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A Survey of American Honeys

8. Effect of Storage on Honey Sugars [1/]

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IT IS WELL KNOWN that honey will darken when it is stored for long periods of time. Milum at Illinois studied this some years ago and also included the effects of some processing variables on color development in storage. In the European literature on honey it was recorded by Auerbach and Bodlander that as honey was stored, its levulose/dextrose ratio increased. De Boer did not confirm this and said that in his experiments no changes took place in the sugars. He did note that other changes that occurred in storage of honey were similar to those that were brought about by heating of honey. By this he meant darkening, decrease in diastase and increase in hydroxymethylfurfural (HMF, a degradation product of sugars).

During our laboratory work on the complete analysis of 504 samples of American honeys from over the entire country, we had the opportunity to do some work on the effects of storage on the composition of honey.

By using cold storage at -4°F. for portions of honey samples when they were received, they could be held without further changes taking place in them. Then, at a suitable time, these samples and corresponding samples that had been stored at laboratory room temperature (73-82°F), were analyzed. Sugars, acids and diastase were determined, since these were the materials that might be expected to change in storage.

Changes in Sugars in Storage

Five unheated honey samples were each divided into three parts when received from their producers. As noted above, part was placed in cold storage and part stored at room temperature. The third part was heated at 130°F. for 30 minutes, cooled and stored at room temperature.

The samples were analyzed after 20-23 months storage. The differences among the sugars in the two room-temperature samples and the cold-storage sample were definite, but it was not clear whether any real differences were present between the heated and raw room-temperature-stored samples. The results were analyzed statistically[2/]. When raw or mildly heated (130°F., 30 min.) honey was stored for one and one-half to two years at a temperature ranging between 73° and 82°F., the following changes took place:

1. A decrease of the free dextrose averaging 13% of that present and a decrease in free levulose averaging 5.5%; an average of 18.5% of the free monosaccharide content of the honey was lost.
2. A large increase in "maltose" or reducing disaccharide content, averaging 68% of that originally present.
3. A slight though real increase in sucrose content.

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.

2/ All F values exceeded the critical value at the 1% probability level.

4. A small (13%) increase in higher sugars present.

5. An increase (averaging 22%) in the unanalysed material.

These changes are in the direction of increased complexity of sugars. They are probably brought about by two mechanisms - chemical and enzymatic. A high sugar concentration and a considerable acidity, both of which are present in honey, are known to promote a slow combination of simple sugars to more complex types of sugars. It is also thought that the enzymes in honey bring about slow increases in the amounts of more complex sugars.

Why Granulated Honey Softens or Liquefys in Time

The decrease in dextrose content on storage is about twice that for the levulose. It is large enough to have a real effect on the granulation tendency of honey.

It was proposed in an earlier article in this series that granulating tendency of honey can be predicted from the dextrose/water ratio: values of 1.70 or less are associated with non-granulating honey, while samples showing a ratio of 2.10 or more will granulate complete and hard. Since one and one-half to two years storage at ordinary temperatures can decrease dextrose content by 13% this will decrease the D/W ratio.

Portions of most samples were stored in the freezer at 20 degrees below zero, centigrade. Irene Kushnir selects samples for analysis in a storage study.—USDA photo by M. C. Audsley.

In the samples we analyzed, storage caused the ratio to decrease by an average of 0.25. Thus a honey of a moderate granulating tendency (D/W = 1.90) would in time become a non-granulating type (D/W = 1.65). Many beekeepers are familiar with the slow "melting" or liquefaction that takes place when a jar of granulated honey is stored for an extended time. This is brought about by the decrease in free dextrose, due to the causes noted above. This action brings the dextrose content in the liquid part of the honey below the amount needed for saturation. This then requires that enough of the granulated, solid dextrose dissolve to bring the concentration in the liquid part back to the saturation level.

This probably is one of the causes of partial liquefaction or excessive softening in finely granulated (Dyce-processed) honey spread when stored too long at room temperature before use. The most obvious way to prevent this is by reducing the storage temperature sufficiently to retard the loss of free dextrose. Ordinary refrigeration will be sufficient for this purpose. It will retard both the chemical and enzymatic reactions involved.

(Next month: - Effect of storage on diastase content.)

Acidity of Honey Increases During Storage

A group of 10 honey samples were stored without heating, both in cold storage (-4°F.) and at room temperature. These were then analyzed for acidity after two years of such storage. None of the samples showed any visible signs of fermentation. Statistical analysis of the results showed that significant[3/] increases in free acidity, lactone and total acidity had taken place in the samples stored at room temperature. We have found a significant relationship between the rate of increase of acidity and enzyme activity in these honeys. This is further evidence that honey contains an enzyme that slowly produces acidity in honey.

3/ Exceeding the critical value at the 1% probability level.