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Isotopic characterization to evaluate the authenticity of Brazilian refined vegetable oil

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1. Introduction

Refined vegetable oils are an important part of the Brazilian diet, and for that reason have high commercial value and are susceptible to fraud.

Isotopes are forms of the same element that differ by the number of neutrons in its nucleus, they can be either unstable or stable, the latter being the case of interest for this work[1]. Through these elements it is possible to collect information and build an isotopic relationship that can be used in several areas of knowledge, such as determination of geographical location and carbon fixation cycles. Specifically, in the case of vegetable oils, this relationship can be an important tool for the characterization of each type of oil, supporting an evaluation of their authenticity.

In this work we aimed to characterize corn, soybean, sunflower and canola oils according to $\delta^{13}C$, $\delta^{18}O$ and $\delta^{2}H$ values and evaluate their authenticity. Soybean oil is the cheapest of all types, and therefore more commonly used for adulteration purposes.

Corn oil is the only oil extracted from a C_4 plant, thus differing from all other types, which are extracted from C_3 plants, in $\delta^{13}C$ values. Other oils can be characterized according to their geographical origin, and so they vary in $\delta^{18}O$ and $\delta^{2}H$.

A new food reference material for carbon, hydrogen and oxygen released in november, 2020[2] allowed for an innovative, faster, and easier analysis where we can acquire $\delta^{13}C$, $\delta^{18}O$ and $\delta^{2}H$ values from a single sample at once.

2. Methodology

A total of 60 oils were bought from local markets of multiple regions in Brazil, those samples were analyzed using a Isotopic Ratio Mass Spectrometer(IRMS) coupled to a high temperature conversion elemental analyzer (TC/EA).

3. Results and Discussion

Figure 1 shows the four groups of oils, it is notable that 2 groups of corn oil were formed regarding $\delta^{13}C$ values, with corn being a C_4 type of plant, the smaller group to the left is very likely to be adulterated with soybean oil[3].

As for the sunflower oil, both groups could be authentic and further analysis of fat acid composition is needed, as there are two different proportion levels of oleic acid allowed in the composition of sunflower

oil which are legally allowed to be in the market, which could explain the two red groups being apart from one another.

For the other two remaining groups, they are both well defined, soybean oil is more spread out across the y-axis due to the fact that soybean is planted all over the country, and thus is more susceptible to $\delta^{18}O$ variations, whereas canola is more strictly cultivated in the southern region of Brazil.

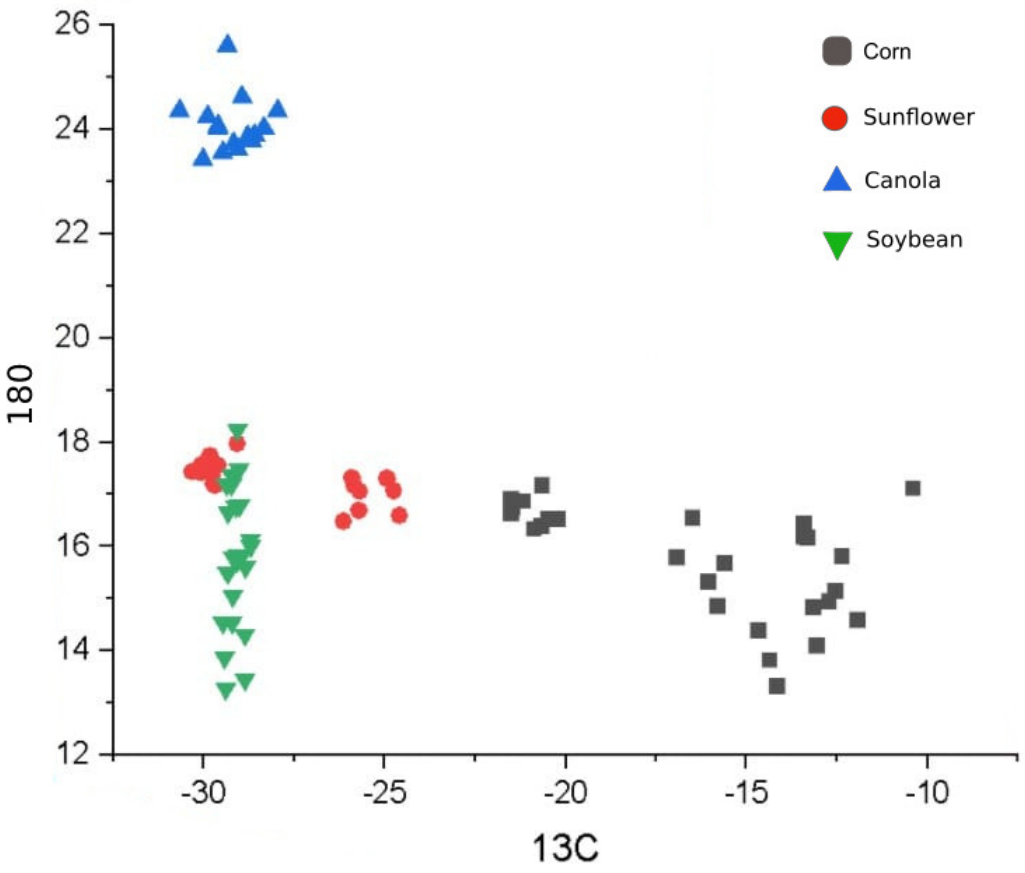

Figure 1: Scatter plot containing each type of oil correlating ^{13}C and ^{18}O.

4. Conclusions

We concluded that the proposed methodology proved to be a useful tool for evaluating the authenticity of refined vegetable oils, and we were able to characterize each type of oil using stable isotope analysis of carbon and oxygen.

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