A meta-analytical Bigelow predictive microbiology model describing the effects of temperature, pH and ºBrix on the thermal resistance of *Neosartorya* spp. in fruit juices

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Abstract

Neosartorya is one of the main genera isolated from fruit juices that show great resistance to heat treatments. This study aimed to synthesise through meta-regression the thermal resistance parameters of this fungus by adjusting an extended Bigelow equation to data from inactivation experiments conducted in liquid media. After a systematic review, from 25 eligible studies published since 1970, the following information was extracted: thermal reduction time (D), pH and ºBrix of the medium, inactivation temperature, type of medium (juice, concentrate, model liquid food), fruit, use of preservatives, inactivation method and age of spores. A Bigelow model describing log D as a function of temperature, pH and ºBrix was transformed into a data-driven overarching linear mixed-effects meta-regression model, from which log D* (log D at reference temperature of 90ºC, pH 3.5 and ºBrix 12), z_T, z_{pH} and z_{Brix} of *Neosartorya* spores were estimated for juices and concentrates as measured by different methods. The pooled log D* of *Neosartorya* spores was estimated at 0.728 (SE=0.059). The main parameters influencing log D* were age of spores (p=0.023) – the older the spores the greater their thermal resistance – and inactivation method (p=0.032). The three-neck round inactivation method produced a higher pooled log D* (1.297, SE=0.247) than the thermal death tubes (0.436, SE=0.133), the polyethylene bag (0.585, SE=0.175) and the capillary methods (0.559, SE=0.189). The addition of preservatives such as benzoic or sorbic acid to the juices increased the pooled z_T from 6.944 ºC (SE=0.393 ºC) to 8.913 ºc (SE=0.969 ºC). Whereas the pooled z_{pH} was estimated at 7.073 (SE=1.463), z_{Brix} was found to be affected by the type or consistency of the medium (p=0.001). Increasing soluble solids in juices was demonstrated to cause a greater increase in the fungus' thermal resistance than increasing soluble solids in concentrates/pastes/purees (p=0.001 for ºBrix×Type). Overall, the strategic incorporation of the various moderators to the basic Bigelow equation was able to explain 43.6% of the variability in log D between studies. The meta-regression model can be useful in thermal process design and shelf-life estimation of fruit juices and concentrates.