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Optimizing the thermal processing of honey by studying the physicochemical properties and its hydroxymethylfurfural content

S. Seyyedi-Mansour [1], P. Donn[1], P. Garcia-Oliveira[1,2], J. Echave [1], F. Chamorro [1], A.G. Pereira [1,2], A. Silva [3,1], A. Perez-Vazquez[1], J. Simal-Gandara [1], M.A. Prieto [1,2,*] and L. Roufegari-nejad[4,*]

[1] Nutrition and Bromatology Group, Department of Analytical and Food Chemistry, Faculty of Food Science and Technology, University of Vigo, Ourense Campus, E32004 Ourense, Spain.

[2] Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolonia, 5300-253 Bragança, Portugal.

[3] LAQV-REQUIMTE Department of Chemistry and Biochemistry. Faculty of Sciences. University of Porto. Rua do Campo Alegre s/n 4169-007 Porto, Portugal.

[4] Department of Food Science and Technology, Azad University, Tabriz branch, Iran Basmenj road, 5157944533, Tabriz, Iran.

* **Correspondence**: mprieto@uvigo.es, L.roufegari@iaut.ac.ir.

INTRODUCTION

Honey, due to its valuable nutritious components and antimicrobial and antioxidative effects, has a nutritional importance [1]. Honey producers heat honey in order to prevent post-bottling crystallization and delay microbial spoilage. In spite of its desirable effects, heating causes some deterioration in honey's physicochemical properties and leads to the formation of unhealthy components such as hydroxyl methyl furfural (HMF) [2]. The formation of this compound during heat treatment is one of the major challenges of consumer safety, and because of its carcinogenic and mutagenic effects, there is strong research potential to achieve the legal levels of food safety. The maximum level of HMF in honey is set at 40 ppm under the codex standards [3]. Thus, the modeling and identification of a relationship between different heat treatment and storage parameters could be a reasonable approach to optimize the process and increase the quality and safety of the end product.

METHODS

This research applied Response Surface Methodology (RSM) and Central Composite Design (CCD) to 1) survey independent variable effects such as heating pasteurization temperature (55, 65 and 75(°C), time of heating (10, 20 and 30 min) and storage temperature (25 and 40(°C) on physicochemical properties (moisture content, pH, color parameters) and HMF formation at the two different storage time (45 and 90 days); 2) find the optimal conditions to minimize the HMF formation (Table 1).

Table 1. Central composite design (by Minitab 16 software)

Run Order	Block	Heating pasteurization temperature (°C)	Time of heating (min)	Storage temperature (°C)
1	1	65	20	25
2	1	55	30	25
3	1	55	10	25
4	1	75	10	25
5	1	65	20	25
6	1	65	20	25
7	1	75	30	25
8	2	65	20	40
9	2	65	30	40
10	2	65	20	40
11	2	65	10	40
12	2	55	20	40
13	2	75	20	40
14	2	65	20	40

RESULTS

The results showed that the heating, processing time, and storage time had no effect on the pH, moisture, or color (data not shown), while the storage temperature had a significant effect on the L* and a* parameters. All the studied factors showed a significant effect on HMF formation ($p < 0.05$), indicating that this content was significantly increased with the increasing heating time, temperature, and storage conditions (Figure 1, 2). From the optimization study, it can be concluded that the minimum content of HMF resulted from heating the honey at 55 C for 10 min and keeping it at 25 C for 45 days. These processing and storage conditions could help us to find the best operation conditions with which to preserve both the quality and safety of honey.

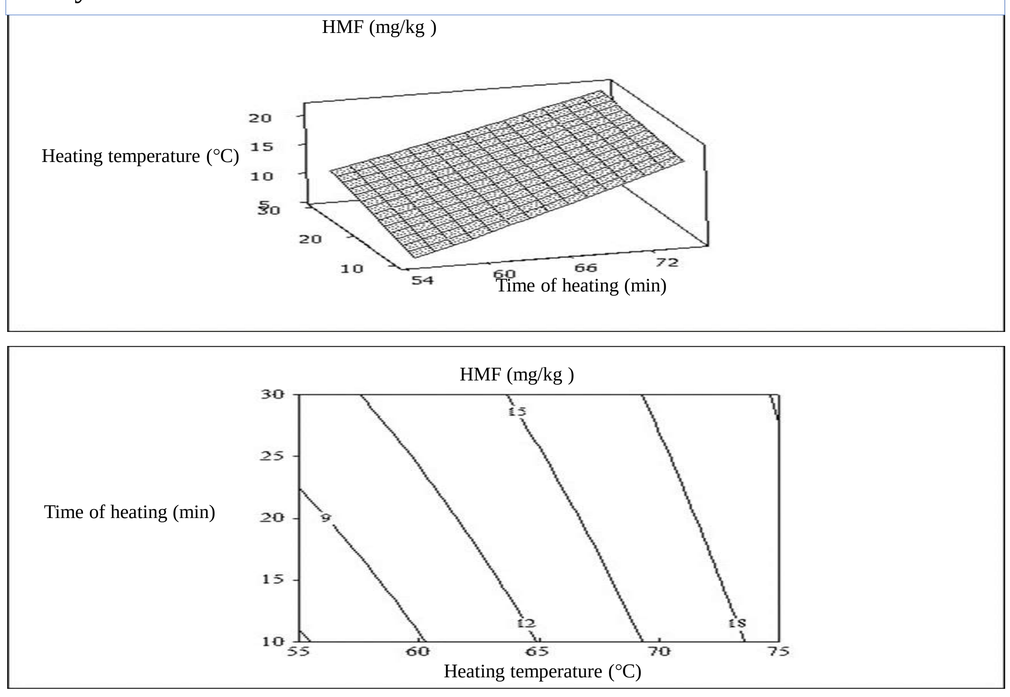

Figure 1. The effect of thermal process temperature on the amount of hydroxymethylfurfural during 45 days storage

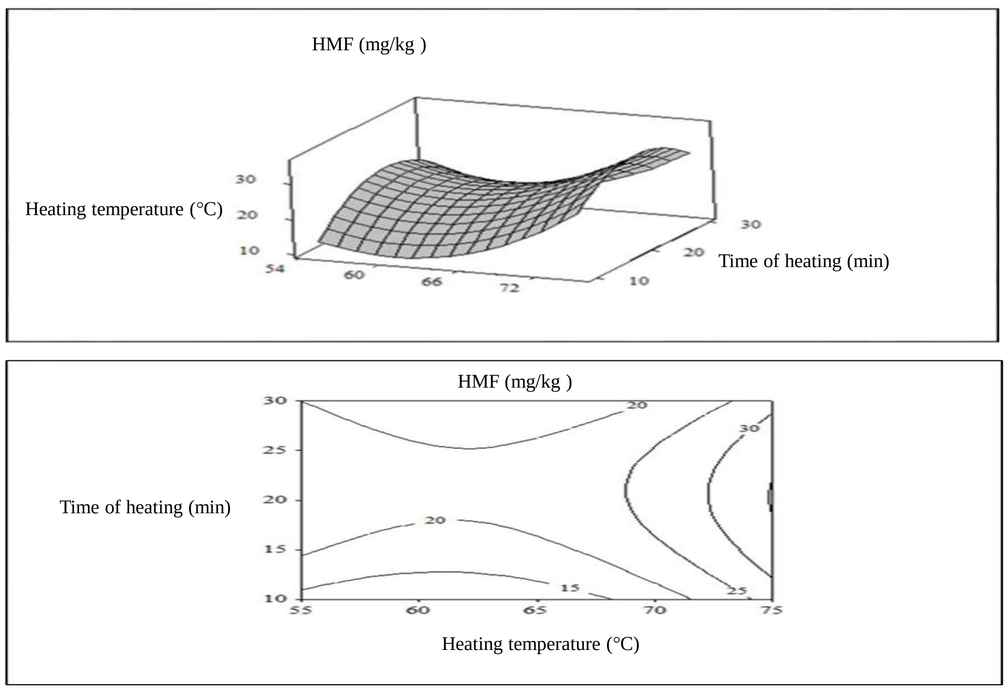

Figure 2. The effect of thermal process temperature on the amount of hydroxymethylfurfural during 90 days storage

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