

# FLAVOURING OF SPONGE CAKE : RETENTION OF ENCAPSULATED AROMA COMPOUNDS

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## I. Introduction

Encapsulation which describes different process to cover an active compound with a protective wall material, can be employed to convert flavours to an impart some degree of protection against evaporation, reaction, or migration in a food. Encapsulation of aromas has been commercialized using many different methods such as spray drying, spray-chilling, or spray cooling, extrusion, freeze-drying, coacervation and molecular inclusion. Encapsulation can be employed to retain aroma in a food product during storage, protect the flavour from undesirable interactions with food, minimize flavour-flavour interactions, guard against light-induced reactions and/or oxidation, increase flavours shelf-life and/or allow a controlled release (Tari & Singhal, 2002). The advantages of controlled release are: the active ingredients are released at controlled rates over prolonged periods of time; loss of ingredients during processing and cooking can be avoided or reduced; reactive or incompatible components can be separated (Brannon-Peppas, 1993). For matrix systems encapsulating volatile compounds, release depends on several mutually dependent processes such as diffusion of the volatile compound through the matrix, type and geometry of the particle, transfer from the matrix to the environment, and degradation/dissolution of the matrix material (Pothakamury & Barbosa-Canovas, 1995). Manufacturing and storage processes, packaging materials and ingredients in foods often cause

modifications in overall flavour by reducing aroma compound intensity or producing off-flavour components (Lubbers *et al.*, 1998). The stability of the matrices is an important condition to preserve the properties of the flavour materials. Many factors such as the kind of wall material (Imagi *et al.*, 1992), ratio of the core material to wall material (Minemoto *et al.*, 1999), encapsulation method (Minemoto *et al.*, 1997), and storage conditions (Yoshii *et al.*, 1997) affect the stability of encapsulated flavour. The aim of this work is to determine the feasibility of using encapsulated flavour to improve the retention of aroma compounds in the sponge cake matrices after cooking.

## 2. Materials and methods

**2.1. Encapsulation of viennoiserie aroma - Emulsion preparations.** A commercial Arabic gum (*Acacia Senegal*) is supplied by CNI (Rouen, France). Maltodextrin with dextrose equivalent DE-18 is purchased. The flavour system, *viennoiserie* aroma, consisted of model mixture of cake aromas, provided by Danone, (Dijon, France). Wall solutions containing are dissolved in distilled water by heating to 60°C for 45 minutes with a ration gum acacia/maltodextrine=1/1. Five capsules formulations are prepared with different concentration in aroma : 6.67, 1.41, 1.13, 0.85 and 0.28% (w/w), respectively, for C1, C2, C3, C4 and C5. Emulsifications are carried out by using an Ultra-Turrax T-25 homogenizer (IKA

Janke and Kunke model Bioblock Scientific, Illirch, France) operated at 13500 rpm for 5 min. Then, emulsions are frozen at -20°C for 20h. A freeze-dried (Christ, alpha 1-2 Ld) is used to dry the frozen emulsions. The samples are freeze-dried in glass-bottles at -60°C for 48h with pressure of 0,1mbar. The lyophilisats obtained were crushed with a disc miller (Retsch ZM200, USA). The powders are kept at 14°C until they will be analyzed.

**- Extraction of encapsulated flavour.** The flavour extraction is carried out by chemical way in glass tubes. 1g of powder are dissolved in a mixture of 1mL of dichlorométhane and 8mL of distilled water. The solution mixtures are then centrifuged at 4500 rpm during 10min. The organic phase containing the flavours is recovered in hermetic bottles then kept at 4°C. 1µL of each solution is injected into a gas chromatograph equipped with FID detector (Perichrom Sarl model PR 2100, Saulx-Les-Chartreux, France). The dimensions of capillary column are "30m x 0,25mm x 0,2µm". The chromatographic conditions used are: an initial temperature of 40°C maintained during 3min, then increase at a rate of 4°C/min until reaching a final temperature of 240°C, maintained during 10min. The temperature of the injector and the detector is of 250°C. The carried gas is nitrogen.

**- Encapsulation efficiency (EE).** In order to calculate the encapsulation efficiency of the powders, the "white" (T) is carried out under the same conditions as the capsules (C). The determination of the EE is obtained by comparison of the surfaces of the peaks of chromatographic profiles between white and capsule.

## 2.2. Matrix preparation

**- Dough preparation.** To obtain the sponge cake dough; eggs, sucrose and salt were mixed together with a household electric mixer in a water bath at 50 °C for 5 min. The mixture was removed from the water bath and was mixed again for 1 min. Flour was then added little by little, and gently

incorporated into the foam. Two sponge cake formulations were prepared, with flavour encapsulated (G) and with native flavour (T). For (T) dough, the aroma mixture was added to the melted palm oil and then immediately to the dough. For the elaboration of dough (G), different quantity of flavour powders are incorporated with flour into the foam (tables 1,2). The concentration of aroma in the dough is 0,1% (w/w). Each dough (35g) was placed in a silicone mould. Baking was achieved in a household electric oven (Whirlpool, model FCF/E3, Italie) for 27 min at 150°C.

Ingredients	Dough
Wheat flour	X
Pasteurised whole eggs liquid	1,8 X
Sucrose	X
Palm oil	0,16X
Potassium sorbet	0,004X
Salt	0,02X

**Table 1 : Formulation of sponge cake.**

Ingredient	T	G1	G2	G3	G4	G5
Dough (g)	35	35	35	35	35	35
Native aroma (g)	0,03	-	-	-	-	-
Aroma capsules (g)	-	0,2	0,7	1,2	1,8	3,5
Aroma capsules (%)	-	0,5	2,1	3,3	5	10

**Table 2 : Dough flavouring of sponge cakes.**

**- Colour of cake crumbs and crusts.** The colour (L, a, b) were determined by the Chromameter CR210 (Minolta France S.A.S., Carrières-Sur-Seine). Crumb or crust cake colour was checked at three different points on each cake and every point was measured five times.

**- Rheological properties of flavoured sponge cake.** For the determination of sponge cake hardness, a testing machine Lloyd LRX Plus was used. Measurements

of simple penetration for the crust and double compression for the crumb are carried. The stem used is of 5 mm of diameter and the speed penetration is 2mm/sec.

**- Impact of encapsulation on the flavour retention.** The quantity of benzaldehyde, butanoate ethyl, hexanoate ethyl and *cis*-3-hexenol present in the packaged sponge cake after 15 days of storage was determined using the static headspace coupled with the analysis by gas chromatography.

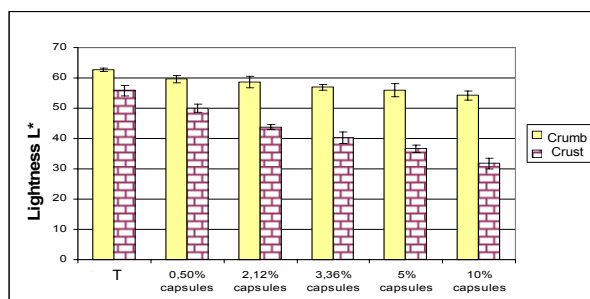
### 3. Results and discussion

**- Encapsulation efficient.** The results obtained of the compound flavour retention shows that the ratio flavour/polysaccharides influence the retention of the volatile molecules. Indeed, the more EE was observed with the higher ratio. Also, the retention of the aromatic compounds during freeze-drying increases with the dry matter and the emulsion viscosity. For example, for the vanillin which is in high quantity in the aroma formulation, the increase in the ratio aroma/polysaccharides has a significant effect on his retention. The EE increases by 60,73% to 88,89% with an increase by 28,75% to 33,33% of dry matter in the emulsion. Higher viscosity prevents the compound diffusion through the polymers matrices, resulting in a rapid skin formation. The tendency to improve retention by increasing the total solids content in the emulsions has been reported in the literature. According to Teixeira *et al.*, (2004) higher feed concentration resulted in larger droplets formed from more viscous emulsions, and attributed the better volatiles retention into the capsules. For each formulation, the retention of the volatile molecules increases with molecular weight, boiling point and hydrophobicity, and decreases with polarity and solubility. According to Goubet *et al.*, (1998) polysaccharides with high molecular weight allow the

conservation of non-polar and least volatile molecules.

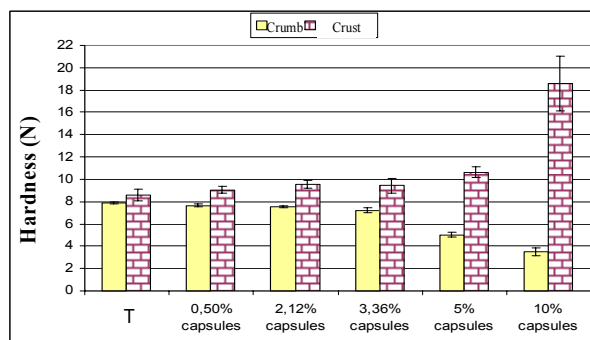
**- Cake colour.** As can be seen in Figure 1 the more the quantity of capsules added in the dough is raised, the more the sponge cake lightness ( $L^*$ ) values decreases.

The  $L^*$  value of G5 is notably higher – 43% and 13,5%– for crust and crumb, respectively, than control cake (T). Sponge cake manufactured with native flavour is in general lighter than cakes flavoured with capsules. This was especially detected in crust, where Maillard reaction take place between polysaccharides of flavour capsules with proteins of eggs, due to the higher temperatures attained.



**Figure 1 : Lightness of crumb and crust of sponge cakes flavoured with native aroma (control) and with different capsules quantity.**

**- Texture.** The effect of encapsulated flavour on crumb hardness of sponge cake is shown in Figure 2.

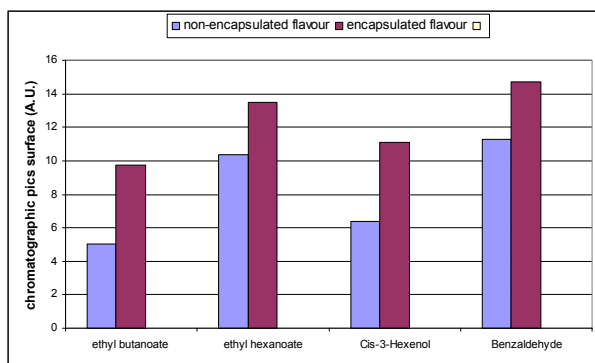


**Figure 2 : Effect of encapsulated flavour quantity used on crumb firmness of crust sponge cake.**

Cakes elaborated with flavour powder had significantly harder crust and softer crumb texture than the control. Indeed, the incorporation of the capsules cause the dry

matter increase, which causes a weak transfer of vapour on the surface of sponge cake, and thus a fast hardening of crust. At the interior of the crumb, water is blocked what makes it wetter.

- **Aroma retention.** The encapsulation effect on flavour retention was presented in figure 3. The retention is higher with hydrophobic character of flavour and strongly interactions between volatile with cake ingredients.



**Figure 3 : Flavour compounds retention after 15 days of packaged sponge cake storage.**

## Conclusion

The incorporation of great quantities of flavoured powder (10%) in the dough affects the colouring of the sponge cakes, while the small quantities of capsules (0,5%, 2,12%) give results similar to the cakes elaborate with native flavour. On textural plan, the addition of great quantities of capsules (10%) supports the hardening of the crust and makes softer the crumb, this is related to the role "barrier" of the crust. This property barrier with the steam proves to be interesting to minimize the transfer of flavour of the crumb towards the outside of the food matrix. The incorporation of encapsulated flavour into the packaged cake allows the protection of aroma after storage.

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