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Isotopic and functional markers for the assessment of territoriality: the case study of Asparago di Altedo PGI in the province of Ferrara (NE Italy)

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Consumers' growing attention on food composition, quality and origin has sparked a renewed interest in food traceability. The use of isotopic markers of territoriality helps emphasize the connection between agricultural products and their specific geographical area of origin, linked both to the soil-to-plant continuity of elemental composition and to contribution from airborne substances assimilated directly by the shoot. Asparago di Altedo PGI is an exclusive product of the Eastern area of Emilia-Romagna region, between Via Emilia and the Adriatic coast. Sandy-based territories favour the emergence of asparagus turions but include significant variations from sandy-clayey loam soils to lean sandy soils, forming a gradient from the inland to the coast. This research aims to detect a potential asparagus diversification driven by soil and environmental characteristics in the province of Ferrara, useful for further defining the product's typicality with respect to the area of origin. For the selected fields (Malborghetto, Mezzano, Bosco Mesola, Mesola, Lagosanto, Volania, Valli Basse), soil and plant sampling took place from May to the early days of June 2023. As an outgroup, samples of common green asparagus cultivated in Abruzzo region (Central Italy) were collected. The turions were transported to the laboratory for analyses of the fast chlorophyll fluorescence induction, a non-destructive near-instantaneous method for physiological plant assessment. Subsequently, soil and asparagus samples were dried and powdered for isotopic analyses. Soil diversification was characterized through pH and chemical analysis of major and trace elements using X-ray fluorescence. To assess the influence of the environment/soil on asparagus, $\delta^{13}C$ and $\delta^{15}N$ isotopic ratios, as well as the C/N ratio, were analyzed on soils and plants using an elemental analyzer associated with an IRMS spectrometer. PCA analysis showed that the soils could be distinguished based on geochemical factors and, for some fields, even at a resolution of a few tens of kilometres. For instance, the abundance of Na_2O separated the coastal fields from those of inland, and the soil samples of the Malborghetto field stood out from the others due to a higher concentration of certain heavy metals (Cr, Ni, Pb). Soil diversification was also attributable to anthropic interventions in the reclamation of the lagoon areas in some parts of the Ferrara province. An interesting correspondence was found between soil diversity and chlorophyll fluorometric parameters. In particular, although the photosynthetic functionality of the plants was very good in all fields, it was possible to distinguish the asparagus

samples based on their origin: for example, the most performing asparagus was from Mesola regardless of the cultivar. Work is still in progress to get a more complete picture of the soil-to-plant continuity in relation to the environmental characteristics of the examined fields.