ANALYTIC DETERMINATIONS OF MINERALS CONTENT BY XRF, ICP AND EEA IN ULTRAFILTERED MILK AND YOGHURT

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***Abstract*—The application of ultrafiltration for milk concentration allows obtaining a raw material for yoghurt elaboration, with total solids increased. The products have special characteristics due to different ratios proteins/lactose can be obtained, as well as they have nutritional properties with beneficial effects in human health. In this study the content of calcium, potassium, phosphorous, iron, zinc, magnesium and sodium in milk, its distribution during ultrafiltration and in the fermented product have been studied by means of X-ray fluorescence spectrometry (XRF). The results show that XRF technique has been successfully used for determination of minerals content in dairy products, still for trace species. The minerals measures were validated with other analytical techniques with high accuracy and versatility as inductively coupled plasma spectrometry (ICP) and atomic emission spectrometry (EEA). Furthermore the proteins content was increased 13 % and lactose content has been reduced in 30 %, in compared with some commercial products.**

***Keywords* — Ultrafiltration, milk, yoghurt, mineral content.**

I. INTRODUCTION

Cow milk and dairy products supply essential inorganic elements for humans, and constitute the most important source of bioavailable calcium in our diet (Closa *et al*., 2003; De la Fuente *et al*., 2003). There is good evidence that a number of milk minerals play important roles in bone metabolism and bone mass (Cashman and Flynn, 1999; Cashman, 2006; Flynn, 2003). Scholz-Ahrens and Schrezenmeir (2006) have recently demonstrated that dairy products have hypotensive effect of fat-reduced and milk minerals have positive effect on components of the metabolic syndrome.

The knowledge of milk and milk products benefices has increased in the time and this tendency has driven the manufacturers to develop and produce a wide variety of products with different characteristics. Fractionated milk components enable a more constant quality and will lead to a more efficient and diverse use. Membrane technology makes it possible to improve the quality of traditional dairy products, to create new food staffs, to a much greater extent for human nutrition (Cheryan and Alvarez, 1995; Brans *et al*., 2004). It is known that ultrafiltration (UF) membranes allow passage of lactose, water and some salts while retaining the proteins, fats and some of the insoluble or bound salts. This behavior was employed in order to obtain a concentrate with high protein content and total solids adequate to manufacture yoghurt (Alvarez *et al*., 1998). The product obtained additionally has reduced the lactose values respect to commercial yoghurts, which benefices to people with intolerance to lactose (Somkutti and Holsinger, 1997). Calcium, phosphorus, potassium, iron and zinc partition and redistribution during ultrafiltration process is measured in this work employing an analytic technology fast and sensitive between the ranges studied, as the X-ray fluorescence spectrometry (XRF), which alloy a direct analysis upon the sample, without previous treatment (Deluigi *et al*., 2003). The mineral determinations were compared employing other methodologies as inductively coupled plasma spectrometry (ICP) and atomic emission spectrometry (AES), with these techniques concentrations of magnesium and sodium were also determined. Accuracy and versatility for dairy samples were determined to evaluate the efficiency of the methodologies employed. The results let to characterize the mineral composition of yoghurt manufactured by fermentation of a skim- milk concentrate and they are compared with commercial products.

II. MATERIALS AND METHODS

A. Raw Material

Partially skim-milk (1.5% fat, 3.5% protein, 4.8% lactose) (MILKAUT, Industry Argentina), was used.

B. Analytical

Raw material, concentrate, permeate and fermented products were analyzed in duplicate according to standard methods (Hart and Fisher, 1991; Casado, 1991). Density (ρ) was measured with a digital densimeter DA-110 Density/Specific (Metter, USA) and pH was measured using a pH digital (Orion model 720A, USA). The total protein content was calculated by determination of total nitrogen by the Kjeldahl method using Tecator accessories for Kjeltec Systems I and Digestion Systems DS6, USA (AOAC 15017). The fat content was measured with the Rosse-Gottlieb method (AOAC 15029). Lactose was determined by reaction with potassium iodate-chloramine T (FIL 28A/1974). Total solids were determined by weighty difference, drying in an oven at 70 ± 1°C (AOAC 15014). For ash determination, samples were weighted into porcelain crucibles and incinerated in a muffle furnace (Indef model 132, Argentine) with a temperature programmer to reach 520 °C (AOAC 15016).

Measurements of calcium, potassium, iron, zinc and phosphorus contents were performed using a Philips