Application of Microwave-Assisted Techniques for Human Tissue Samples Preparation for Actinide Analysis

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This paper describes the application of microwave-assisted drying and digestion procedures using an Anton Paar Multiwave 3000 microwave system (MW3000), equipped with a Rotor DRY1 (RD1) for drying, and a Rotor 8 (R8) for digestion.

Advantages of the microwave-assisted drying process were tested using bovine brain, kidney, and liver samples. A comparison of the MW3000/RD1 with a convection drying oven VWR 1685 was performed in reference to the sample processing time and drying efficiency (reduction of sample mass). Samples of ~5 g to ~250 g, representative of masses typically analyzed at the USTUR, were presented. Individual sample size was limited to ≤250 g due to the RD1 size restrictions. Microwave drying resulted in an average efficiency of 74.5±4.3% (n=34), while convection drying resulted in the efficiency of 67.1±6.4% (n=16).

Preliminary results indicated that microwave-assisted drying is a viable method for rapid processing of small batches or a single sample, and may be preferred over convection oven drying for larger samples. With regard to the latter, its limited sample throughput makes it ineffective for processing high numbers of tissue samples. Moreover, it was found to be more demanding of staff time on a per-sample basis.

Microwave-assisted digestion using an MW3000, equipped with an R8, was tested using NIST Standard Reference Materials (SRM): SRM4351, human lung freeze-dried powder; SRM4352, human liver freeze-dried powder; and SRM4356, human bone ash. The efficiency of microwave digestion was investigated with respect to sample mass, reagent mixture used, and microwave operational conditions. Tests to optimize sample mass and characterize system performance were conducted using SRM4356. Sample masses varied from 0.5 to 5 g for bone ash (SRM4356), and were 1 g for SRM4351 and SRM4352. The HNO_3-HCl mixture was used for digestion of bone and liver samples, and HNO_3-HCl-HF mixture was used in the case of lung samples (SRM4351). Regardless of sample size, tissue type and reagent mixture used, microwave digestion was performed at a controlled pressure of 50 bar and temperature of 210°C for 20 min. Analyses of digested SRM4351 and SRM4352 for $^{239/240}$Pu showed excellent agreement with certified values.

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