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THE EDXRF ANALYSIS TO MONITOR IRON DEFICIENCY ANEMIA

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1. Introduction

Iron deficiency anemia is a nutritional deficiency of greater magnitude in the world, affecting mainly pregnant women and children under two years. It occurs mainly due to an insufficient amount of iron in the diet [1,2]. It is also related to insufficient intake of folic acid and copper. Iron deficiency anemia results from low or depleted iron stores, which are needed to make red blood cells. Small amounts of iron are lost daily through skin, hair, nails, feces, and urine. In women, there is an additional loss due to menstruation and breast milk. The average daily loss for adults is 1 mg for men and 1.5 mg for women. Global data related to the lack of dietary iron fortification affects 40% of children; 30% of women of childbearing age and 38% of pregnant women. Iron deficiency in the body is gradual, until the development of anemia. In Brazil, anemia is considered a public health problem [3]. The importance of obtaining a quick diagnosis, with a simple and low-cost test, motivated the search for an alternative for iron evaluation in the blood. This work proposes the use of portable equipment, based on X-ray Fluorescence technology, to evaluate the iron concentration in whole blood samples for the diagnosis of iron deficiency anemia.

2. Methodology

The samples came from Paulista Blood Bank. Whole blood samples were obtained from a group consisting of male (n = 10) and female (n = 10) donors (18-30 age, 55-85kg) diagnosed with iron deficiency anemia. For the blood collection, (CAAE: 69992117.7.0000.0081), a small capillary pin (Clinitubes, Radiometer Copenhagen) was inserted in the subject's finger and 50 (± 0.5 %) µL was dropped on a Whatman no. 41 filter paper (2.2 cm^2) using a calibrated micropipette. Samples were collected in duplicate. The EDXRF analysis was performed using an X-Ray Spectrometer (X-123 SDD model - Amptek®), with an Au X-ray tube. The characteristic fluorescent X-rays emitted from the samples (Kα line) were measured with a Si Drift detector (25 mm^2 x 500µm) with Be window (12.5µm). The excitation conditions were optimized in 30 kV and 5 µA and a counting time of 200s. The spectra analysis was performed using the WinQxas software program [4].

3. Results and Discussion

The Fe concentration determined in blood samples is presented in Table 1. The reference values, from the control group were included for comparison (considering a confidence interval of 95%). To visualize, these results are shown in Figure 1. The control group results are presented in Table 2. The results were expressed by mean value (MV), standard deviation (±1SD), minimum (Min), maximum (Max), and the range for a confidence interval of 95%.

Table I - Fe concentrations result in whole blood by EDXRF analysis.

Female [326 - 570]*	Male [386 - 622]*
n=20	
262 ± 16	271 ±13
211 ± 13	259 ± 16
171± 10	238 ± 14
270 ± 16	217 ± 13
212 ± 13	279 ± 17
234 ± 14	277 ± 17
242 ±15	218 ± 13
248 ± 15	254 ±15
276 ±17	234 ±14
241 ±14	279 ±17

n: number of samples

*Reference values

Table II - Control Group results by EDXRF.

Fe (mg/l)	Male n = 42	Female n = 40
VM	504	448
1DP	59	61
Min	374	307
Max	589	587
Range	386 - 622	326 - 570

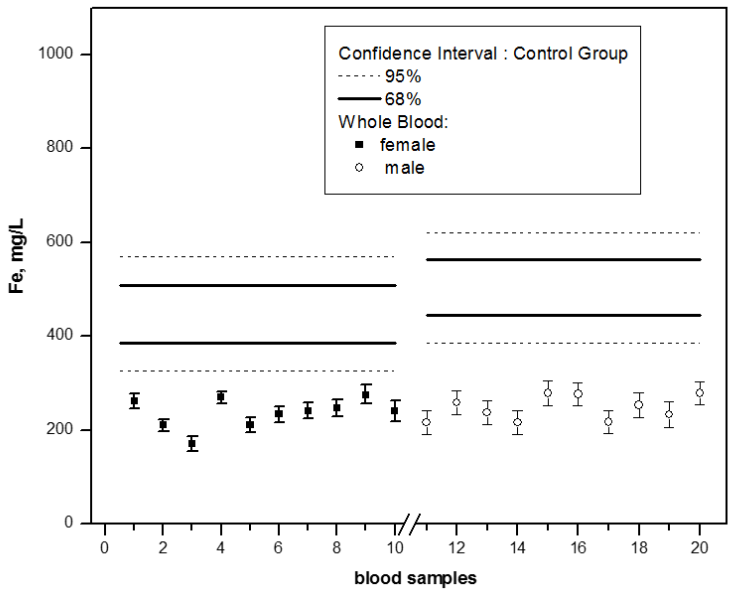

Figure 1 - Fe concentration results in whole blood samples by EDXRF technique.

The Fe concentrations results in whole blood of subjects with iron deficiency anemia when compared with the reference values showed a decrease. This procedure offers quick iron deficiency anemia diagnosis, with a simple and low-cost test. Related to the alternative procedure (EDXRF) some positive aspects can be emphasized: the simplicity involved in the whole blood collection and sample preparation as well as the speed (minutes) to perform the measurements.

4. Conclusions

The use of the EDXRF technique allowed an efficient evaluation of Fe in whole blood samples. In addition, this procedure has potential use when the biological material is scarce, case of the pediatric practice in newborns due to the high prevalence of iron deficiency anemia in this age group.

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