Liquefying Crystallized Honey With a Microwave Oven

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MICROWAVES are similar to radio waves, infrared waves, and light waves, that is, they are a nonionizing* type of radiation. When microwaves are absorbed by a material, the temperature of the material is increased. The microwave oven used in our study (Figure 1) was a commercially available kitchen model with a fiberglass tray (13 x 18 inches) on which food or other materials could be placed in nonmetallic containers for heating. The microwave element (magnetron tube) was located at the top of the unit. The unit had a frequency of 2450 MHz. A metal wave distributing fan was provided to disperse the waves more evenly. The inside height of the oven was about 10 inches.

In preliminary tests, we found that the microwave oven would liquefy crystallized honey. Further tests were therefore made with 1- and 2-lb. jars of crystallized alfalfa honey. After "seeding" and storage for several months, the honey was solidly crystallized. The crystals were "coarse," about 1 mm in size, not fine grained like creamed honey. Before the jars of honey were placed in the microwave oven, the metal lids were removed because metal reflects microwaves, which results in uneven heating. Also, removing the lids avoided the buildup of pressure while the honey was heating. A glass baking dish was placed under the jars in the oven to catch honey that might boil over.

Table 1 shows the results. Total liquefaction of a 1-lb. jar of crystallized honey was achieved by a 2½-minute exposure in the microwave oven. The honey was completely liquefied without boiling, and there was no darkening. However, the honey was not evenly heated due to limited penetration of the microwaves. At the top of the honey where the microwaves were most direct, the honey was the hottest: 98° C (208° F); the honey in the middle of the jar was 60° C (140° F); and at the bottom it was 68° C (154° F). The method of recording honey temperatures is demonstrated in Figure 2. Once the honey had been stirred, the temperature throughout the mass was 68° C (154° F). The 2½-minute exposure tests were repeated 5 times with five 1-lb. jars with the same results!

In comparison, when the conventional method (heating in a pan of hot water) at 82° C (180° F) was used to liquefy a similar 1-lb. jar of honey, the honey was heated to 70° C (158° F). However, the maximum temperature to which honey should be heated is 71° C (160° F) (Root et al. 1966). Also, by the water method, one jar at a time, it took 22 times longer to liquefy the honey than by the microwave method. In addition, the paper labels on the honey jars were not damaged or removed by microwave heating, but labels came off the jars that were heated in the hot water bath. No jars were cracked or broken by the microwaves.

The honey exposed to microwaves for 2½ minutes in the 1-lb. jars and to the water bath was subsequently graded for possible color changes with the Pfund and USDA honey graders. The average values obtained by Pfund color grading were 1.7 for the microwave heated honey and 1.9 for the honey heated in the hot water bath, respectively. Thus both grading systems showed that microwave heating did not darken the honey compared with honey treated by the conventional method. Honey in a 2-lb. jar required longer exposure and started to boil in 5½ minutes. Additional boiling for 4½ minutes caused slight darkening.

Apparently, microwaves penetrate and are absorbed most by the honey in the top 1-in. of the jar; the next greatest heating occurs at all other surface layers; and the least heating takes place in the center. This pattern of heat stratification comes about because the center receives less radiation than

* Nonionizing radiation causes organic substances to heat; ionizing radiation can cause chemical changes with little or no heating (see reference 1).

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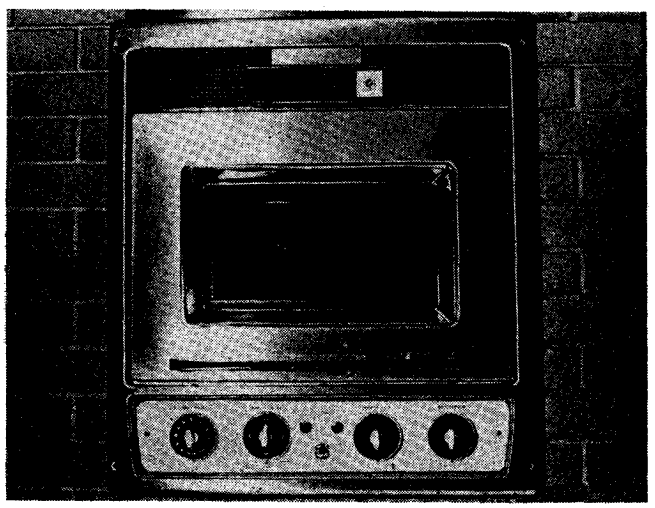

Fig. 1. This type of built-in microwave oven was used successfully to liquefy honey. A counter-top model also was satisfactory.

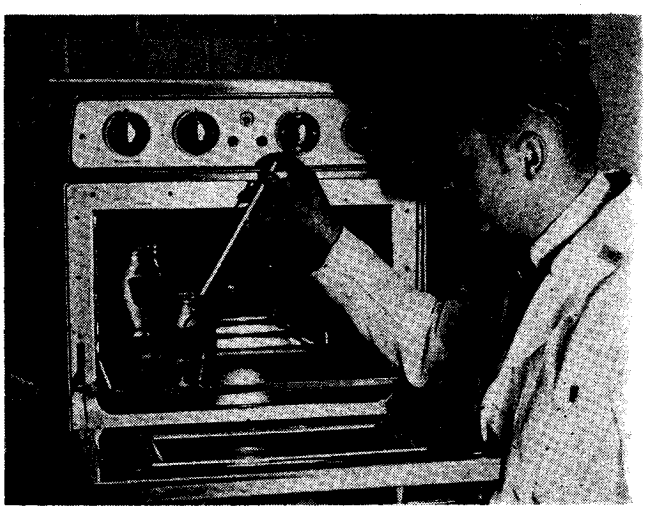

Fig. 2. Determining the temperature of honey liquefied in a microwave oven.

Table 1. Liquefaction of Crystallized Honey in a Microwave Oven

Exposure time (min.)	No. of jars	Weight of honey per jar (lb.)	Approx. % liquefaction	Oven setting	Remarks
1	1	1	2	High	Jar slightly warm
2	1	1	80	High	Jar and honey hot
2½	1	1	100	High	Jar and honey hot*
7	6	1	75 outer jars 60 inner jars	High	Jars spaced 1 in. apart
9	6	1	90 outer jars 75 inner jars	High	Jars spaced 1 in. apart
5	1	2	100	High	Honey boiled over in 3 minutes
10	1	2	100	Low	Honey boiled over in 5½ minutes, and completely liquefied in 5½ minutes**
5	1	2	99+	Low	A few crystals remained
16	6	1	98 outer jars 80 inner jars	Low	Jars spaced 1 in. apart
3+3***	1	2	98	Low	Honey boiled over the last minute of exposure
2+2+2***	1	2	98	Low	Honey boiled over the last minute of exposure
1+1+1+ 1+1+1***	1	2	100	Low	Honey was stirred to dissolve a few remaining crystals

* Very good results, repeated 5 times
** Honey was darkened
*** 5-minute interval between exposures

any other portion, which was also shown subsequently by the need to expose 2-lb. jars of honey for a longer time than 1-lb. jars. Moreover, several 1-lb. jars of honey exposed at the same time in the oven did not liquefy as completely nor as fast as a single 1-lb. jar (Table 1). Thus, longer exposure to microwaves is necessary as oven loading is increased, and spacing of several jars 1 in. apart gave better results than placing them against each other in the oven.

Larger quantities of honey given several short exposures to microwaves were liquefied without boiling the top layer. For example, 6 exposures of 1 minute, with 5-minute intervals between exposures, gave good results. (The 5-minute interval allowed the heat to be conducted from the hot areas on the surface to the inner regions where the microwaves did not penetrate.) If a few crystals remained, they were rapidly dissolved by stirring the honey. More than one jar of honey (6) were not liquefied successfully with microwaves.

Partially granulated comb honey was also exposed to microwaves, but in 30 seconds, the comb collapsed, and honey dripped from the softened cells. Figure 3 shows what happened. Thus, unfortunately, the near instantaneous heating of the honey with this particular model of oven did not lend itself to liquefying honey in the comb.

OTHER POSSIBLE USES FOR MICROWAVES

The possibility of installing a microwave heating element in a honey extracting system in which the microwave elements would serve as the flash-heating component should be investigated. It may be feasible to flash-heat honey en route to storage tanks, thereby eliminating a heating tank or other conventional methods of heating.

The use of microwaves to remove crystallized honey from 60-lb. cans, 55-gal. drums, or larger storage containers should also be investigated. This method, if successful, could save much time and labor in the honey industry.

Heating honey during the bottling process might be another practical application for microwave ovens. There are apparently some definite advantages in heating small amounts of honey quickly while it is being packed instead of large amounts that require a longer heating time and take longer to cool.

A small packer could use an ordinary kitchen model microwave oven of the type currently available commercially to flash-heat and liquefy his crystallized honey. However, much more controlled experimentation is necessary to determine the applicability of the microwave heating process to larger extracting and/or packing systems. ●

CAUTION: Microwaves can cause damage to skin and eyes if used improperly.

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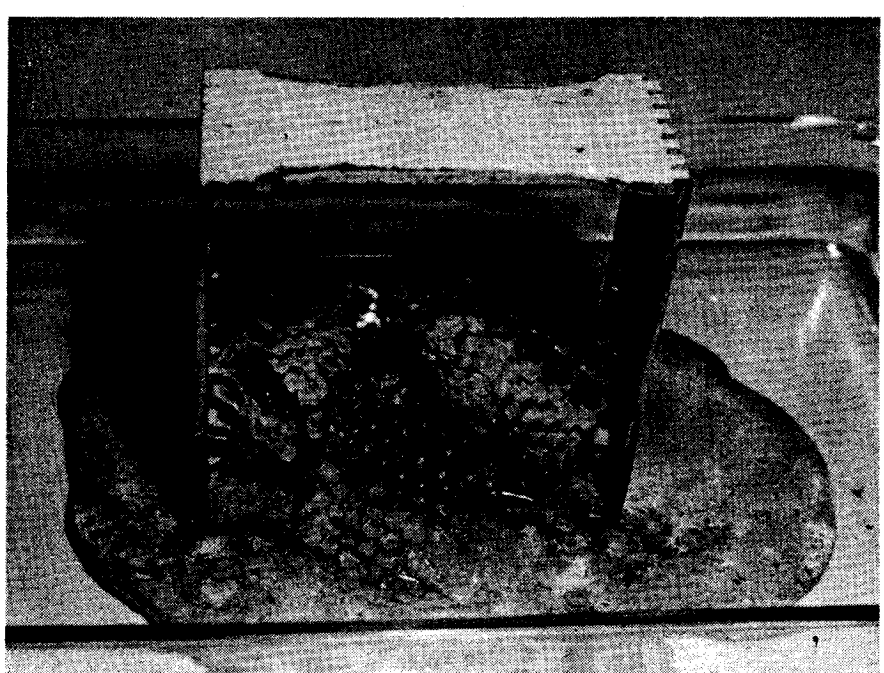

Fig. 3. Softened and melted comb honey after 30-seconds exposure inside a microwave oven. Note the liquid honey in the bottom of the glass tray.