E88   Bovine Meat Fraud and Adulteration in Brazil: Innovative Techniques for Tamper Detection

Karen M. Nunes*, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, BRAZIL; Marcus Vinicius de Oliveira Andrade, MSc, Brazilian Federal Police, Belo Horizonte, Minas Gerais 30441-170, BRAZIL; Marcio Talhavini, PhD, Brasilia, Distrito Federal 70736-030, BRAZIL; Mariana R. Almeida, PhD, Universidade Federal de Minas Gerais, Belo Horizonte 31270901, BRAZIL; Jose M. Amigo, PhD, University of Basque Country, Leioa, Vizcaya 48940, SPAIN; Marcelo M. Sena, PhD, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais 31270-400, BRAZIL

Learning Overview: After attending this presentation, attendees will understand important aspects about economically motivated food fraud in Brazil, specifically meat fraud processes, and new approaches using spectroscopic techniques combined with chemometric tools to detect illegal adulterations in bovine meat *in natura*.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by showing techniques with great potential for applications as a screening method, especially in regard to meat fraud identification.

World meat production has been growing at a rate of 0.64% per year. Alongside the United States, which accounted for 19.50% of total world production in 2018, Brazil is one of the world's largest meat producers (15.75% in the same year). The country accounted for 19.89% of all meat exported in the world last year, equivalent to 1.64 million tons ($ 6.57 billion).[1] This corresponds to a growth of 7.9% over the previous year.

Due to the high demand for quality characteristics of fresh meat for export, concerns about the authenticity of food have been growing in recent years. In 2013 in Europe, one of the most famous incidents involving horsemeat tampering occurred.[2] In Brazil, the Federal Police had several scandals in recent years. In 2012, major food processors were investigated for bovine meat fraud by adding non-meat ingredients.[3] In 2017, the meat fraud in Brazil had the highest visibility and international impact with "Operation Weak Flesh."[4] The focus of this investigation was on the verification of irregularities, such as the use of animal carcasses for food production in other processing units, use of additives not permitted by law, bribes to federal inspectors and enforcement agents, and corruption.

The official methods for testing meat authenticity have employed classical techniques used for meat quality control, determining physico-chemical and microbiological parameters. However, these methods are time-consuming, laborious, and these individual parameters are inappropriate to characterize fraud due to the wide variation in the chemical composition of bovine meat, as a function of sex, cut, breed, feed intake, and slaughter age. On the other hand, the utilization of spectroscopic techniques combined with chemometric tools has shown great potential for forensic application as a screening method, because it provides fast, low-cost, minimally destructive analytical methods and requires little or no sample preparation.

In this work, the use of Raman hyperspectral imaging spectroscopy as a screening tool for fraud detection in bovine meat *in natura* by the addition of solutions of sodium salts and polysaccharides with the intention of increasing the water-holding capacity and, consequently, of obtaining economic gain. The mapped spectral range was from 2,400cm^{-1} to 400cm^{-1}. Data were processed using the HYPER-Tools graphical interface, and chemical maps were constructed using the Multivariate Curve Resolution (MCR)algorithm. As a result, the use of Raman imaging spectroscopy, combined with a chemometric tool, proved to be a promising method to help enforcement agencies fight against food fraud and adulterations. The use of these techniques facilitate this process, saving time and reducing costs.

Reference(s):

1.   OECD/FAO, OECD-FAO *Agricultural Outlook 2019-2028.* Paris: OECD Publishing and Rome: Food and Agriculture Organization of the United Nations. 2019. http://www.fao.org/3/ca4076en/ca4076en.pdf.
2.   FSAI. FSAI survey finds horse DNA in some beef burger products. *Food Safety Authority of Ireland*, 2013 Jan 15. https://www.fsai.ie/details.aspx?id=11878.
3.   Karen M., Nunes K.M., Marcus V.O., Antônio M.P., Filho S., Lasmar M.C., Sena M.M. Detection and characterization of frauds in bovine meat *in natura* by non-meat ingredient additions using data fusion of chemical parameters and ATR-FTIR spectroscopy. *Food Chemistry*. 2016;205:14-22. https://doi.org/10.1016/j.foodchem.2016.02.158.
4.   Phillips D. Brazil meat scandal is called "a punch in the stomach." *The New York Times*. 2017 Mar 22. https://www.nytimes.com/2017/03/22/world/americas/brazil-meat-industry-scandal-exports.html.

Meat Adulteration, Hyperspectral Images, Raman Spectroscopy

*Presenting Author