PharmaNutrition 5 (2017) 64–75

Contents lists available at ScienceDirect

PharmaNutrition

journal homepage: www.elsevier.com/locate/phanu

Review

Lutein, a versatile phyto-nutraceutical: An insight on pharmacology, therapeutic indications, challenges and recent advances in drug delivery

Tushar Madaan[a], Andleeb Nikhat Choudhary[a], Suman Gyenwalee[a], Shindu Thomas[c], Harshita Mishra[a], Mohammad Tariq[b], Divya Vohora[d], Sushama Talegaonkar[a,*]

[a] Department of Pharmaceutics, Faculty of Pharmacy, Jamia Hamdard, New Delhi, 110062, India
[b] National Institute of Immunology, New Delhi, 110067, India
[c] Fresenius Kabi Oncology Limited, Gurgaon, Haryana, 122018, India
[d] Department of Pharmacology, Faculty of Pharmacy, Jamia Hamdard, New Delhi, 110062, India

ARTICLE INFO

Article history:
Received 24 December 2016
Received in revised form 22 February 2017
Accepted 23 February 2017
Available online 9 March 2017

Keywords:
Lutein
Pharmacokinetics
Novel drug delivery systems
Mechanism of action
Formulations
Disease

ABSTRACT

Carotenoids are natural pigments known for their ability to provide protection from ultraviolet radiation and singlet-oxygen-induced damage such as mutation, immunosuppression, and oxidative stress induction. Lutein is a xanthophyll of the carotenoid family and numerous research studies on it have revealed that it is a potential drug candidate for various diseases like age-related macular degeneration, lung cancer, skin cancer, atherosclerosis, etc.

Despite of being efficacious for multiple afflictions, the drug delivery of lutein is challenging owing to its poor bioavailability due to its poor solubility and instability in gastrointestinal milieu. Various novel approaches such as microencapsulation, nano-encapsulation, complexation with cyclodextrin, etc. have been employed by researchers to develop an effective formulation. As the nutraceutical market is booming day by day, lutein formulations should be subjected to further pre-clinical and clinical research, so that lutein, with its tremendous scope in the treatment of a wide range of diseases, can be included as a common intervention for the aforementioned disorders.

The main objective of this review article is to give insight on the various studies supporting the wide range of pharmacological activities and applications of lutein, as well as to give an update on the recent advancements in its drug delivery.

Contents

* Corresponding author.
E-mail addresses: stalegaonkar@gmail.com, stalegaonkar@jamiahamdard.ac.in (S. Talegaonkar).

http://dx.doi.org/10.1016/j.phanu.2017.02.005
2213-4344/

1. Introduction

Fruits and vegetables are good sources of antioxidants. Among them, carotenoids like β -carotene, lycopene and lutein that impart antioxidant activities such as quenching of singlet oxygen and other electronically excited reactions and thus, reduce the progression of many oxidative stress induced degenerative diseases are abundantly present (Di Mascio P, Kaiser S & Sies H, 2010). Lutein is a member of the xanthophyll group, a subgroup of the carotenoid family and usually coexists with zeaxanthin. Lutein and zeaxanthin are widely distributed in brightly colored fruits and dark green vegetables [1,2].

Lutein is one of the essential components for sustenance of vital human physiological functions [3]. Since the human body cannot synthesize lutein by its own, its requirement needs to be fulfilled from dietary sources such as dark green leafy vegetables like spinach, beans, and kale, vegetables like maize, and lutein containing fruits like kiwi fruit, grapes, oranges, etc. [4].

The main naturally occurring stereoisomer of lutein is (3*R*, 3′*R*, 6′*R*)-*beta*, *epsilon*-carotene-3, 3′-diol which contains a long chromophore comprising of conjugated double bonds in basic polyene chain structure (Fig. 1) that is responsible for its distinctive light-absorbing properties and shows absorption maxima in visible range. The light filtering property of carotenoids is held responsible for its protective effect. Lutein is known for its ability to prevent ocular diseases including age related macular degeneration, cataract and diabetic retinopathy [2].

2. Source

Although lutein is synthesized exclusively in plants, it is found in both plants as well as animals. Animals obtain lutein, either directly or indirectly, from plants.

Lutein is present in plants as fatty-acid esters, related to beta-carotene and vitamin A, with one or two fatty acids bound to the two hydroxyl-groups on either side. Lutein-rich fruits and vegetables include broccoli, corn, orange, pepper, kale, grapes, spinach, carrot, kiwi fruit, squash, orange juice, and zucchini. Commercial lutein, which is extracted from *Tagetus erecta*, is typically a mixture of 90% lutein and 5% zeaxanthin [5].

Lutein is utilized by animals as an antioxidant as well as for blue light absorption. It is found in animal fat and egg yolk and also imparts yellow color to chicken skin and tissue fat. Although lutein is found in a number of human tissues like adipose tissues, the target organ of lutein is the retinal tissue of the eye, and it is has been estimated that the lutein concentration in the eyes is about 500 times greater than its concentration in other tissues of the body [6]. Thus, the availability of lutein in plasma always results in deposition of lutein in the retina of the eye [7]. The human retinal tissue collects zeaxanthin and lutein where the former prevails at the macula lutea region whereas the latter preponderates elsewhere in the retina, where it serves as a photo-protectant against the harmful effects of free radicals generated by blue light [8,2].

3. Physicochemical properties of lutein

Physiochemical properties of lutein are listed in Table 1 [9,10,7].

3.1. Stability

Lutein is found to be highly sensitive against light, heat and oxygen due to the presence of eight conjugated double bonds in its chemical structure and hence, it is easily decomposed and unstable on exposure to the aforementioned stimuli [11,12]. Moreover, degradation of lutein follows first-order kinetics [13]. The characteristic polyene chain is very sensitive and highly susceptible towards oxidative degradation in the presence of light or heat and is also chemically unstable in acids [7]. Due to aforesaid complications, its application in food and pharmaceutical industries is limited.

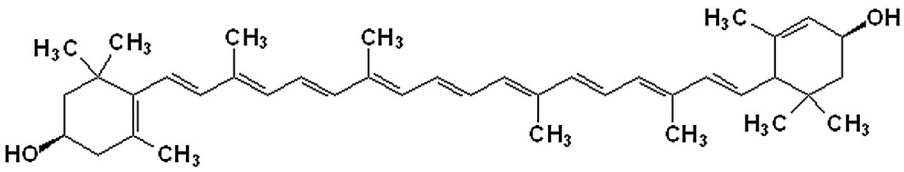

Fig. 1. Chemical structure of lutein.