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Research on improving the utilization of dairy products, animal fats, hides and leather, potatoes, fruits, tobacco, maple products and honey is carried out at the Eastern Utilization Research and Development Div. at Wyndmoor, near Philadelphia.—Photo by USDA, M. C. Audsley.

A Survey of American Honeys

1. Introduction and Average Composition [1/]

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DURING THE PAST several years we have carried out a major analytical project involving the collection and complete chemical and physical analysis of many samples of honey from the entire United States. The results of this work are now becoming available. In the time before the complete detailed results of this work appear in print, a series of short articles describing the more important results and conclusions have been prepared.

Purpose of the Work

With hundreds of plants attractive to bees, honey is produced in each of our 50 states. Added to these sources of variation in honey, we have the potential effects of local climate and weather conditions, different soils, variations in beekeeping and farming practices, not to mention different processing operations. All of these combine to make honey potentially a most variable commodity.

The food industry in general is a large user of honey and we feel holds a potential for considerable increase. Of the several factors that seem to re-

1/ This is one in a series of articles describing a large-scale study of the composition of honeys from over the United States. Complete data interpretation and conclusions will

appear in a forthcoming Department of Agriculture publication.

tard increasing the use of honey, two that are heard most often are its variability and its relatively unknown composition. The trend in the food industry seems to be toward standardization of ingredients and increasing use of material of known composition. Honey, as a most valuable carbohydrate and one carrying unique flavoring properties, is a relatively complex material whose composition, either in general or specifically, is only imperfectly known and reported. To provide this information was the objective of this work.

Many Commercial Types Available

Of the hundreds of known floral types and blends of honey, only perhaps 25 or 30 have commercial significance. These are the bulk honeys of commerce, available year to year and providing most of the commercial beekeeper's income. Variation in these types of honey is encountered, but little accurate information is available. It has been 52 years since the Department of Agriculture published C. A. Browne's work, "Chemical Analysis and Composition of American Honeys" in which the analysis was given of 100 samples of honey from 42 floral and honeydew sources. This work has served its purpose well and is still consulted as an authoritative source of information. However, the analytical methods then used are obsolete, and great changes have taken place in agriculture and beekeeping since then.

Scope of the Work

We have had the active cooperation of hundreds of beekeepers, extension workers, local and national beekeeping organizations, for which we are deeply grateful. With their help we have collected 504 samples of honey and honeydew, originating in 47 of the 50 states and representing 83 single floral types and 93 blends of known composition, as well as four honeydew types. These were all collected from the 1956 and 1957 crops. The degree of certainty regarding floral type(s) of the samples is not absolute by any means, but depends on information supplied by the producers. For the more common and important types of honey, samples obtained from different places have given us information on variation due to area of production.

Complete Publication Coming

The full and complete description of all samples, analytical methods, individual results, and discussion of them is to appear as a U. S. Department of Agriculture Technical Bulletin. Since some time will elapse before this is available, we have prepared a series of short articles giving highlights of the work and some of the important conclusions. These will include the following subjects:

Characterization of various types of honey.
Identity of honey sugars.
Effect of crop year on composition.
Effect of area of production on composition.
Relation of granulation to composition.
Relation of color to composition.
Effect of storage on honey sugars.
Effect of storage on diastase content.

Average Composition of U. S. Honey

Using the most modern methods available, most of which are now accepted by the Association of Official Agricultural Chemists, a group of chemists at our laboratory[2/] has analyzed these samples. The results were transferred to machine punch cards and have been classified and averaged by a computer, with the cooperation of the Biometrical Services group of the Department.

2/ The sugar analyses were carried out by Mary H. Subers, Irene Kushnir, Mary L. Riethof. Others responsible for analysis of individual components are R. B. Hager, F. W. Pairent, Laverne Scroggins, Allison Smith, Ronald Campbell, Dolores Boe, and Oksana Panasiuk.

The values given in the tables are averages for 490 samples of U. S. honey and of 14 samples of honeydew. Also shown in the tables are the extreme high and low values found for each component.

Nearly all of the entries in the tables will be familiar. The levulose and dextrose are the simple sugars making up most of the honey. Sucrose (table sugar) is present in high concentration in nectar from which honey is made. Maltose represents a group of more complex sugars that will be discussed at more length in a later article. Higher sugars is a more descriptive term for the material formerly called honey dextrin.

The undertermined value is found by adding all the sugar percentages to the

Table 1. Average Composition of Honey and Range of Values Among 490 Samples

	Average	Range
Color 1/	Dark half of White	Light half Water-White to Dark
Granulating tendency 2/	Few clumps of crystals, ⅛-¼" layer	Liquid to complete hard granulation
Moisture (%)	17.2	13.4 - 22.9
Levulose (%)	38.19	27.25 - 44.26
Dextrose (%)	31.28	22.03 - 40.75
Sucrose (%)	1.31	0.25 - 7.57
Maltose (%)	7.31	2.74 - 15.98
Higher Sugars (%)	1.50	0.13 - 8.49
Undetermined (%)	3.1	0.0 - 13.2
pH	3.91	3.42 - 6.10
Free Acidity (meq./kg.)	22.03	6.75 - 47.19
Lactone (meq./kg.)	7.11	0.00 - 18.76
Total Acidity (meq./kg.)	29.12	8.68 - 59.49
Lactone ÷ Free Acid	0.335	0.00 - 0.950
Ash (%)	0.169	0.020 - 1.028
Nitrogen (%)	0.041	0.000 - 0.133
Diastase 3/	20.8	2.1 - 61.2

1/ Expressed in terms of USDA color classes.
2/ Extent of granulation for a heated sample after six months undisturbed storage.
3/ 270 samples.

Table 2. Average Composition of Honeydew and Range of Values Among 14 Samples

	Average	Range
Color	Light half of Amber	Dark half of Extra Light Amber, to Dark
Granulating tendency	1/16-⅛" layer crystals	Liquid to complete soft granulation
Moisture (%)	16.3	12.2 - 18.2
Levulose (%)	31.80	23.91 - 38.12
Dextrose (%)	26.08	19.23 - 31.86
Sucrose (%)	0.80	0.44 - 1.14
Maltose (%)	8.80	5.11 - 12.48
Higher Sugars (%)	4.70	1.28 - 11.50
Undetermined (%)	10.1	2.7 - 22.4
pH	4.45	3.90 - 4.88
Free Acidity (meq./kg.)	49.07	30.29 - 66.02
Lactone (meq./kg.)	5.80	0.36 - 14.09
Total Acidity (meq./kg.)	54.88	34.62 - 76.49
Lactone ÷ Free Acid	0.127	0.007 - 0.385
Ash (%)	0.736	0.212 - 1.185
Nitrogen (%)	0.100	0.047 - 0.223
Diastase 1/	31.9	6.7 - 48.4

1/ Four samples only.

moisture value and subtracting from 100. The active acidity of a material is expressed as pH; the larger the number, the lower is the active acidity. The lactone is a newly found component of honey; lactones may be considered to be a reserve acidity, since by chemically adding water to them ("hydrolysis") an acid is formed. The ash is, of course, the material remaining after the honey is burned and represents mineral matter. The nitrogen is a measure of the protein material, including the enzymes, and diastase is a specific starch-digesting enzyme.

Most of these are expressed in per cent, that is, parts per hundred of honey. The acidity is reported differently. In earlier times acidity was reported

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as per cent formic acid. We now know that there are many acids in honey, with formic acid being one of the least important. Since we have recently found a sugar acid, gluconic acid, to be the principal one in honey, these results could be expressed as "per cent gluconic acid" by multiplying the numbers in the table by 0.0196. Actually there are many acids in honey, so we have used the term "milliequivalents per kilogram" to avoid implying that only one acid is found in honey. This figure is such that it properly expresses the acidity of a honey sample independently of the kind or kinds of acids present.

(Next month:- Characterization of individual floral types of honey.)