



GRUPPO SCIENTIFICO ITALIANO di
CONFEZIONAMENTO ALIMENTARE

Primo Convegno
Nazionale

Shelf-life degli alimenti confezionati

Milano 11-13 giugno 2003

a cura di
LUCIANO PIERGIOVANNI e SARA LIMBO

Special Issue

ITALIAN JOURNAL
OF
FOOD SCIENCE



GRUPPO SCIENTIFICO ITALIANO di
CONFEZIONAMENTO ALIMENTARE

Primo Convegno
Nazionale

Shelf-life degli alimenti confezionati

Milano 11-13 giugno 2003

a cura di
LUCIANO PIERGIOVANNI e SARA LIMBO

Special Issue

ITALIAN JOURNAL
OF
FOOD SCIENCE



La stampa degli atti del Convegno è stata realizzata con il contributo del cofinanziamento MIUR al programma di ricerca di interesse nazionale “Studio degli effetti di basse e bassissime pressioni parziali di ossigeno sulla qualità degli alimenti al consumo” COFIN 2002.

A cura di Luciano Piergiovanni e Sara Limbo

ISBN 1120-1770 © 2004

ITALIAN JOURNAL OF FOOD SCIENCE

(RIVISTA ITALIANA DI SCIENZA DEGLI ALIMENTI)

Property of the University of Perugia

“Official Journal of the Italian Society of Food Science and Technology -
Società Italiana di Scienze e Tecnologie Alimentari (S.I.S.T.A.I)”

Supported in part by the Italian Research Council (CNR) - Roma - Italy

Editor-in-Chief:

Paolo Fantozzi

Dipartimento di Scienze degli Alimenti, Università di Perugia, S. Costanzo, I-06126 Perugia, Italy

Tel. +39 075 5857910 - Telex 662078 UNIPG - Telefax +39 075 5857939-5852067

E-mail: paolofan@unipg.it

Assistant Editor:

S. Mary F. Traynor, F.S.E.

Dipartimento di Scienze degli Alimenti, Università di Perugia, S. Costanzo, I-06126 Perugia, Italy

Tel. +39 075 5857912 - Telex 662078 UNIPG - Telefax +39 075 5857939-5852067

E-mail: ijfs@unipg.it

Publisher:

Alberto Chiriotti

Chiriotti Editori s.p.a., Viale Rimembranza 60, I-10064 Pinerolo, Italy

Tel. +39 0121 393127 - Telefax +39 0121 794480

E-mail: info@chiriottieditori.it - URL: www.chiriottieditori.it

Aim: The Italian Journal of Food Science is an international journal publishing original, basic and applied papers, reviews, short communications, surveys and opinions in food science (chemistry, analysis, microbiology), food technology (engineering, processing) and related areas (nutrition, safety, toxicity, physiology, dietetics, economics, etc.). Upon request and free of charge, announcements of congresses, presentations of research institutes, books and proceedings may also be published in a special “News” section.

Review Policy:

The Advisory Board with the Editor-in-Chief will select submitted manuscripts in relationship to their innovative and original content. Referees will be selected from the Advisory Board and/or from the “IJFS Official Referee List” composed of 200 qualified Italian or foreign scientists. Acceptance of a paper rests with the referees.

Frequency: Quarterly - One volume in four issues. Guide for Authors and annual indices will be published only in number 4 of each volume.

Impact Factor: 0.639 published in the 2002 Journal of Citation Reports, Institute for Scientific Information

Subscription Rate: 2004: Volume XVI

Ordinary	€	120.00
Supporting	€	500.00

IJFS is abstracted/indexed in: Chemical Abstracts Service (USA); Foods Adlibra Publ. (USA); Gialine - Ensia (F); Institut Information Sci. Acad. Sciences (Russia); Institute for Scientific Information; CurrentContents®/AB&ES; SciSearch® (USA-GB); Int. Food Information Service - IFIS (D); Int. Food Information Service - IFIS (UK); EBSCO Publishing.

IJFS has a page charge of € 20.00 up to 5 pages; extra pages are € 30.00.

Reprints (100) will be sent free of charge.

COMITATO SCIENTIFICO

Domenico ACIERNO, Università degli Studi di Napoli
Clelia ALTIERI, Università degli Studi di Foggia
Gianpaolo ANDRICH, Università degli Studi di Pisa
Davide BARBANTI, Università degli Studi di Ancona
Mario BERTUCCIOLI, Università degli Studi di Firenze
Cinzia CAGGIA, Università degli Studi di Catania
Raimondo Edoardo CUBADDA, Università degli Studi del Molise
Marco DALLA ROSA, Università degli Studi di Bologna
Alessandro Matteo DEL NOBILE, Università degli Studi di Foggia
Paolo FANTOZZI, Università degli Studi di Perugia
Giovanni Antonio FARRIS, Università degli Studi di Sassari
Patrizia FAVA, Università degli Studi di Modena e Reggio Emilia
Carlo FINOLI, Università degli Studi di Palermo
Antonietta GALLI, Università degli Studi di Milano
Vincenzo GERBI, Università degli Studi di Torino
Paolo GIUDICI, Università degli Studi di Modena e Reggio Emilia
Tommaso Francesco GOMES, Università degli Studi di Bari
Elisabetta GUERZONI, Università degli Studi di Bologna
Loredana INCARNATO, Università degli Studi di Salerno
Giovanni LERCKER, Università degli Studi di Bologna
Paolo MASI, Università degli Studi di Napoli
Roberto MASSINI, Università degli Studi di Parma
Valeria MAZZOLENI, Università Cattolica del Sacro Cuore (Piacenza)
Biagio MINCIONE, Università degli Studi di Reggio Calabria
Angelo MONTENERO, Università degli Studi di Parma
Mauro MORESI, Università degli Studi della Tuscia
Giuseppe MURATORE, Università degli Studi di Catania
Luigi NICOLAIS, CNR Napoli
Antonio PAPARELLA, Università degli Studi di Teramo
Luciano PIERGIOVANNI, Università degli Studi di Milano
Sebastiano PORRETTA, SSICA (Parma)
Alessandro SENSIDONI, Università degli Studi di Udine
Catherine SIMONEAU, JRC-Ispra (VA)
Paolo SPETTOLI, Università degli Studi di Padova
Mara STECCHINI, Università degli Studi di Udine
Gianluigi VESTRUCCI, CSI Gruppo IMQ

CONTENTS

AUTHOR INDEX	X
INTRODUCTION ...	XV

SESSION I: SHELF LIFE MODELLING

Main lecture: Prof. Kit K.L. Yam - Rutgers University, NJ - USA

An overview of shelf life models for packaged foods	3
K.K.L. Yam	

LECTURES

The sensory and consumer approach to the shelf life of foods	5
S. Porretta	
Effect of composition and viscosity on carotenoid oxidation rate	7
L. Manzocco, E. Venir, M. Anese, M.C. Nicoli, E. Maltini	
Effect of the physical state of lipids on shelf life of frozen foods	9
S. Calligaris, L. Manzocco, M. Munari, M.C. Nicoli	
The prediction of shelf life of cheese on the basis of storage temperature	11
S. Parisi	
Effects of storage temperature, oxygen level and lightness on shelf-life of brown parboiled rice	20
M. Zardi, S. Limbo, G. Aletti	
Shelf-life prediction of sliced fresh apples	29
P. Rocculi, M.A. Del Nobile, A. Bacci, M. Dalla Rosa	
Instrumental texture determination of Ricotta cheese during storage	41
L. Piazza, M. Bartoccini, S. Barzaghi	
Modelling the barrier properties of nylon film destined for food packaging applications	53
G.G. Buonocore, M.A. Del Nobile	

POSTERS

A ready-to-eat food: steamed carrots in protective atmosphere packages	64
A. Langella, F. Villani, P. Masi	

Time-temperature exposure of fresh milk during commercial life	70
M. Riva, V. Crepaldi	
Accurate determination of pressure, composition and amount of unfilled volume (UFV) in packaged foods. Set up of a new quasi-automatic device	79
C. Spreafico, M. Squarzone, L. Piergiovanni, P. Maiocchi	
Accelerated shelf life testing: possible applications of a new instrument (Oxitest) to oxygen sensitive food products	85
L. Indino, L. Piergiovanni, P. Maiocchi	

SESSION II: NEW TECHNOLOGIES FOR EXTENDING SHELF-LIFE

Main lecture: Prof. Joseph H. Hotchkiss - Cornell University, NY - USA

Current and future packaging approaches to extended shelf life of foods	97
J.H. Hotchkiss	

LECTURES

Product innovation in food science: ready to eat products	98
V. Nicolais, F. Villani, P. Masi	
Behaviour of film wrapped Ponkan mandarins treated with imazalil and sodium carbonate	109
S. D'Aquino, A. Palma, G. Lanza	
Biopreservation of fresh vegetables: microbiology and ecology	121
G. Scolari, M. Vescovo	
Polysaccharide-lipid edible coating as water vapour barrier: application to bakery products	130
A. Sensidoni, B. Bravin, D. Peressini	
The influence of using different packaging on the quality decay kinetics of "Cuccia"	132
G. Muratore, C.M. Lanza, M.A. Del Nobile, M. Leonardi, P. Tamagnone, C. Nicolosi Asmundo	
Effectiveness of pasteurization on <i>Alicyclobacillus acidoterrestris</i> spores in the presence of low molecular weight chitosan	142
P.M. Falcone, D. Campaniello, C. Altieri, M. Sinigaglia, M.R. Corbo, M. Anese, M.A. Del Nobile	
Superficial treatment using plasma processes on polymer films used for packaging	152
L. Laguardia, A. Cremona, E. Vassallo, R. De Mitri	

Study and development of an antimicrobial packaging system based on the release of silver ions	166
M. Cannarsi, C. Altieri, M.A. Del Nobile, P. Favia, G. Iacoviello, R. D'Agostino	
Potentiality of PEEKWC as a new material in food packaging	173
A.M. Torchia, G. Clarizia, A. Figoli, E. Drioli	
Study of an innovative PET (Polyethylene terephthalate) packaging for mayonnaise and evaluation of product shelf-life	185
A. Sensidoni, M. Leonardi, A. Possamai, P. Tamagnone, D. Peressini	
POSTERS	
Prediction of water permeability of flexible multilayer films intended for food packaging applications	196
G.G. Buonocore, D. Dainelli, M.A. Del Nobile	
The influence of using packaging films with different permeabilities on the quality decay kinetic of plum tomato (Pomodoro Datterino)	199
G. Muratore, M.A. Del Nobile, L. Bongiovanni, G.G. Buonocore, C.M. Lanza, C. Nicolosi Asmundo	
Study of apple slice preservation by combined methods technology	204
P. Rocculi, S. Romani, C. Lisi, M. Dalla Rosa	
Quality evaluation of pastries with an almond paste base	212
A. Baiano, G.G. Buonocore, V. Marchitelli, M.A. Del Nobile	
Controlled release of active compounds from antimicrobial films intended for food packaging applications	216
A. Conte, G.G. Buonocore, L. Nicolais, M.A. Del Nobile	
Biological oxygen scavengers for the maintenance of brief maturation dairy products	219
M. Cannarsi, C. Altieri, M.R. Corbo, M. Sinigaglia, M.A. Del Nobile	
Antimicrobial and antioxidative packaging material incorporating nisin and α -tocopherol to extend shelf life of perishable foods	221
C.H. Lee, D.S. An, S.C. Lee, H.J. Park, D.S. Lee	
Performance comparison of PVC and PE cling film by means of shelf-life evaluation tests ...	223
S. Colli, S. Pozzo, M. Piana	
Performance evaluation of active EPS tray for fresh bass fillet	228
F. Mostardini, M. Brazzoli	

SESSION III: SHELF-LIFE TESTING

Main lecture: Prof. H. Hofstra - TNO Netherlands - AJ Zeist - The Netherlands

An overview of methods and procedures for shelf life testing	235
S. Notermans, M. de Nijs, H. Hofstra	

LECTURES

Shelf life monitoring and modelling by e-nose and image-analysis	237
M. Riva, S. Mannino	

Shelf life study of packed industrial Ricotta cheese	252
P.M. Toppino, L. Campagnol, D. Carminati, G. Mucchetti, M. Povolo, S. Benedetti, M. Riva	

Volatile compounds as indicators of microbial spoilage	267
M.L. Puglisi, M. Gullo, L. De Vero, P. Fava	

Influence of the oxygen barrier properties of the package on the shelf life of extra virgin olive oil	269
G. Gambacorta, M.A. Del Nobile, P. Tamagnone, M. Leonardi, E. La Notte	

Water vapour barrier properties of biodegradable films	279
C. Giardi, G.G. Buonocore, L. Nicolais, M.A. Del Nobile	

Shelf-life of <i>Brassica Rapa</i> L. var. <i>Silvestris</i> in protective atmosphere packaging	287
V. Nicolais, T. Maturi, A. Langella, A. Romano, F. Villani, G. Barbieri, P. Masi	

Blood orange slices minimally transformed: chemical, microbiological and sensory studies ...	298
C. Caggia, P. Rapisarda, C.M. Lanza, S.E. Bellomo, P. Pannuzzo, M. Lo Bianco, C. Restuccia, C. Spampinato, A.G. Sciuto	

Combined technologies to improve quality of reconstituted apple cubes during processing and storage	315
P. Pittia, G. Sacchetti, D. Mastrocola	

Specific spoilage organisms and shelf life of green olives directly fermented in ready-to-sell packages	327
A.D. Romano, G. Muratore, C.L. Randazzo, M. Di Salvo, C. Caggia	

Influence of temperature on the quality factors of shredded carrots	336
E. Torrieri, M.J. Sousa, A. Horta, P. Masi, J. Kerry, F.A.R. Oliveira	

POSTERS

Evaluation of HMF as a marker of the shelf-life of honey	349
B. Fallico, M. Zappalà, E. Arena, A. Verzera	
Non-conventional analytical indices to evaluate the quality of the covering oil during the shelf-life of preserved vegetables	353
T. Gomes, A. Baiano, F. Caponio	
Effect of superheated water cooking on some textural characteristics of cuttlefish (<i>Sepia officinalis</i>)	357
D. Barbanti, R. Massini, E. Chiavaro, M. Rinaldi	
The influence of water activity on physico-chemical characteristics of edible coatings	361
A. Conte, C. Giardi, G.G. Buonocore, M.A. Del Nobile	
Influence of packaging material on bread characteristics	365
M.A. Pagani, M. Lucisano, M. Mariotti, S. Limbo	
Use of recent analytical parameters to evaluate the quality of refined oils used as a covering medium for canned fish	369
F. Caponio, A. Pasqualone, T. Gomes	
Potential use of “Ponkan” and “Page” mandarins as minimally processed fruit	373
A. Palma, S. D’Aquino, V. Astone, P. Rapisarda, M. Agabbio	
Method for evaluating the barrier properties of food packaging versus external pollutants	377
M. Baronciani, M. Amicabile, L. Tinelli, V. Rocchelli	
Shelf-life study of Taleggio cheese packed with paper or in modified atmosphere and comparison of analytical methods for ammonia detection	381
P.M. Toppino, M. Riva, E. Cori, L. Campagnol, L. Passolungo, C. Pinelli	
Shelf-life extension of minimally processed artichokes	385
A.G. Fiore, M. Anese, M. Sinigaglia, T. De Pilli, A. Derossi	
Study on sorption of flavor compounds from wine by polyethylene film	390
G. Muratore, N. Guarrera, M.A. Del Nobile, P. Fava, C. Nicolosi Asmundo	
Preliminary study for the extension of the shelf-life of a typical Sardinian product, “Pardulas”, by means of active packaging	394
P. De Regibus, G. Vestrucci, M. Zappa	
Microbiological aspects of horsemeat packed in modified atmosphere	396
L. Franzetti, M. Pompei, A. Posata, A. Galli	
SIRAP-GEMA	404
SIPA	405

AUTHOR INDEX

Agabbio M.	373
Aletti G.	20
Altieri C.	142-166-219
Amicabile M.	377
An D.S.	221
Anese M. ..	7-142-385
Arena E.	349
Astone V. T.	373
Bacci A.	29
Baiano A.	212-353
Barbanti D.	357
Barbieri G.	287
Baronciani M.	377
Bartoccini M.	41
Barzaghi S.	41
Bellomo S.E.	298
Benedetti S.	252
Bongiovanni L.	199
Bravin B.	130
Brazzoli M.	228
Buonocore G.G.	53-196-199-212-216-279-361
Caggia C.	298-327
Calligaris S.	9
Campagnol L.	252-381
Campaniello D. ...	142
Cannarsi M.	166-219
Caponio F. ...	353-369
Carminati D.	252
Chiavaro E.	357
Clarizia G.	173
Colli S.	223
Conte A.	216-361
Corbo M.R. .	142-219
Cori E.	381
Cremona A.	152
Crepaldi V.	70
D'Agostino R.	166
D'Aquino S.	109-373
Dainelli D.	196
Dalla Rosa M.	29-204
De Mitri R.	152
De Nijs M.	235

De Pilli T.	385
De Regibus P.	394
De Vero L.	267
Del Nobile M.A.	29-53-132-142-166-196-199-212-216-219-269-279-361-390
Derossi A.	385
Di Salvo M.	327
Drioli E.	173
Falcone P.M.	142
Fallico B.	349
Fava P.	267-390
Favia P.	166
Figoli A.	173
Fiore A.G.	385
Franzetti L.	396
Galli A.	396
Gambacorta G.	269
Giardi C.	279-361
Gomes T.	353-369
Guarrera N.	390
Gullo M.	267
Hofstra H.	235
Horta A.	336
Hotchkiss J.H.	97
Iacoviello G.	166
Indino L.	85
Kerry J.	336
La Notte E.	269
Laguardia L.	152
Langella A.	64-287
Lanza C.M.	132-199-298
Lanza G.	109
Lee C.H.	221
Lee D.S.	221
Lee S.C.	221
Leonardi M.	132-185-269
Limbo S.	20-365
Lisi C.	204
Lo Bianco M.	298
Lucisano M.	365
Maiocchi P.	79-85
Maltini E.	7
Mannino S.	237
Manzocco L.	7-9
Marchitelli V.	212
Mariotti M.	365
Masi P.	64-98-287-336

Massini R.	357
Mastrocola D.	315
Maturi T.	287
Mostardini F.	228
Mucchetti G.	252
Munari M.	9
Muratore G.	132-199-327-390
Nicolais L. ...	216-279
Nicolais V.	98-287
Nicoli M.C.	7-9
Nicolosi Asmundo C.	132-199-390
Notermans S.	235
Oliveira F.A.R.	336
Pagani M.A.	365
Palma A.	109-373
Pannuzzo P.	298
Parisi S.	11
Park H.J.	221
Pasqualone A.	369
Passolungo L.	381
Peressini D.	130-185
Piana M.	223
Piazza L.	41
Piergiovanni L.	79-85
Pinelli C.	381
Pittia P.	315
Pompei M.	396
Porretta S.	5
Posata A.	396
Possamai A.	185
Povolo M.	252
Pozzo S.	223
Puglisi M.L.	267
Randazzo C.L.	327
Rapisarda P.	298-373
Restuccia C.	298
Rinaldi M.	357
Riva M.	70-237-252-381
Rocchelli V.	377
Rocculi P.	29-204
Romani S.	204
Romano A.	287
Romano A.D.	327
Sacchetti G.	315
Sciuto A.G.	298
Scolari G.	121

Sensidoni A.	130-185
Sinigaglia M.	142-219-385
Sousa M.J.	336
Spampinato C.	298
Sprefico C.	79
Squarzoni M.	79
Tamagnone P.	132-185-269
Tinelli L.	377
Toppino P.M.	252-381
Torchia A.M.	173
Torrieri E.	336
Vassallo E.	152
Venir E.	7
Verzera A.	349
Vescovo M.	121
Vestrucci G.	394
Villani F. ...	64-98-287
Yam K.K.L.	3
Zappa M.	394
Zappalà M.	349
Zardi M.	20

EVALUATION OF HMF AS A MARKER OF THE SHELF-LIFE OF HONEY

VALUTAZIONE DELL'HMF: PARAMETRO DI SHELF-LIFE DEL MIELE

B. FALLICO^{1*}, M. ZAPPALÀ¹, E. ARENA¹ and A. VERZERA²

¹DOFATA - Facoltà di Agraria - Università di Catania - Via S. Sofia 98 -
95123 Catania - Italy

²Dipartimento di Chimica Organica e Biologica - Università di Messina -
Papardo - 98168 Messina - Italy

*corresponding Author: bfallico@unict.it

ABSTRACT

Samples of orange and eucalyptus honey were pasteurised at 70°C for different times and then stored for ten months at 25°C. HMF content, diastase activity, pH and total acidity were determined on fresh honeys, on pasteurised honeys and periodically on stored honey samples. Pasteurisation did not induce negative effect on HMF content in orange and eucalyptus honeys. After ten months of storage orange honey shows a HMF content above the fixed EU limit of 15 mg/kg, while eucalyptus honeys, during storage, show a very variable trend of HMF content which prevented the quality of this honey to be evaluated.

RIASSUNTO

Campioni di miele d'Arancio e di Eucalipto sono stati pastorizzati a 70°C per tempi diversi e poi conservati a 25°C per dieci mesi. Il contenuto in HMF, l'attività diastatica, il pH e l'acidità totale sono stati determinati sui mieli non pastorizzati,

- Key words: HMF, honey, storage, thermic treatment -

su quelli pastorizzati e periodicamente sui campioni sottoposti a conservazione. La pastorizzazione non ha indotto alcun incremento del contenuto in HMF in entrambe le varietà di miele. Il miele d'Arancio dopo dieci mesi di conservazione presenta un contenuto in HMF superiore al limite fissato dall'EU di 15 mg/kg, mentre il miele di Eucalipto mostra un andamento del contenuto in HMF durante la conservazione molto variabile e ciò non permette di valutare realmente la qualità di questo prodotto.

INTRODUCTION

The shelf-life of honey is fixed at 24 months and, after this period, it is not considered satisfactory as regards its aroma, biological and nutritional value. Evidently, it is necessary to have parameters that can determine the honey quality and a correct shelf-life. The European Directive n. 110 (2001) utilises HMF (5-Hydroxymethylfurfuraldehyde) as parameter for honey quality: it gives information on the total heat exposure, conditioning and storage of honey.

HMF is formed during acid-catalysed dehydration of hexoses and is connected to the chemical properties of honey, like pH, total acidity, and mineral content (Singh and Bath, 1998). Generally not present in fresh honey, its content increases during heat conditioning and storage (Fallico *et al.*, 2003). Honey processing requires heating to reduce viscosity and to avoid fermentation, usually in air ventilated chambers at 45°-50°C for 4/5 days; moreover a pasteurisation at 70°C for 3-5 min can be carried out to avoid crystallisation for a prolonged period (Gonnet M., 1997).

Codex Alimentarius Commission (2000) established that the HMF content of honey after processing and/or blending must not exceed 40 mg/kg, with the exception of honey coming from countries or regions with tropical temperatures. In this case, HMF content must not exceed 80 mg/kg. The European Union, moreover, established a maximum of 15 mg/kg for honeys which have low enzymatic content (EU Directive 110/2001).

The aim of this research is to verify if the official standards, HMF, diastase activity and total acidity are appropriate for defining shelf-life in fresh and pasteurised honeys.

MATERIALS AND METHODS

Samples of orange (*Citrus aurantium* L.) and eucalyptus (*Eucalyptus camaldulensis* L.) honey, were picked from stainless steel drums directly provided by local beekeepers [Zafferana Etnea (CT), Sicily]. Honey samples were from the 2002 season and were conditioned in April. The honeys were analysed as fresh honeys (treated at 45°-50°C for 4/5 days), and after a pasteurisation at 70°C for 3, 5 and 7 min. Pasteurised honeys were stored at 25±2°C from April 2002 to February 2003 and were analysed monthly or every two months. pH, total acidity, and diastase activity were determined on all honey samples according to official methods (AOAC, 1980). HMF levels were determined as follow: 5 g of honey samples were diluted up to 50 mL with distilled water, filtered on 0.45 mm filter and immediately injected in a HPLC (Varian 9012Q) equipped with a Diode Array Detector (Varian, Star 330). The HPLC column was a Merck Lichrospher, RP-18, 5 µm, 125x4 mm, fitted with

a guard cartridge packed with the same stationary phase (Merck, Milan). The HPLC conditions were the following: isocratic mobile phase, 90% water at 1% of acetic acid and 10% methanol; flow rate, 0.7 mL/minute; injection volume, 20 μ L. All the solvents were HPLC grade (Merck, Milan). The wavelength range was 220-660 nm and the chromatograms were monitored at 285 nm. HMF was identified by splitting the peak in honey with a standard HMF (Sigma-Aldrich, Milan), and by comparison the spectra of HMF standard with that one of honey samples. The amount of HMF was determined using an external calibration curve, measuring the signal at $\lambda=285$ nm.

RESULTS AND DISCUSSION

Tables 1 and 2 report the HMF content, diastase activity, pH and total acidity in fresh and pasteurised honey samples. It is possible to assert that the pasteurisation does not increase the initial content of HMF in orange honey samples (11.0 mg/kg, 10.8 mg/kg after 3 min, 11.7 mg/kg after 5 min, 12.2 mg/kg after 7 min at 70°C, respectively), while a lower level compared to the initial value was observed in eucalyptus honey samples (35.8 mg/kg, 15.9 mg/kg after 3 min, 14.0 mg/kg after 5 min, 15.1 mg/kg after 7 min at 70°C, respectively). Diastase activity does not seem to be influenced by pasteurisation process in orange or eucalyptus honeys. Pasteurised and unpasteurized orange honey samples increased their HMF content during storage, at 25 \pm 2°C, in a similar way (Table 1). Different time of pasteurisation (3, 5 and 7 min) did not influence the HMF formation. After 10 months of storage all honey samples show a HMF concentration above the fixed

Table 1 - Average values for HMF (mg/kg), diastase (nd), pH and total acidity (meq/kg) in fresh and pasteurised Orange honeys.

		Apr.	May	Giu.	Jul.	Sep.	Oct.	Dec.	Feb.
Fresh honey	HMF	11.0	14.6	15.4	19.1	27.1	30.1	32.4	39.8
	Diastase	8.5	8.4	8.2	7.8	7.2	7.2	7.2	7.2
	pH	3.30	3.72	3.72	3.72	3.66	3.60	3.58	3.72
	Total acidity	32.5	33.3	32.7	34.7	29.5	31.5	32.5	27.5
Pasteurised honey 3 min a 70°C	HMF	10.8	14.1	16.1	19.1	26.1	31.0	30.7	41.2
	Diastase	8.4	8.3	8.1	7.9	7.5	7.3	7.3	7.0
	pH	3.43	3.71	3.61	3.70	3.64	3.61	3.55	3.69
	Total acidity	32.0	34.6	32.5	36.2	30.8	32.0	33.5	28.8
Pasteurised honey 5 min a 70°C	HMF	11.7	13.8	14.9	19.1	27.8	33.2	32.5	44.7
	Diastase	8.4	7.8	7.7	7.7	7.6	7.0	6.8	6.8
	pH	3.43	3.73	3.68	3.70	3.63	3.62	3.36	3.59
	Total acidity	33.5	34.4	35.2	35.7	32.0	32.0	35.3	28.5
Pasteurised honey 7 min a 70°C	HMF	12.2	14.2	15.2	19.0	28.0	32.7	34.2	47.6
	Diastase	8.1	8.0	7.6	7.6	7.6	7.6	7.5	6.9
	pH	3.48	3.79	3.75	3.74	3.73	3.71	3.44	3.52
	Total acidity	30.5	32.3	31.0	32.9	29.8	31.0	30.5	27.8

Table 2 - Average values for HMF (mg/kg), diastase (nd), pH and total acidity (meq/kg) in fresh and pasteurised Eucalyptus honeys.

		Apr.	May	June	Jul.	Sep.	Oct.	Dec.	Feb.
Fresh honey	HMF	35.8	40.5	9.7	17.5	25.1	52.2	19.1	23.1
	Diastase	23.5	20.6	19.5	17.2	17.0	16.7	16.4	16.1
	pH	3.73	3.93	3.98	3.72	4.00	4.11	3.79	3.89
	Total acidity	34.5	33.0	34.7	36.5	33.5	34.0	35.3	29.0
Pasteurised honey 3 min a 70°C	HMF	15.9	39.8	0.0	12.9	25.8	55.6	16.1	25.2
	Diastase	22.5	20.3	18.5	17.7	17.7	17.0	16.8	16.1
	pH	3.74	3.93	3.98	3.70	3.95	3.98	3.83	3.88
	Total acidity	34.0	34.2	35.7	36.0	34.0	34.8	34.0	30.0
Pasteurised honey 5 min a 70°C	HMF	14.0	16.2	0.0	11.4	23.5	51.2	19.5	23.4
	Diastase	19.7	19.0	19.2	18.2	17.4	16.9	16.5	15.8
	pH	3.74	3.94	3.92	3.70	3.96	4.00	3.72	3.90
	Total acidity	34.5	34.7	35.2	36.0	34.3	35.5	35.8	29.3
Pasteurised honey 7 min a 70°C	HMF	15.1	13.5	9.8	18.1	23.5	51.2	21.1	19.1
	Diastase	20.0	19.3	19.2	18.3	17.8	16.4	16.3	15.2
	pH	3.74	3.96	3.94	3.74	3.94	3.98	3.76	3.83
	Total acidity	34.0	34.6	35.5	34.5	33.3	34.0	34.5	26.8

limit for this variety (15 mg/kg). Diastase activity slowly decreased with storage time (Table 1).

The trend of HMF concentration in unpasteurised and pasteurised eucalyptus honey samples during storage was variable (Table 2) and it is very difficult to predict the development during storage. Also in this case pasteurisation, did not influence the HMF formation and diastase activity decreased with storage time. Total acidity decreased during storage in both orange and eucalyptus honeys; all values were lower than the legal limits (50 meq/kg) (Table 2).

Twenty four months of shelf-life, does not meet citrus honey the EU HMF legal limit (15 mg/kg). Although the authors confirm their opinion that this limit is too low, they suggest a 12-month shelf-life for this honey. As concerns eucalyptus honey it is important to note the decrease of HMF after sample pasteurization and the unpredictable behaviour of HMF during the 10 months of storage.

REFERENCES

- AOAC Official Methods of Analysis 1980. 13th ed. Horwitz, W., Ed.; Association of Official Analytical Chemists: Washington DC. Method 31.111, p. 521.
- European Directive 110/2001 about honey.
- Fallico B., Zappalà M., Arena E., and Verzera, A. 2003. Effects of heating process on chemical composition and HMF levels in Sicilian monofloral honeys. Sent to Food Chem.
- Gonnet, M. 1997. Liquefazione, pastorizzazione e cristallizzazione controllata del miele. In Miele: aspetti tecnologici. Apimondia Bucarest: 61.
- Singh N., Bath P.K. 1998. Relationship between heating & hydroxymethylfurfural formation in different honey types. J. Food Sci. Technol., 35: 154.