

## Images in Cardiology

# Elemental Mapping of Cardiac Tissue by Scanning Electron Microscopy and Energy Dispersive X-ray Spectroscopy: Proof of Principle in Chaga's Disease Myocarditis Model

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Tissue electrolytes (especially calcium, sodium, and potassium) are critical elements for proper cardiomyocyte and whole heart contractile performance. The levels of these minerals are markedly altered in cardiomyopathies.<sup>1</sup> Energy dispersive X-ray spectroscopy (EDS) associated with scanning electron microscopes has a potential applicability to the spatial mapping and evaluation of the relative distribution of chemical elements in biological tissues, including cardiac tissue.<sup>2</sup> Thus, a scanning electron microscope (Le01430VP; Carl Zeiss, Jena, Thuringia, Germany) with an attached X-ray detector (TracorTN5502; Middleton, WI) was used to obtain images of the distribution of chemical elements and to determine the proportion of carbon, sodium, potassium, calcium, magnesium, copper, zinc, and selenium in cardiac tissue infected by *Trypanosoma cruzi*. Nine male Wistar rats aged 4 months and infected with *T. cruzi* Y strain (300,000 trypomastigotes/50 g body weight, intraperitoneally) and an equal number of control rats were used. Ten weeks after inoculation, the animals were euthanized and their right ventricles dissected (Ethics approval number 30/2009, Federal University of Viçosa). Fragments (4×3×2.5 mm) from the right ventricle were fixed in 2.5% glutaraldehyde, dehydrated in ethanol, cryofractured with liquid nitrogen, submitted to critical point drying, and coated with carbon. The EDS microanalysis was performed at ×1000 magnification with an accelerating voltage of 20 kV.

Figure 1 shows, for the first time, an elemental map of cardiac tissue obtained by scanning electron microscopy and energy dispersive X-ray spectroscopy, which is very different in normal compared with infected myocardium. Although the mineral distribution was homogeneous, there was a higher density of copper, zinc, and selenium (involved in oxidative processes) and low density of magnesium (involved in adenosine triphosphate metabolism) in the heart infected by *T. cruzi*. These data suggest that the density of some minerals is modified in cardiac tissue in response to *T. cruzi* infection. This fact opens further perspectives concerning the role of these minerals in the heart structure and function during experimentally transmitted Chagas disease. Furthermore, it is expected to contribute further to understanding the participation of minerals in cardiomyopathies with different etiologies.

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### Disclosures

The authors have no conflicts of interest to disclose.

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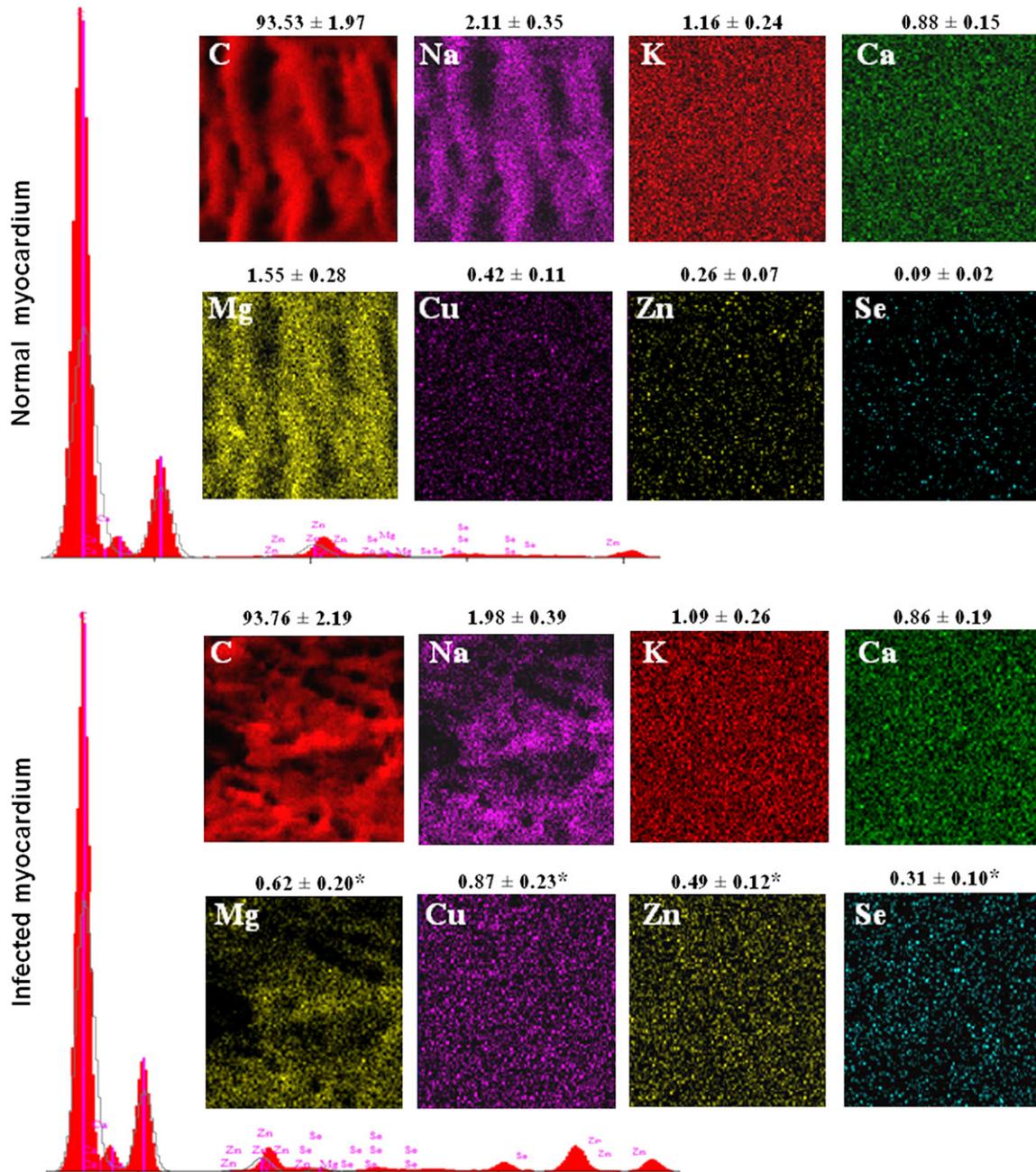
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See page 639.e3 for disclosure information.



**Figure 1.** Elemental map of normal (top panel) and *Trypanosoma cruzi*-infected (bottom panel) cardiac tissue (magnification  $\times 1000$ ). The graphics represent the X-ray emission spectrum for the elements analyzed. The numbers indicate the percentage of each element (mean  $\pm$  standard deviation) in the cardiac tissue. \*Statistical difference compared with normal myocardium ( $P < 0.01$ ), student *t* test. C, carbon; Na, sodium; K, potassium; Ca, calcium; Mg, magnesium; Cu, copper; Zn, zinc; Se, selenium.