Italian tomato-based products authentication by multi-element approach: A mineral elements database to distinguish the domestic provenance

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A B S T R A C T

In this study, we propose a novel mineral elements database for the authentication of Italian processed tomato, able to discriminate the domestic provenance from the Chinese, US and Spanish ones. Multi-element analyses by Inductively Coupled Plasma orthogonal acceleration Time-of-Flight Mass Spectrometry (ICP-oa-TOF-MS) and Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) were used for quantifying 26 mineral elements (Li, Be, Na, Mg, Al, K, Ca, V, Cr, Mn, Co, Cu, Zn, Ga, As, Cs, Sr, Ag, Cd, In, Cs, Ba, Ti, Pb, Bi and U) in 183 tomato-based samples of different origin (Italy, China, US and Spain) collected in three different years of production (2013, 2015 and 2017). Linear Discriminant Analysis (LDA) applied to 28 variables (single elements + elemental ratios) allowed excellent separation between Italian and non-Italian tomato samples. Three elemental ratios (Li/Cu, Co/Rb and Sr/Cd) resulted highly effective in identifying the domestic provenance of tomato (100% prediction ability of the model and 98.8% in cross-validation). This result highlighted that ratios between elements were more important than single elements in discrimination.

1. Introduction

In the age of globalization of food markets, the concept of “authenticity” (genuineness and origin) of raw materials has been becoming an increasingly interesting topic for the entire food chain, consumers, and industries. For this reason, the European Community started improving information about the origin of foods, introducing, for some products, the mandatory indication on the label, and allowing member states to make country of origin labelling (COOL) mandatory if consumers feel this important (Regulation 1169/2011).

Thus, in 2016 first France and then Italy, in order to increase consumer transparency, extended the requirement of origin declaration to meat and dairy in prepared foods (Decree No 2016/1137, French Decree) and to milk and dairy products (9th December 2016, Italian Decree), respectively.

Afterwards in 2017, Italy further protected “Made in Italy” in the important sector of processing tomato, broadening the mandatory origin on the label to all tomato derivatives other than passata, already regulated by the 17th February 2006 Italian Decree, as well as to tomato-based products composed with more than 50% of tomato (16th November 2017, Italian Decree).

Processing tomato sector in Italy is the basis of the food economy. Italy is, in fact, the first European producer and the third in the world after California and China respectively, with about 5.2 million metric tons of processing tomatoes produced in 2017 (WPTC, The World Processing Tomato Council, 12 October 2017).

Worldwide, a common fraud against the consumer, known as “Italian sounding”, is the use of geographical names, images and/or brands that recall the “Made in Italy” in market products that are not traceable to Italy. The business turnover of the “Italian sounding” has been globally estimated at exceeding 60 billion euros per year, an amount 2.6 times higher than the current value of Italian exports of agri-food products. This means that, for example, for every box of truly Italian peeled tomatoes there are three whose raw material, though selling as Italian, was cultivated abroad (Monti & Ponzi, 2013).

The interest in the prevention of food frauds has led to the development of analytical techniques able to trace “scientifically” the geographical provenance of food (Danezis, Tsagkaris, Brusic, & Georgiou, 2016; Luykx & van Ruth, 2008). In particular, in the field of the mass spectrometry techniques which are able to analyze bio or mineral elements of food, three kinds of approaches are currently employed: a) the measurement of the variations in the abundances of light stable isotopes (H, C, N, O and S), by Isotope-Ratio Mass Spectrometry (IR-MS); b) the measurement of the variations in the abundances of heavy stable isotopes (Sr, Pb), by Thermal Ionisation Mass Spectrometry (TIMS) or High Resolution Inductively Coupled Plasma Mass Spectrometry (HR-ICP-MS); c) the determination of the elemental composition (multi-element analysis), by Inductively Coupled Plasma Mass Spectrometry (ICP-MS).