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

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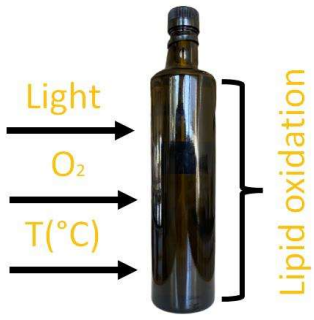
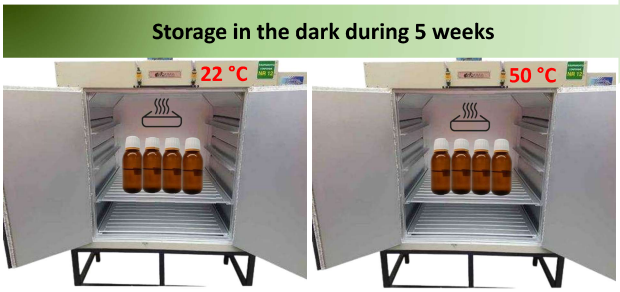
Introduction and objectives

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. 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. 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). Two types of shelf-life prediction models are available: kinetic and empirical ones. In this study, classical kinetic models were developed aiming to evaluate the complexity of the oxidation reactions based on the degradation of oil quality.



Material and methods



Peroxide value (PV)

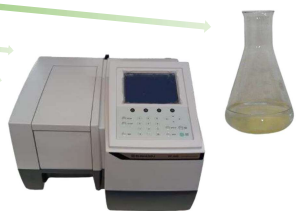
K_{232}

K_{268}

Kinetic models

$$\frac{dc}{dt} = k * c^n$$

SHELF-LIFE prediction



Results and discussion

Zero-order kinetic models were established using the experimental data collected during the 5 weeks of storage at 22 or 50 ºC allowing to estimate the rate constants (**Table 1**). Considering the maximum legal limits for EVOO grade classification (PV ≤ 20 mEq.O_2/kg oil; K_{232} ≤ 2.50, and K_{268} ≤ 0.22) the respective SL (**Table 2**), *i.e.*, the Time required to Reach the Upper legal Limit, (TRUL), were also determined for the studied EVOO, varying between 35 days for 50 ºC and 47 days at 22 ºC.

The SL values were slightly greater than those reported by Gomez-Alonso et al. [1] but much lower than those reported for monovarietal EVOO from cv. Coratina (377 and 61 months for 25 and 50 ºC, respectively) [2].

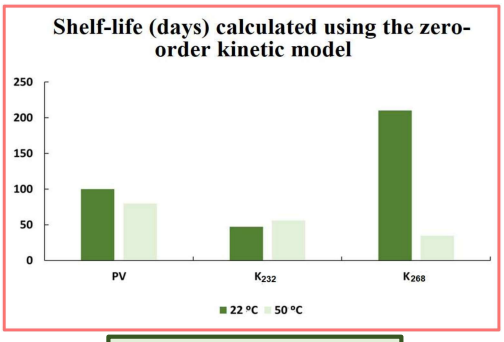
This variability may be tentatively attributed to the expected differences in the chemical composition of each olive oil.

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

Variable	22 ºC		50 ºC	
	k ± SE	R	k ± 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

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

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



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. 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 the present results and those previous reported, it is clear that the SL prediction is greatly dependent onthe 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.

References: [1] S. Gomez-Alonso et al., European Journal of Lipid Science and Technology, 106 (2004) 369-375; [2] V. Mancebo-campos et al., European Journal of Lipid Science and Technology, 110 (2008) 969-976

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