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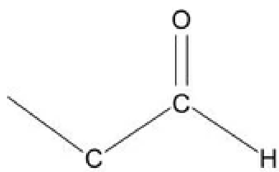
The Maillard Reaction

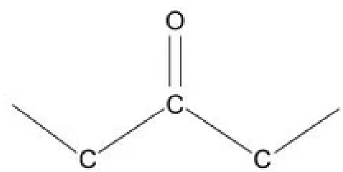
The Maillard reaction is a reaction that nearly every cook uses to make their food taste good. This is often described as caramelization or the "browning" of foods. More specifically, this is a chemical reaction between the food's amino acids and reducing sugars. This reaction leads to the distinctive flavors of seared meat, fried potstickers, bread, toasted marshmallows, and many more. This reaction was initially described by French chemist Louis Camille Maillard in 1912 while attempting to reproduce protein synthesis. This discovery leads to further discussions in the food sciences about the said reaction.

The Food Lab describes the reaction as "many small simultaneous chemical reactions that occur when the proteins and sugars in and on your food are transformed by heat, producing new flavors, aromas, and colors." The strength of this reaction is often based on the food itself. Each food has a different ratio of protein, sugar, and water. A steak, for example, is a muscle, which is mostly protein and water with little sugar. This high protein concentration leads to a Maillard reaction that yields more flavor molecules and less aromatic ones. In contrast, a cookie is mostly sugar. This high concentration of sugar leads to a Maillard reaction that yields more aromatic molecules than flavor ones.

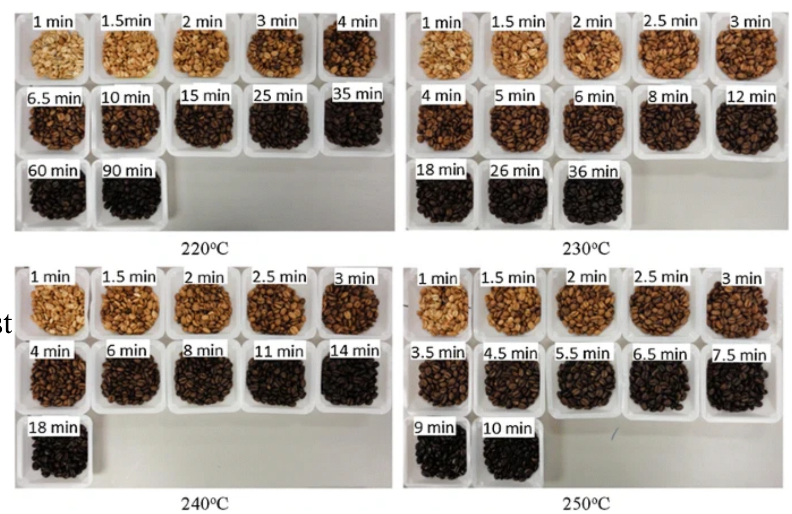
In the Maillard Reaction precisely, the kinetics can be described as the time and temperature necessary to cause the reaction. For coffee beans, this reaction occurs between 280ºF and 330°F. Within this 50° range, the Maillard reaction can create hundreds of new flavors. Specifically, this makes the roast-y and malty flavors that many enjoy daily. This flavor breakdown happens due to reducing sugars and amino acids. A “reducing sugar” is any sugar that has a free aldehyde group or ketone group. An aldehyde is just any chemical compound that contains a carbonyl center bonded with a Hydrogen atom. A ketone group is any chemical compound with a carbonyl center with two carbon-containing substituents—examples of both are shown below.



Aldehyde group

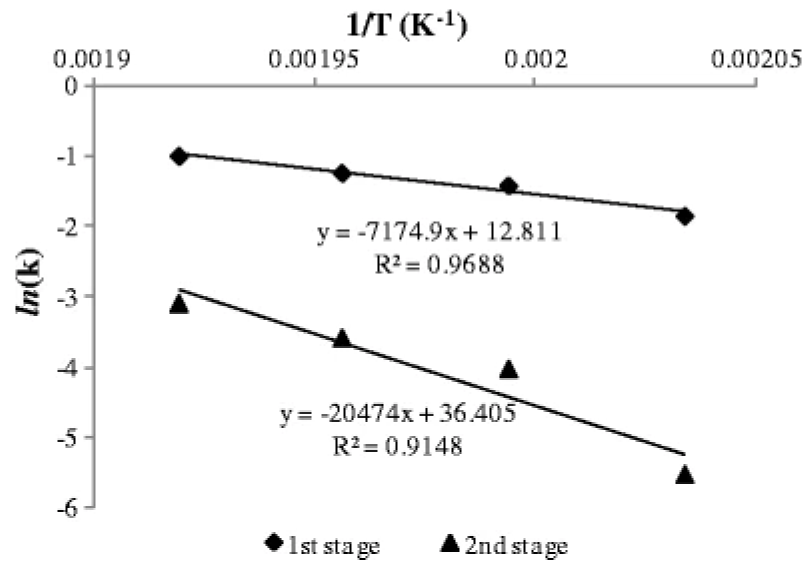


Ketone group



Kinetics for the Maillard reaction is vital because any difference in temperature or time can lead to a different outcome. Examples of such include the roast level of coffee. The kinetics of a light roast consists of a lower temperature for a lower time. This leads to a more hydrated bean with a more acidic taste. This differs from a dark roast, which consists of a higher temperature roast for a longer time. This leads to a more dehydrated bean with a concentrated, caramelized taste. These different outcomes exemplify the difference in kinetics. The different temperatures and durations have led to a completely different end product.

The Maillard reaction can be shown using the Arrhenius model. As the temperature increases, so does the rate of the reaction. This leads to a quicker roasting of the coffee bean.



From the image, we can derive the effect of the increase in temperature on the Arrhenius rate contents. We notice that as the reciprocal of time increases, the natural log of the reaction rate increases.

Concluding this paper, I have realized that I do not fully understand the applications of the Arrhenius equation in this particular reaction. However, I understood how to apply the kinetics of the specific reaction. Describing the effects of time and temperature on foods through the Maillard reaction was mainly self-explanatory; however, once it came to explaining this through the Arrhenius model, I did not know how to continue.

S*ources*

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