Journal of Photochemistry and Photobiology A: Chemistry 336 (2017) 131–139

Contents lists available at ScienceDirect

Journal of Photochemistry and Photobiology A: Chemistry

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

Invited feature article

The photostability of flavanones, flavonols and flavones and evolution of their antioxidant activity

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ARTICLE INFO

Article history:
Received 24 June 2016
Received in revised form 24 December 2016
Accepted 27 December 2016
Available online 3 January 2017

Keywords:
Photostability
Oxidation
Flavonoid
Antioxidant activity

ABSTRACT

The objective of this paper is to study the effect the light on the stability of 6 flavonoids with different structures under different oxygen amounts. The evolution of their antioxidant activity and the identification of degradation products were also investigated. The results obtained indicated that the kinetics of flavonoid degradation are not only influenced by the light intensity and the oxygen amount but also by the flavonoid structure. The 6 flavonoids can be ranked below according to their stability: naringin, eriodictyol then rutin, luteolin, luteolin-7-*O*-glucoside and mesquitol. The presence of a hydroxyl group in position 3 and a double bond C2-C3 decrease flavonoid stability. Moreover, it was also observed that despite the total degradation of some flavonoids, the treated solutions still have an antioxidant activity. The identification of the degraded products by LC–MS showed that the degradation pathways are different according to the flavonoid studied.

1. Introduction

Recent epidemiological studies showed that a diet of fruit and vegetables rich in phenolic compounds leads to a general well-being of consumers. This observation is attributed to the antioxidant activity of phenol which favors the reduction of specific diseases such as diabetes, cancer, cardiovascular or neuronal diseases [1]. Among phenolic compounds, flavonoids are the most studied class. These studies indicated that the antioxidant activity of flavonoids depends on their structure [2,3]. Thus, any modification of their structure such as alkylation or glycosylation leads to an increase or a decrease of their antioxidant activity. The physico-chemical environmental of their storage such as light, oxygen, pH, temperature and darkness also provokes significant variations of their antioxidant activity. Landete [4] reported severe degradations successively due to oxygen and light. Thus, flavonoids exposed to light or oxygen undergo degradations of their structure, which can alter their activities. Ioannou et al. [5] reviewed the effect of light on flavonoid content and conclude that flavonoids in raw food are stable to light because they are protected by the food matrix, [6,7] whereas flavonoids in processed food undergo photo degradation. [8] The effect of light and oxygen on antioxidant activity has scarcely been discussed; only Aramwit et al. [9] mentioned a significant decrease of anthocyanin content and antioxidant properties of mulberry fruit extracts after their exposure to normal fluorescent light for 10 h. Moreover, most studies on the flavonoid stability under light deal with flavonoids in raw food. Thus, the conclusions drawn vary according to the food matrix and the lighting conditions (intensity, visible light or UV). In this paper, the effect of light on the stability of 6 flavonoids (rutin, mesquitol, naringin, eriodictyol, luteolin and luteolin-7-*O*-glucoside), and the evolution of their antioxidant activity will be thoroughly investigated under different operating conditions (with/without light, at two oxygen amounts). Model solutions of these compounds were exposed to darkness and light for two weeks at two oxygen amounts. The kinetics of their degradation and the evolution of their antioxidant activity were established and compared. Moreover, both the behavior of these kinetics and antioxidant activity were discussed taking the different flavonoid structures into account.

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http://dx.doi.org/10.1016/j.jphotochem.2016.12.027
1010-6030/

2. Materials and methods

2.1. Reagents

Naringin, rutin, 2′-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) diammonium salt (ABTS) were purchased from Sigma-Aldrich Chemical (Lyon, France). Eriodictyol, luteolin, luteolin-7-*O*-glucoside were purchased from Extrasynthese (Lyon, France). Mesquitol was extracted from a Kenya tree *proposis juliflora*. Structural elucidation was based on FTIR, 1H and 13C NMR, GC–MS and HPLC analyses. Results obtained showed the obtaining of (−) mesquitol as a sole compound with a high purity [10]. Trolox and potassium persulfate were purchased from Fluka-Sigma-Aldrich. Methanol and ethanol were respectively from Carlo Erba (Marseille, France) and VWR (Paris, France). All reagents and solvents were of analytical grade.

2.2. Structural differences between flavonoids

The flavonoids chosen for this study are characterized by a difference in their structure (Fig. 1) and have a good solubility in water. The flavonoids are subdivided into nine classes. All compounds of the same class have a common structure; four classes are relevant to study because their common structure differs from each other by one structural element (Table 1). To study the effect of light and oxygen, six molecules belonging to these four classes of flavonoids were selected.

Flavones (luteolin, luteolin-7-*O*-glucoside) differ from flavonols (rutin, quercetin) by the absence of the catechol structure. Flavanones (naringin, eriodictyol) differ from flavonols (rutin, quercetin) by the absence of the enone structure on the ring C. Flavanols (mesquitol) differ from flavonols (rutin, quercetin) by the absence of the enone structure and a carbonyl group on the ring C.

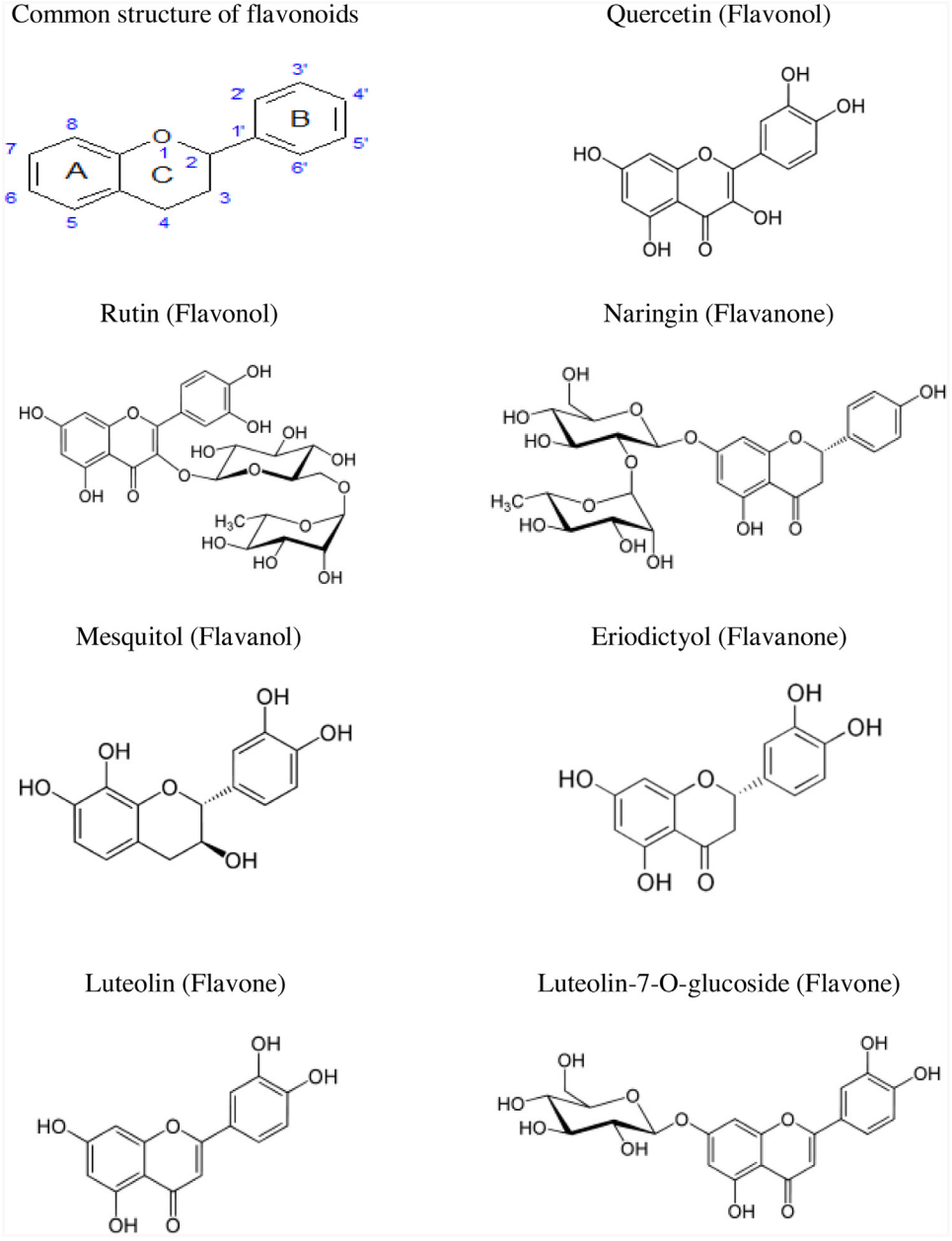

Fig. 1. Chemical structure of the flavonoids studied.