HONEY LIQUEFACTION, PASTEURIZATION, AND INDUCED CRYSTALLIZATION

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These three important technological operations are increasingly often used in processing honey. We summarize in this paper the methods used, the necessary material conditions, and precautions to be taken.

I. Liquefaction of crystallized honey

This is a difficult operation, especially when complete liquefaction is necessary to be obtained. Honey should be melted only when really needed, and very carefully.

Several possibilities exist for this purpose:

- The warm (pre-melting) room with a controlled temperature of 40-50 °C. This is a suitable method for the crystallized honey already packed in containers holding small amounts, and even in small drums – of 50 or 100 kgs. Melting will take 40 to 48 hours; it is recommended to mix the honey 2-3 times.

- The melting room, heated at 45 °C, and provided with sloping racks on which honey drums are placed. This is the best method for industrial operations when the honey to be liquefied is in barrels of various capacities. In this situation melting proceeds in two stages: first, the semi-liquid honey warmed in the premelting room is left to flow into a double-jacketed tank placed beneath it. Secondly, further heating of the honey by circulating hot water between the two walls of the tank, while honey is mixed by the agitator with which the tank is equipped.

**Grids of hot-water heated pipes**, which by their weight and because of the heat penetrate into the honey bulk melting it. This principle is most appropriate, provided the heating temperature is under constant control to ensure slow flowing of the honey.

We also mention the water-bath, used mainly when the honey in only a few containers is to be melted. Temperature should be controlled, and honey mixed; complete and fast liquefaction takes place.

Any other means of heating – by electric resistance or fire in direct contact to honey are definitely inadmissible.

Melting is considered to be proper when the HMF content is similar to or slightly higher than that before heating.

Most often, in the liquefied honey crystallization sets in immediately, and is coarse. In order to avoid this coarse granulation usually following after melting, pasteurization and then induced granulation of the honey are recommended.

II. Pasteurization

Now the advantages of pasteurization are well known, and I shall only briefly review them.

1) Distraction of the sugar-tolerant yeasts which may cause fermentation.

2) Dissolution of any dextrose crystals present, in order to maintain honey in liquid state.

Heating to this end has been more and more used, because it was necessary to reduce to the utmost the time consumed for pre-melting and cooling of honey. Methods and equipment have been the object of numerous investigation and tests. The two types of equipment used more often are then tubular heat-exchangers, and plate-type heat exchangers.

In the tubular heat-exchangers, the honey passes through them in a layer of 7 mm on an average, being heated quickly. The hot water flows on each side of the honey, but in opposite direction to the honey. Cooling takes place in the same way, but in other pipes through which honey and cold water pass.

The plate-type heat exchangers consist of two sections: in the first section, honey is heated very quickly as it passes through pipes in a layer of 1-2 mm, and the temperature of honey being maintained constant by the close circuit. Water passes in close circuit, on all sides of the plates, and in opposite direction to the honey. The honey passes into the second section where it is cooled, with cold water, in a similar way. This method is now the most widely used such a plate type heat exchanger, and made a number of tests.

We have been mainly concerned with finding the disadvantages of pasteurization. We have made comparative analyses of samples of the same honey – pasteurized and non-pasteurized. The changes recorded are mostly biochemical: 80% of the glucoinvertase in honey is destroyed, and 25% of diastase
(amylase), as well as about 10% of the antibiotic activity. On the other hand, both before and after pasteurization, we have not recorded any damage of the reducing sugars, or increase in the HMF content, or darkening, or significant changes in acidity – which is a positive result.

It is therefore obvious that pasteurization always causes a considerable deterioration of the honey quality. In order to avoid essential chemical changes and an increased HMF content, and to ensure a diastase activity meeting the requirements of the European legislation, several precautions should be taken:
- In the technical field: using the best conditions. We tested various temperatures, for various periods of time. The conditions found by us to be the best are: a temperature of 78 °C, and heating for 6-7 minutes.
- With respect to purity: before pasteurization, honey must be left to settle, or should be strained. Any foreign matter which remains in the honey after pasteurization will stimulate or act as nuclei for crystal formation. Worth mentioning is that filtering of heated honey with diatomaceous earth is legal and currently used in USA, but prohibited in Europe.
- With respect to the nature of the honey itself: the honey to be pasteurized must be selected judiciously. All honeys with a moisture content higher than 19% - liable to fermentation, should be pasteurized. Also recommended to be pasteurized are all honeys with natural tendency to crystallize slowly – in 2-3 or more months; such are in general the honeys whose glucose/water ratio is lower than or equal to 2, and whose glucose content is below 35%. On the contrary, one should avoid pasteurization of honeys with an inverse glucose/water ratio, and of those with a tendency to crystallize quickly – of course only when such honeys are not intended for deliberate seeding to obtain finely granulated (creamed) honey.

In conclusion, I wish to describe the pasteurization of a very special honey – that of heather (Calluna). We have studied this problem and reached some interesting conclusions.

This honey, whose water content is high in general – between 18 and 24%, is likely to ferment very soon. Consequently, it must be pasteurized, but when cooled it turns to gel and clogs, which makes its passage through the plates of a usual heat-exchanger very difficult, and this because of its uncommonly high protein content. It is therefore necessary to heat it at 40-45 °C before it passes through the heat exchanger. In the first section, honey is heated at the normal level with this system (tubular or plate-type heat-exchangers); but cooling must be made most carefully. Honey should be cooled down to about 45 °C – in pipes or plates, in a relatively thick layer (3-5 mm – in plates), in order to avoid clogging. Heather honey is currently heated at 70 °C, for 5 minutes.

Under such conditions, the negative effects on honey are of relatively small consequence; the method is advantageous for two reasons:
- The yeasts which make honey to ferment are destroyed;
- Protein substances coagulate, which turns honey into gel, with a pleasant appearance.

It results that pasteurization of heather honey is highly and definitely recommended.

III. Induced crystallization and preparation of finely granulated (creamed) honey

The procedure by which finely granulated honey is obtained is well known at present, so here is a summary: into a completely liquid honey, an amount of finely granulated honey is incorporated. This starter is a very finely, naturally granulated honey – of rape or clover; also, honey previously seeded with ground dextrose crystals may be used – as starter. The liquid honey (90%) is then mixed with the starter (10%), at about 25 °C. Then it is left to settle before bottling it. After bottling, it is stored at low temperatures – about 14 °C, and after 10-15 days it will be completely granulated. Honey is mixed by stirring devices fitted at the surface of the tank with honey. These devices should rotate very slowly, to prevent incorporation of air bubbles into honey. For cooling honey faster, in USA votators are used – units meant precisely for mixing and cooling viscous materials. But it is very expensive to purchase, being not indispensable in fact.

In order to obtain a uniform and complete crystallization, and a stable crystal network, honey should be selected. It glucose content should not exceed 35%, and the glucose/water ratio should not be higher than 2. A finely-granulated honey is not always obtained with the method described above: the crystalline structure may be choesive and then the honey is too hard. We have perfected a method for obtaining real creamed honey: use of a homogenizer for industrial production of all kinds of creamed food and other products. It consists of two main parts:
- A piston pump, which is in fact a cylinder incorporated into a tank with honey, and
- An obturator fitted at the delivery end of the pump; it has grooves forming baffles. Under the pump pressure, the honey is forced against the grooves and crystals are fractured. No excessive heating is necessary, and the process takes place in air-tight conditions.

Here is how the operation proceeds: the crystallized honey (either naturally or by seeding it) is kept in the warm (premelting) room, at approximately 25-27 °C, to have a creamy consistency. The honey is forced through the homogenizer, then left to settle, and bottled. It is afterwards stored at 14 °C, or, still, better, at 4-5 °C – if possible.
After presenting the advantages and drawbacks of homogenization, here is a review:

Advantages: the product obtained is an excellent creamed honey, and it maintains so when stored under proper conditions. The method is reproducible with various honeys, resulting in a similar product in different years, which means that constant quality is ensured. It is also most convenient commercially: when kept in refrigerator at 4-5 °C it remains soft and spreadable. The “pulling-away” of granulated honey – because of cold – which gives the honey a streaked appearance (broad white bands) which may be seen through the glass or plastic jars, is no more experienced with homogenized honey stored at such a temperature. In this situation, even if honey shrinks, this phenomenon is compensated by the settling of the creamy structure. And finally, this creamed honey may be packed in various types of containers; it is even easily forced out of a tube, which is impossible with a normally crystallized honey.

The main drawback is the relative instability of the crystalline structure of the creamed honey: the most often difficulty is the melting of the network. In order to avoid it, honey must meet the composition requirements which ensure a proper crystallization, and have the lowest possible water content. Honey with more than 18% water should not be homogenized. At an average storage temperature (20-22 °C), a homogenized honey with moisture content up to 170 % will preserve its soft structure of creamed honey for one year and even more; when its water content is of 17-17.5 % - it maintains as such for 6 months to one year; between 17.5 and 18 % water content, the stability of its structure lasts for 3-6 months, and beyond 18 % moisture, stability is no more guaranteed. At lower temperatures, the stability of the above mentioned honeys is ensured for longer periods of time.

Homogenization is efficient only in completely crystallized honeys. Therefore, it is better not melt (not even partially) the honey before homogenizing it; pre-melting should also be made very carefully. For a successful homogenization, modern equipment is necessary (warm room, homogenizer, tanks, pumps, bottling device).

Conclusion

The modern processing methods used at present meet the commercial requirements, but must be used with precaution. Honey must preserve its initial properties; we must process it only if absolutely indispensable. One may for instance melt a crystallized honey and then pasteurize it, but then it should be packed directly in containers for sale, without heating it again.

A modern equipment is very important; although expensive to purchase, it secures a healthy honey, of good quality.