Chapter 1
Development of Artificial Mouths for In Vitro Studies of Aroma from Liquid and Solid Foods

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ABSTRACT
This chapter deals with the development of “artificial mouths” in food aroma research. After a brief outline on how aroma is perceived in vivo, the need to develop instrumental techniques that reproduce mouth conditions is explained. The devices described in the literature are then presented, and the difficulties and advances in reproducing oral functions, such as mouth temperature, saliva, breathing and mastication, are discussed. Finally, the artificial mouth designed by the authors is presented as well as the improvements it will bring in food aroma research. In particular, this is the first device enabling the aroma of especially hard food to be studied. By means of this technique, volatile compounds contributing to the aroma perception of all kinds of foodstuffs can be identified and a better understanding of the release of aroma during mastication will be possible.

INTRODUCTION
Food is composed mainly of macromolecules, vitamins and minerals, but also of small quantities of volatile molecules without nutritional value. These compounds are responsible for the perception of the odor and the aroma of food. They belong to all chemical classes and are characterised by a low molecular weight (between 30 and 300 Da) and a high saturating vapour pressure (Richard, 1992). They are distributed between the food product and the gas phase. In a gaseous state, some of these compounds
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Figure 1. Pathways of molecules generating odor and aroma perception

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can reach the olfactory epithelium and generate a stimulus, called either odor when the product is smelt (orthonasal way) or aroma when the food is eaten (retronasal way). The overall sensation produced in the mouth by the association between taste and aroma constitutes the flavour.

Perception of aroma is a complex phenomenon, involving different steps. In the oral cavity, volatile compounds are released from the matrix into the gas phase, under the effects of mastication, mouth temperature, and saliva. Compounds are then transported via the retronasal way to the nasal cavity, where they interact with the corresponding receptors in the olfactory epithelium (Figure 1). Subsequently, sensory signals are transferred to the brain. Only those compounds released from the food in sufficiently high concentration will stimulate the olfactory receptors. Furthermore, most odorant perceptions are generated by mixtures of several aroma compounds, in well-defined proportions. A slight change in the volatile composition can modify the nature and intensity of the perception. Competition between compounds for receptors can occur. Thus, the perception is not linearly correlated with the concentration of the released volatile compounds (Stone and Sidel, 2004). Moreover, in food matrices, only a fraction of the total aroma compounds can be released, because of interactions that can occur between them and the matrix. Therefore, the perceived aroma quality and intensity cannot be predicted by the concentration of volatiles in the food.

Odor and aroma are particularly important in consumer acceptance of food. For instance, a recent survey showed that 73% of French teenagers state that the flavor of food is the main factor that influences their choice. Therefore, it is essential for food research laboratories and food companies to understand the mechanisms involved in the odor and aroma perception of a food and the link between food composition and the release of volatile compounds in mastication conditions.

INSTRUMENTAL TECHNIQUES TO STUDY VOLATILE COMPOUNDS RESPONSIBLE FOR FOOD AROMA

During the last two decades, several approaches have been developed to identify the molecules responsible for the odor and aroma of a food. Aroma perception can be studied by combining instrumental techniques and sensory analysis (Taylor, 1996).