

Influence of lutein delivery nanoemulsion formulation on the in vitro bioaccessibility of carotenoids

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Abstract

Human studies suggest that the daily intake of lutein can lead to the accumulation of this carotenoid in the retina, helping to protect the eyes against age-related macular degeneration. Absorption of carotenoids from many natural and processed foods is often inefficient and highly variable. The use of nanoemulsions has shown to be a trend in the food industry because they are more stable and increase the bioaccessibility of lipophilic bioactive compounds, such as carotenoids. The aim of the present work was to verify the influence of the formulation of lutein delivery nanoemulsions on the in vitro bioaccessibility of carotenoids.

Key words:

bioaccessibility, nanoemulsion, carotenoids

Introduction

Lutein, which is found in the petals of *Tagetes* genus flowers also known as marigold, is a natural pigment belonging to the class of carotenoids. The consumption of food rich in lutein through the diet is associated with a decreased incidence of cataracts and age-related macular degeneration (AMD) (Richer et al., 2004). Human studies suggest that the daily intake of lutein can lead to the accumulation of this carotenoid in the retina, helping to protect the eyes against AMD. Since lutein is not easily absorbed by the body due to its lipophilic character (Sotomayor-Gerding et al., 2016), oil in water nanoemulsions can be used to encapsulate, protect and enhance its bioaccessibility. The aim of the present work was to verify the influence of lutein delivery nanoemulsion formulation on the in vitro bioaccessibility of carotenoids.

Results and Discussion

Seven different nanoemulsion formulations were prepared using 1.5% Tween 20 aqueous solution as emulsifier, soy oil rich in carotenoids (5%) and antioxidants (1 mg/ g oil): α -tocopherol, rutin, gallic acid, quercetin and trolox, and a formulation without antioxidant. Nanoemulsions were characterized by their carotenoid content, droplet size, zeta potential and the carotenoid bioaccessibility was determined by an in vitro digestion method standardized by the Infogest action of the COST network (Minekus et al., 2014). All analyzes were performed in triplicate. The droplet sizes varied from 201 to 270 nm and the zeta potential ranged from -34.5 to -20.0 mV. Carotenoid contents of all nanoemulsions are presented in Table 1. The higher contents of carotenoids found in the nanoemulsions without antioxidant and with quercetin are due to the fact that they were produced using a different batch of oil rich in carotenoids from marigold petals.

Table 1. Carotenoid content in the nanoemulsions ($\mu\text{g/mL}$)

No Antioxidant	Rutin	Quercetin
27.96 \pm 0.17	17.56 \pm 0.77	31.38 \pm 2.55
α -Tocoferol	Gallic Acid	Trolox
19.89 \pm 1.85	13.65 \pm 0.40	16.17 \pm 0.91

Carotenoid bioaccessibility varied depending on the antioxidant added (Table 2). Tukey's test showed that nanoemulsions containing rutin, gallic acid and trolox presented higher carotenoid bioaccessibility than the ones with α -tocopherol and without antioxidant.

Table 2. Carotenoid bioaccessibility (%)

No Antioxidant	Rutin	Quercetin
9.79 \pm 0.33 ^d	36.39 \pm 0.87 ^a	8.36 \pm 0.005 ^d
α -Tocoferol	Gallic Acid	Trolox
18.73 \pm 0.50 ^c	34.75 \pm 3.05 ^a	22.47 \pm 1.83 ^b

Conclusions

The use of phenolic compounds could be an alternative to enhance carotenoid bioaccessibility. Formulations containing phenolic compounds such as rutin and gallic acid showed an increase of 272% and 255% of the carotenoid bioaccessibility, respectively, in comparison to the nanoemulsion without addition.

Acknowledgement

Bolsa SAE (PIBIC), CNPq (Projeto Universal-455748/2014-4), Bolsa IC Fapesp (Processo 2014/27302-0) e EMU Fapesp (2009/54137-1).

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