UNIVERSITI TEKNOLOGI MARA

CHEMICAL CHARACTERIZATION OF ANIMAL BONE BASED CERAMIC AND CHEMOMETRIC METHOD

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MSc

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Chemical characterization is a process of defining chemical properties in a substance. In this study, chemical characterization focuses on animal bone ashes and animal bone based ceramic samples. Ceramic products derived from the bones of non-halal animal have become a growing concern for Muslims in terms of its uncertainty status. This research quantifies concentration of eight elements in animal bones ashes, animal bone based ceramics with different percentages of bone ashes and control (a ceramic body without bone ashes). Profiles of the multi-elemental concentrations from cow, goat, swine bone ashes and ceramic samples were created by characterizing using Inductively Coupled Plasma -Atomic Emission Spectroscopy, Flame Atomic Absorption Spectroscopy, Fourier Transform Infra-Red and Scanning Electron Microscope (SEM). Characterization was performed by Inductively Coupled Plasma -Atomic Emission Spectroscopy (Shimadzu ICPE 9800) for Ag, Al, K, Na, Si, P and Flame Atomic Absorption Spectroscopy (FAAS Agilent, 240) for Ca and Mg elements. Spectral data was performed using Fourier Transform Infra-Red (FTIR) and surface morphology performed by Scanning Electron Microscope (SEM). The data of animal bone ashes concentration depicted phosphate concentrations in swine bone ashes as the highest mineral followed by cow and goat bone ashes. The chemometric analysis employed to classify animal bone ashes using Principal Component Analysis (PCA) presented close correlations of bone ashes treated at 800 °C and 1000 °C with phosphate. Animal bone-based ceramic samples characterized by the spectroscopy method found that concentrations of phosphate in the ceramics made from swine bone ashes were higher than ceramic samples from cow and goat bone ashes. PCA categorized and discriminated animal bone based ceramic samples of different animal bone ashes. Clustering was determined by Agglomerative Hierarchical Clustering (AHC) analysis by clustering together ceramic samples with bone ashes in higher percentages while ceramic samples with lower percentages of bone ashes composition clustered together as depicted through the distinctive hierarchical pattern on a dendogram. Linear Discriminant Analysis (LDA) successfully class the ceramic samples based on types of animals bone ashes and discriminated from the blank samples. Spectral data of bone ashes and the animal bone based ceramics samples using Fourier Transform Infra-Red (FTIR) methods shown spectral data of ceramics samples mainly represent by tricalcium phosphate, silica glass, and anorthite. The intensity of peaks at 1046.91cm^{-1} were due to the fundamental stretching and bending vibrations of the PO_4^{3-}, phosphate functional groups in animal bone ashes. Scanning Electron Microscope (SEM) examined surface morphology of animal bone based ceramic showed an identical pattern of the samples. The results encourage continuing the research but with more emphasis on the phosphate as the main indicator to classify samples of animal bone-based ceramics and further experimenting with the pre-processing of instrumental and spectroscopic data.

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