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A Review. Processing, conditioning and evaluation of physico-chemical indicators of bee honey

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Abstract

Bee honey is considered a staple food in terms of human nutrition. Bee honey has very good nutritional properties and is easily digestible. In order for bee honey to be marketed, it must comply with certain rules in terms of quality indicators. Main quality indicators of bee honey studied in this paper are: moisture content, total reducing sugars, sucrose content, acidity, mineral content and hydroxymethylfurfurol (HMF). Regarding the conditioning process of bee honey, each operation in the technological flow must be treated with care, especially when we are talking about the heating of honey and its pasteurization. Failure to comply with working parameters (temperature and time) in case of two operations can lead to negative changes in terms of physico-chemical composition of bee honey.

Keywords: bee honey, physical-chemical indicators, conditioning

1. Introduction

Honey consumption has a very long history for humans. Bee honey has been used as a sweetener and flavoring in many foods and beverages. Since ancient times, honey has been known for its nutritional and therapeutic aspects [1].

Honey contains glucose, fructose and water, in addition to small amounts of protein, minerals, organic acids and vitamins. It is pleasant for its characteristic aroma, sweetness and texture. Honey has over 100 pharmacological effects favorable to a human body as antimicrobial, anti-inflammatory, antimutagenic, antioxidant and probiotic properties. Flavonoids, phenolic acids, peptides, organic acids, enzymes, Maillard reaction products and other minor components provide antioxidant properties for honey, especially in case of phenolic substances. All plants produce phenolic compounds as

secondary metabolites as a result of their metabolism. These compounds are found in various compositions and amounts in all herbal products [2].

Honey extracted from honeycombs and apiaries contains pollen, beeswax and other unwanted materials, in addition to yeast, which are to be removed for better product quality as well as to extend the shelf life [3].

Proper management practices, optimal knowledge in beekeeping, bee breeds, optimal climatic conditions as well as suitable places for beekeeping have increased the quality and quantity of bee honey [4].

Types of honey found in our country:

Acacia honey is a monofloral honey, obtained exclusively from the nectar of acacia flowers. It is colorless or slightly yellow and has a specific aroma of acacia flowers. It is rich in fructose, with psychic calming properties. It is a good expectorant, emollient for the digestive tract and a stimulant for cardiac activity [5, 6].

Polyfloral honey is obtained from nectar of several species of plants that bloom in the same period. Color and aroma vary depending on the type of flower predominant. It has a lot of beneficial effects on health: it stimulates appetite, facilitates digestive process, improves activity of heart and liver, causes an increase in percentage of hemoglobin in blood and is an excellent remedy for physical and mental fatigue [5, 6].

Mana honey is obtained from beech, ash and oak leaves or is a type of extra-floral honey, obtained from substances secreted by various insects that live on the green parts of a plant. It has a dark, brown,

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greenish color and due to its composition and origin it can remain liquid or viscous for years. It contains much stronger laxative properties than other types of honey, has an anti-inflammatory effect on digestive tract, promotes elimination of toxins from body [5, 6].

Linden honey has the most pleasant and strong aroma of all types of honey. It is recognized as a psychic sedative, sleeping pill, anaphroditic. This type of honey relaxes you after a stressful day [5, 6].

Sunflower honey is somehow on opposite side of lime honey. It has psychic and general tonic properties, is an aphrodisiac, stimulates immunity. It is useful in atherosclerosis, has antibacterial properties. It is used as an adjunct in treatment of bronchitis, anemia, hypo and hypertension and stomach diseases. It contains a lot of glucose, which causes it to form large, irregular crystals. It is only honey that contains lecithin in its pure state, being recommended to those who make an intense intellectual effort [5, 6].

Fir tree and other conifer honey are very rare, with bee harvesting yields low. It has exceptional properties on lungs and respiratory system, benefiting from anti-infective, expectorant, antitussive properties and, when consumed with honeycomb, bronchodilators [5, 6].

Raspberry honey is one of the so-called forest varieties. It has a whitish, specific color, after which it can be recognized. It regulates activity of the ovaries, is rejuvenating, prevents the appearance of diseases such as osteoporosis, scleroderma. It is recommended for sweetening teas used as a remedy for colds, and coughs.It is known to rejuvenate the skin [5, 6].

Mint honey is harvested by bees from mint crops spread over tens of hectares. It is used as an antitussive, bronchodilator, gastric sedative, analgesic, antispasmodic. Facilitates digestion, fights bloating. It is rich in vitamin C [5, 6].

2. Method

Physico-chemical indicators of bee honey

Community Directive sets out general definition of honey that may be marketed in European Union. Directive also indicates general and specific compositional characteristics of honey, such as sugar content, moisture, acidity, electrical conductivity, diastase activity and hydroxymethylfurfural (HMF) content.

In addition, labels on honey packaging may be supplemented to include information on regional or topographical origin of product, its floral or vegetable origin or even specific quality criteria [7].

Water content of bee honey evaluation

Water content is one of most important indicators of bee honey, because it influences viscosity, specific gravity, maturity, crystallization, aroma, preservation and its shelf life. Water content of bee honey depends on several factors bee species, flower source, honey harvest period, maturity reached in hive (complete dehydration) as well as climatic factors [8].

Humidity is assessed to determine safety of product in terms of its stability over time as well as risk of its fermentation. High water content results in crystallization of product, favors development of osmophilic microorganisms responsible for fermentation and negatively affects sensory properties, nutritional value and shelf life of honey [8].

Total reducing sugar content of honey determination

By assessing total reducing sugar content, it cannot distinguish between natural and falsified samples of natural honey. To this end, quality analyzes (eg glucose, fructose, sucrose content and fructose / glucose ratio) should be performed. Reducing sugar content depends on various factors (e.g. storage time and even honey collection time). Sugar content of honey is mainly fructose (~ 38% w / v), glucose (~ 31%) and, to a lesser extent, sucrose (~ 1%). Fructose is compound responsible for sweetness of honey, while glucose content depends on source of nectar. Although determination of individual sugar content of monosaccharides (glucose, fructose) or disaccharides (sucrose) is essential, a significant qualification of honey samples should be made by further determining fructose / glucose ratio [9].

Bee honey acidity evaluation

Acidity of honey is due to organic acids (tartaric, citric, oxalic, acetic, etc.), nectar or bee secretions. Acidity of honey can be determined by titration with sodium hydroxide (free acidity) or directly by measuring *pH* value. Natural acidity of honey can be increased by storing and maturing honey, as well as during fermentation of honey. Maximum acidity in European Union is 40 meq / kg [10].

Assessment sucrose content of bee honey

Direct counterfeiting of honey is usually done by directly adding a certain amount of sucrose syrup to the honey. Sucrose syrup could come from sugar beet, maltose syrup, or industrial sugar syrups (glucose and fructose) obtained by heat, enzymatic, or starch treatment. Direct counterfeiting harms consumers and producers of pure honey [11].

Evaluation of ash - total mineral elements in bee honey

Ash is inorganic residue left over after water and organic matter have been removed by heating in presence of oxidizing agents, which provides a measure total amount of minerals in a food [12].

Certain compounds of nitrogen, minerals, vitamins, pigments and aromatic substances contribute to the ash content of honey. The ash content of honey averages about 0.2122% by weight, but varies widely from 0.02 to over 1.0%. Commission Codex Alimentarius (2001) standards for honey, the proposed ash content does not exceed 0.6% for normal honey [13].

Hydroxymethylfurfural (HMF) evaluation in bee honey.

All types of honey are composed of a certain amount of hydroxymethylfurfural (HMF) which is formed due to the action of honey's acidity on reducing sugars based on the Maillard reaction. Main factors influencing the formation of hydroxymethylfurfural (HMF) are, overheating during processing or improper storage. Hydroxymethylfurfural (HMF) content is a very important indicator for assessing quality of honey in terms of its freshness and warmth. Both EU Directive and Codex Standard 12-1981 and its subsequent revisions have set a limit of 40 mg / kg for HMF for honey after processing and a maximum value of 80 mg / kg for honey from countries or regions with tropical temperatures. Most commonly used method of determination for hydroxymethylfurfurol (HMF) is reverse phase UV detector HPLC [14, 15].

Table 1. Physico-chemical indicators of bee honey, international standards [16]

Country/Organ	Moisture content, %	Total reducing sugars %	Sucrose content, %	Acidity meq/kg	Mineral content, %	HMF
EU	21	65	5	40	1	40
FAO/WHO	21-23	65	5-10	40	0.61	80
Spain	22.5	70	3	5	0.6	-
Canada	20	60	8	-	0.25	-
Latin America Codex	20	-	8	54	0.8	-
Argentina	18	-	8	54	0.4	40
Mexico	-	63.9	9	8-52	0.25	-

2. Technological process of conditioning bee honey

Honeycomb removal operation

Tools and equipment used for stripping are: stripping knives and forks, stripping toothed cylinders, manual or professional drills, stripping trays and tables, and semi-automatic or automatic stripping machines [17].

Stripping knives are used to peel honeycombs with even (flat) surfaces in order to extract honey. The main types used are: simple stainless steel and steam or electric heated [17].

Cylinders with teeth for stripping are rolled on the capped surfaces of the combs and their teeth will pierce the cell caps so that the honey can flow out of the cells [17].

Stripping trays and tables serve as a support for honeycomb frames to be stripped before extracting honey and collecting resulting wax caps and spilled honey during operation [17].

Unpacking trays they are made of tinplate, food grade stainless steel or plastic at least 0.5 mm thick, with reinforced edges. Walls are sloping and bottom is fitted with a 2 x 2mm wire mesh. In walls of tray are mounted supports on which frame is placed in a vertical or oblique position for execution of honeycomb opening operation. Under the tray sieve is a honey collection tray with a nozzle and drain plug [17].

A high-yield stripping required in the case of extracting honey from a large number of frames is obtained by means of semi-automatic or electrically operated stripping machines [17].

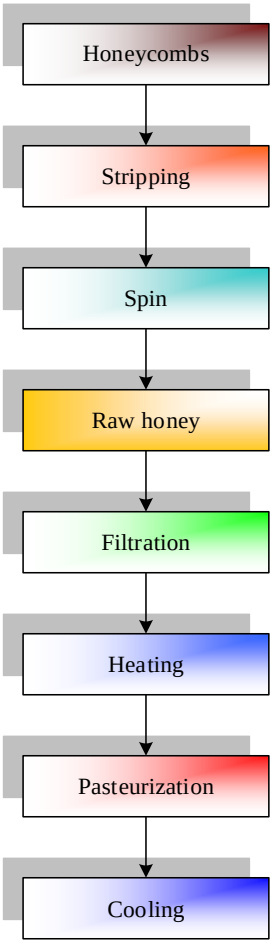

Figure 1. Block diagram for conditioning bee honey

In case of semi-automatic stripping machines, they are equipped with rotating drums and nylon brushes. Honeycomb frames are pushed manually between electric drum rotated by electric motor and detached caps are collected in a container intended for this purpose [17].

Automatic stripping machines automatically perform the operation by taking the frames to order and inserting them into the stripping system which performs the operation of the frames on both sides and collecting the stripping. Drums of release system can be adjusted for different frame sizes. All components are made of food grade stainless steel [17].

Honey extraction by centrifugation

Centrifugal extraction does not provide honey that can be bottled directly. The design of the honey droplets on walls of the extractor has disadvantage that it incorporates a lot of air in the form of microscopic bubbles. Honey particles ripped from honeycomb at time of release also reach the honey, as do fragments of propolis and small amounts of pollen from pollen cells that are more or less in number among honey cells [18].

Squeezing honey is virtually abandoned. It corresponds to an endangered form of beekeeping, that of baskets. Use of hive with movable frames involves extraction of honey by centrifugation and recovery of wax from combs for following year [19].

Centrifugal extractor, invented in last century, has different shapes depending on destination: for a modest operation with a few hives or for a professional enterprise where a few tons or tens of tons of honey are extracted every year. But from hand-operated four-frame puller to forty or eighty frames driven by an electric motor, principle is the same [19].

Tangential extractor has a small capacity for how much space it takes up. It is very suitable for small farms or for extracting honey with high viscosity, because tangential position of frames is more effective than radial position [18].

Radial extractor has advantage of its large capacity - up to eighty large Dadant frames - for a small volume. It does not require resumption of frames. To be complete, extraction takes a longer time [18].

Modern extractors are made exclusively of noble materials. Use of stainless steel and food grade plastic guarantees the cleanliness, hygiene and cleanliness of heavy metals. Electric motor extractors have an automatic clutch, a gearbox, a brake, and most advanced models can be programmed so that rotational speed and extraction time can be optimized without intervention of operator during operation [18].

Centrifugal force to be applied to honey depends on its viscosity, so its water content and temperature. Variations in viscosity depending on floral origin are not greater than in case of hand honey. To facilitate extraction of honey, it is good to work at temperatures high enough to reduce its viscosity.

Prior to extraction, frames can be stored at 25-30 °C in a heated room. Too cold an environment makes extraction difficult [18].

Filtering operation

Filtration is performed to remove debris from lids, any larvae or other impurities in honey. It can be done manually or by mechanical means. Method

and equipment used for filtration depend on amount of honey to be processed. On a small scale, filtration is done using cloth, nylon or stainless steel sieves, which are frequently cleaned to remove particulate deposits. On a large scale, filtering operation is combined with preheating (up to 40 °C), heated pressure filters are used [3, 18].

Heating operation

Best methods of purifying honey are by heating to a controlled temperature. During heating operation, honey is subjected to a double heat treatment. First heat treatment is carried out over a period of 24 hours at a temperature of 50 °C, and crystals formed in honey can be melted and viscosity decreases. It is known that quality of honey is compromised when it undergoes heat processing due to its instability, thermolabile components, decomposition of vitamins and also destruction of integrity of enzymes especially when heated to temperatures above 60 °C. In case of honey intended for large-scale marketing, heating operation is very important, having potential to eliminate microorganisms, facilitating packaging and delaying crystallization. In the case of honey intended for large-scale marketing, heating operation is very important, having potential to eliminate microorganisms, facilitating packaging and delaying crystallization [20].

Pasteurization operation

Pasteurization is process of heating a product to a predetermined temperature for a certain period of time. Pasteurization destroys pathogens and therefore makes products safer for consumption, also improves shelf life by reducing amount of bacteria that contribute to its spoilage [21].

There are many thermal processes to maintain liquid consistency of honey for a longer period of time while increasing its shelf life. High-temperature, short-term heating, pasteurization is widely used in honey industry. Flash pasteurization of bee honey at 80 ° C for 30 seconds, followed by rapid cooling. This method eliminated all fungi and yeasts.

In addition, glucose microcrystals melted and air bubbles were removed, delaying post-processing crystallization [22].

Research by Y. Eshete and T. Eshete has shown that in case of industrial processing of bee honey, pasteurization is rapid heating for a few seconds at 70-78 °C and then rapid cooling to minimize thermal damage. Following pasteurization process, diastase activity and HMF content remain almost unchanged, while invertase is damaged. Heating honey at a temperature of 32-40 °C to reduce viscosity leads to a better efficiency of extraction, straining, filtration and filling in specific packaging. This temperature value is equal to that of hive and does not change physical and chemical indicators of bee honey [20].

2.Conclusion

As regards physico-chemical indicators of bee honey, they must be evaluated in such a way that they do not exceed limits permitted by legislation and rules in force. Physico-chemical indicators of moisture content, total reducing sugars, sucrose content, acidity, mineral content and hydroxymethylfurfurol (HMF) of honey discussed in this paper have limits established by norms and standards in force depending on the origin of its origin.

Technological process presented in this paper includes the following technological operations: honeycomb stripping, honey extraction, filtration, heating and pasteurization. Type of equipment used in stripping and extraction operation is chosen according to amount of honey to be processed. Starting with small processors that in case of stripping operation can use knives and forks for stripping, cylinders with teeth for stripping, manual or professional perforators, trays and tables for stripping respectively for extraction operation of tangential extractor.

In case of unloading operation, the large processors use semi-automatic or automatic unloading machines, electrically operated, latter having the possibility of automatically taking over rames to be unloaded. In terms of extraction in case of large processors are used modern extractors made of noble materials, stainless steel and food grade plastic with additional mechanical elements, electric motor, automatic clutch, gearbox and brake, high-performance models can be automatically programmed thus optimizing extraction without intervention of the operator during operation.

In case of filtering operation, equipment used for small processors is simple on-site filters of different nylon, canvas or stainless steel materials, respectively large processors use heated pressure filters. Heating operation has an important role in terms of reducing viscosity and eliminating crystals

formed in bee honey but must be performed within a maximum of 60 °C due to its instability, in terms of physico-chemical characteristics.

Pasteurization operation aims to maintain the liquid consistency of bee honey for a longer period of time while increasing its shelf life. Flash pasteurization of honey at 80° C for a period of 30 seconds, followed by rapid cooling. This method eliminated all fungi and yeasts. One of the pasteurization methods presented in this paper is carried out at a temperature of 70-78 °C followed by rapid cooling to minimize thermal effects. Following this pasteurization method, diastase activity and HMF content remain almost unchanged, while the invertase is damaged.

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