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Original Article

Rapid quantification of iron, copper and zinc in food premixes using energy dispersive X-ray fluorescence

Loïc Perring*, Daniel Andrey, Marija Basic-Dvorzak, Daniel Hammer

Department of Quality and Safety Assurance, Nestlé Research Centre—Nestec, Vers chez-les-Blanc, CH-1000, Lausanne 26, Switzerland

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Abstract

A simple and rapid method for the determination of iron, copper and zinc in food premixes (used during human food processing) by energy dispersive X-ray fluorescence (XRF) has been established and validated using 25 samples. Reference values were obtained by inductively coupled plasma-optical emission spectroscopy after microwave acidic digestions. Studied samples presenting wide ranges of concentrations: Fe = 500–35000 mg/kg, Cu = 50–4000 mg/kg and Zn = 700–32000 mg/kg were quantified in 200 s by XRF measurements using a rhodium tube.

Keywords: EDXRF; ICP-AES; Iron; Copper; Zinc; Premixes; Alternative; Reference; Quantitative analysis; Rapids; Minerals

1. Introduction

The addition of vitamins and minerals to foods—fortification—is a way:

- To provide a measure for the correction and prevention of nutritional deficiencies in the population.
- To restore those nutrients lost during processing (and then to maintain the nutritional quality of foods).

*Corresponding author. Tel.: +41-217858373: fax: +41-217858553.
E-mail address: loic.perring@rdls.nestle.com (L. Perring).

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- To allow the standardization of the nutrient content in foods (that naturally show variable concentrations) and thus to maintain or increase product quality consistency.
- To add value to finished products because consumers are interested in nutrition and its relationship to health and well being.

Early examples of fortified foods are iodized salt, milk with vitamin D, flour and bread enriched with vitamins B_1, B_2 and Fe. Fortification has helped to eliminate diseases such as goitre, rickets, and beriberi in many countries (Mejia, 1994).

To ensure correct addition of premixes during infant formulae production, analytes such as calcium, iron or zinc may be determined in final products (Fig. 1). Data obtained with accurate and rapid analyses can be used to update the process parameters and thus to ensure target concentration of premixes added to the milk powders is achieved. When target concentrations are obtained, the infant formulae production can be released. Controlling nutrient levels only in final products is not, however, sufficient. It is obvious that the concentrations of vitamins and minerals in food premixes also have to be well defined and checked to ensure the compliance with the finished product declaration (or to guarantee correct food labelling) (Flynn et al., 2003).

In this connection, providing rapid, robust, multielemental and accurate techniques to obtain data about toxicity, origin, nutrition/health or processing has become a first priority, given the advent of greater control of starting raw materials as well as finished food products. The major advantage of the X-ray fluorescence (XRF) technique compared to wet chemical analysis is that the measurements can be carried out directly on solid samples (powder in sample cup or pressed into pellets). This avoids lengthy sample preparation steps, using corrosive and toxic reagents which in turn lead to contamination risks. Less manipulation and time consuming digestions mean time and cost savings. Further advantages of XRF include simplicity of use, short analysis time and simultaneous analysis leading to a high throughput. The XRF technique possesses the main characteristics of an analytical tool to be used near the food production lines (Kueppers and Haider, 2003). For milk powders and infant formulae, the use of XRF technique shows successful results (Hughes and Fong, 2000; Hughes and Fong, 2002; Perring and Andrey, 2003, 2004), thus minimizing risks of recall or rework. In the present paper, an energy dispersive X-ray fluorescence (EDXRF) method is proposed for rapidly checking iron, copper and zinc in premixes used in the manufacturing of foodstuff.

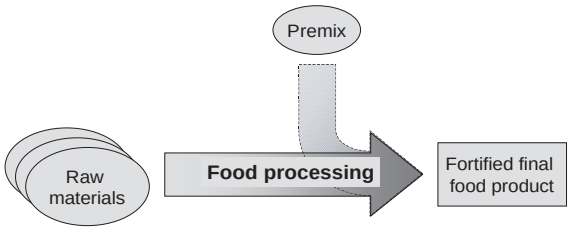

Fig. 1. Overview for premix addition.