Microencapsulation of bioactive compounds and its application in functional foods formulation

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Introduction

MICROENCAPSULATION is the process of surrounding substances (core) within another substance (wall) yielding capsules ranging from less than one micron to several hundred microns in size.

The aims of bioactive compounds microencapsulation are:

➢enhancing entrapped compounds stability against oxidation processes,

➢modifying physicochemical properties of bioactive compounds in order to better integrate these compounds during the food processing,

➢controlling their release.

In this work, different bioactive compounds microencapsulation have been studied and optimized. Microcapsules with higher yield and efficiency are been selected to produce two different food products, obtaining more competitive products, with enhanced nutritional quality and with a longer shelf-life.

Materials and methods

The **wall materials** used are binary and tertiary blends of:

▪arabic gum (AG)
▪maltodextrin (MD) 15DE
▪maltodextrin (MD) 4-7DE
▪commercial modified starch (CMS)

In order to improve emulsion process, Tween 80® is added.

Bioactive compounds encapsluted are :

▪α-tocopherol (vitamin E)
▪carvacrol
▪β-carotene (pro-vitamin A)
▪eugenol

Microcapsules are formed by emulsion and then spray-dried.

All of the bioactive compounds are analized by high performance liquid chromatography (HPLC).

Encapsulated eugenol in AG/CMS is selected because of its high yield in the microencapsualtion process:

▪fermented dairy food (yogurt drink) (Figure 1)
▪meat product (fresh chorizo sausage) (Figure 2)

Figure 1. Yogurt drink with encapsulated eugenol

Figure 2. Fresh chorizo sausage with encapsulated eugenol

Results

MICROCAPSULES CHARACTERIZATION

➢Yield (Table 1)

➢Efficiency (Table 2)

➢Stability (Figure 3)

➢Thermal stability by thermogravimetry analysis (TGA). In Table 3, T_1 is the temperature refers to the water loss. T_2 and T_3 are the breakdown temperatures of the wall materials

➢Shape and size are studied by scanning electronic microscopy (SEM) (Figure 4)

TOTAL ANTIOXIDANT CAPACITY (T.A.C.) VARIATION IN YOGURT DRINK

➢The addition of eugenol microcapsules in yogurt drink, increases the T.A.C. of the product, although there are no significant differences regarding control sample (Figure 5)

ENCAPSULATED EUGENOL RELEASE IN FRESH CHORIZO SAUSAGE THROUGHOUT TIME

➢Eugenol evolution has been studied throughout time in two different fresh chorizo sausage samples (E_{10} y E_{50}), which have been formulated similar to the control sample but with 10 g y 50 g of eugenol microcapsules added, respectively (Table 4)

Tabla 1. Microencapsulation yield

Microcapsule	Yield (%)
AG/MD 15DE	83.5
AG/MD 4-7DE	69.2
AG/CMS	87.0
AG/MD 15DE /CMS	70.5

Tabla 2. Microencapsulation efficiency

Microcapsules	Efficiency (%)
AG/MD 15DE	97.0
AG/MD 4-7DE	94.0
AG/CMS	93.0
AG/MD 15DE /CMS	94.0

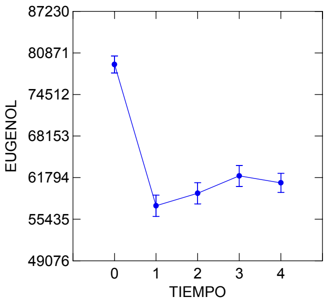

Figura 3. Entrapped compound stability throughout time (AG/CMS/eugenol microcapsules)

Tabla 3. Thermal stability of microcapsules

Microcapsule	T_1 (ºC)	T_2 (ºC)	T_3 (ºC)
AG/MD 15DE	112.7	367.0	390.2
AG/MD 4-7DE	110.6	369.1	402.2
AG/CMS	115.0	365.2	411.3
AG/MD 15DE /CMS	113.6	368.0	410.8

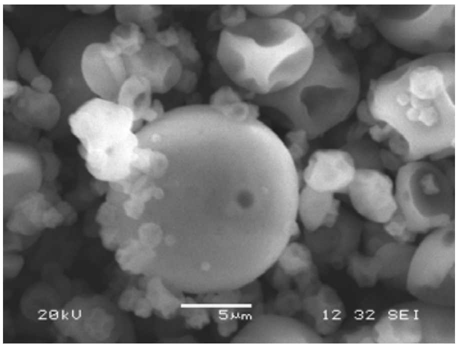

Figura 4. SEM micrograph of microcapsules: eugenol in AG/ MD 15DE /CMS (4000 x)

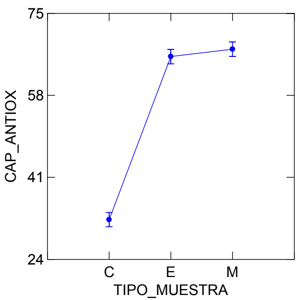

Figura 5. T.A.C. variation between control yogurt (C), yogurt with free eugenol (E) and yogurt with microcapsules of eugenol (M)

Tabla 4. Encapsulated eugenol evolution in fresh chorizo sausage

Time (days)	Eugenol (mg/Kg)	
	E_{10}	E_{50}
4	229.93	882.70
6	330.88	1533.86
7	321.95	1531.33
12	289.67	1480.92

Conclusion

✓High yield in microencapsulation process (69.2% - 87.0%).

✓High efficiency in microencapsulation process (93.0% - 97.0%).

✓Increased stability of the bioactive compound for at least four months, in which there has not been a significant decrease of entrapped compound.

✓Microcapsule sizes between 4.4 µm and 5.6 µm.

✓Increase of total antioxidant capacity in food products with eugenol microcapsules.

✓No microbiological differences were found between control samples and samples with eugenol microcapsules.