POTENTIAL OF RAMAN ANALYSIS IN THE DETERMINATION OF MILK ADULTERATION

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1. Introduction

Raw milk production on EU farms was 172.2 million tonnes in 2018, representing an annual increase of 1.6 million tonnes. The vast majority of raw milk is delivered to dairy factories; only 12.2 million tons were used on farms: consumed by the farmer and his family, sold directly to consumers, used as feed or processed directly. Of the 160.0 million tons of milk delivered to dairy factories, 156.0 million tons were cow's milk, the rest being a combination of sheep's milk, goat's milk and buffalo. [1] The average price, in real terms, of milk has fluctuated sharply in recent years. The significant decreases in 2015 and 2016 were followed by a strong recovery in 2017. Compared to these changes, the decrease in price in real terms in 2018 was moderate (-3.7% on average). Among the main milk-producing Member States, there were, in particular, average decreases in real milk prices in 2018, for example: ● Germany (-6.3%), ● Netherlands (-7.8%) and ● Ireland (-6.6%), but lower than the average decrease in ● France (-1.1%), ● United Kingdom (- 0.4%) and ● Italy (-1.8%). Milk and dairy adulteration has come to global attention after the discovery of melamine contamination of dairy products in China in 2008. However, the history of milk adulteration is very old. In 1850 a scandal involving the adulteration of milk was reported, which resulted in the deaths of 8,000 children in New York alone. Milk is considered to be the "ideal food" due to the abundant nutrients needed by both infants and adults. It is one of the best sources of protein, fat, carbohydrates, vitamins and minerals. Unfortunately, milk is very easy to adulterate around the world. Possible reasons behind this process may include the difference in supply and demand, the perishable nature of the milk, the low purchasing power of the customer and the lack of adequate detection tests. The motivation for food fraud is economic, but the impact is a real public health problem [2]

The purpose of the study is to evaluate the capacity of the Raman technique to be used for the determination of milk adulteration.

2. Methodology

A PROGENY portable Raman spectrometer, Rigaku manufacturer, was chosen for the development of fast analytical methods. (fig 1)

Fig. 1 PROGENY portable Raman

With the help of the PROGENY spectrometer, an analytical method has been developed that can be used both to detect the type of milk and to confirm the non-adulteration of cow's milk, by determining the change in the ratio between dry substances. Cow, goat and buffalo milk were used for testing. The samples were placed in a 4 ml bottle which was fixed in the special vial holder of the spectrometer which, in addition, allows the distance or proximity of the sample to the laser source.

3. Results and conclusions

The analysis method developed has the following working parameters:

- Laser frequency: 1064 nm;
- Laser power: 380 mW;
- Exposure time: 6000 ms;
- Spectral range: 200-2000 cm-1.

The analysis of the obtained results clearly shows a significant difference of intensity between the maxima from 1263, 1303, 1441, 1657 cm-1 for each type of milk. (table 1, fig 2-4)

Table 1 Differences in maximum intensity for the three types of milk

Peak (cm^{-1})	Intensity		
	Cow milk	Goat milk	Buffalo milk
818	1163.0643	865.8706	1139.8436
1300	918.7159	748.7739	986.5394
1441	1087.5845	1179.6652	1362.9011
1953	768.4746	778.4495	1049.9562

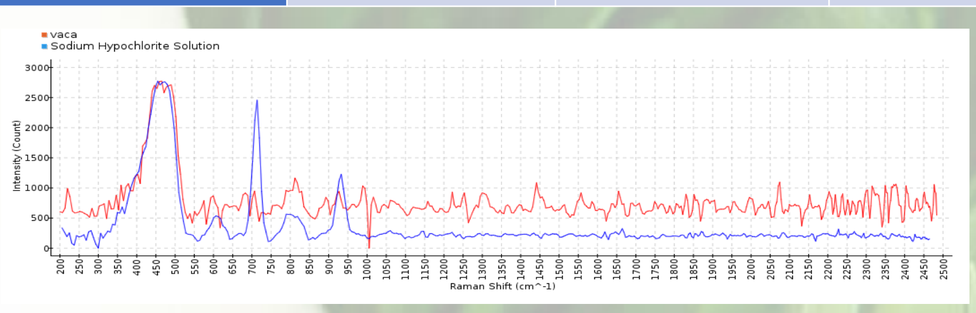

Fig.2 Raman analysis for cow milk

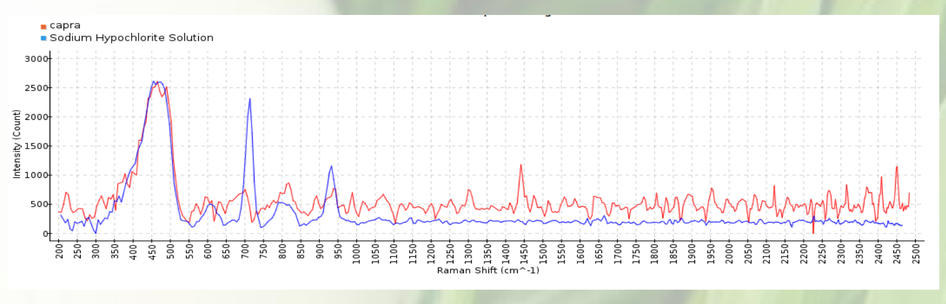

Fig.3 Raman analysis for goat milk

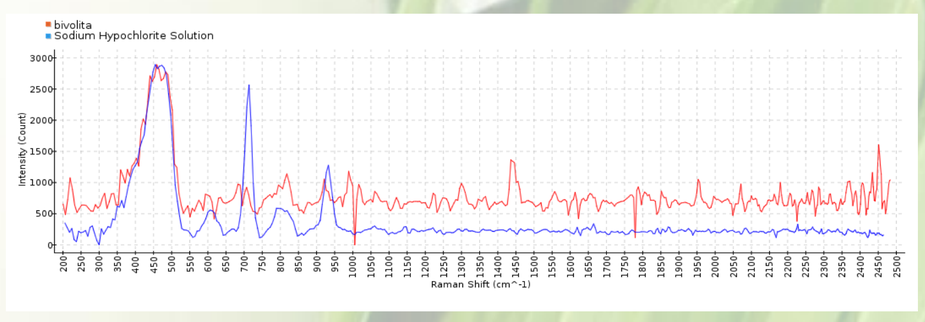

Fig.4 Raman analysis for buffalo milk

- ❑ There is a significant difference between the results obtained from the analysis of the 3 types of milk, which demonstrates the adequacy of the method.
- ❑ The analysis can be done easily, it is only necessary to homogenize the sample;
- ❑ Cow's milk had the maximum with the highest value at 818, 1163 cm-1.
- ❑ Goat's milk had the maximum with the highest value at 1441, 1179 cm-1.
- ❑ Buffalo milk had the maximum with the highest value at 1441, 1362 cm-1.
- ❑ The differences in the maximum values represent the profile of fatty acids, specific to each type of milk.
- ❑ Based on the results obtained, it will be possible to develop, using the PLS method, an equation for predicting adulteration.

References

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