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Crystallization of Honey and its Affecting Factors

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Abstract

It is still unknown what the basic causes are for honey crystallization to occur on a regular basis. Here, we contrasted the artificial and natural forms of honey crystallization. The fundamental physical and structural properties of six unifloral honey samples were analysed using microscopy, colorimetry, rheology, texture, and calorimetry techniques. A comparison was conducted with honey seed crystals-induced crystallization. Honey transformed into a pseudoplastic fluid with an increase in cohesion, hardness, and L-value during natural crystallization. The fastest rate of crystallization occurred at 16% water content and 14 °C. The addition of seed crystals to honey crystallization had two main effects: it quickened the process and enhanced the crystallization's characteristics, such as homogeneous particle size and reduced stratification.

Keywords: Crystallization, Honey, Microscopy, Seed crystals,

Introduction

Due to its naturally sweet flavor and the numerous health benefits of its bioactive components—which include sugars, polyphenolic compounds, proteins, enzymes, lipids, vitamins, minerals, and pollen grains—honey is a popular ancient complex food (Nikhat & Fazil, 2022). According to Sahin et al. (2020), crystallization of honey occurs often throughout processing, storage, and shelf life. This is primarily caused by the precipitation of glucose, which transforms into glucose monohydrate (Cavia et al., 2002; Conforti et al., 2006; Naik et al., 2019). A natural process called "honey crystallization," or "granulation," causes honey to change from a liquid (runny) to a semi-solid state. This is known to beekeepers as set honey. The general consumer has little understanding of how honey crystallizes. Many people believe that honey that has crystallized is an artificial or contaminated product. That is untrue. The process of crystallization is actually spontaneous and natural. Over time, most unheated, raw, or pure honey has a propensity to crystallize. The only things that are impacted by

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crystallization in honey are color and texture. Honey that has crystallized retains the flavor and quality attributes of liquid honey without going bad. Because it tastes better and is easier to spread on toast or bread without dribbling off, some honey consumers prefer their honey in this condition.

Why Honey Crystallizes

Less than 20% of honey is water and more than 70% is sugars. Honey has a high sugar concentration compared to its water content. Honey becomes unstable due to its excessive sugar content. Since honey is an overly saturated sugar solution, crystallization is a natural occurrence. Glucose (grape sugar) and fructose (fruit sugar) are the two main sugars found in honey. The amount of fructose and glucose in honey varies depending on the kind. Typically, the ranges for fructose and glucose are 30–44% and 25–40%, respectively. The primary cause of honey's crystallization is the balance between these two major sugars; the proportion of each dictate how quickly or slowly the honey crystallizes Glucose crystallizes because of its decreased solubility. Compared to glucose, fructose is more soluble in water and stays fluid. Glucose crystallizes when it separates from the water and becomes little crystals. More glucose crystallizes as the crystallization process goes on, and these crystals disperse throughout the honey. After the solution transforms into a stable saturated state, the honey eventually crystallizes or gets thick.

How Fast will Honey Crystallize?

- The pace at which various varieties of honey crystallize varies. After being removed from the combs, some honey crystallizes in a matter of weeks, while other honey stays liquid for months or even years. The following elements affect how quickly crystallization occurs:
- The source of nectar that bees gather (the sugar content of honey); the handling and processing techniques used; and the preservation temperature.

Affecting Factors:

Temperature, water content, and sugar composition are the three key elements that lead to honey crystallization. In terms of sugar composition, high-glucose honey often crystallizes readily. F/G (fructose/glucose), G/W (glucose/water), and (G - W)/F [(glucose-water)/fructose] had been proposed as useful indicators of honey crystallization under natural settings. There was no propensity to crystallize when the F/G number was over 1.58, difficult to crystallize

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when it was above 1.33, and crystallization occurred when it was below 1.11. According to Bhandari et al. (1999), honey that does not crystallize quickly has a G/W value of less than 1.7, whereas honey that crystallizes quickly has a value of 2.2 or higher. When it comes to water content, too much water content decreases the pace of crystallization and increases the quantity of dissolved glucose, both of which are bad for honey crystallization Regarding temperature, it influences the solubility of glucose, which in turn impacts the crystallization of honey. A temperature that is too high can decrease honey's viscosity and encourage the movement of the crystal nucleus, but it also makes glucose more soluble and prevents honey from crystallizing. As a result, there is a temperature at which honey crystallizes best. According to the majority of research, honey crystallizes most quickly between 13 and 15.5 ◦C. Additionally, minuscule quantities of pollen, air bubbles, and other contaminants in honey can function as "nucleation seeds," influencing the crystallization process. Pollen and bubbles in honey are examples of contaminants that cause phase inhomogeneity, which lowers the surface energy barrier and causes crystal nuclei to form. By introducing seed crystals, several researchers have taken use of this characteristic to intentionally regulate the crystallization of honey. Furthermore, techniques like stirring, micro discharging, and others can help honey crystallize more effectively. On the other hand, adding glucose, dextrin, and other substances to honey in order to improve crystallization is a widely used method that has generated controversy. The International Codex Alimentarius Commission's honey laws, which state that "Honey sold as such shall not have added to it any food ingredient, nor shall any other additions be made other than honey," are adhered to by the International Federation of Beekeepers' Association. This addition is thus not compatible. However, Dyce was the first to employ crystallized honey crystals to produce creamed honey, so adding them is a nice alternative. This work also employed this technique. As far as we know, crystallization was long thought to be an unwanted process for liquid honey, one that needed to be postponed or avoided. Of course, there is still research being done on methods to prevent crystallization, including heat treatment, ultrasound, adding food additives, and more. There is currently a lot of excitement surrounding crystallized honey as a novel honey product. However, there is a risk of non-compliance with current methods, and there has been less research done on the most common natural crystallization, with most efforts concentrated on improving methods of induced crystallization characteristics. The current study's objective was to compare the key structural

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and physical characteristics of honey during its natural crystallization process with those of seed crystal-induced crystallization in six unfloral honey samples. This study used crystallized honey as a seed crystal for induced crystallization, an induction technique that is not debatable and conforms with honey processing laws. Microscopy, colorimetry, rheology, texture, and calorimetry were all used in the thorough examination. Through correlation analysis, the effects of the various conditions on the crystallization of honey were statistically assessed.

Conclusion

Honey crystallization results in modifications to its color, texture, rheological characteristics, and thermodynamic attributes. A water concentration of 16% is ideal for honey crystallization. The ideal temperature for crystallization is 14 ◦C. One way to describe the improvement in the crystallization qualities of the original honey sample is the result of stirring and adding 10% seed crystals to the honey. This includes a three-fold increase in crystallization rate compared to natural crystallization, a decrease in crystal sizes, and a reduction in the honey crystal layering. It was found that the (G-W)/F ratio was a more accurate way to measure the degree of honey crystallization, and that fructose and pollen quantity had less correlation with honey-induced crystallization. This article advances our knowledge of the crystallization process of honey and its influencing variables, such as temperature, water content, honey variety, and seed crystals. Subsequent tests will follow up on this strategy, which calls for future trials to examine the impacts of various activities on crystallization honey and to adapt seed crystals induced crystallization under industrial circumstances.

References

A Thrasyvoulou, J Manikis, D Tselios. 1994. Liquefying crystallized honey with ultrasonic waves. Apidologie, Springer Verlag. 25(3). pp. 297-302.

ADA. 2004. Use of nutritive and nonnutritive sweeteners. Journal of the American. Dietetic Association. 104: 255–275.

Ajibola A, Chamunorwa J P, Erlwanger K H. 2012. Nutraceutical values of natural honey and its contribution to human health and wealth. Nutrition & Metabolism. 9:61.

Amariei, S., Norocel, L., & Scripca, ˇ L. A. (2020). An innovative method for preventing honey crystallization. Innovative Food Science & Emerging Technologies, 66, Article 102481. https://doi.org/10.1016/j.ifset.2020.102481

Belitz H D and Grosch W. 1999. Food Chemistry. 2ed. Berlin: Springer-Verlag. 992p

Chen L, Mehta A, Berenbaum M, Zangerl A R and Engeseth N J. 2000.Honeys from different floral sources as inhibitorsof enzymatic browning in fruit and vegetable homogenates. Journal of Agriculture and Food Chemistry. 48: 4997–5000.

Dunford C, Cooper R A, White R J, Molan P C 2000. The use of honey in wound management. Nursing Standard. 15: 63-68

Ezz El-Arab A M, Girgis S M, Hegazy M E, Abd EI-Khalek A B. 2006. Effect of dietary honey on intestinal microflora and toxicity of mycotoxin in mice. BMC Complementary and Alternative Medicine. 6:1-13

FAO. 1996. Food and Agriculture Organization. Value-added products form beekeeping. FAO Agricultural Services Bulletin.Orme, Italy.

Han, W., Chai, X., Zaaboul, F., Tan, C.-P., Sun, Y., Liu, C., & Liu, Y. (2022). Beeswax crystals form a network structure in highly unsaturated oils and O/W emulsions under supersaturation and cool temperature conditions. LWT, 164, Article 113594. https://doi.org/10.1016/j.lwt.2022.113594

Henriques A, Jackson S, Cooper R, Burton N.2006. Free radical production and quenching in honeys with wound healing potential. Journal of Antimicrobial Chemotherpy. 58: 773-777.

Jones K P, Blair S, Tonks A, Price A, Cooper R. 2000. Honey and the stimulation of inflammatory cytokine release from a monocyticcell line. First World Wound Healing Congress: Melbourne, Australia

Molan P C. 2001. Why honey is effective as a medicine 2. The scientific explanation of its effects. Bee World. 82: 22-40

Tappi, S., Glicerina, V., Ragni, L., Dettori, A., Romani, S., & Rocculi, P. (2021). Physical and structural properties of honey crystallized by static and dynamic processes. Journal of Food Engineering, 292, Article 110316. https://doi.org/10.1016/j.jfoodeng.2020.110316