



ChemPor 2023

**14th International Chemical and Biological
Engineering Conference**

Book of Abstracts

Instituto Politécnico de Bragança | September 12-15



ORDEM
DOS
ENGENHEIROS



Title

14th International Chemical and Biological Engineering Conference (CHEMPOR 2023): book of abstracts

Editors

Ana Maria Alves Queiroz da Silva

António Manuel Coelho Lino Peres

António Manuel Esteves Ribeiro

Maria Olga de Amorim e Sá Ferreira

Maria Filomena Filipe Barreiro

Paulo Miguel Pereira de Brito

Simão Pedro de Almeida Pinho

Publisher

Instituto Politécnico de Bragança

September 2023

ISBN 978-972-745-327-6

Medium chain fatty acids production from syngas by a co-culture of <i>Clostridium acetivum</i> and <i>Clostridium kluyveri</i>	290
<i>C. Fernández-Blanco, M.C. Veiga, C. Kennes</i>	
Response surface methodology approach for keratin recovery using a bio-based ionic liquid	292
<i>C. Polesca, A. Al Ghatta, H. Passos, J.A.P. Coutinho, J.P. Hallett, M.G. Freire</i>	
Recovery of carotenoids from <i>Yarrowia lipolytica</i> using biosolvents	294
<i>C. Naveira-Pazos, M.C. Veiga, C. Kennes, J.F.B. Pereira</i>	
Obtaining liquid fuels by applying bifunctional catalysts in the Fischer-Tropsch process.....	296
<i>D. Costa, J. Joaquim, E. Falabella, C.M. Magalhães, B.F. Machado, M.F. Ribeiro</i>	
Impact of storage conditions on the chemical composition of wine industry by-products.....	298
<i>A.K. Barreto, R.A. Fernandes, J. Santos, P. Magalhães, J.M. Martins, I. Brás, L.H. Carvalho</i>	
Towards sustainable valorization of industrial waste - catalysts derived from sugar cane molasses for upgrading glycerol to fuel additives	300
<i>K.M. Eblagon, A. Malaika, K. Ptaczyńska, M. Kozłowski, J.L. Figueiredo</i>	
Production of 5-hydroxymethylfurfural from table sugar in water using bifunctional biochar catalysts	302
<i>A. Malaika, K.M. Eblagon, M.A.C. Bravo, M. Kozłowski, J.L. Figueiredo</i>	
Poster Session BIOTECHNOLOGY	304
Solubility of amino acids: the effect of chaotropic anions	305
<i>M. Aliyeva, P. Brandão, J.A.P. Coutinho, O. Ferreira, S.P. Pinho</i>	
Olive pomace extracts as antimicrobial agents for leather treatments	307
<i>K. Kebaili, H.H.S. Almeida, A.E.K. Benhlma, M.F. Barreiro, P.J.L. Crujeira</i>	
Development of acorn shell extract solid-in-oil-in-water (S/O/W) emulsion-based carriers envisaging cosmetic applications	309
<i>L.F. Fernandes, L.G. Teixeira, G. Colucci, M.P. Sousa, P.S. Babo, A. Santamaria-Echart, R.F. Canadas, M.F. Barreiro</i>	
Gellable aqueous biphasic systems as a novel strategy for mRNA nasal delivery	311
<i>B. Kopolovic, N. Laroui, J.A.P. Coutinho, C. Pichon, M.G. Freire</i>	
Exploiting winemaking residues as ingredients for cosmeceutical applications	312
<i>C.N. Duarte, A. dos Santos, T. Oludemi, C. Santos-Buelga, R.C.S. Dias, L. Barros, J.S. Amaral</i>	
Potassium evoked ROS signals in mitochondria.....	314
<i>J.L.R. Alves, M.S. Sousa, P.M. Reis, R.M. Quinta-Ferreira, M.E. Quinta-Ferreira, C. M. Matias</i>	
Near-infrared spectroscopy analysis of bread: study of shelf life and correlation with microbiological analysis	316
<i>D. Amendoeira, A. Teixeira, L.G. Dias, L. Estevinho</i>	

Analysis of bread using potentiometric electronic tongue: importance for quality control.....	318
<i>A. Teixeira, D. Amendoeira, L. Estevinho, L.G. Dias</i>	
Optimization of phenolic compounds extraction from mountain ash fruit pulp	320
<i>G. Vergara, N.L. Seixas, N.P. Mira, L. Estevinho, L.G. Dias</i>	
Extraction of phenolic compounds from <i>Sorbus aucuparia</i> tree leaves for use in food	321
<i>H.F. Rodrigues, N.L. Seixas, N.P. Mira, L.G. Dias, L.M. Estevinho</i>	
Laccase mediated grafting of pine sawdust for oil spill recovery	323
<i>N. Miguez, A. Sanromán, D. Moldes</i>	
Development of an integrated process for the recovery and purification of recombinant messenger RNA vaccines resorting to bio-based ionic liquids	325
<i>A.S.C. Marques, A.Q. Pedro, C. Gonçalves, A.P.M. Tavares, C. Pichon, M.G. Freire</i>	
Dextran-based hydrogel composites for tissue engineering	327
<i>P. Alves, A.F. Simões, M.F.P. Graça, I.J. Correia, P. Ferreira</i>	
Valorization of brewery spent grain to produce volatile fatty acids through acidogenic fermentation.....	329
<i>L. Ferreira, M.C. Veiga, C. Kennes</i>	
Predicting the shelf-life of extra virgin olive oil during storage at 22 and 50°C, using a kinetic modelling approach.....	331
<i>N. Ferreira, J.A. Pereira, N. Rodrigues, A.M. Peres</i>	
Metal-ion zeolites obtained by chemical and mechanochemical methods as Fenton-like catalysts for health applications.....	333
<i>J.T. Costa, V. Ivasiv, A.R. Bertão, N. Nunes, A.S. Mestre, A.P. Carvalho, A.M. Fonseca,</i> <i>F. Baltazar, J.N. Moreira, I.C. Neves, A. Martins</i>	
Computer-aided identification of trihalomethane degradation by haloalkane dehalogenase DhaA from <i>Rhodococcus</i> sp.	335
<i>M.M. Pereira, R.C. Martins</i>	
Ultrasound-assisted synthesis of inulin esters with antimicrobial and anti-inflammatory activities	337
<i>I. Hambarliyska, N. Petkova, Y. Tumbarski, D. Vassilev, M. Brazkova, A. Krastanov, I. Ivanov,</i> <i>P. Denev, I. Gotova, Z. Dimitrov</i>	
Urea as an alternative source of nitrogen for microalgae cultivation: effect on growth and biomass composition	338
<i>P.S. Corrêa, M.M.A. Freitas, N.S. Caetano</i>	
Microencapsulation of biocide benzisothiazolinone: a promising technique for the improvement of its aqueous solubility	340
<i>V.F.M. Silva, E.M.P.J. Garrido, F. Borges, J.M.P.J. Garrido</i>	

<i>In vitro</i> evaluation of avian immunoglobulin Y (IgY) antibodies to fight infectious illnesses caused by methicillin-resistance <i>Staphylococcus aureus</i> (MRSA)	342
<i>C. Almeida, M.C. Neves, M.G. Freire</i>	
Extraction study of bioactive compounds from ginger by ultrasound an analysis of antioxidant action	344
<i>S.S. Bernardoni, B.L. Schneider, D.A. Nardino, R.M. Suzuki, C.C. Sipoli</i>	
Validation of a prototype of a miniaturized near infrared spectrometer on complex organic samples.....	346
<i>L.L. Monteiro, P. Zoio, B.B. Carvalho, L.P. Fonseca, C.R.C. Calado</i>	
Interaction between <i>Chlorella vulgaris</i> and microplastic (PET) particles examined by optical and nuclear microscopy	348
<i>S.A. Vaz, T. Pinheiro, L.P. Monteiro, S.M. Badenes, R.C. Martins, H.M. Pinheiro</i>	
Polymer-based aqueous biphasic systems as a tool for the recovery of protein-based biopharmaceuticals.....	350
<i>L.S. Castro, A.Q. Pedro, M.G. Freire</i>	
Application of PNA-FISH based-methods for bacterial detection and localization in biofilms	352
<i>A. Barbosa, D. Goeres, N.F. Azevedo, L. Cerqueira</i>	
Development of efficient platforms for breast cancer biomarkers extraction resorting to ionic liquid-based aqueous biphasic systems	354
<i>M.S.M. Mendes, M.C. Souza, J.P. Conde, M.G. Freire, F.A. e Silva</i>	
Streamlining bacterial infection diagnosis: rapid Gram classification using FTIR spectroscopy.....	356
<i>R. Araújo, L. Ramalhete, T. Fonseca, C. von Rekowski, L. Bento, C. Calado</i>	
Enhancing plastic waste recycling: investigating the impact of additives on polymer degradation via laccase from <i>Trametes versicolor</i>	358
<i>M.I.S. Aguiar, A.F. Sousa, A.P.M. Tavares, A.M. Ferreira</i>	
Poster Session ENERGY AND ENVIRONMENT.....	360
Life cycle environmental impact assessment of a pajama shirt	361
<i>A.A. Martins, R. Lapa, B. Mota, S. Maia, J.C.G.E. da Silva, C. Soares, T.M. Mata</i>	
Life cycle assessment: a comparison of different tools using an academic case study	363
<i>R.N. Dias, N. Stamatopoulou, R.M. Filipe, H.A. Matos</i>	
Porous PDMS membranes as P25 supports for the photocatalytic degradation of parabens.....	365
<i>M.J. Silva, R. Alves, P. Alves, J. Gomes, P. Ferreira, R.C. Martins</i>	
Catalytic conversion of hemicellulose-derived pentoses into sugar/aliphatic acids	367
<i>V. Van-Dúnem, L.C. Duarte, L.M.D.R.S. Martins, F. Carvalheiro</i>	
Analysis of energy transition scenarios in industry, using RETScreen	369
<i>B. Moreira, C.G. Braz, M.C. Fernandes</i>	

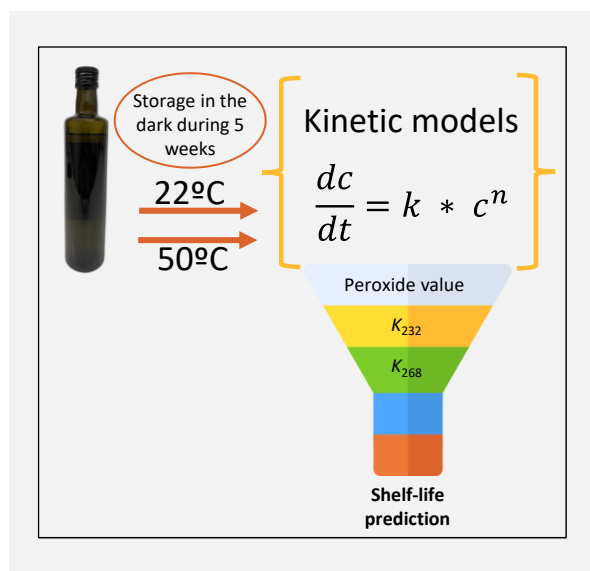
Predicting the shelf-life of extra virgin olive oil during storage at 22 and 50°C, using a kinetic modelling approach

N. Ferreiro^{1,2,3*}, J.A. Pereira^{1,2}, N. Rodrigues^{1,2}, A.M. Peres^{1,2}

¹Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus Sta Apolónia, Bragança, Portugal;

²Laboratório associado para a sustentabilidade e tecnologia em regiões de montanha (SusTEC), Campus Sta Apolónia, Bragança, Portugal; ³Universidad de León, Departamento de Ingeniería Agrária, Av. Portugal, nº41, León, 24071, Espanha.

*nuno.ferreiro@ipb.pt



Olive oil (OO) is a high-value food due to its appreciated sensory attributes and health benefits. The shelf life (SL) of an OO is a key parameter, being influenced by the olive cultivar, agro-climatic, extraction and storage conditions. So, kinetic models were developed for 3 physicochemical quality parameters (peroxide value and the extinction coefficients at 232 and 268 nm), to estimate the SL, based on a Time to Reach the legal Upper Limit (TRUL) approach. For that, a ripe EVOO, stored in amber glass bottles, in the dark and during 5 weeks, at 22 and 50°C, was used. Zero-, first-, and second-order kinetic models were evaluated, and the best correlations were achieved for the zero-order model. Based on this model, the SL of the stored EVOOs were predicted to be 47-210 days and 35-80 days at 22 and 50°C, respectively. As expected, the SL decreased for the higher storage temperature, being the lowest values predicted for K_{232} and K_{268} , data, for 22 and 50°C, respectively.

Introduction

Only extra virgin or virgin olive oils (EVOOs or VOOs), can be commercialized, being their classification dependent on the fulfillment of a set of legal thresholds [1]. EVOO is a key ingredient of the Mediterranean cuisine [2] and its intake was associated to several health benefits recognized by nutritional and health claims [3,4]. However, olive oil is prone to lipid oxidation due to its richness in unsaturated fatty acids, which is responsible for degrading the chemical and sensory quality of EVOO leading to the appearance of unpleasant off-flavors, obliging a quality grade re-classification to VOO or even lampante oil, which cannot be commercialized.

Thus, besides monitoring the oil quality through the extraction line, the olive oil industry is urged to guarantee the label information authenticity from packaging, during storage and transportation, until purchased by the end-consumer. Several strategies have been proposed aiming to establish accurate models for predicting the olive oil shelf-life (SL) [5], which can be defined as the time-period under normal storage conditions within which no off-flavors are developed and the quality parameters are within the legal limits [6]. Two types of shelf-life prediction models are available: kinetic and empirical [5,7-11].

In this study, classical kinetic models were applied aiming to describe in a straightforward way the complexity of the oxidation reactions and related oil quality degradation.

Materials and Methods

Ripe EVOO samples, from the crop year of 2022, were collected and further used. The oil was stored in amber glass bottles (100 mL) with a plastic cap. In total, 40 bottles were used, being 20 stored at 22°C and the other 20 bottles stored at 50°C, all of them protected from light exposure. Bottles were stored during 5 weeks, being 4 bottles picked from each storage condition, each week for analysis. Before storage, the quality parameters of the

olive oil (free acidity, peroxide value and extinction coefficients at 232 and 268 nm) were assessed, following the procedures described in the Commission Delegated Regulation (EU) 2022/2104, allowing confirming the EVOO classification (FA = 0.28%; PV = 5.8 mEqO₂/kg oil; K_{232} = 1.87, and K_{268} = 0.13). The total phenols content (TPC) and total carotenoids content (TCC) of the initial EVOO were also determined, by spectrophotometry, being equal to 245 ± 24 mg GAE/kg and 8.0 ± 0.2 mg/kg. At each sampling date (7, 14, 21, 28, and 35 days) the quality parameters of the stored oils were evaluated following the EU guidelines, being further used to establish the kinetic models, which were then applied to estimate the SL of the olive oils in terms of commercial grade.

The evolution of the PV, K_{232} and K_{268} data at each storage temperature studied (22 and 50°C), were used to calculate the thermal rate constants due to the oxidation process that took place during the storage time-period. Since the FA was almost constant along the storage time, this parameter was not considered, in terms of kinetic modelling. Three reaction orders were considered (zero-, first- and second-order kinetic models, Equation (1)), being selected the kinetic model that allowed the best mathematical fit of the experimental data:

$$\frac{dP}{dt} = k \times P^n \quad (\text{Eq. 1})$$

where, P refers to the parameter under study (PV, K_{232} , or K_{268}), t is the storage time-period (in days), and k is the rate constant and n is the reaction order (equal to 0, 1 or 2 for zero-, first- and second-order kinetic models, respectively).

Results and Discussion

The results showed that the zero-order kinetic model allowed the best fitting of the experimental data for the three quality parameters, which was slightly superior compared to the first- and second-order kinetic models. Table 1 shows the rate

constants ($k \pm$ standard error [SE]) and the correlation coefficients (R) obtained assuming the zero-order kinetic mechanism for the thermal degradation of the EVOO quality due to the natural oxidation process at 22 and 50°C, during the 5 weeks of storage.

Table 1. Rate constants ($k \pm$ standard error [SE]) and correlation coefficient (R) for olive oils stored during 5 weeks at 22 or 50°C, obtained assuming a zero-order kinetic model.

Variable	22°C		50°C	
	$k \pm$ SE	R	$k \pm$ SE	R
PV	0.14±0.03*	0.928	0.18±0.04*	0.945
K_{232}	0.013±0.003*	0.935	0.011±0.003*	0.920
K_{268}	0.0004±0.0002*	0.866	0.0026±0.0002*	0.994

* k units for PV: $\text{mEq.O}_2 \times \text{kg}^{-1} \times \text{day}^{-1}$; k units for K_{232} and K_{268} : day^{-1}

Taking into account the maximum legal limits [1] for EVOO grade classification ($\text{PV} \leq 20$ $\text{mEq.O}_2/\text{kg}$ oil; $K_{232} \leq 2.50$, and $K_{268} \leq 0.22$) and using the zero-order kinetic models previously established, based on the experimental data collected during the 5 weeks of storage at 22 or 50°C, it was possible to estimate the SL (i.e., the Time required to Reach the Upper Legal Limit, TRUL) for the studied oil, considering the initial values determined for the oil before storage. Table 2 shows the SL determined according to each parameter and storage temperature, predicted using the zero-order fitting. The SL values were slightly greater than those reported by Gomez-Alonso et al. [12], based on the time to reach the upper limit of PV or of the extinction coefficients, for purified olive oil, stored at 25 and 50°C (48-104 days, and 5-24 days, respectively). However, the predicted SL were lower than those reported for monovarietal EVOO from cv. Cornicabra stored at 25°C (238-686 days) and of the same order of magnitude of those determined at 50°C (15-59 days) [13], which were estimated using zero- or first-order kinetic models developed for the same three quality parameters. On the other hand, for monovarietal EVOO from cv. Coratina, significantly greater SLs were

Acknowledgements

NF acknowledges his PhD scholarship (2022.10072.BD), from the Portuguese Foundation of Science and Technology (FCT). This study was supported by FCT under the scope of the strategic funding of CIMO (UIDB/00690/2020 and UIDP/00690/2020), and Associate Laboratory SusTEC (LA/P/0007/2020).

References

- [1] European Commission Regulation EC No 2568/91, Official Journal of the European Union, L248 (1991) 1-82.
- [2] V. Gkotsamanis et al., *Maturitas*, 159 (2022) 33-39.
- [3] European Commission Regulation (EU) No 432/2012, Official Journal of the European Union, L136 (2012) 1-40.
- [4] Regulation (EC) No 1924/2006 of the European Parliament and of the Council, Official Journal of the European Union, L404 (2006) 9-25.
- [5] X. Li et al., *Journal of Food Quality*, 2018 (2018) 1639260.
- [6] C. Guillaume et al., *Journal of Chemistry*, 2016 (2016) 6393962.
- [7] R. Aparicio-Ruiz et al., *Grasas y Aceites*, 68 (2017) e219.
- [8] M.G. Di Serio et al., *Journal of Food Processing Preservation*, 42 (2018) e13663.
- [9] L. Conte et al., *Foods*, 9 (2020) 295.
- [10] A. Serrano et al., *LWT*, 136 (2021) 110257.
- [11] V. Mancebo-Campos et al., *Antioxidants*, 11 (2022) 539.
- [12] S. Gomez-Alonso et al., *European Journal of Lipid Science and Technology*, 106 (2004) 369-375.
- [13] V. Mancebo-campos et al., *European Journal of Lipid Science and Technology*, 110 (2008) 969-976.

reported in the literature (377 and 61 months for 25 and 50°C, respectively) [9]. This variability may be tentatively attributed to the expected differences in the chemical composition of each olive oil, which greatly depend on the cultivar, agro-climatic conditions, olive maturation index at harvest, and extraction conditions.

Table 2. Shelf-life (SL, in days) calculated using the zero-order kinetic model.

Variable	Shelf-life (days)	
	22°C	50°C
PV	100	80
K_{232}	47	56
K_{268}	210	35

As can be inferred from Table 2, in general, the SL decreases when the storage temperature increases (with the exception of the results for K_{232}). Moreover, the correctness of the EVOO label for the studied olive oil, stored at 22°C, mimicking the usual temperature of oil's storage, could only be ensured for 47 days, which is a rather low SL, taking into account that olive oils are often stored for 10-12 months.

Conclusions

The study performed allowed confirming that zero-order kinetic models can be used to estimate the SL of olive oils, based on the TRUL of three quality parameters (PV, K_{232} , and K_{268}) used to establish the commercial grade of olive oil, in-line with the literature. Moreover, it also highlighted that, from the referred parameters, the extinction coefficients were those that would suffer a faster raise, being those that should be used to estimate the SL of olive oils. Finally, from our results and those previously reported, it is clear that the SL prediction is greatly dependent of the olive oil under study. Besides, the study also points out that the classical kinetic models alone can hardly describe the complexity of the oxidation reactions and related oil chemical-sensory degradation.