# Preparation of honey tablet by vacuum cooking

Hojjatpashazadehkelisakand[1], Mustafa Fatih Ertugay[2*]

[1]*Atatürk University, Engineering Faculty, Food Engineering Department, Erzurum/Turkey*

[2] *Erzincan University, Engineering Faculty, Food Engineering Department, Erzincan/Turkey*

***Abstract-****The aim of this study was to obtain healthy a new product called honey tablet instead of adulterated candies for the children and to carry easily with us in daily life. Vacuum cooking was investigated as a potential technique for obtaining honey tablet. For the purpose, honey was treated invacuum cookers at 3 different vacuum pressures (-0.6, -0.7 and -0.8 Bar) and 130°Cfor 8:00, 5:30 and 4:30 minute processing times, respectively. The cooking process was ceased after honey reachedto final Brix (81.25), andhoney that reached to high viscosity was immediately poured to mouldsin order to shape.*

*The effect of vacuum cooking process on honey tablets was investigated by analyzing hydroxymethylfurfural (HMF), diastase number, color and sensorial characteristics. The interaction between operating conditions and HMF, diastase number, color and sensorial characteristics was investigated ($p<0,01$) and it was determined that increasing in HMF and decreasing in diastase number were under limits accepted by International Honey Commission. Furthermore, sensorial and color characteristics of honey tablets were also positively affected by vacuum cooking.*

**Key Words:***Honey tablet, vacuum cooking, honey, diastase, hydroxymethylfurfural*

## 1. INTRODUCTION

Honey produced by bees foraging nectar from flowers composes of 70-80% carbohydrates, 10-20% water and other minor constituents such as organic acids, vitamins, proteins, phenolic compounds, lipids and free amino acids [1],[2]. The physicochemical characteristics of honey, such as high viscosity, consistency and sweetness, are due to the fact that it is actually a natural solution with a high concentration of sugars. Semi-liquid honey (15-18% water) has significantly carbohydrates comprising glucose and fructose[3].

Color, moisture content and viscosity are considered as significant quality parameters. The color of honey may vary according to the geographical origin, the pigment and polyphenol contents [4],[5],[6], [7], and honey may have relatively or completely crystallize form. There is a close relationship between moisture content of honey and its specific weight and deterioration due to intensive sugar solution. Honey which has higher moisture content tends to fermentation by osmophilic yeasts. The significance level of yeast fermentation changes depending on amount of osmophilic yeast spores in the range of 17.1 and 20% while it can be ignored in lower moisture contents than 17%[8]. The moisture content of honey changes depending on temperature, precipitations, vitrification level, filtration and maturation.

The viscosity of honey also depends on its composition and moisture content. Viscosity decreases as temperature and moisture content increase [9]. Viscosity has critical significance during processing and storage. The factor which effects viscosity is the composition of sugars in honey.

Heat treatment has been applied on the purpose of reducing viscosity and moisture content and delaying crystallization before filtration process in the food industry. Lot of textural changes like undesirable hydroxymethylfurfural (HMF) formation, reduction in enzyme activities, color alteration and viscosity reducing has been observed. HMF is one of the significant parameters with regard to determination of honey quality since HMF formation depends on pH, temperature, heat treatment time and sugar concentration[10]. In the other words, fresh honey has practically lower HMF amount, and HMF increases according to heat treatment applied, storage temperature, acidity (pH) and sugar concentration.

The diastase number is also one of the significant quality parameters for honey besides HMF value. Diastase number states that starch amount is hydrolyzed in honey of 100 g for 1 h at 40°C [11]and this number should be at least 8 according to Turkish food codex. In consideration of these quality parameters, the degree of unfavorable alteration occurred by heat treatment can be determined [12], and it can be formed an opinion that the degree or intensity of heat treatment applied[13].

The aim of this study is honey tablet production without causing a significant change in the physical and chemical properties by reducing moisture content at different vacuum levels and 130°C. It is aimed that natural and healthy honey tablets are consumed instead of candies produced by various additives.

* *Corresponding author: Prof. Dr. Mustafa Fatih Ertugay, Erzincan University, Engineering Faculty, Food Engineering Department, Erzincan/Turkey, Phone: +90 532 6714637, Fax. 90 446 2240077.*

## II. MATERIALS and METHODS

### *2.1. Materials*

The extracted honey obtained from flowers in Marmara and Aegean regions was used in the study. 3 kg of honey was weighed for processing in vacuum cooker. The characteristics of extracted honey sample are shown in Table I. The determination of moisture content (by means of refractometric method), free acidity, pH, diastase number, proline, electrical conductivity in extracted honey samples were carried out according to Harmonized Methods of the International Honey Commission [14].

**Table I. The characteristics of extracted honey**

| Characteristics | Value |
|---|---|
| Moisture | 17,3% |
| Free acidity | 26 meq $kg^{-1}$ |
| pH | 4,21 |
| Diastase number | 13,5 |
| HMF | 13,85 mg $kg^{-1}$ |
| Proline | 683 mg $kg^{-1}$ |
| Conductivity | 0,62 ms $cm^{-1}$ |

### 2.2. Methods

### *A. Vacuum cooking (production of honey tablet)*

The extracted honey samples were operated in the vacuum pressures of 0.6, 0.7 and 0.8 bar and operating times of 8, 5:30 and 4:30 minutes, respectively in the vacuum cooker (Chocotech, Princess Candy, Germany) which consists of mixing chamber, vacuum pump, feed hopper and computerized control system. The vacuum cooking was ended until honey samples reached to current brix, and processed honey which has less water content and higher viscosity was immediately poured to mold round shaped. The operating conditions like vacuum pressure, temperature and treatment time were determined according to preliminary tests for honey samples have non-sticky, bright, lower HMF value and higher diastase number. It was gone into production after suitable conditions were determined.

### *B. Hydroxymethylfurfural (HMF)*

HMF analysis for honey tablets was carried out according to standard DIN 10751-3 (DIN 2002). Ten grams of honey was weighed into a beaker, dissolved in 50 ml of distilled water and quantitatively transferred to 100 ml volumetric flask. Honey sample was filtered through a filter paper and stabilized by Carezz solution. The filtrate was prepared for HPLC analysis. Quantitative results were obtained by the external standard method from peak areas of the test and calibration solutions, while their retention times were used for identification. Chromatographic conditions optimized were given in Table II.

**Table II. HPLC conditions**

| | |
|---|---|
| Column | Lichrospher 100RP18EC-5m, L:250 mm, ID:3 mm |
| Mobile phase | 2:98 Methanol:Ultra distilled water |
| Injection volume | 20 µL |
| Detector (UV-VIS) | λ= 284 nm |
| Flow | 0,70 ml/min |
| Retention time | 24 min |

### *C. Color measurement*

CIELAB L* a* b* color parameters were measured by colorimeter (Model CR-200, Minolta Camera Co. Ltd, Osaka, Japan). Samples were placed in petri dishes and readings were taken at three different points and the average values were calculated. Each sample was measured for color values three times. The instrument was calibrated using a white tile (L* = 94.52, a* = 0.36 and b* = 1.04) as standard and then the reflectance was measured.

The CIE color parameters used were L*(Lightness: L*= 100 for white and 0 for black), a* (redness/greenness axis: positive a* is red and negative a* is green), b* (yellowness/blueness axis: positive b* is yellow and negative b* is blue). The chroma ($C= (a^2+ b^2)^{1/2}$) and total color difference ($\Delta E=[(\Delta L^2)+(\Delta a^2)+(\Delta b^2)]^{1/2}$) were calculated using the measured parameters [16].

### *D. Sensorial analysis*

Sensory analyses of honey tablets after vacuum cooking were carried out by twenty panelists. A 9-point scoring scale was employed in the evaluation of the honey tablet characteristics as: appearance, color, brightness, hardness, stickiness, caramel taste, original taste, odor, mouthfeel and general acceptability (where 1 corresponds to “the worst” and 9 to “the best”).

### *E. Statistical analysis*

SPSS software (13.0, SPSS Inc., Chicago, U.S.A) was used for the statistical analysis. All the data were subjected to analysis of variance (ANOVA), and mean values of data were compared at $p<0.01$ significant level using Duncan's multiple range test.

## III. Results and Discussion

The treatments were found significant ($p<0,05$) according to Duncan's multiple-range test results in order to determine which treatment the difference from(Table III).

**Table III. Statistical analysis of HMF value and diastasenumber of honey tablets***

| Treatments | N | HMF | DiastaseNumber |
|---|---|---|---|
| Control | 2 | 13,850 a | 13,450a |
| -0,6 Bar | 2 | 35,150 0b | 11,850b |
| -0,7 Bar | 2 | 34,050 0c | 10,350c |
| -0,8 Bar | 2 | 33,05 00d | 10,350c |

*Means not sharing a common superscript letter within a column are significantly different as assessed by Duncan's by multiple-range test (p<0,05).

Diastase number and HMF content are used together as quality control parameters [17], assuming that they are indicative of the heating intensity to which honey hasbeen treated[18].According to InternationalHoney Commission, the diastase numbershould be notless than or equal to 8 and the EU Directive (110/2001) and the Codex Alimentarius (ALINORM 01/2000) standards limit HMF to 40 $mgkg^{-1}$ for honey [18]. Thermal treatment can produce a decrease in honey quality, which is made evident by a simultaneous reduction in the diastase activity,referred to as diastase number, and an increase in the HMF content [19]. Thermal treatment under different vacuum pressureswas performed on honey samples considering the minimum acceptable diastase number and the maximum acceptableHMFamount (Table III). It was shown that the vacuum cooking did not significantly reduced with regard to diastase number of honey tablets comparing control sample.

The vacuum pressure was found significant on HMF and diastase number of honey tablets according to analysis of variance (p<0,01).The closest HMF value in comparison control sample was obtained for honey tablets processed at 130°C and -0,8 bar vacuum pressure (Figure 1). As shown in Figure 1, HMF concentration decreases as the vacuum pressure increases because of the moisture in honey faster evaporating at higher vacuum pressures. In other words, honey treated was exposed to temperature in a short time. It was also determined that the HMF amount in honey depended on essentially the temperature and processing time in the other studies[21],[22],[3], [20],[23].

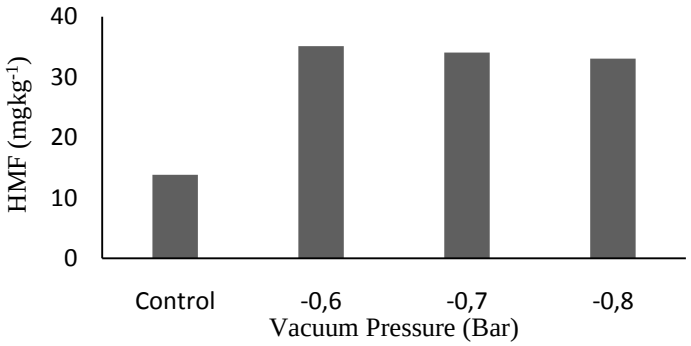


Fig 1.The relationship vacuum pressure and HMF concentration

The color of honey is one of the factors determining its commercial value, and also its acceptability by the consumers. It was significantly affected by the temperature besides the geographical origin, pigment, polyphenol contents etc. Multiple variance analysis was performed to color parameters (*L, a, b, C, ΔE*) and the means of data were compared by Duncan's multiple-range test (p<0,01). The treatments were found significant (p<0,05) according to Duncan's multiple-range test results in order to determine which treatment the difference from (Table IV).

**Table IV. Statistical analysis for color characteristics of honey tablets***

| Treatments | N | *L* | *a* | *b* | *C* | *ΔE* |
|---|---|---|---|---|---|---|
| Control | 2 | 52,2400a | 3,2950a | 37,225a | 37,3700a | - |
| -0.6 Bar | 2 | 46,0800b | 4,9900b | 8,8500b | 10,1650b | 29,0650a |
| -0.7 Bar | 2 | 39,8150c | 5,0800c | 9,2300c | 10,5350c | 30,6600b |
| -0.8 Bar | 2 | 39,2700d | 9,2150d | 11,0450d | 14,6950d | 29,4450c |

*Means not sharing a common superscript letter within a column are significantly different as assessed by Duncan'smultiple-range test
(p<0,05).

Table IV shows that the all color parameters are significantly different from those ofcontrol.This can be explained by browning and losing moisture in honey tablet associated with increasing temperature. The similar results were obtained by other researchers [24],[25].

The sensorial analysis was performed with the purpose of determining consumer preference, and appearance, hardness, stickiness, original taste, mouthfeel, color, caramel taste andodorwere found significant (p<0,05) while brightness and general acceptability were found insignificant (p<0,01) according to variance analysis.

**Table V.Statistical analysis for sensorial characteristics of honey tablets***

| Treatments | N | Appearance | Color | Brightness | Hardness | Stickiness | Caramel taste | Original taste | Odor | Mouthfeel | General acceptability |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -0,6 Bar | 2 | 6,3150a | 7,3800a | 6,8650a | 5,6300a | 6,1800a | 6,9550a | 7,2250a | 7,4500a | 6,3150a | 6,34750a |
| -0,7 Bar | 2 | 6,9500b | 7,3050ab | 6,9150a | 6,6150b | 6,4500b | 6,6500b | 7,9500b | 7,3150a | 6,8400b | 7,02550a |
| -0,8 Bar | 2 | 7,3550c | 7,0800b | 7,0500a | 6,5800b | 7,0500c | 6,6050b | 7,7100c | 7,1000d | 6,7650b | 7,00600a |

*Means not sharing a common superscript letter within a column are significantly different as assessed by Duncan'smultiple-range test ($p<0,05$).

The results obtained in the present study indicate that honey tablets submitted to vacuum cooking presented good acceptability. Consequently, taking into consideration the significant issue of stingless bee honey conservation resulting from its high moisture content, dehumidificationemerges as a promising technique, preventing honey fermentation and consequent deterioration.

## ACKNOWLEDGEMENT

This study was carried out in Elvan Food Industry and Trade Inc. and the authors are grateful to for the technical support of this work.

## REFERENCES

[1] S. Ouchemoukh, H. Louaileche, and P. Schweitzer, “Physicochemical characteristics and pollen spectrum of some Algerian honeys” Food Control, vol.18, pp. 52-58, 2007.

[2] S. Gomes, L. G. Dias, L. L. Moreira, P. Rodrigues, andL. Estevinho,“Physicochemical, microbiological and anti-microbial properties of commercial honeys from Portugal” Food and Chemical Toxicology, vol. 48, pp. 544-548, 2010.

[3] B. Fallıco, M. Zappala, E. Arena, and A. Verzera, “Effects of Conditioning on HMF Content in Unifloral Honeys” Food Chemistry, vol.85, pp.305–313, 2004.

[4] M. O. Iurlina, A. I. Saiz, R. Fritz, and G. D. Manrique, “Major flavonoids of Argentinean honeys. Optimization of the extraction method and analysis of their content in relationship to the geographical source of honeys” Food Chem., vol. 115, pp.1141–1149, 2009.

[5] I. K. Karabagias, A. Badeka, S. Kontakos, S. Karabournioti, and M. G. Kontominas, “Characterization and classification of *Thymus capitatus*(L.) honey according to geographical origin based on volatile compounds, physicochemical parameters and chemometrics” Food Res. Int., vol.55, pp. 363–372, 2014.

[6] M. F. Silvano, M. S. Varela, M. A. Palacio, S. Ruffinengo, and D. K. Yamul, “Physicochemical parameters and sensory properties of honeys from Buenos Aires region” Food Chem., vol.152, pp.500–507., 2014.

[7] C. I. G. Tuberoso, I. Jerkovic, G. Sarais, F. Congiu, Z. Marijanovic, and P. Marek Kus, “Color evaluation of seventeen European unifloral honey types by means of spectrophotometrically determined CIE L*C*$_{ab}$ h$^{0ab}$ chromaticity coordinates” Food Chem.,vol. 145, pp. 284–291, 2014.

[8] H. D.Belitz, W.Grosch, and P. Schieberle, Food Chemistry (4th ed.). Springer-Verlag, pp. 883–891, 2009.

[9] S. Yanniotis, S. Skaltsi, andS. Karaburnioti, “Effect of moisture content on the viscosity of honey at different temperatures” Journal of Food Engineering, vol. 72, pp. 372-377, 2006.

[10] D. DindarCapar,“Determination of Physicochemical Properties and Mineral Composition of Pine Honey in Turkey and Their Changes During Storage” MS Thesis,Selcuk University, pp. 1-46, Konya, 2010.

[11] E. Tosi, R. Martinet, M. Ortega, H. Lucero, and E. Re, “Honey diastase activity modified by heating” Food Chemistry, vol. 106, pp. 883–887, 2008.

[12] S. Bogdanov,“Liquefaction of honey”Apiacta, vol.28, pp.4-10,1993.

[13] M. A. Ramirez Cervantes, S. A. Gonzalez Novelo, and E. SauriDuch, “Effect of the temporary thermic treatment of honey on variation of the same during storage”Apiacta, vol.35, No 4, pp.162–170, 2000.

[14] S. Bogdanov, Harmonized Methods of the International Honey Commission. International Honey Commission, pp.1–62, 2002.

[15] DIN 10751-3: 2002-02, “Determining the hydroxymethylfurfural content of honey by high performance liquid chromatography”, 2002.

[16] F. W. Bilmeyer, and M. Saltzman, Principles of Color Technology, 2nd ed. New York: John Wiley and Sons, p. 63, 1981.

[17] S. Bogdanov, P. Martin, and C. Lüllmann, “Harmonized methods of the European honey commission”,Apidologie (extra issue), pp. 1-59, 1997.

[18] R. Rotarescu, and C. Vidican,“Impact’s assessment of thermal processing and storage conditions on enzymatic activity and HMF content in honey” Carpathian Journal of Food Science and Technology, vol. 2, No 1, pp. 1–13, 2010.

[19] Codex Alimentarius, Alinorm 01/25, Draft Revised Standard for Honey at Step 8 of the Codex Procedure; EU Directive /1/110/2001 of 02/12/2001 (L 10/47), 2000.

[20] E. Tosi, H. Lucero, E. Re, and L. Bulacio, “Effect of honey high-temperature short-time heating on parameters related to quality, crystallization phenomena and fungal inhibition”Lebensm.-Wiss. u.-Technol., vol. 37, pp. 669–678, 2004.

[21] P.K.Bath and N.Singh,“Effect of microwave heating on hydroxymethylfurfural formation and browning in Helianthus annuus and Eucalyptus lanceolatus honey” Journal of Food Science and Technology-Mysore, vol.38,pp.366–368, 2001.

[22] H. U. Hebbar, K. E. Nandini, M. Ch. Lakshmi, and R. Subramanian, “Microwave and infrared heat processing of honey and its quality” Food Science and Technology Research, vol9,pp. 49–53, 2003.

[23] K. Bartáková, M. Dračková, I. Borkovcová, and L. Vorlová, “Impact of Microwave Heating on Hydroxymethylfurfural Content in Czech Honeys” Czech J. Food Sci., vol.29, No 4, pp.328-336, 2011.

[24] N. Turkmen, F. Sari, E. S. Poyrazoglu, and Y. S. Velioglu,“Effects of prolonged heating on antioxidant activity and colorof honey” Food Chemistry,vol. 95, pp. 653–657, 2006.

[25] Z. Cui, L. Sun, W. Chen, and D. Sun,“Preparation of dry honey by microwave–vacuum drying” Journal of Food Engineering, vol. 84, pp.582–590, 2008.