



Determination of iron in wheat and corn flour using x-ray fluorescence technique

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1. Introduction

Iron deficiency anemia is a global public health problem. It is one of the determining factors behind delayed child development, resulting in low school performance and lower productivity in adult life. In Brazil, it affects around 25% of children under two years of age, reaching more than 50% depending on the region, and also affects 30% of pregnant women and women of childbearing age % [1, 2]. In 2002, the prevalence of anemia in children under 5 years old was around 40% (approximately 3 million Brazilian children had anemia) reaching in some studies up to 60.9 % [3]. Aiming to combat anemia due to nutritional deficiency of iron and folic acid, the World Health Organization (WHO) and Pan American Health Organization (PAHO) recommend the fortification of food products. Anemia in Brazil is a public health problem due to iron-deficiency, in 2002 ANVISA instituted the mandatory supplementation of wheat and corn-based flours, these products must contain at least 4.2 mg of iron for every 100g [4]. Several studies have shown that Fe iron supplementation still is inappropriately used: many foods fortified with iron does not reach the minimum amount or exceed the recommended limit [5-7]. In this research, several brands of corn and wheat flour, commercially available in São Paulo city (the Southeast Region of the country), were evaluated by iron determination using Energy Dispersive X-Ray Fluorescence technique (EDXRF).

2. Methodology

Samples of wheat flour (18) and corn flour (16) commercialized in the large region of São Paulo were investigated. Each sample (100 mg), prepared in triplicate, were weighed on a precision analytical balance (Shimadzu AUW220D), then pulverized in an Agate stone mortar with a pestle so that the flour samples were homogeneous. After, each sample was compressed in a manual press. This method of preparation does not require binder, substrate and/or digestion.

The EDFRX analysis was performed using X-Ray Spectrometer (X-123 SDD model from Amptek®), with Silver (Ag) X-ray tube [8]. The characteristic fluorescent X-rays emitted from the samples ($Fe_{K\alpha}$

line, 6.42 keV) was measured with a Si Drift detector (25 mm² x 500 μm) with Be window (12.5 μm) [9]. The excitation conditions were optimized in 30 kV and 5 μA and counting time of 200 s. The spectra analysis was performed using WinQxas software program [10].

3. Results and Discussion

The data for Fe in corn and wheat flour samples are presented in Table I. ANVISA established a minimum amount (MR) of 42 mg/kg (4.2mg/100g) Iron in flour. The corn flour samples evaluated showed an average value and stand deviation of 55 ± 6 mg/kg while the wheat flour results are expressed as 56 ± 15 mg/kg. Only one sample (W18 = 39 mg/kg, see Table I) is near of the minimum recommended, all the other samples were above the minimum limit established by Brazilian legislation.

Table I: Iron concentration in wheat and corn flour samples by EDXRF

Wheat flour samples (n=18)	Fe concentration ± SD (mg/kg)		Corn flour samples (n =16)	Fe concentration ± SD (mg/kg)	
W01	111	5	C01	49	3
W02	59	3	C02	57	3
W03	59	3	C03	57	3
W04	58	3	C04	56	2
W05	57	3	C05	51	3
W06	57	3	C06	67	3
W07	56	3	C07	50	2
W08	56	3	C08	45	2
W09	54	4	C09	58	3
W10	53	3	C10	56	3
W11	52	4	C11	63	3
W12	52	3	C12	61	3
W13	52	3	C13	55	3
W14	51	2	C14	53	3
W15	48	2	C15	52	3
W16	45	2	C16	56	3
W17	45	2			
W18	39	2			

MR: minimum recommended, C: Corn flour sample and W: Wheat flour sample

The Fig. 1 shows the iron concentration rate in samples in relation to the minimum recommended amount (MR in Black). According to this figure, the W01 sample is 2.6 times above the minimum and the W18 sample is below the minimum recommended.

The values found in this investigation were better in relation to previous studies performed in different regions of Brazil [5, 6, 11]. In the São Paulo city region, 26.5% of corn flour samples and 22.5% of wheat flour samples were found below the minimum concentration using flame atomic absorption spectrometry technique [5]. In the Southeast Region of the country, in Minas Gerais, in the city of Itapira, out of 10 batches of flour, one batch was below the determined minimum using ICP-OES spectrometer technique [6]. In the Northeast region of the country, a study carried out with 10 samples of corn flour, obtained from the local market, none of them met the legislation criteria using UV/visible molecular absorption spectrophotometry technique [11].

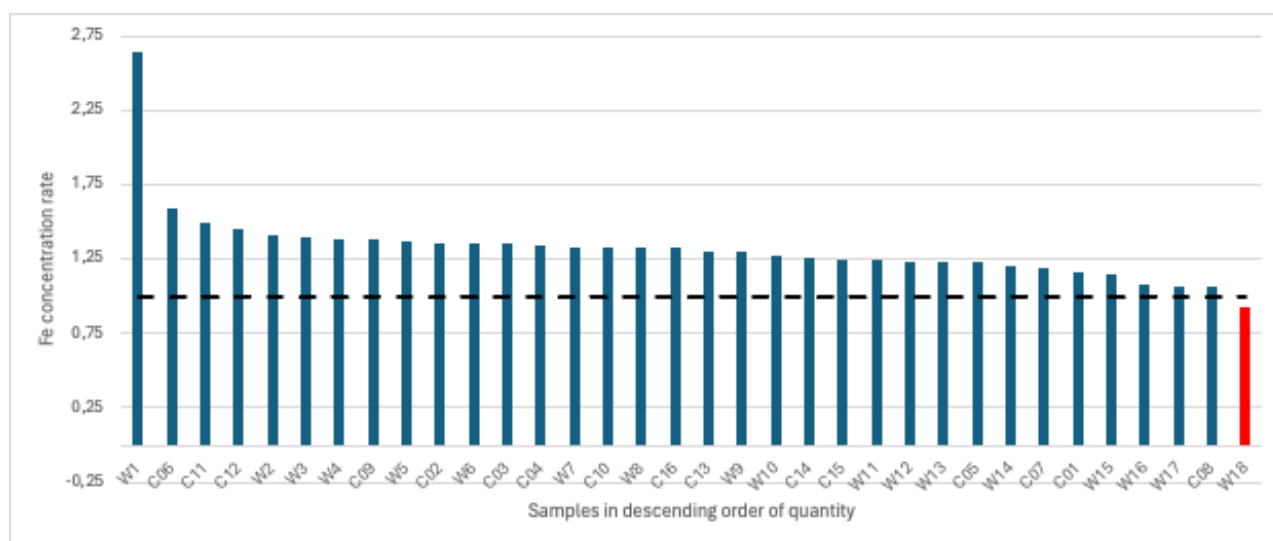


Figure 1: Graph showing the Fe concentration rate in samples compared to the minimum recommended amount (black dotted line)

In this study, the W1 sample is 2.6 times above the MR. Other studies also show high concentrations of Fe. Alves *et al* [6] found 50% of the samples with more than 2 times the MR, ranging from 8.4 to 10.3 mg/100g. Also Buzzo *et al* [5] found a sample with 19.9 mg/100g practically 4.7 times above the RM. In another study, performed by Boen *et al* [12], used flame atomic absorption spectrometry technique were evaluated samples with up to 9 mg/100g (practically 2.0 times above the RM) . Current Brazilian legislation establishes a minimum value for supplementation without a defined maximum value [13]. This is a problem for patients with iron overload in the body, as there is no physiological mechanism for eliminating iron, only a mechanism for reducing absorption. This characteristic is important for cases of genetic hemochromatosis, where iron overload occurs due to excessive absorption of dietary iron or recurrent blood transfusions due to refractory chronic anemia e.g., sickle cell anemia (sickle-shaped red blood cells, and therefore there is deficiency in iron transport) and aplastic anemia (bone marrow produces insufficient red blood cells) [14, 15].

4. Conclusions

The Fe levels determined in samples of wheat and corn flour, sold in greater São Paulo, meet the Minimum Recommended. However, some samples are even above the RM (up to 2.6 times). This raises a warning for people with iron overload, as the food label indicates the RM and not the amount present. This study also emphasizes the importance of monitoring processed foods, as well as the need for detailed regulation regarding labeling.

Acknowledgements

The authors thank the financial support of IPEN /CNEN-SP, FUNDEP, Estácio de Carapicuíba.

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