Oxidative stability of sardine oil microencapsulated by vanillic acid-grafted chitosan

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Importance of marine lipids in human health has been continuously increasing. Many pharmacological studies have shown the medicinal importance of n-3 fatty acids. The unsaturated moieties of omega-3 and omega-6 fatty acids are crucial for their health promoting functions. However, n-3 fatty acids are highly susceptible to oxidation. Oxidation reduces the quality of oil and produces off-flavour through the breakdown of lipid hydro-peroxides. Off flavour and colour degradation of fish oil are the limiting factors for its use in foods. Furthermore, the hydroperoxides generated during lipid oxidation also have been considered to be toxic. Prevention of oxidation of n-3 fatty acids is essential in allowing them to accomplish their original physiological functions. Hence, fish oil needs to be protected from factors that promote oxidation (oxygen, light, free radicals and pro-oxidants). Lipid oxidation of oils can be reduced by the addition of antioxidants or by microencapsulation. Microencapsulation is a very suitable method to facilitate the incorpo-

ration of omega-3 fatty acid into foods. Encapsulation by spray drying is a rapidly expanding technology in pharmaceutical and food industries, wherein a lipophilic active ingredient is loaded within a wall material to form microcapsules. Microencapsulation improves storage stability, ease of handling and controlled delivery of lipophilic active ingredient.

In the present study, microencapsulation of sardine oil by emulsification-spray drying technique was carried out for stabilizing the ω-3 fatty acids. Vanillic acid-grafted chitosan was used as a novel wall material. Further, the oxidative stability was assessed under accelerated oxidative atmosphere by conducting a rancimat test and peroxide value of the encapsulated powder was determined during storage at room temperature.

Stable emulsion of sardine oil and vanillic acid-grafted chitosan was prepared using 0.1% Tween 20 and 8mg of beta-carotene/g of oil. Microscopic structure of emulsion containing 0.1% Tween 20 (Fig. 1) did not show any coalescence. Lower cocentration of Tween 20 acted as a protective layer around the droplet in the emulsion and revealed good emulsion stability.

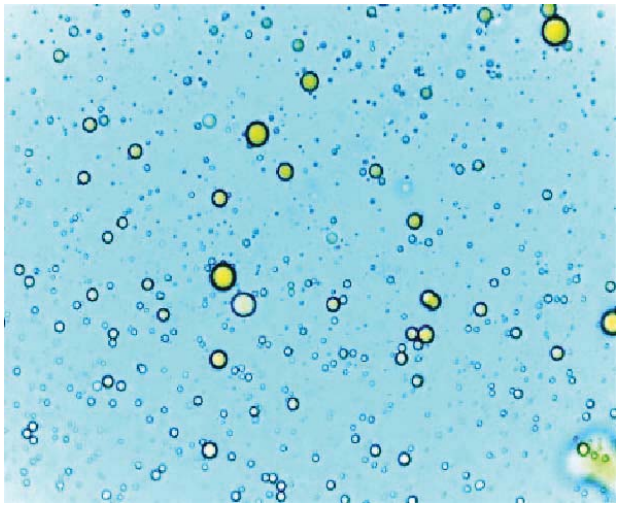

Fig. 1. Microscopic structure of emulsion containing 0.1% of Tween 20.

Moisture content of spray dried powder was found to be 2%. Moisture content along with temperature affects the shelf life of dried microcapsules. The maximum moisture specification for most dried powders in the food industry range between 3-4% (Kagami *et al.*, 2003).

Peroxide value of spray dried powder increased slowly during storage period (Fig. 2). The encapsulated oil was found to be less susceptible to lipid peroxidation compared to un-encapsulated one. Peroxide value of fish oil in free form increased throughout storage period. At the end of 4th week, the PV of the un-encapsulated oil reached 27.6 mmol/kg oil. Encapsulated fish oil exhibited slower rates of peroxide formation compared to un-encapsulated oil. The peroxide value of encapsulated fish oil on 4th week reached 5.5 mmol/kg oil only revealing that encapsulated fish oil is more stable than un-encapsulated fish oil.

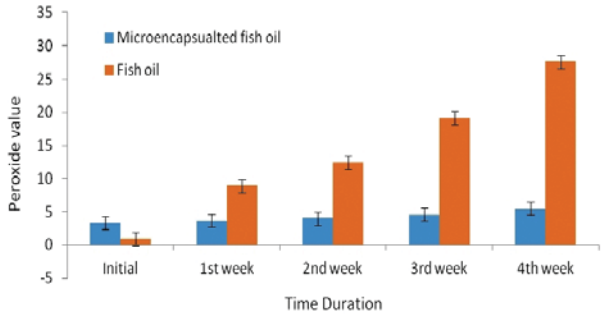

Fig. 2. Peroxide value of sardine oil and microencapsulated sardine oil powder

The accelerated rancimat test is an easy method (Velasco *et al.*, 2003) to determine the oxidative stability of oils. Encapsulated fish oil was heated under atmospheric pressure at 110 ºC and bubbled with oxygen at constant flow, which can be considered as an accelerated oxidation test. Under these conditions, the lipids get oxidized to short chain volatile acids like formic acid and acetic acid which are collected in distilled water increasing its conductivity. The IP (Induction Point) value indicates the time required to produce a sudden increase of conductivity, which can be defined as an indirect measure of oil stability. Table 1 shows the Induction Point values of microencapsulated oil

Table. 1. IP values of microencapsulated oil compared to bulk sardine oil

Sample	IPR1 (At 110˚)	IP R2 (At 110˚)
5% fish oil	0.67 h±0.01	0.71 h±0.03
5% encapsulated fish oil	7.67 h±0.05	7.57 h±0.07

compared to bulk sardine oil. Bulk sardine oil presented an IP of 0.67 ± 0.01 h which is comparable to the value reported for fish oil (0.75 h), whereas microencapsulated oil showed IP value of 7.67 ± 0.05 h. IP values obtained for microcapsules clearly showed a protective effect of the vanillic acid-grafted matrix against sardine oil oxidation.

References

Kagami, Y., Sugimura, S., Fugishima, N., Matsuda, K., Kometani, T. and Matsumura, Y. (2003) - Oxidative stability, structure, and physical characteristics of microcapsules formed by spray drying of fish oil with protein and dextrin wall materials. *J. Food Sci.*, **68:** 2248-2255.

Velasco, J., Dobarganes, C., Holgado, F. and Marquez-Ruiz, G. (2009) - A follow - up oxidation study in dried microencapsulated oils under the accelerated conditions of the rancimat test. *Food Res. Intl*, **42(1):** 56-62.