J. Agric. Sci. Mansoura Univ., 30 (9): 5653 - 5660, 2005

EFFECT OF TEMPORARY THERMIC TREATMENTS ON THE QUALITY OF SOME EGYPTIAN BEE HONEYS

Mazeed, A. M. M.
Department of Economic Entomology and Pesticides, Faculty of Agriculture, Cairo University, Giza, Egypt

ABSTRACT

Three honey types of different botanical origin were heated in a water bath at 40°C, 50°C. and 60°C for half, one and two hours. Hydroxymethylfurfural (HMF), enzymes activity, including diastase, invertase, and catalase, and both proline content and electrical conductivity (EC) were determined for all samples before and after heating treatments. The obtained results indicated an increase of HMF content with increasing temperature degree and period with different ratios according to honey types. For all enzymes under study, there was a tendency of activity declining with increasing of heating temperature and period. After two hours of exposure period at 60°C, the rate of activity declining was greater in catalase (87%) than diastase (63%) and invertase (56%). Proline content as well as electrical conductivity did not show sensitivity towards both heating temperature and period.

INTRODUCTION

Honey is an extremely variable mixture of many components. Its composition reflects contributions of the plant, climate and other environmental conditions and beekeepers skills. Enzymes are among the most important components of honey, because they play a vital role in the production of honey from its ultimate raw plant materials. Enzymes are heat-sensitive and an extra low level may indicate that the honey has been overheated (Crane, 1990).

The determination of honey enzymes and HMF content is the most characteristics used as indicators for detecting honey misrepresentation or detecting heat-induced defects in honey (Ruolf and Bogdanov, 2004).

Nour and Al-Jabr (2001) stated that heating honeys at 100°C led to a full destroy of diastase, invertase and glucose-oxidase enzymes in Saudi honey. According to Dustmann *et al* (1984) the invertase activity is a very important indicator for honey quality. Schade et al (1958) found that a very low quantity of diastase indicated that honey had been subjected to unfavorable temperature conditions. White (1992) suggested that diastase content is not useful in evaluating honey quality and especially heating, while HMF is more appropriate and can provide all the informations needed to estimate the effect of heat exposure of any honey. Dustmann (1993) maintained that invertase in combination with other analytical criteria can detect damage by heating or overstorage, and also HMF is rather inappropriate for the proof of heat damage, if taken into account as a sole criterion.

Heating honey is a common practice for many of both beekeepers and customers, in order to prevent or delay granulation. For Beekeepers and honey processors, honey is heated to kill yeasts that may be present and thereby prevent fermentation; it will also lower the viscosity, which greatly eases the flow of honey to facilitate straining, handling and packing (Morse and Hopper, 1985).

For customers, granulated honey is needed to be liquefied by heating, in order to be easily used as a food. Recently, there has been an increasing demand of fresh honey that has not been heated, because it is thought that heating of honey reduce its quality.

So, the aim of the present work is to evaluate the effect of some heating treatments on the properties of three honey types in Egypt.

MATERIALS AND METHODS

Three fresh Egyptian honey types (Citrus, Clover and Cotton) were used in this study. The honey samples were collected from different beekeepers in spring and summer seasons, 2005. The botanical origin of the three tested honeys was verified by carrying out pollen analysis according to (Louveaux *et al*, 1978)

One sample from each honey type was kept unheated and the rest were placed in a water bath at different temperatures and for different periods as follows:

1- 40°C for 1/2 , 1 and 2 hours,
2- 50°C for 1/2 , 1 and 2 hours,
3- 60°C for 1/2, 1 and 2 hours.

The tested honey samples were analyzed for detecting the following parameters:

1. The content of Hydroxynethylfurfural (HMF, mg/kg. honey) in honey was measured according to the method of Winkler (1955).
2. Diastase activity (diastase number) was detected by the spectrophotometric method of Schade *et al.* (1958),
3. Invertase activity (U./kg.honey) was determined based on colorimetric method of Bogdanov *et al* (1997).
4. Catalase activity (K) was assessed according to Bergmeyer (1970).
5. Proline content (ppm) was determined according to Bogdanov (1997),
6. Electrical conductivity (EC, ms/cm)) of honey was measured according to the method of Bogdanov *et al* (1997).

The obtained results were subjected to analysis of variance by using Almo-Statistic-Program (Holm, 2004)

RESULTS AND DISCUSSION

Data presented in Table (1) and Figure (1) showed that, HMF content increased gradually with increasing of heating temperature and period in all types of honeys, although with different ratios. After applying the different heating degrees and periods, it was noticed that a vast increase in HMF concentration in Cotton honey has taken place in comparison with Citrus and Clover honeys. The increase of the HMF content during heating was significantly higher in the Cotton honey than in both Citrus and Clover ones ($P < 0.001$).

As shown in Table (1), the value of HMF content was duplicated at 40°C in both Clover and Citrus honey, when the exposure periods were 1- and 2-hours, respectively. The same trend was recorded at 50°C, but at 60°C the value was duplicated for periods of ½- and 1-hour in Clover and Citrus honey,

respectively. In Cotton honey, the HMF content reached a value of more than 15 folds (40.1 mg/kg) as great as that in the control sample at 40°C for ½ hour. The accumulation rate of HMF was shown to vary among honeys under similar heating temperature, as mentioned by Schade *et al* (1958); Kubis and Ingr (2003).

Table (1): The values of 6 characteristics of three sorts of honeys before and after applying different heating degrees for different exposure times.

Honey type	Heating temperature	Heating period	HMF (mg/kg)	Diastase number (DN)	Invertase (U/kg)	Catalase (K*)	Proline (ppm)	EC (ms/cm)
Citrus	40 °C	½ hour	9.6	4.2	13.5	0.036	709.19	0.17
		1 hour	11.52	4.2	10.80	0.025	639.99	0.16
		2 hour	13.44	3.3	9.85	0.024	639.99	0.16
	50°C	½ hour	9.6	6	12.55	0.035	674.59	0.14
		1 hour	11.52	4.2	12.39	0.021	639.99	0.16
		2 hour	15.36	3	9.53	0.012	622.7	0.16
	60°C	½ hour	13.4	6	13.03	0.028	674.59	0.16
		1 hour	15.36	3.15	7.47	0.019	674.59	0.16
		2 hour	20.16	2.7	5.08	0.006	657.29	0.12
	Control		**7.68**	**5**	**13.98**	**0.043**	**622.7**	**0.16**
Clover	40 °C	½ hour	2.88	6.57	25.43	0.051	709.19	0.14
		1 hour	4.22	3	22.89	0.032	674.59	0.14
		2 hour	7.68	2.5	19.07	0.028	726.48	0.14
	50°C	½ hour	1.92	7.5	23.84	0.054	743.78	0.14
		1 hour	5.76	3.3	22.25	0.042	761	0.14
		2 hour	7.78	2.3	16.37	0.001	743.78	0.14
	60°C	½ hour	4.6	6	21.3	0.033	743.78	0.14
		1 hour	7.68	4.6	14.78	0.02	743.78	0.14
		2 hour	11.52	2.14	10.17	0.004	743.78	0.16
	Control		**1.92**	**7.5**	**28.93**	**0.05**	**726.48**	**0.16**
Cotton	40 °C	½ hour	40.1	6.57	14.3	0.041	761	0.42
		1 hour	67.2	4.61	13.83	0.024	709.19	0.44
		2 hour	84.48	2.14	10.33	0.02	743.78	0.45
	50°C	½ hour	32.64	6	13.98	0.037	709.19	0.42
		1 hour	72.96	5.45	12.87	0.028	709.19	0.42
		2 hour	84.48	2	11.12	0.015	726.48	0.44
	60°C 6	½ hour	71.04	6.75	13.66	0.025	726.48	0.44
		1 hour	80.64	3.52	11.76	0.021	743.78	0.45
		2 hour	97.92	1.76	9.37	0.007	726.48	0.39
	Control		**3.8**	**6.57**	**15.87**	**0.041**	**726.48**	**0.44**

*** factor of enzyme activity.**

Regards to the enzymes, there was a decrease of their activity with different ratios after the exposure to the different heating treatments. The decomposition of Invertase was faster in both Citrus and Clover than in Cotton honey. Additionally, both heating degrees and periods affected the decrease of the enzyme significantly ($P < 0.001$). The enzyme was more sensitive to the

heating periods than the different heating degrees (Table,2). In both Citrus and Clover honey, the level of the enzyme reached about half as great as that in the control sample at 60°C for 1-hour-heating period, but it did not reach that level in Cotton honey (Table,1 and Fig.2)

Diastase was affected by heating period to which the honeys were s... ...ted (P< 0.001). The sensitivity to heating period was affected by the honey types (Table 2).The effect of heating degrees and honey types on the decrease of the enzyme concentration was not significant. The activity of diastase reached its ...wer value, which represent less than the half-value of the non-heated honey (except in Citrus honey at 60°C), when the exposure period reached 2-hours at 40°C, 50°C, and 60°C (Table,1 and Fig. 3).

The catalase enzyme showed a significant reaction to the three factors under study (Table, 2). The results also showed a significant interaction between both heating degrees and periods. The effect of heating period was stronger than the effect of heating degrees on the decrease of the enzyme activity (Table, 2). In Citrus Honey, the enzyme content decreased to about half as great as that in control sample at 50°C for 1-hour. The same trend was observed in both Clover and Cotton honeys, but at 40°C for 2 hour heating period (Fig.4)

Table (2): Significant effect of honey types (A), heating degrees (B) and heating times (C) on 6 honey parameters after applying three-way analysis of variance. (ns = non significant)

Source of variation	HMF	Diastase	Invertase	Catalase	Proline	EC
A	P < 0.001	ns	P < 0.001	P < 0.01	P <0.001	P <0.001
B	P < 0.01	ns	P < 0.001	P < 0.01	ns	ns
C	P < 0.001	P <0.001	P < 0.001	P <0.001	ns	ns
AB	ns	ns	P < 0.05	ns	P < 0.05	ns
AC	P < 0.001	P < 0.05	P < 0.001	ns	P < 0.05	ns
BC	ns	ns	P < 0.05	P < 0.05	ns	ns

Both of Proline content and electerical conductivity of honey were not affected by heating levels or periods (Table,1). Both Parameters did not show a significant reaction towards both of heating degrees and periods (P> 0.05; Table 2). Only honey type has a significant effect on the quantity of proline, the Clover honey showing significantly lower values than in both Citrus and Cotton honeys. As in the case of proline, only the sort of honey affected electrical conductivity significantly (P < 0.001), the Cotton honey having the highst values in comparison with Citrus and Clover honey (Table, 1).

As the results indicated, the three factors (honey type, heating degrees, and heating periods) affected the parameters under study differently. There was an increase in HMF content and a decrease of Diastase, Invertase and Catalase activity. The resistance to heat is sometimes different according to botanical origin of the honey.

Although the initial values of HMF in Citrus honey was higher than Cotton honey, the concentration of this parameter increased seriously in Cotton than in Citrus honey.

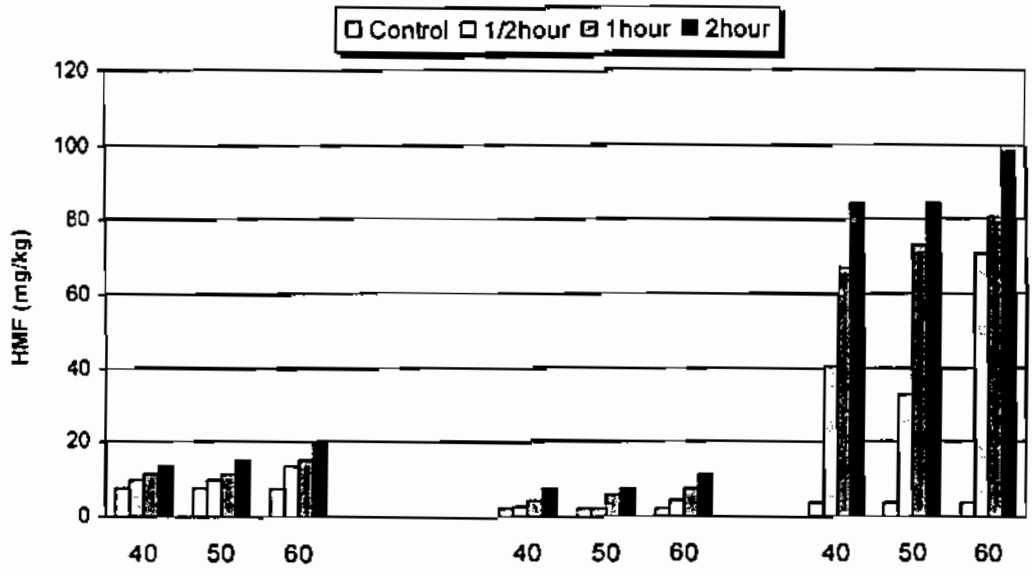

Figure (1): Effect of temperature degrees (40, 50 and 60°C) and different heating periods (1/2, 1, 2 hours) on the hydroxymethylfurfural (HMF) content in Citrus, Clover and Cotton honey

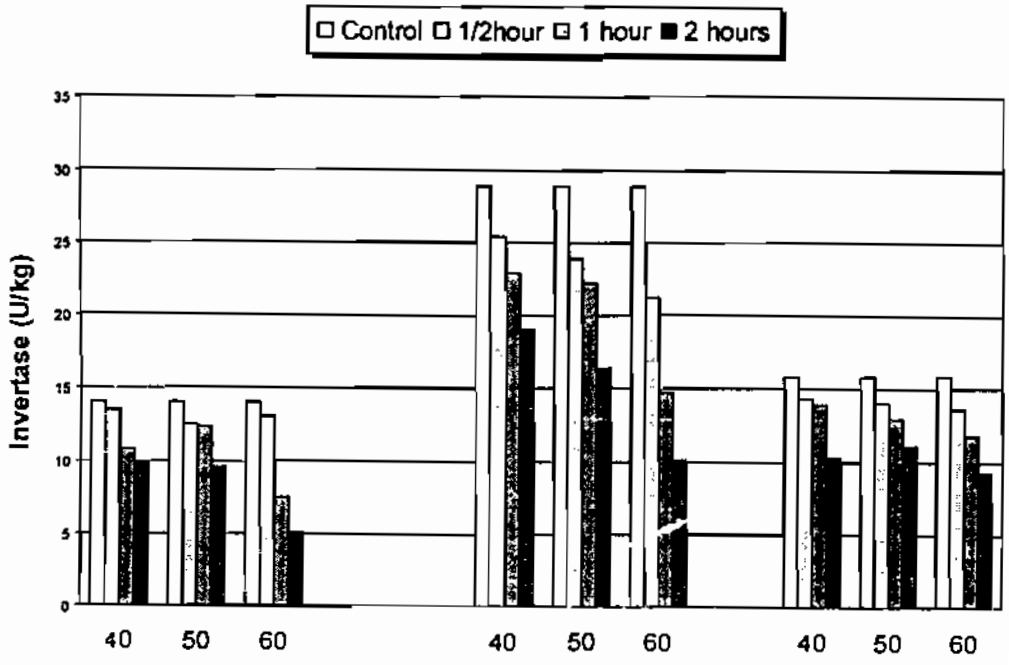

Figure (2): Effect of temperature degrees (40, 50 and 60°C) and different heating periods (1/2, 1. 2 hours) on invertase activity in Citrus, Clover and Cotton honey

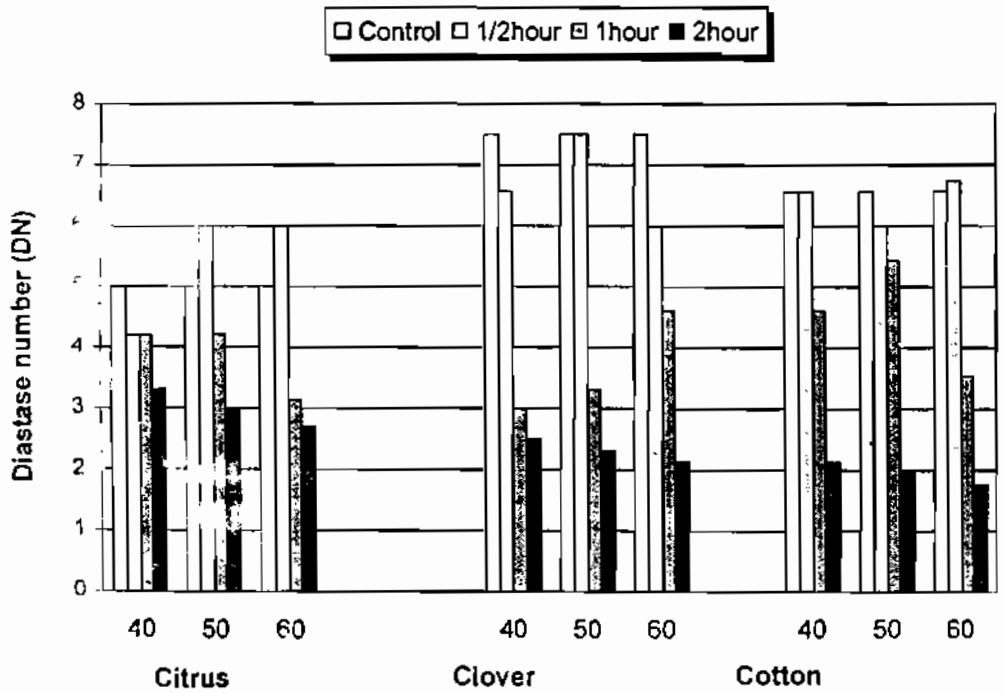

Figure (3): Effect of temperature degrees (40, 50 and 60°C) and different heating periods (1/2, 1, 2 hours) on diastase activity in Citrus, Clover and Cotton honey.

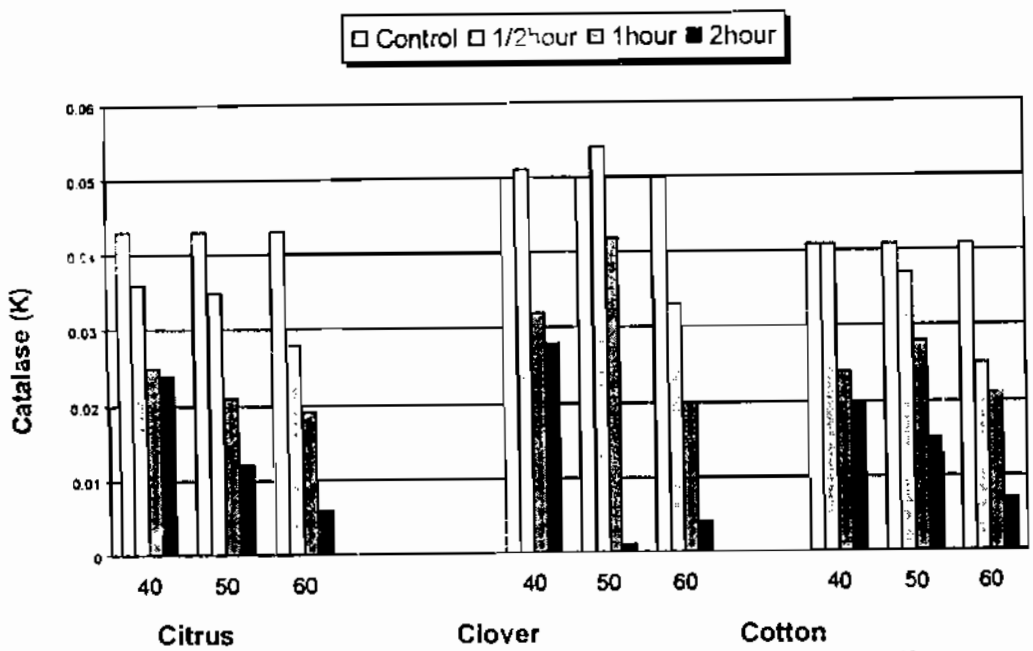

Figure (4): Effect of temperature degrees (40, 50 and 60°C) and different heating periods (1/2, 1, 2 hours) on catalase activity in Citrus, Clover and Cotton honey .

The Codex Alimentarius (1998) and Egyptian Standard (2003) allow a maximum HMF content of 40 mg/kg. The previous value was obtained when Cotton honey was heated at 40°C for half an hour (40.1 mg/kg), but not in the other honey sorts The maximum values were 20.16 and 11.52 mg/kg, at 60 °C for two hours, for Citrus and Clover honey, respectively. Accordingly, the cotton honey is much more sensitive to heating than the other types concerning HMF.

As shown in Table (1), the change of honey enzymes activity, after applying the different heating degrees and periods, followed similar behavior, although according to different ratios. By exposure the different honey types at 60°C heating for two hours, it had lost about 46%, 72% and 73% of the diastase activity in Citrus, Clover and Cotton honeys, respectively, while in invertase the decrease was by 64%, 65% and 41% for the three types of honeys. In catalase, the decrease of the activity was obviously higher in the three types than in invertase and diastase honeys at 60°C for 2-hours (86%, 92% and 83%, respectively).

Both of proline content and the electrical conductivity of the three kinds of honey did not show sensitivity towards both of heating degrees and periods; they showed sensitivity towards honey type (Table, 2), which indicated their useful use as a characteristic of the botanical origin of bee honey (Horn and Luellmann, 2002; Von der Ohe *et al*, 1991),

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تأثير التسخين المؤقت على جودة بعض الأعسال المصرية

عادل محمود محمد مزيد

قسم الحشرات الاقتصادية والمبيدات – كلية الزراعة – جامعة القاهرة – القاهرة – مصر

تم تعريض ثلاثة أنواع من الأعسال المصرية للتسخين فى حمام مائى على درجات حرارة ٤٠، ٥٠، ٦٠ م لمدد تسخين ٣٠، ٦، ١٢٠ دقيقه. وقد تم تقدير بعض خصائص هذه الأعسال مُمثلة فى محتوى مادة هيدروكسى ميثيل فورفورال ونشاط انزيم الدياستيز والانفرتيز والكتاليز بالاضافة الى البرولين وخاصية التوصيل الكهربى، وذلك قبل وبعد تطبيق معاملات التسخين المختلفة عليها. وقد أظهرت النتائج تأثر محتوى هذه الاعسال من مادة هيدروكسى ميثيل فورفورال بارتفاع الحرارة وبدرجات مختلفة، حيث زاد تركيز هذه المادة بزيادة كلا من درجة الحرارة ومدة التسخين؛ كما أوضحت النتائج انخفاض نشاط الانزيمات تحت الدراسة بزيادة درجة الحرارة ومدة التعريض اليها، وقد كان معدل هذه الانخفاض أكبر فى انزيم الكتاليز(٨٧%) عنه فى الانفرتيز(٥٦%) والدياستيز(٦٣%) عند التسخين على درجة ٦٠ م ولمدة ساعتين، فى حين لم يتأثر التوصيل الكهربى ومحتوى العسل من مادة البرولين بمعاملات التسخين المختلفة.