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Invited commentary

Phytosterol oxidation products: state of the art

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Abstract – This editorial gives an overview of the current status of the research on the phytosterol oxidation products. The most relevant studies on their in vivo origin, biological effects and analysis in foodstuffs and biological samples are critically reviewed, in order to give concluding remarks on and to establish the future research needs in this field.

Sterols, as unsaturated lipids, can undergo oxidation leading to the formation of sterol oxidation products (SOPs), also called oxysterols. The term SOPs includes both cholesterol oxidation products (COPs) or oxycholesterols and phytosterol oxidation products (POPs) or oxyphytosterols. Historically, COPs have attracted much more attention than POPs and from the late sixties several biological effects of COPs, mainly detrimental and related with several chronic and degenerative diseases, have been comprehensively studied [1–3]. In addition, the presence of COPs in some fresh foods and in many processed foods has been widely reported [2, 4]. Furthermore, in the human body, COPs can be formed in vivo by enzymatic and nonenzymatic oxidation of cholesterol, and may also be derived from the diet (comprehensively reviewed in [2]).

On the contrary, there is only one study in the intestinal absorption of various POPs [5], which seems to be lower than that of the corresponding COPs. However, due to methodological differences between studies, it is difficult to compare the absorption rates reported in the literature for POPs and COPs. Thus, studies comparing the absorption of POPs and COPs in the same conditions would be very relevant. In addition, very recently, it has been demonstrated that the incorporation of POPs in various hamster tissues depends on the level of POPs in the diet [6]. In addition, some POPs have been found in plasma from healthy human subjects[7] and in serum from patients with phytosterolemia or cerobrotendinous xanthomatosis [8]. Thus, since the dietary origin of POPs is plausible, the main question related to this topic is whether the POPs can be formed in vivo. In fact, some studies indicate that some phytosterols and POPs undergo metabolic reactions before being excreted, but the knowledge on this aspect is rather limited [2, 5, 6, 9]. In addition, for the moment, there is no evidence of the nonenzymatic oxidation of phytosterols in vivo [9], but this point must be much further studied.

Also, the studies on the biological effects of these compounds are very scarce [2]. There is only one study comparing the biological effects of POPs and COPs, which reported that POPs and COPs show similar cytotoxic effects on macrophages, but POPs with less potency [10]. In this field, more studies assessing the potential biological effects of POPs in comparison to COPs are necessary.

COPs have been analyzed in numerous samples of many types, the methods for their analysis are rather well solved, and some attempts to harmonize COP analysis have even been carried out [2, 11, 12]. On the contrary, POPs have been analyzed mostly in heated vegetable oils, French fries and potato chips, but also in a few cereal-based foods, infant formulas, coffee samples, and biological samples [2, 12]. However, the chromatographic resolution of the analytes, which is the main problem of POP analysis in plant foods in comparison to COP analysis in animal foods, has been fairly well solved [2, 12] using GC-FID. But the analysis of SOPs (COPs + POPs) in foods of mixed origin

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(plant/animal-based foods) is much more complex. In fact, only a few scientists have faced this challenging analysis even though some GC conditions provide a good resolution for very complex sterol and SOP mixtures [2, 12] and highly selective chromatographic techniques exist such as GC coupled to a mass selective detector operated in selected ion monitoring mode. Therefore, further studies are necessary in this field, especially in terms of SOP analysis in foods of mixed origin with special emphasis on improving the efficiency of the purification and enrichment systems and the selectivity of the determination systems.

In addition, the interest in POPs has increased as a result of the fortification of some foods with phytosterols and phytosterol esters because of their blood LDL cholesterol-lowering effect. Therefore, these compounds were very recently determined in spreads enriched with these sterol esters [13, 14]. Thus, food scientists as well as nutritionists are interested in the accurate quantification of POPs in foods and in the assessment of their potential risk for health.

REFERENCES

[1] Brown AJ, Jessup W. Oxysterols and atherosclerosis. Atherosclerosis 1999, 142: 1–28.

[2] Guardiola F, Dutta PC, Savage GP, Codony R (Eds). Cholesterol and Phytosterol Oxidation Products in Foods and Biological Samples: Analysis, Occurrence and Biological Effects. AOCS Press, Champaign, IL, 2002.

[3] Schroepfer GJ. Oxysterols: modulators of cholesterol metabolism and other processes. Physiol Rev 2000, 80: 361–554.

[4] Paniangvait P, King AJ, Jones AD, German BG. Cholesterol oxides in foods of animal origin. J Food Sci 1995, 60: 1159–1174.

[5] Grandgirard A, Sergiel JP, Nour M, Demaison-Meloche J, Ginies C. Lymphatic absorption of phytosterol oxides in rats. Lipids 1999, 34: 563–570.

[6] Grandgirard A, Demaison-Meloche J, Cordelet C, Demaison L. Incorporation of oxyphytosterols in tissues of hamster. Reprod Nutr Dev 2004, 44: 599–608.

[7] Grandgirard A, Martine L, Demaison L, Cordelet C, Joffre C, Berdeaux O, Semon E. Oxyphytosterols are present in plasma of healthy human subjects. Br J Nutr 2004, 91: 101–106

[8] Plat J, Brzezinka H, Lütjohann D, Mensink RP, von Bergmann K. Oxidized plant sterols in human serum and lipid infusions as measured by combined gas-liquid chromatography-mass spectrometry. J Lip Res 2001,42: 2030–2038.

[9] Grandgirard A, Martine L, Duaneda P, Cordelet C. Sitostanetriol is not formed in vivo from sitosterol in the rat. Reprod Nutr Dev 2004, 44: 609–616.

[10] Adcox C, Boyd L, Oehrl L, Allen J, Fenner G. Comparative effects of phytosterol oxides and cholesterol oxides in cultured macrophage-derived cell lines. J Agr Food Chem 2001, 49: 2090–2095.

[11] Appelqvist L-A. Harmonization of methods for analysis of cholesterol oxides in foods-the first portion of a long road toward standardization: interlaboratory atudy. J AOAC Int 2004, 87: 511–519.

[12] Guardiola F, Bou R, Boatella J, Codony R. Analysis of sterol oxidation products in foods. J AOAC Int 2004, 87: 441–466.

[13] Louter AJH. Determination of plant sterol oxidation products in plant sterol enriched spreads, fat blends, and plant sterol concentrates. J AOAC Int 2004, 87: 485–492.

[14] Grandgirard A, Martine L, Joffre C, Juaneda P, Berdeaux O. Gas chromatographic separation and mass spectrometric identification of mixtures of oxyphytosterol and oxycholesterol derivatives. Application to a phytosterol-enriched food. J Chromatogr A 2004, 1040: 239–250.