Study on the Water in Oil Emulsions with Curcumine and β-Carotene as Antioxidants by Conventional Techniques

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Abstract:

Stability of emulsions still attracts many researches. Among other things, this is intricate because of practical importance of such systems, for example, in food industries. Emulfication is a complicated process. In practical emulsions the droplet size is about micro- or submicro-meter. As it is well known, several processes can perform the emulsions instability: Ostwald ripening (transfer of material from small droplets to larger ones), sedimentation, aggregation, coalescence and partial coalescence. The partial coalescence may be a first step of true coalescence. The acceptance by customer of food emulsions depends on a large number of factors such as colour, appearance, taste, smell and texture. Colour and appearance are usually the first qualities to be perceived and thus may have a stronger impact on product acceptance than other parameters. Usage of the dyes in alimentation it is controlled in each country or continent and the number of dyes allowed it is limited and strictly controlled. Additionally, the public opinion is very sensible when are used additives in generally and dyes in particularly, with an increasing tendency to use naturally dyes.

On the other hand, the lipid oxidation is a big problem in the case of the food emulsions because it leads to the development of the rancidity. The use of food dyes in emulsions with high fat contents e.g. mayonnaises or creams present organoleptic advantages. The dyes are associated with them functional properties. The mostly used are yellow dyes. This paper is concentrate on the antioxidant properties of curcumine and β-carotene in some food emulsions, which are structurally similar to many food products (e.g. mayonnaise). To assess more precisely the antioxidant effect of β-carotene the results were expressed by comparison with the antioxidant activity of curcumine and the propylgalat - as positive antioxidant. The curcumine is a yellow pigment derived from the roots and rhizomes of the plant Curcuma longa. These polyphenol dye and functional ingredient contain in its structure [(1E, 6E)-1,7-bis (4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione] phenol groups and conjugated double bounds.

The antioxidant activity is measured using various methods e.g. linoleic acid peroxidation assay, superoxide anion radical scavenging assay and DPPH, free radical-scavenging assay etc. On the other hand, the use of unsaturation index or peroxide index for the oils peroxidation analysis is well known. The objectives of this study were to investigate the stability of water-in-oil emulsions containing natural food dyes and the comparative effects of β-carotene and curcumine addition in some emulsions on the model systems peroxidation before and after forced reaction. In this paper the different lypophilic food dyes which are in food colloidal sistems: curcumine (E 100, C.I. no. 75300) and β-carotene (E 160, C.I. no. 408000) were used. Differences in the hue of the dyes used in the emulsion formation are due to differences in absorbtion spectra.

The water-in-oil emulsions were prepared at 20 ± 2 0C with Span 80 solution using a high-speed blender. In all emulsions, the volume fraction of oil was 0.3. The stability of the emulsions with edible dyes prepared using the technique discussed above during storage was investigated. Coalescence and aggregation of the emulsion droplets were not observed over a period of 60 days. The emulsions thus prepared are: control emulsion, emulsion with curcumine (0.175 wt.%), emulsion with ß-carotene (0.25 wt.%), emulsion with 0.01 wt.% propyilgalate (PG) and emulsion with ß-carotene and PG (1:1 ratio).

This study is focuses on the antioxidant potential of curcumine and β-carotene in water-in-oil emulsions which have not been widely investigated in the present conditions. The studies were achieved under forced reaction conditions at 70 oC with air bubbling in the sample test tube on water bath. The experimental values show that the utilised dyes demonstrate an increase in antioxidant activity with concentration. From Figure 1 result that ß-carotene and curcumine showed a increase in antioxidant activity with concentration from 0.05 to 0.25 wt.%.

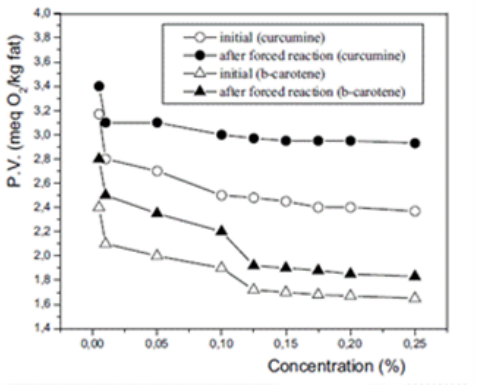

Fig. 1. Effect of dye concentrations on the antioxidant activity (expressed by peroxide value, P.V.) in oil-in-water emulsions.

Differences in the effectiveness of the antioxidant properties of these edible/bio dyes can be attributed to their structures and different affinities for the air-oil and water-oil interfaces in the food systems.

Mixture of ß-carotene with PG in food emulsion, at 1:1 ratio, increased the antioxidant activity of individual dye (results not shown). Also, the addition of curcumine in water-in-oil emulsion produced an decrease on the thiobarbituric acid (TBA) index opposite to the situation of forced oxidation (Table 1).

Sample		IV, g I2/100 g fat			TBA, mg malondialdehyde/100 g fat		
		minimum	maximum	*medium	minimum	maximum	*medium
Oil	i*	122.7	123.6	123.13±0.45	8.46	8.97	8.75±0.26
	f**	103.1	103.9	103.57±0.42	11.63	11.94	11.79±0.16
Emulsion	i*	129.3	129.7	129.48±0.2	4.83	4.92	4.88±0.04
	f**	113.9	114.4	114.17±0.25	6.92	7.14	7.05±0.12

Table 1. Comparison between the variation of chemical indicators of oxidative degradation (iodine value, IV and TBA index, TBA) for sun flower oil and model system emulsion (without dyes). The samples were analyzed in triplicates. Values were expressed as mean ± S.D.

*i – initial and **f – after forced reaction

These aspects regarding antioxidant potential of some yellow dyes e.g. ß-carotene and curcumine in food emulsions are sustained of the chromatic evaluation.

The table 2 show the results obtained for objective colour evaluation carried out in CIEXYZ systems.

Emulsion type	Conditions	Tristimulus values			Chromaticity coordinates			λd (nm)
		X	Y	Z	x	y	z	
ß-carotene emulsion	i	47.13	48.349	42.61	0.341	0.350	0.308	575
	f	39.94	39.95	34.52	0.349	0.349	0.302	576.5
Curcumine emulsion	i	9.625	9.548	7.126	0.366	0.363	0.271	580.5
	f	7.087	7.035	6.256	0.325	0.387	0.287	596

Table 2. The experimental results of emulsions samples with curcumine and ß-carotene obtained according to CIE 1964 (x, y) colour system (CIEXYZ)

λd – dominant wavelength (for colour points located in the spectral purples triangle from chromaticity diagram).

As shown in Table 2 dominant wavelength varies from 575 (initial) to 576.5 nm when curcumin emulsion is under forced oxidation conditions. These dominant wavelength values correspond to the region yellow in chromatic diagram. In the case of the emulsion with ß-carotene the dominant wavelength values correspond to the region yellow-orange in chromatic diagram (580.5÷596 nm). Experimental studies have shown that stable emulsions can be obtained with nonionic surfactant using usual techniques.

The results of the oxidation trial show that at a concentration of 0.25%, β-carotene significantly reduces the self-oxidation process of some food emulsion with sunflower oil. Mixture of β-carotene with PG (1:1 ratio) increased the antioxidant activity of individual carotenoid. The curcumine antioxidant activity from food emulsion was slowly higher than in the cases of β-carotene. The antioxidants/dyes (curcumine and β-carotene) were found to be more effective in water-in-oil emulsion than in oil sample.

This study has shown that stable vegetable water-in-oil emulsions with edible dyes added to the oil phases can be prepared using a simple method that utilizes standard preparation procedures (homogenization and ultrasonication). On the other hand, the experimental results show that at a concentrations of 0.175 wt% and 0.125 wt% the curcumine and β-carotene, respectively significantly reduces the self oxidation process. Tristimulus Colorimetry has proved to be a useful tool for following the little change in the colour evolution of these emulsions. Comparing these results, in terms of chemical indicators of oxidative degradation, with those of a colour variation, it can be concluded that the chromatic evaluation is a promising method to widen the use of colour parameters as a potential indicators regarding antioxidant potential of some edible/bio dyes in food emulsions.