P-028 **Development of a basil and corn soup powder enriched with microencpasulated linseed oil as a source of omega-3**

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INTRODUCTION AND OBJECTIVES

In the last decades consumer demands in the field of functional food production have increased considerably. Functional foods play an outstanding role to promote health, increase longevity and prevent the onset of chronic diseases. In this context, the development of new functional food products turns out to be increasingly challenging.

The administration of oils rich in essential fatty acids has proved to be effective in the prevention and treatment of these abnormalities. These potential health effects have gained the interest of the food industry, the medical community and consumers, and have promoted increased numbers of products containing n-3 fatty acids.

Linseed oil is named as functional food due to the fact that it is excellent dietary source of the alpha-linolenic acid (ALA; C18:3n-3), an important polyunsaturated fatty acid (PUFA). The scientific literature is full of evidence that suggest that regular consumption and/or dietary supplementation with long chain n-3 PUFA gives several health benefits including prevention of cardiovascular diseases, inflammatory diseases, dyslexia and depression (Garg et al., 2006).

For incorporating linseed oil components through the diet it is necessary to protect them against oxidative rancidity, the main cause of deterioration that affects food with high fat content (highly unsaturated). Microencapsulation by spray drying has been found effective for retarding or suppressing the oxidation of unsaturated fatty acids (Shaikh et al., 2006; Gharsallaoui et al., 2007).

In this study, the process conditions for optimizing the microencapsulation efficiency of linseed oil by spray drying were determined to obtain an edible oil as powder ingredient, with an enhanced stability to oxidation useful to food industry. In addition, a basil and corn soup powder enriched with microencapsulated linseed oil as a source of omega-3 was formulated for contributing to functional food development according to the requirements of current markets.

MATERIALS AND METHODS

Linseed oil microencapsulation
For this purpose, the process conditions for optimizing the microencapsulation efficiency of linseed oil by spray drying were determined using the Taguchi methodology with an orthogonal array $L_4(2^3)$. The effect of the variables such as wall concentration (25 and 30%), oil concentration (14 and 20%) and wall type (arabic gum and a mixture maltodextrine/arabig gum) was evaluated on the microencapsulation efficiency. According to the experimental design, the linseed oil was added to the encapsulating solution and then the mixture was emulsified using a model 400DS Benchtop homogenizer.

For the determination of microencapsulation efficiency, it was necessary to quantify the total oil in the microcapsule and the free oil (known as the non-encapsulated oil fraction). The determination of the total oil of microcapsules was performed according to the AOAC (1990). The fraction of free oil was determined acccording to Velasco et al. (2006). The microencapsulation efficiency (ME) was calculated as reported by Velasco et al. (2006) as follows:

ME (%) = [microencapsulated oil (g)/ total oil (g)] ×100

The oxidative stability of oil extracted from the microcapsule was determined by the Rancimat method. A morphological and size characterization of microcapsules was performed by scanning electronic microscopy, confocal microscopy and laser diffraction.

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The optimization of the basil and corn soup formulation was reached by means of the Response Surface Methodology with a factorial central composite design of 3^2. A sensorial analysis and an acceptability test of the optimized soup formulation were carried out. Chemical characterization of formulated soup and the oxidative stability of extracted oil from soup were also evaluated.

RESULTS AND DISCUSSION

Microencapsulation efficiency of linseed oil
The value range of microencapsulation efficiency of linseed oil was found between 54.6% and 90.7% (the value obtained for the design point 3). The results showed that higher microencapsulation efficiency values were obtained with a high concentration of encapsulating wall.

The results of Rancimat test for samples of microencapsulated linseed oil showed the average value of the design matrix for induction time (IT) was 2.67 h and for stability time (OSI) was 3.68 h. The design point 3 showed the highest IT value (2.83 ± 0.62 h) and OSI value of 3.78 ± 0.01 h.

Figure 1 shows the microcapsules obtained by the design point 3 which reached the higher microencapsulation efficiency. The microcapsules were spherical particles with a surface smooth and free of pores, which is essential for the stability of the microcapsule as the pores facilitate the entry of oxygen, the exit of the encapsulated material and therefore a decrease in encapsulation efficiency over time and oxidation of compounds such as fatty acids.

The Figure 2 clearly shows the presence of oil globules into the microcapsules particles identified by the emitted fluorescence using confocal microscopy.

Particle size distributions for microcapsules obtained from design point 3 were measured by laser diffraction. The 10% of volume of particles presented a diameter less to 7.3 µm whereas 90% of volume of particles showed a diameter less to 67.4 µm. The distribution mean was 23.1 µm showing a homogeneous distribution of microcapsules.

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The soup was prepared according to Ricero and Santamaría (2004) and the sensorial quality was evaluated by panelists on the consistency and saltiness to obtain the optimal mixture.

By analyzing the response surface for the soup, the best combination obtained corresponded to the region of central points of the independent variables (consistency and saltiness). Then, the soup was formulated based on the best combination of corn strach and sodium reduced salt obtaining the best sensory quality.

According to the acceptability test, the product was qualified as a product that the consumers "like much it" with an average value of 4.6.

Compared with marketed soups, formulated soup presented a similar energy and carbohydrate values, an increased protein content (between 24 and 36% more) and 25% more of total fat content. However it is noted that the oil in the soup is unsaturated with a high content of omega-3. The average induction time of soup was 14.85 h and the stability time was 15.61 h. The determined lifetime was 8.78 months which is less than the marketed soups (12 months). With the addition of antioxidants, the soup formulated in this study could present a longer lifetime.

CONCLUSIONS

As conclusion, the incorporation of microencapsulated linseed oil in an optimized formulation of soup provides a source of omega-3 for a high consumption food like soup with health benefits and highly acceptable by consumers.

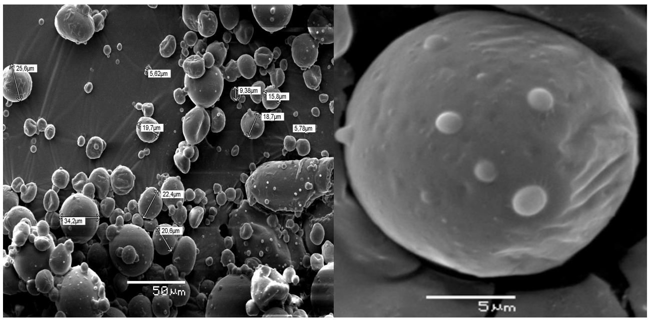

Figure 1. Morphology of micropasules by SEM

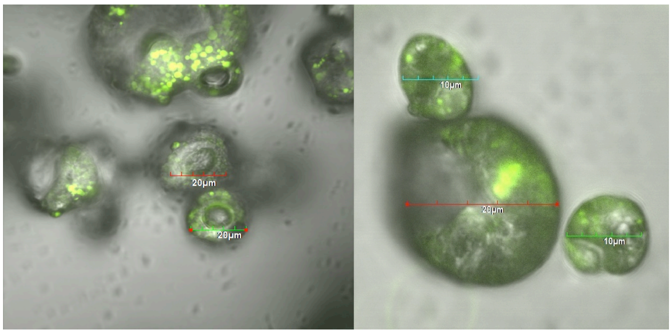

Figure 2. Confocal micrographies of microencapsules

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