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A Review on the Effect of Processing Temperature and Time duration on Commercial Honey Quality

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Abstract

Raw honey after harvesting is usually strained and filtered to remove suspended materials including pollen, proplis and bee wax prior to heating for commercial processing. Heating honey is to facilitate filtering and bottling of honey by reducing the viscosity. In commercial processing plant, honey is usually heated in order to purify, filter, facilitate packaging to inhibit microorganism growth, to reduce the moisture content at the standard level and to delay crystallization process. Even though heating is of great important in commercial honey processing, no guideline is available till to date for the use of heating temperature and time combination based on types and origin of honey. The optimal heating conditions are mainly relied on the geographical and botanical origins of honey. Uncontrolled temperature can be detrimental to the quality of honey and to its biological and bio active chemical properties. In Ethiopia, commercial honey processing industries can perform their processes in a different ways depending on various factors, including economic, technological and technique reasons. Honey has a probability to loss the natural quality when it goes through uncontrolled thermal processing. The loss of the natural quality is due to the decomposition of vitamins, destruction of the integrity of the enzymes and the development HFM content. HMF content and enzymatic activities are the recognized honey quality parameters to penetrate and sustain in the international market. As heating is of great important on commercial honey processing industry, it needs to have standard guideline for the use of optimum heating temperature and time duration.

Keywords: Temperature; HFM; Quality; Honey.

Introduction

Honey, a natural biological product with the composition of unique combination of components has a great benefit to human beings both as medicine and food. It is consumed in every country of the world in different forms. Honey contains pollens, beeswax, and other undesirable materials, besides yeast, that are to be removed for better product quality and shelf life. Heat or thermal processing of honey eliminates the microorganisms responsible for spoilage and reduces the moisture content to a level that retards the fermentation process [1]. Liquid honey is more demanded in market, so solid honey often is heated in order to melt and decrease the viscosity. One of the most traditional ways to melt the honey is by heating using thermal treatment usually in higher temperature more than 50 °C [2].The composition and physico-chemical properties of honey has mainly dependent on processing temperature, storage condition, regional and climatic conditions [3]. Raw honey after harvesting is usually strained and filtered to remove suspended materials including pollen and beeswax prior to heating for commercial processing. Heating honey is not only eases the processing and bottling by reducing the viscosity of honey [4]. But it also reduces the water content to prevent honey fermentation [1], dissolves the sugar crystal nuclei to retard granulation [5, 6], homogenizes honey color for the preference of consumers [7]. Heating destroys the sugar tolerant Osmophilic yeasts to prolong the shelf life of honey [8]. The HMF content and the enzymatic activity of honey is an indicators for honey freshness [1]. The HMF content will increase, whereas the diastase activity of honey will decrease for over-heated, aged and poorly stored honey. Honey is known to have wide range of health promoting phytochemicals which can possess antimicrobial, antiviral, antiparasitory, antiinflammatory, antioxidant, antimutagenic and antitumor effects [9]. The importance of these bioactive compounds on human health and nutrition therefore, generates a great interest in honey processing temperature and time duration research [39]. Even though heating is of great important, there is a limitation of widespread standard guideline for the use of heating temperature and time duration for a particular types of honey. It is believed that the optimum heating conditions are mainly relied on the geographical and botanical origins of honey [10,50]. A wide range of heating temperatures ranging from 30 to 140° C for a few seconds up to several hours had been practiced by honey producers and commercial processors world wide, with the aim to reduce the water content in honey below 20% for shelf life prolongation [5,8]. In commercial processing plant, honey is usually heated for purification, filtering, inhibiting microorganism, facilitating packaging and delaying crystallization. Although thermal processing is a convenient way to protect honey from fermentation, since an increase of water activity during crystallization tends to cause fermentation, high temperature can be detrimental to the quality and biological properties as well as masking its originality [11]. This research review aims to organize the information that developed on effect of honey processing temperature and time duration on honey quality and to indicate further research areas on optimal combination of temperature and time duration during processing of different honey types.

Principles of Commercial Honey Processing

Raw honey after harvesting is usually strained and filtered to remove suspended materials including pollen and bee wax prior to heating [42]. The best methods for honey purification is through heating under the controlled temperature. Heat treatment of honey is subjected to double heat treatment. The first heat treatment process is performed for the period of 24 hours and the honey is heated up to a temperature of 50°C, and the crystals formed in honey can be melted and the Viscosity is become decreased [12]. The production flow of commercial honey processing involves six different steps, from the initial extraction to the final packaging. It should be considered that different industries can perform their processes in a different ways depending on various factors, including economic, technique and technological reasons [13].

The quality of honey is known to be compromised when it goes through thermal processing due to the unstable and thermolabile components, decomposition of vitamins and also destruction of the integrity of the enzymes particularly when it is heated at 60°C and above [22,49]. In commercial honey processing applications of heat is an important operation and is known to have a potential for eliminating spoilage microorganisms, facilitating packaging and delaying crystallization [1]. However, heating honey to higher temperatures of more than 70°C is not suitable because it causes alteration of flavor, color and granulation of honey; also degrade bioactive compounds and antioxidants and result in product quality deterioration [14]. The deterioration of honey quality and its nutritional properties is due to the unstable and thermolabile honey components [11].

Bulk processing method

Large quantity of honey is processed through bulk processing methods. In this method honey is undergoes thermal water bath heating and flow through series of sieves of various sizes. The sieves are arranged in a concentric manner where the coarser mesh is being on the inside while the finest on the outside. The semi refined honey is heated between 45-50°C temperature in a sump tank which is then flow by gravity through the sieves usually referred as strainers; into a settling tank to settle at least to 3 days [12]. The scum collected at the top of the strained honey is then removed and the honey is packed.

Conventional thermal processing

A wide range of heating temperatures ranging from 30 to 140°C for a few seconds up to several hours had been practiced by honey producers worldwide, with the aim to reduce the water content in honey below 20% for shelf life prolongation [5, 8,10]. The composition and properties of honey depends, first of all, on the floral origin in relation with the geographic area and the climate regime [15]. Processing methods, together with the storage condition can affect honey quality [16,49]. It is well known that honey as a natural product may be processed by means of thermal treatment for two main reasons: to destroy the micro-organisms that may contaminate it and to modify its tendency to crystallization or delay the appearance of monosaccharide crystals [17]. On the other hand uncontrolled heating influences the quality parameters such as hydroxymethylfurfural (HMF) content and enzymatic activity and results in increasing or decreasing these parameters, respectively [1], which finally determinate the quality of honey.

The major problem faced by honey producers in tropical countries is its rapid deterioration in quality due to fermentation [18]. The unprocessed honey tends to ferment within a few days of storage at ambient temperature because of its high moisture content and yeast count. Heat processing of honey eliminates the microorganisms responsible for spoilage and reduces the moisture content to a level that retards the fermentation process. Studies have shown that heating honey at 63, 65 and 68°C for 35, 25 and 7.5 min, respectively can destroy the yeast cells completely [19]. Cooling has significance importance in order to protect its natural color, flavor, enzyme content and other biological substances [20,49].

Honey Processing Temperature and Time Duration

It is believed that the optimum heating conditions are mainly relied on the geographical and botanical origins of honey. Different origins of honey vary in their biochemical composition [42]. Thermal processing is a popular technology for food industry which ensures microbiological safety of the products [21]. Liquefaction is operated at approximately 55°C and has a purpose to ensure the honey can stay in liquid form as long as possible for filtering. Heating honey above 75°C is not suitable because it causes degradation of bioactive compounds which could affect the quality of the honey [5]. Even though heating is of great important, in commercial honey processing:- filtration, handling and shelf life prolongation there is a limitation of wide spread standard guideline for the use of heating temperature and time for a particular type and kinds of honey. It is believed that the optimum heating conditions are mainly relied on the geographical and botanical origins of honey [42,50]. Different origins of honey vary in their biochemical composition. The HMF content and the enzymatic activity of honey are the indicators for honey freshness [1]. When the HMF content of honey can increased the diastase activity is decreasing for over-heated, aged and poorly stored honey. The use of excessive heat or liquefaction or pasteurization of honey has adverse effects on honey quality. Quantification of HMF content and enzyme activities are useful tools in detecting heat induced defects in honey [23]. The enzymes are very sensitive to overheating above 35 °C or storage at too high temperature. Because they are destroyed by heating, a low enzyme level may mean that honey has been heated, but many honeys of good quality are naturally low in enzyme content [24].

Effect of Temperature on HFM Content

Hydroxymethylfurfural (HMF), a cyclic aldehyde, is one of such unfavorable compounds, which is virtually absent in fresh and untreated honey [25]. Although HMF is found in a variety of processed foods; honey is the only food for which there exists a recommendation on the allowable content of HMF. HMF is high in honeys that have been heat treated, stored in non-adequate conditions or adulterated with invert syrup [26]. HMF is a recognized parameter related to the quality of honey [27,52]. The International Honey Commission (IHC) has stated that after processing and/or blending, HMF levels shall not exceed 40 mg/kg, unless the honey originates from regions with tropical ambient temperatures, in which case levels shall not exceed 80 mg/kg. HMF is formed by the breakdown process of fructose, is toxic and cancerogenic [28,52]. Therefore it is mentioned in all honey standards and is used while regulating honey quality. The HFM content of unheated honey ranged from 5-30 mg/ kg [29]. The allowable limit laid out in EU standards is up to 40 mg kg. Excessive amount of HMF has been considered evidence of overheating, implying a darkening of color and a loss of freshness of honey.

Enzymatic Activities of Natural Honey

Saliva of bee is the source of diastase (amylase) [32], that is one of the most important enzymes making honey easily digestible. This enzyme degrades depending on the heat treatment and time applied to honey is a crucial indicator used in the determination of freshness of honey. The content of enzymes in honey can be used to classify a good quality of unadulterated honey [30]. Fresh honey contains low amount of hydroxymethylfurfural (HMF) with natural levels of enzymes [53]. Diastase and invertase are normally used as the parameter to determine the freshness of a honey. Honey contains many enzymes, the major ones being diastase, invertase, amylase and glucose oxidase [31]. Invertase is more sensitive than Diastase to thermal treatment and storage condition of honey hence invertase is better parameter to characterize thermal treatment and storage time [34].

The determination of enzyme diastase in honey has long been used to detect the overheating of honey. The minimum value for diastase activity in processed honey specified as diastase value (8). It was observed that long heating periods of 60 to 90 s duration at power levels of 30, 50 and 70 reduced the diastase activity of honey by nearly 50% of its original value [32]. At a power level of 100, heating above 45 s resulted in reduction of the diastase value to a level lower than the minimum permissible statutory value of 8. Heating of honey above 90°C results in caramelization of sugar [33]. Different combinations of heat treatment (temperature and duration) can be used to achieve the main objective of yeast reduction in honey to a commercially acceptable level.

Natural Crystallization Process of Honey

Crystallization of honey is a natural process, depending on the sugar content, the temperature, the water content and the storage time [43]. The higher the glucose content, the faster the crystallization. Honeys with more than 28% glucose crystallize fast, while those with less than 28 % remain generally liquid [35,15]. The optimal temperature for honey crystallization can be lies between 10 and 18°C. Honey is prone to sugar crystallization, commercial honey processing methods such as heating above 15°C, decrease viscosity and thus successfully decrease the rate of crystallization of honey [5]. Crystallization of honey is little understood by the consuming public. Many assume that honey appears crystallized to be an adulterated or unnatural product. Crystallization does not affect honey quality only influence on color and texture change [1, 15].

Honey crystallization is a natural occurrence in honey maturing and in some respects it can be taken as an indicator of natural honey composition [35,43]. Most consumers prefer liquid, freshly looking honey [36]. Over heating has been reported to decrease the antioxidative activities of honey due to decomposition of vitamins and also destruction of the integrity of the enzymes, particularly at higher temperature of 100°C [11,37,38,40,51].

Pasteurization

Commercial pasteurization practice is flash-heating for a few seconds at 70-78 °C and then rapidly cooling for minimization of heat damage. After pasteurization, diastase activity and HMF content remain almost unchanged, while invertase is damaged [52]. Honey is usually warmed to a temperature of 32-40 °C to lower its viscosity, which facilitates extraction, straining, filtration and filling. This temperature is similar to that in beehives and does not affect the honey.

Honey Fermentation

Fermentation is the only microbiological alteration to which honey is susceptible. Only osmophilic yeasts can grow in the high sugar concentrations. Honey is composed of organic compounds, mainly reducing sugars, of which fructose accounts for the largest share 38.4%, glucose for 30.3%, maltose for 7.3%, sucrose for 1.3% [44]. These compounds are suitable for the propagation of sugar-tolerant yeasts, as a result, at favorable temperatures (23°-27°C), moisture content of 17- 21.1%, [45]. In order to keep honey fit for consumption and to have prolonged shelf life its moisture content should be <17.1% and storage temperature below 11°C [1].

To inhibit yeasts and fungi in natural honey heating at higher temperature of 80°C for 60s using the technique of high temperature-short time heating [17]. Heating honey at temperature between 60 to 70°C for 10 min as well as indirect heating in conventional process which is in the range of 60 to 65°C for 25- 30 min can destroy the yeasts completely.

The different combination of temperature and time treatment is necessary to inactivate all types of microbes specially mold and yeasts since they are the only microbes which have been reported to grow in honey [19,46]. The effect of high temperature short time heating of honey on qualitative parameters related to HMF content, diastase activity and crystallization process [17]. In recent decades, HMF has drawn the attention of the scientific community for its carcinogenic potential for humans. Some studies have shown that this metabolite can be converted in vivo to 5-sulfooxymethylfurfural (SMF), a genotoxic compound [47,52]. The Codex Alimentarius and the European Commission have set a maximum HMF level for honey of 40 mg/Kg, except for honeys coming from tropical countries and honeys with low enzyme levels, the HMF limit of which was set in 80 and 15 mg/Kg respectively [48,52].

Conclusion

Thermal heating is of great important in commercial honey processing, to reduce the moisture content, to facilitate filtering, bottling, packaging and to maintain quality of honey, but there is a limitation of wide spread standard guideline on the use of heating temperature and time duration. The biochemical compositions of honey varies based on a number of factors including its origins. Hence, it is believed that the optimum heating conditions are mainly relied on the geographical and botanical origins of honey. A wide range of heating temperatures ranging from 30 to 140 °C for a few seconds up to several hours had been practiced by honey producers worldwide, with the aim processing facilitation and to reduce the water content in honey below 20% for shelf life handling and prolongation.

Although the application of high/uncontrolled heat treatment to honey is not allowed, some producers do it intentionally for pasteurization purposes and/or liquefaction, thereby affecting negatively the quality of honey. Therefore, keeping its freshness and using controlled standard heating temperature are the most important quality control and authenticity parameters of honey, that assessment is performed by the standard methods that rely on the determinations of diastase activity and HMF content. It is understood that, unwise use of thermal heating temperature can affect the internationally recognized honey quality parameters and influenced on National honey export market.

Recommendations

- Conduct assessment and research on the commercial honey processing industries and investigate the operational processing temperature and time combination.
- Further research works to evaluate the impact of high and prolonged thermal temperature on national honey export market by affecting the internationally recognized honey quality parameter, Hydroxymethylfurfural (HMF) and enzymatic activities.
- Different honey types in Ethiopia and there quality response when exposed to different temperature and time exposure should be studied.

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