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Short communication

Quantifying the spoilage and shelf-life of yoghurt with fruits

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ABSTRACT

The aim of the present study was to develop a predictive model to quantify the spoilage of yoghurt with fruits. Product samples were stored at various temperatures (5–20 °C). Samples were subjected to microbiological (total viable counts, lactic acid bacteria-LAB, yeasts and moulds) and physico-chemical analysis (pH, titratable acidity and sugars). LAB was the dominant micro-flora. Yeasts population increased at all temperatures but a delay was observed during the first days of storage. Titratable acidity and pH remained almost constant at low temperatures (5 and 10 °C). However, at higher temperatures (>10 °C), an increase in titratable acidity and reduction in pH was observed. Sugar concentration (fructose, lactose and glucose) decreased during storage. A mathematical model was developed for shelf-life determination of the product. It was successfully validated at a temperature (17 °C) not used during model development. The results showed that shelf-life of this product could not be established based only on microbiological data and use of other parameters such as sensory or/and physico-chemical analysis is required. Shelf-life determination by spoilage tests is time-consuming and the need for new rapid techniques has been raised. The developed model could help dairy industries to establish shelf-life predictions on yoghurt with fruits stored under constant temperature conditions.

1. Introduction

Yoghurt is a widely known dairy product with high consumption worldwide mainly because of the beneficial impact on consumers' health. In circumstances of poor manufacturing practices and storage conditions, spoilage of the product occurs within a relatively short time. The deterioration of yoghurt is the result of changes in its physical, chemical and organoleptic/sensorial characteristics, making it unacceptable for human consumption. The spoilage of dairy products such as yoghurt and cheese is mainly due to the development of yeasts and moulds, which are the Specific Spoilage Organisms (SSOs) of this kind of products. Spoilage is perceived by the appearance of mould formation on the surface of the product, discolouration, off-odours, etc. (Suriyarachchi and Fleet, 1981).

The shelf-life stated on the product usually is largely relied on commercial experience and the use of predictive models to establish the shelf-life of the yoghurt is scarce. Determination of yoghurt shelf-life has been made using Artificial Neural Networks and Weibull hazard analysis (Al-Kadamany et al., 2002,2003; Sofu and Ekinci, 2007). Conventional microbiological methods (e.g. spoilage tests), used to determine the shelf-life of the products, are time-consuming, give retrospective results and in many occasions are expensive. The development and application of mathematical modelling, which predicts the increase of SSOs, the concentration of metabolic products and/or the onset time of spoilage signs, allows the reliable determination of the shelf-life in a short time (Koutsoumanis and Nychas, 2000).

The objective of the present study was to develop a predictive spoilage model capable of giving reliable and accurate predictions. The potential for shelf-life prediction constitutes a valuable information source for food industries, especially dairy, which apply food quality assurance systems.

2. Materials and methods

The methodology followed to develop the predictive spoilage model capable of predicting the spoilage of yoghurt with fruits is briefly presented in Fig. 1. The samples were obtained directly from a dairy industry on the day of their manufacturing. Briefly, the manufacture of the product was: heating of milk at 85–95 °C, homogenization, cooling to achieve the desired temperature for inoculation, addition of starter cultures, stirring until the desired pH is achieved, further cooling, addition of fruits and other additives (e.g. stabilizers and flavours), packaging and storage at 4 °C. The chemical composition of the product was the following (g/100 g): protein, 5; carbohydrates, 20; and fat, 2.5. Two replicates were analyzed on each sampling day and the experiment was

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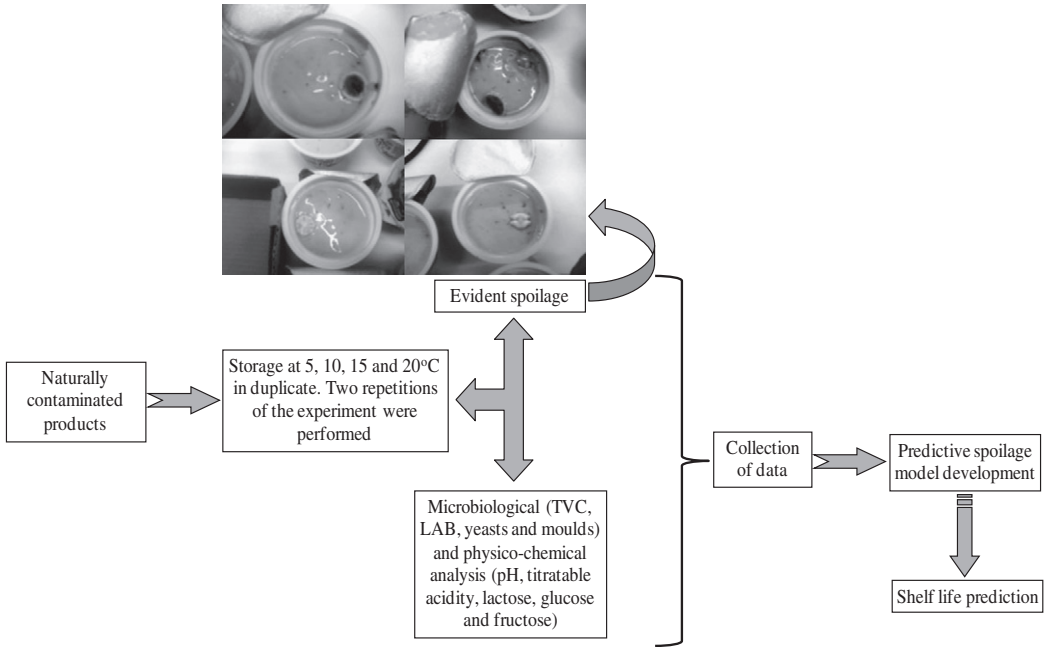

Fig. 1. Methodology followed for developing the spoilage predictive model of yoghurt with fruits.

conducted again using a different batch of the product (four replicates in total per sampling day) to take into account the biological variability within and between batches. Microbiological analysis was performed as described in Mataragas et al. (2006). The pH was measured by using a digital pH-meter (WTW, pH 526, Weilheim, Germany) and titratable acidity according to the IDF Standard (1991). Sugar concentration was determined by High Performance Liquid Chromatography (HPLC) using refractive index (RI) detector (Perkin Elmer LC-30, Waltham, Massachusetts, USA) (Lefebvre et al., 2002). HPLC conditions used are referred in Mataragas et al. (2006). The assessment of product organoleptic acceptability was performed visually after opening the products and before the microbiological and physico-chemical analysis based on criteria such as mould formation on the surface of the product, off-odours, discolouration and syneresis (evident spoilage) (Fig. 1). The experimental data were fitted to the equation

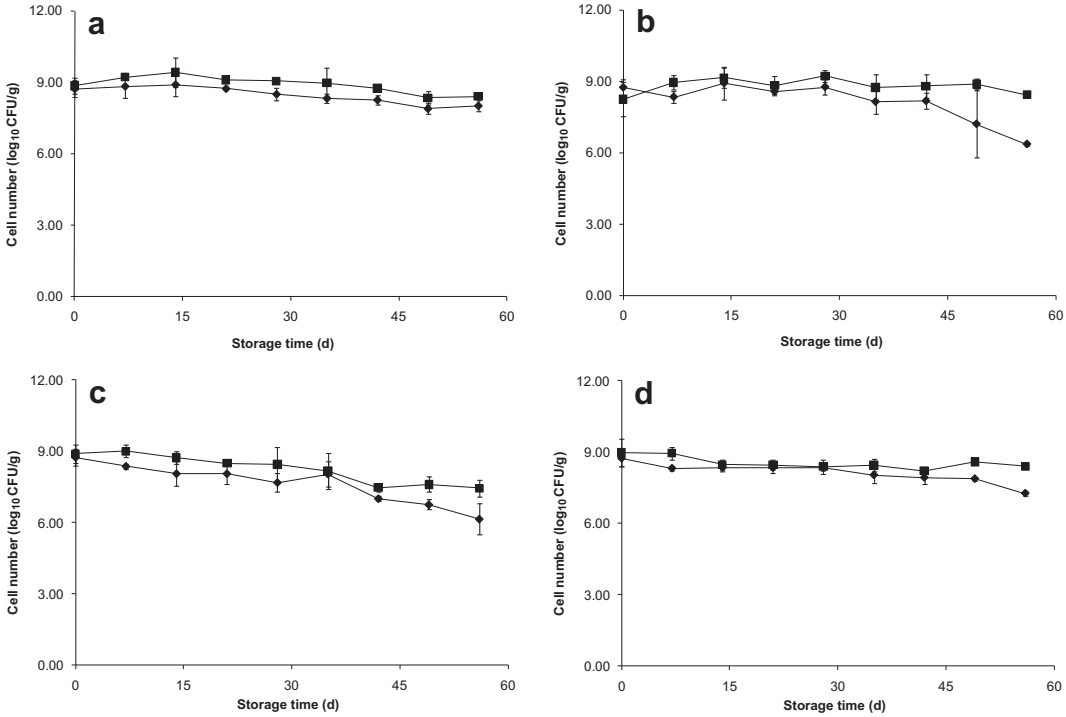

Fig. 2. Micro-flora population changes during the storage of yoghurt with fruits at the following temperatures: a) 5 °C, b) 10 °C, c) 15 °C and d) 20 °C. (◆) LAB and (■) TVC. Symbols are mean values of four replicates with the associated s.d.