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Lead and Strontium isotopic signatures in bovine blood: indicators of cattle diet, origin, and farm management practices

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The present project investigates the potential of isotopic compositions from bovine blood as bioindicators for monitoring the cattle diet and their geographic origin, testing therefore the isotopes as traceability tools to ensure meat quality. The strategy is based on lead (Pb) and strontium (Sr) isotopic analyses of blood samples from 10/12 cow specimens originating from three different farms located on contrasting geological bedrocks in southern Belgium: CRA-W site in Gembloux (Hesbaye); CTA site in Strée (Condroz); Se site in Seloignes, Chimay (Fagne). In addition to bovine blood samples, the various environmental reservoirs (pasture plants, mineral and food complements, atmospheric fallouts, bedrock) of the cattle were collected to identify their respective controls of the blood isotopic signatures. First, Pb and Sr isotope ratios in cow blood reflect the dominant contribution of three reservoirs, in decreasing order of importance: (1) the diet composed of pasture plants (hay, spelt, silage), (2) the geological bedrock - comparable to mineral food supplement, and (3) the atmospheric fallouts. The similarity between plant and bedrock signatures highlights the suitability of the selected isotopic systems as bioindicators of cattle provenance.

Secondly, as for each animal, blood samples were collected twice a year, the seasonal variability of blood isotopic compositions was evaluated according to the seasonal dietary changes. During winter, cattle diets rely heavily on imported feed or silage, whereas summer feeding is dominated by local pasture plants with only limited food supplements (mineral salts). At the CTA experimental farm, the $^{206}Pb/^{207}Pb$ values are similar across both seasons (1.168 ± 0.004 for $^{206}Pb/^{207}Pb$), suggesting a relatively stable year-round isotopic signature. This stability is consistent with the farm's management practices, as CTA produces nearly all feed supplements on-site, with only minimal external inputs such as mineral salts. In contrast, the private farm in Seloignes (Se-site) exhibited two clearly distinct isotopic signatures corresponding to summer (1.172 ± 0.001 for $^{206}Pb/^{207}Pb$) and winter (1.175 ± 0.003 for $^{206}Pb/^{207}Pb$) feeding periods. This variability, driven by the winter feed imports from distant regions, suggests that cows' blood signatures reflect their geological origin more reliably when sampled after the summer season.