	—	0.3

Table 17 (continued)
NUTRIENTS IN HONEY IN RELATION TO
HUMAN REQUIREMENTS

Nutrient	Unit	Quantity in 100 g honey	Recommended daily intake, U.S.
Minerals			
Calcium	g	0.004—0.03	1.0
Phosphorus	g	0.002—0.06	1.0
Copper	mg	0.01—0.1	2.0
Iron	mg	—	18
Manganese	mg	0.1—3.4	—
Magnesium	mg	0.7—13	400
Potassium	g	0.01—0.47	—
Sodium	g	0.0006—0.04	—
Zinc	mg	0.2—0.5	15

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Table 18
AROMA CONSTITUENTS OF HONEY

Alcohols	Carbonyl compounds	Esters	Ethers
<i>Iso</i> propanol	Formaldehyde	Methyl formate	Diethyl ether
Ethanol	Acetaldehyde	Ethyl formate	—
2-Butanol	Propionaldehyde	—	—
<i>n</i> -Propanol	<i>Iso</i> butyraldehyde	—	—
3-Pentanol	Butyraldehyde	—	—
<i>n</i> -Pentanol	<i>Iso</i> valeraldehyde	—	—
<i>Iso</i> obutanol	Methacrolein	—	—
3-Methyl-2-butanol	Acetone	—	—
3-Methyl-1-butanol	Methyl ethyl ketone	—	—
<i>n</i> -Butanol	—	—	—
β -Methallyl alcohol	—	—	—
2-Methyl-1-butanol	—	—	—
Phenylethyl alcohol	—	—	—
Benzyl alcohol	—	—	—

From White, J. W., Jr., in *Honey*, Crane, E., Ed., Heinemann, London, 1975, 197. With permission.

Table 19
ORGANIC ACIDS OF HONEY

Acetic acid	Maleic acid
Butyric acid	Malic acid
Citric acid	Oxalic acid
Formic acid	Pyroglutamic acid
Gluconic acid	Succinic acid
Lactic acid	

From White, J. W., Jr., *Honey*, Crane, E., Ed., Heinemann, London, 1975, 169. With permission.

Table 20
FREE AMINO ACIDS OF HONEY
(MG/100 G HONEY)

	Finnish	—	Rape	Lime	Buckeye	Honey Milk	Type rape	Orange	Buckey	Acacia	—	—
Lysine	0.6	0.4	38.2	8.1	36.7	2.50	2.71	1.85	1.91	1.31	2.07	1.46—2.8
Histidine			6.7	2.6	10.7	0.94	0.92	0.61	0.93	0.63	0.75	0.56—1.2
Arginine	0.6	0.0	5.4	5.1	5.8	0.63	0.42	0.33	0.56	+	0.46	0.35—0.53
Aspartic acid	0.4	0.5	12.3	7.9	17.0	1.81	0.90	0.84	0.86	3.97	0.17	0.06—0.53
Threonine	0.2	0.2	2.6	0.8	4.5	0.39	0.42	0.35	0.26	0.26	1.10	0.45—1.9
Serine	0.5	0.5	23.6	3.2	11.8	1.43	0.70	0.65	0.34	0.62	1.19	0.84—1.57
Glutamic acid	2.5	0.5	19.0	8.3	13.0	1.85	1.91	1.36	1.61	1.34	1.42	1.25—1.80
Proline	6.2	19.0	297	134	249	28.71	20.20	22.19	21.06	16.91	14.6	12.5—17.1
Glycine	0.2	0.2	5.9	2.2	3.6	0.31	0.23	0.14	0.12	0.13	0.46	0.33—0.54
Alanine	0.6	0.4	10.5	4.6	8.5	0.46	0.53	0.32	0.41	0.31	1.3	0.60—1.65
Cystine			6.1	5.5	0.0	—	0.35	0.44	+	+	+	+
Valine	0.6	0.3	9.7	3.0	7.3	0.52	0.45	0.19	0.46	0.33	0.91	0.71—1.05
Methionine	0.2	0.0	2.7	1.2	0.8	—	0.05	0.04	0.17	—	+	+—0.19
Isoleucine			4.6	2.3	3.6	0.28	0.34	0.12	0.16	0.19	0.77	0.44—1.1
Leucine	0.7	0.9	5.3	1.4	4.9	0.30	0.34	0.12	0.25	0.15	0.58	0.32—0.95
Tyrosine			6.9	3.3	6.2	0.49	0.47	0.27	0.26	0.18	2.59	1.3—3.9
Phenylalanine			9.6	10.5	11.4	0.93	1.62	0.58	0.54	0.28	16.6	5.0—42.0
Tryptophan			0.0	0.0	0.1	+	+	+	—	+		

Note: + indicates traces; — indicates absent; blank indicates not reported.

From White, J. W., Jr., in *Honey*, Crane, E., Ed., Heinemann, London, 1975, 178. With permission.

Table 21
AVERAGE DEXTROSE-WATER RATIOS
(D/W) FOR HONEYS CLASSIFIED BY
GRANULATION CHARACTERISTICS*

Extent of granulation	No. samples	D/W
None	96	1.58
Few scattered crystals	114	1.76
1.5—3 mm layer of crystals	67	1.79
6—12 mm layer of crystals	68	1.83
Few clumps of crystals	19	1.86
¼ of depth granulated	32	1.99
½ of depth granulated	19	1.98
¾ of depth granulated	16	2.06
Complete soft granulation	18	2.16
Complete hard granulation	28	2.24

Table 22
TOXICANTS ISOLATED FROM HONEY OR NECTAR¹⁷

Compound	Source	Conc. (ppm)
Acetyl andromedol (Grayanotoxin I, andromedotoxin, rhodotoxin asebotoxin)	<i>Kalmia latifolia</i> honey <i>Rhododendron thompsonii</i> nectar	100 108
Andromedol (Grayanotoxin III, deacetyl andromedo toxin)	Unknown honey	7
Anhydro andromedol	Unknown honey	3
Desacetyl pieristoxin B	Unknown honey	> 7
Tutin	Honey containing honeydew from <i>Scolypopa australis</i> or <i>Coriaria arboria</i> (tree tutu)	20
Hyenanchin	As above	160
Pyrrolizidine alkaloids (seneci- onine, seneciphylline, jacoline, jacolbine, jacozine)	<i>Senecio jacobaea L.</i> honey	0.3—3.9

Table 23
STANDARD COLOR DESIGNATION OF HONEY AND RANGE FOR EACH COLOR

USDA color standards	Color range USDA color standards	Color range Pfund scales (mm)	Optical density
Water white	Honey that is water white or lighter in color than water white color standard	8 or less	0.0945
Extra white	Honey that is darker than water white but not darker than extra white color standard	Over 8 to and including 17	0.189
White	Honey that is darker than extra white but not darker than white color standard	Over 17 to and including 34	0.378
Extra light amber	Honey that is darker than white but not darker than extra light amber or golden color standard	Over 34 to and including 50	0.595
Light amber	Honey that is darker than extra light amber but not darker than light amber color standard	Over 50 to and including 85	1.389
Amber	Honey that is darker than light amber but not darker than amber color standard	Over 85 to and including 114	3.008
Dark amber	Honey that is darker than amber color standard	Over 114	—

From White, J. W., Jr., *Advances in Food Research*, Vol. 24, Academic Press, New York, 1978, 291.
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Table 24
MAJOR REFERENCES FOR ADDITIONAL INFORMATION ON HONEY COMPOSITION, PROCESSING, AND DISTRIBUTION

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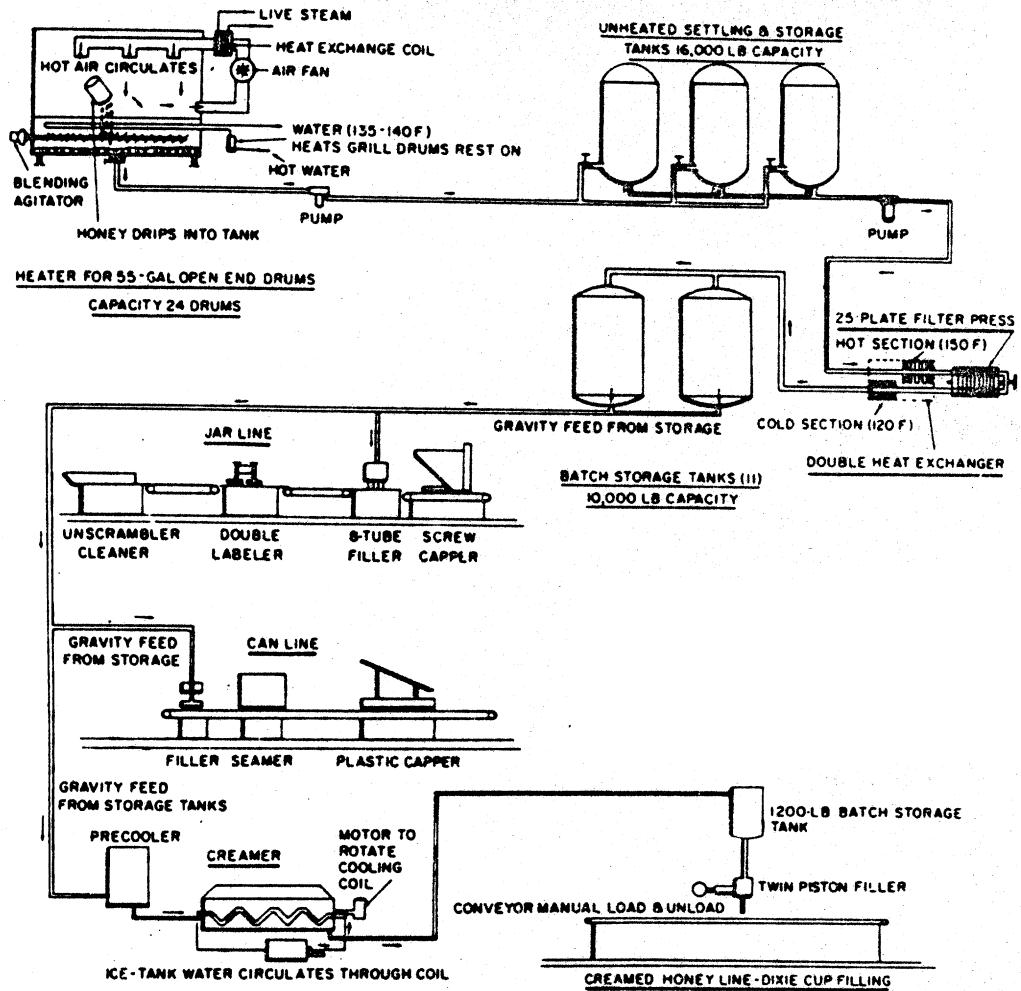


FIGURE 1. A modern honey processing—packaging operation. (From White, J. W., Jr., in *Advances in Food Research*, Vol. 24, Academic Press, New York, 1978, 291. With permission.)

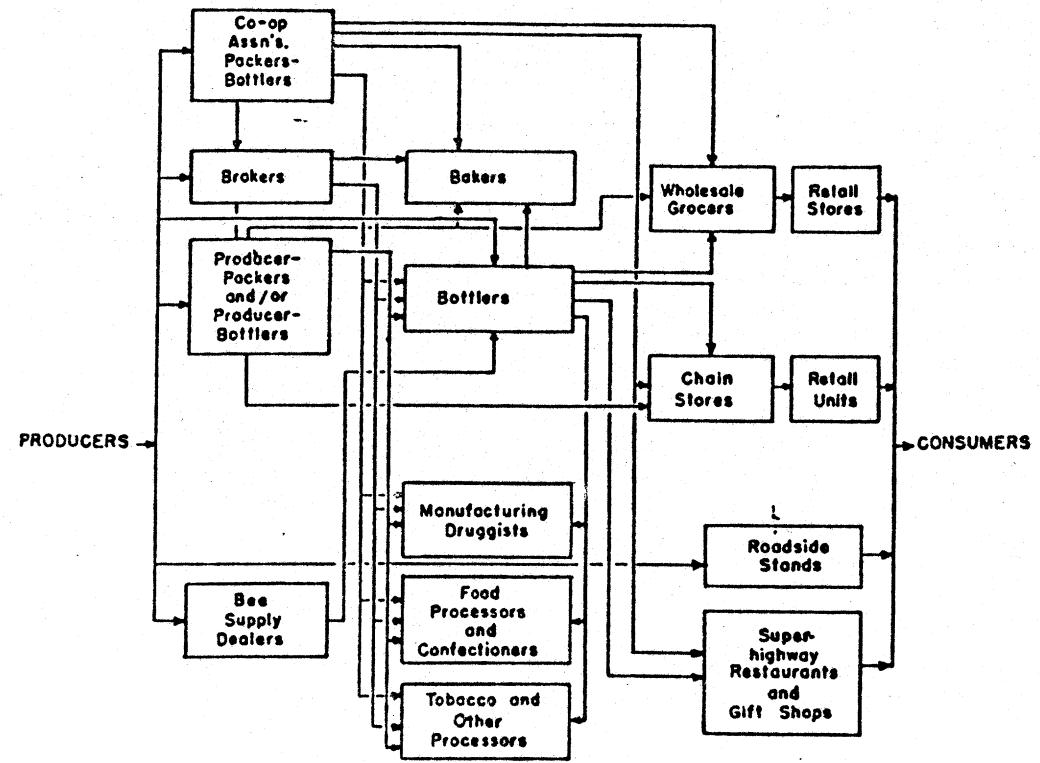


FIGURE 2. Principal distribution channels for marketing domestic honey in the U.S.⁴

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