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Rapid detection of adulteration of meat by electrical bio-impedance

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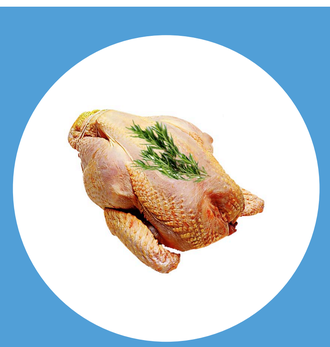

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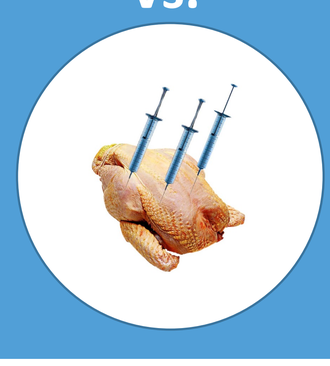


The quest for a rapid checking of the adulteration of chicken meat

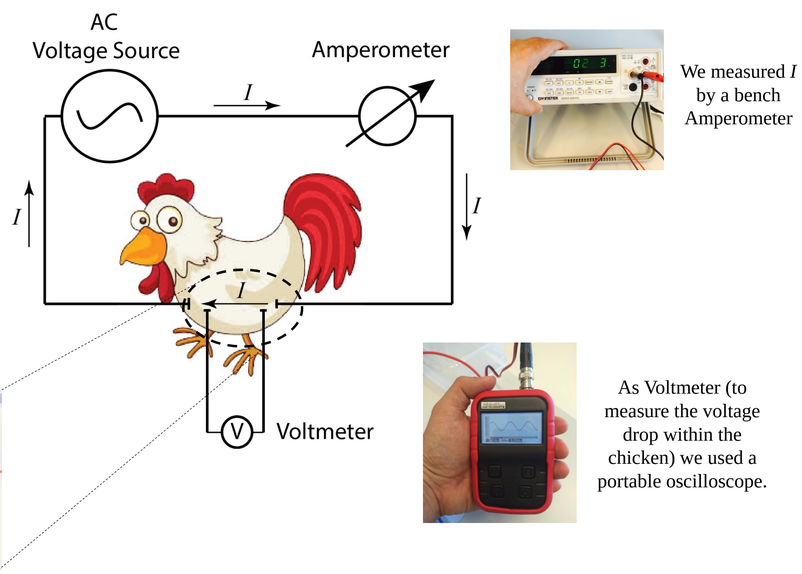
To increase their weight, and to flavour them, chickens meats are sometimes injected with seawater. This adulteration disrupts the quality of the product, defrauds consumers, and increases the content of sodium of the chickens. A rapid assay for the authenticity of chicken meat will protect consumers, and the reputation of retailers by constantly monitoring the products on the shelves. We propose a rapid physical-chemical assays based on the measurements of the electrical behavior of chicken samples. Electrical properties, in fact, depends on the composition, and structure. In addition, our method does not requires any preparation, and does not need dedicated hardware. By contrast, conventional methods of analysis of water content of meats require long times, trained personnel, and the destruction of the sample.

Checking the authenticity of chicken by measuring their electrical impedance with a portable setup.

Composition, structure, and geometry of a chicken meat sample determine the value of the impedance Z.(Ω). This impedance can be estimated by measuring, at a given frequency, the AC current *I* (A) flowing through a circuit closed by a chicken sample, and the AC voltage drop V (V) within the sample, by the ratio:

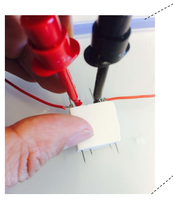
$$|Z| = \frac{|V|}{|I|}$$

We used a portable frequency generator as a tunable AC voltage source



We measured *I* by a bench Amperometer

We used a 4-electrode probe to measure the voltage drop.
We designed the probe to minimize effects of interfaces and geometry



As Voltmeter (to measure the voltage drop within the chicken) we used a portable oscilloscope.

Circuit used to estimate the value of the electrical impedance of chicken filets. This setup made it possible to run hundreds of measurements per day.

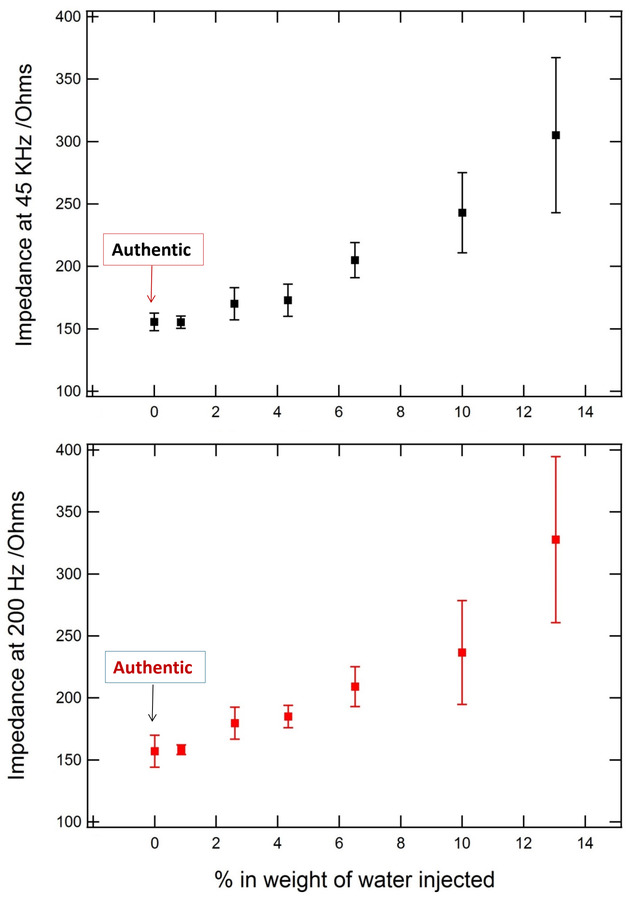
Values of impedance increased substantially as water was injected into the chicken samples

The reference value of Z ~160 Ω for authentic chicken filets was determined from measurements of Z for 40 different filets from the Dutch market.

Values of Z > 200 Ω indicated adulteration

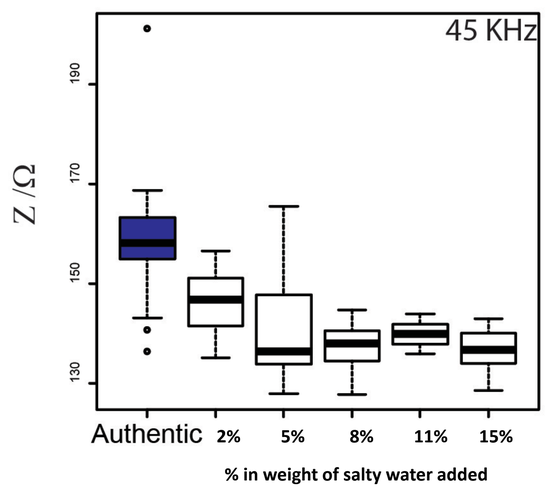
.The values of Z for chicken injected with tap water increase depending on the amount of water added., because tap-water is poorly conductive.

We did not observe differences in the values of Z measured at low (200Hz) and high (45 KHz) frequencies. These results suggest that adulteration involves only the extra-cellular matrix of the tissue

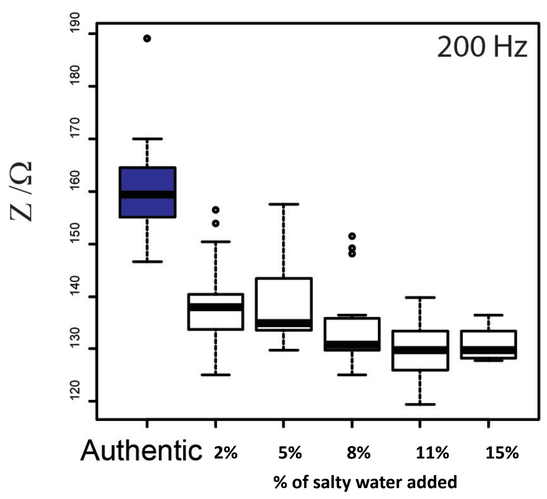


Mean values of Z measured at high (45 KHz), and low (200 Hz) AC frequencies for chicken filets from the Dutch market.

Injecting chicken with salty water decreased the value of the electrical impedance



Impedance of salty water (2 g/L of NaCl in water) quickly dominates the impedance of the chicken filets, which are much less conductive than the salty solution.

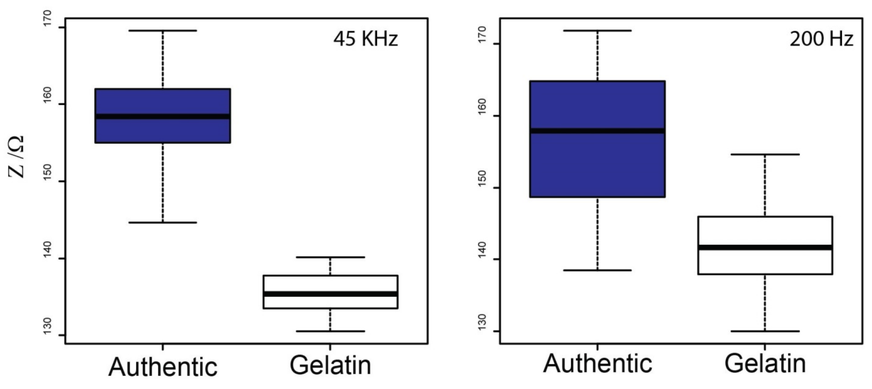


Z < 140 Ω
indicated adulteration

Because the electrical properties of the salty solution dominates the values of Z, it was possible to detect the adulteration, but not to quantify it, because injecting salty water levelled the values of Z for the chicken samples regardless of the amount injected.

Boxplots for values of impedance Z for authentic (Blue), and adulterated (white) chicken filets. Filets were adulterated by controlled injection of different volumes of a 2 g/L solution of NaCl in tap-water.

Adding gelatifying pork proteins (moisture retaining agents) decreased the value of impedance of an amount depending on the frequency of the AC source.



Because the formation of a gel modifies the physical properties of the extracellular matrix of the filets, the value of Z for adulterated samples decreased at high frequencies (45 KHz). This variation of the value of Z between low and high frequencies can be used to specifically detect adulteration by gelatifying agents.

Z < 140 Ω
indicated adulteration

ΔZ ~100 Ω between 45 KHz and 200Hz
indicated a gelified extracellular matrix

Conclusions

- **Values of impedance give information about the authenticity of chicken filets. The approach can be easily extended to other types of food subject to adulteration;**
- **Measuring impedance of animal tissues can be useful to check the metabolism of the animals in a livestock;**
- **Measuring impedance for a continuous variation of the frequencies up to 1 MHz, by improving the current setup, might further extend the range of adulterations that can be detected.**

Acknowledgements

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