Encapsulation of a flavour compound in alginate microparticles

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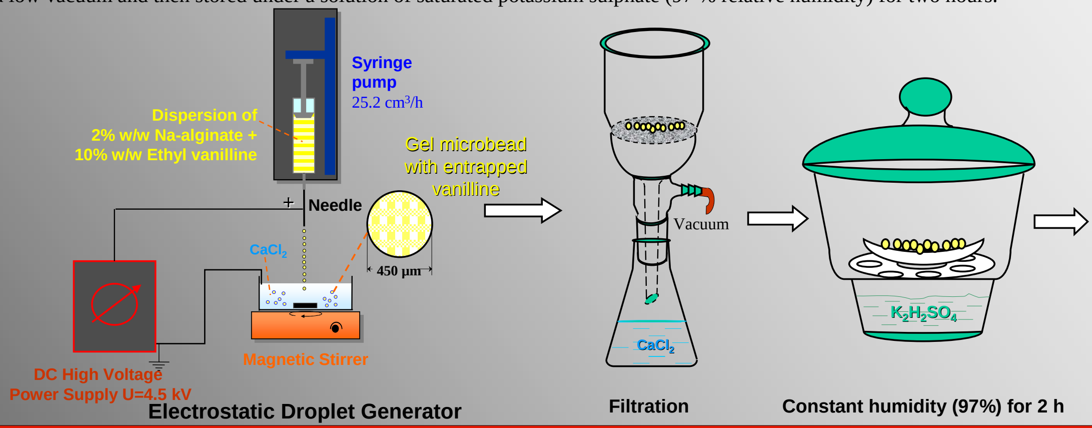
Introduction

Encapsulation provides an effective method to protect flavour compounds from evaporation, degradation, and migration from food. Flavour encapsulation can be accomplished by a variety of methods. Electrostatic extrusion is a suitable technique for the production of very small particles and has advantages over other extrusion techniques when large-sized capsules negatively affect the textural and sensorial properties of food products. In this study, calcium alginate gel was employed as the matrix for flavour encapsulation. The subject of this study was the development of flavour alginate formulations aimed for thermally processed foods. Ethyl vanilline (3-ethoxy-4-hydroxybenzaldehyde) was used as the aroma agent. The thermal behaviour of alginate beads encapsulating ethyl vanilline was investigated by thermogravimetric (TG) and differential scanning calorimetry measurements (TG-DSC) under heating conditions which mimicked usual food processing to provide information about thermal decomposition of alginate matrix and kinetics of aroma release.

Materials and methods

Electrostatic extrusion technique was applied to produce spherical microbeads containing vanilline. Prior to the TG measurements, the alginate microbeads were filtered under a low vacuum and then stored under a solution of saturated potassium sulphate (97 % relative humidity) for two hours.



TG-DSC SDT Q-600 (New Castle, Delaware, US)
- Air flow rate of 0.1 dm³/min
- Heating rate of 10 °C/min per run

Results and discussion

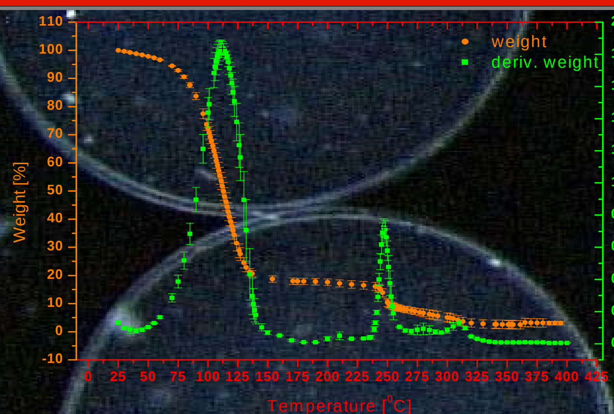


Figure 1. TG and DTG curves of 2 % w/w alginate microbeads entrapping approx. 10 % w/w ethyl vanilline (data present the average of n = 4).

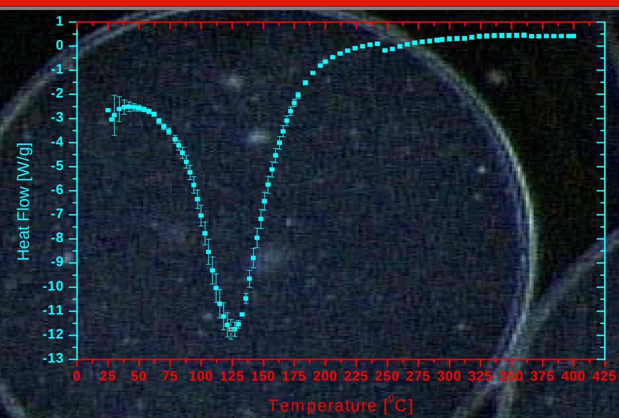


Figure 2. DSC curve of 2 % w/w alginate microbeads entrapping approx. 10 % w/w ethyl vanilline (data present the average of n = 4).

The TG and DTG curves of the vanilline encapsulated microbeads in the 20-400 °C temperature range are shown in Figure 1. It can be seen that there are two well resolved weight loss ranges. The first weight loss occurs in the 50-150°C range, with a maximum at approx. 112 °C on the DTG curve. According to prior measurements of vanilline-free microbeads, this loss can be attributed to the dehydration of the polymer network. This event is also accompanied by an endotherm in the DSC curve (Figure 2). The TG curve exhibits a plateau up to 220 °C, indicating that ethyl vanilline remained entrapped inside the polymer matrix. The second weight loss occurs in the 220-325 °C range and it corresponds to the release of vanilline. There are three DTG maxima in this temperature range and the main one is centred at about 247 °C. The fact that the release of vanilline occurs over a relatively wide range of temperature and that it proceeds in several steps strongly support the conclusion that vanilline is mostly encapsulated inside the polymer matrix (not only physically adsorbed at the surface of the bead) and that the encapsulation enables a slow release of the flavour agent. For a comparison, a cooking process is usually completed below 230 °C. At this temperature most of vanilline remains *intacta*. TG-DSC measurements of Ca-alginate (Figure 3) showed that the decomposition of the carrier begins around 155 °C. The two peaks in DTG curves indicate that weight losses occur at around 205 °C and 300 °C. About 20 wt.% of the matrix decomposed up to 230 °C, which is usually final backing process temperature .

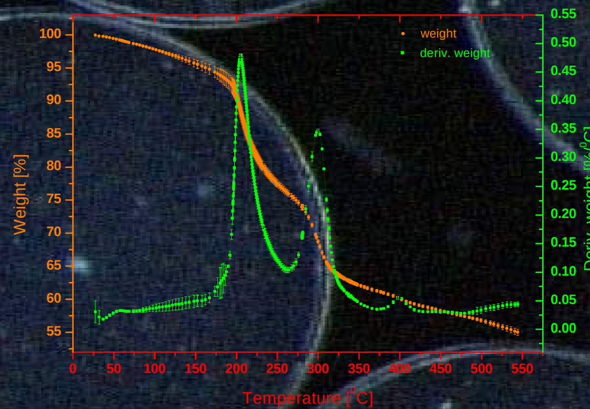


Figure 3. TG and DTG curves of 2 % w/w calcium alginate (n = 2).

Conclusions

Electrostatic extrusion appears to be a convenient technique for the immobilisation of vanilla into small, monodisperse alginate microbeads. Apparently, TG-DSC is a suitable method for investigating the release of vanilla from alginate microbeads. This study showed that the decomposition process under heating consists of two consecutive, distinctive steps: polymer dehydration and vanilla evaporation. Rupture of weak bonds between alginate chains and water molecules occurs in the 50-150 °C temperature range and polymer dehydration is most rapid at about 112°C. Vanilla release begins at a temperature of approx. 225°C and rapidly finishes at 247°C. In order to achieve desirable aroma release, further investigations are planned based on determining the optimal matrix, size of the encapsulating particles and heating conditions. The understanding and control of the complex behaviour of aroma compounds in thermally processed foods require research in both domains: engineering of the matrix with a suitable microstructure and texture properties, as well as the development of the process for the manufacture of microcapsules.