7th Workshop

SPECIFIC METHODS FOR FOOD SAFETY AND QUALITY

September 22nd 2021, Vinča Institute of Nuclear Sciences - National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia

PROCEEDINGS

SPECIFIC METHODS FOR FOOD SAFETY AND QUALITY

7th WORKSHOP: SPECIFIC METHODS FOR FOOD SAFETY AND QUALITY

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MODULATION OF REDOX PARAMETERS IN RAT LIVER INDUCED BY FLAXSEED OIL

A. Todorović[1], I. Pavlović[1], S. Pejić[1], J. Miletić Vukajlović[1], F. Veljković[2], J. Filipović Tričković[1] A. Valenta Šobot[1], J. Martinović[1], I. Guševac Stojanović[1], Z. Stojanović[2], and D. Drakulić[1]

[1]*Vinča Institute of Nuclear Sciences - National Institute of the Republic of Serbia, University of Belgrade, P.O.Box 522, Belgrade, Republic of Serbia*
(anato@vin.bg.ac.rs)
[2]*Institute of Technical Sciences of SASA, Knez Mihailova Street 35/4, Belgrade, Republic of Serbia*

ABSTRACT

Flaxseed oil, extracted from ripened flaxseeds, is functional food source that is associated with health benefits in many diseases, including cardiovascular, cancer, osteoporosis, etc. Besides saturated fatty acids and monounsaturated fatty acids, it also contains easily oxidized polyunsaturated fatty acids of the n-3 family. In current study, we tested the effects of commercial flaxseed oil in rat liver by measuring parameters related to free radical challenge (pro/antioxidant balance (PAB), lipid peroxidation (LPO) products and glutathione (GSH) level). Overall, applied treatment maintains general prooxidant load and antioxidant capacity since the level of PAB was unchanged. However, it exerts significant modulatory effect on particular redox parameters by increasing the amount of LPO products and consequently the susceptibility of tissue to free radical oxidative damage, which challenges the antioxidant defence system that in return elevates GSH concentration.

INTRODUCTION

Flax plant (*Linum usitatissimum L.*) is cultivated for its seeds and fibers since antiquity for variety of purposes, including health and industrial uses. In the food markets, flaxseed products are available in various edible forms, such as whole flaxseeds, milled/powdered flaxseeds, roasted flaxseeds and flaxseed oil (FO). FO, cold pressed to extract from dried, ripened flaxseeds, comprises about 9 % of saturated fatty acids (palmitic and stearic acid), 18 % of monounsaturated fatty acids (oleic acid), and 73 % polyunsaturated fatty acids (PUFAs) (linoleic and α-linolenic acid). Although having naturally high levels of antioxidants like tocopherols and beta-carotene, due to elevated content of PUFAs, FO is highly prone to free radical oxidative reactions [1].

Free radicals are created by various endogenous systems in different physiochemical conditions as well as pathological states. For proper physiological function, it is necessary to maintain a balance between free radicals generation and their removal by the antioxidant system, including its nonenzymatic component, glutathione (GSH). Inadequately removed, free radicals can cause excessive oxidation of structural and functional biomolecules (lipids, proteins and DNA) and provoke oxidative stress, a condition responsible for triggering a number of diseases [2]. In recent years, literature highlights the role of functional foods, including flaxseeds and FO, in sustaining the balance between pro- and antioxidants [1]. FO consumption is associated with health benefits by bringing mental and physical endurance, fighting fatigue and controlling aging process. It also showed positive outcome in many diseases, including cardiovascular, cancers, etc [1].

In the present study livers of healthy adult male rats were used to test the potential alterations of several redox parameters (pro/antioxidant balance (PAB), lipid peroxidation (LPO) products, and GSH level) induced by chronic FO treatment.

EXPERIMENTAL

According to authorized protocol (number 02/11) on the first day of the experiment, seven weeks old male Wistar rats were randomly divided into two groups with 4 per group/cage. Intact animals used as controls were assigned to the group I, while rats from the group II were intragastrically intubated with commercial flaxseed oil, at a dose of 1 mg/kg three times per week for 4 weeks (FO group). The treatment was applied by reusable stainless steel feeding needle, 16-G4", 3 mm ball diameter (Cadence Inc., USA). Body mass/mass gain of rats was monitored weekly. All animals were decapitated with guillotine (Harvard Apparatus, Holliston, MA, USA) and livers were dissected and frozen till processing. All analyses were performed as previously described [4, 5].

Statistical analysis was performed by t-test, using GraphPad Prism 5 Software (USA). The significance level was $p < 0.05$, with values expressed as a percentage of the mean of the values in control group ± SEM (standard error of the mean).

RESULTS AND DISCUSSION

There was no significant difference in initial body weight between control and FO group and such trend was maintained throughout the whole experiment (Figure 1A). Moreover, our results demonstrate that rats from both groups exhibited steady increase in the weekly body mass gain (Figure 1A). This is in an agreement with several studies in humans that reported no effect of PUFAs, specifically α-linolenic, on weight management [5].

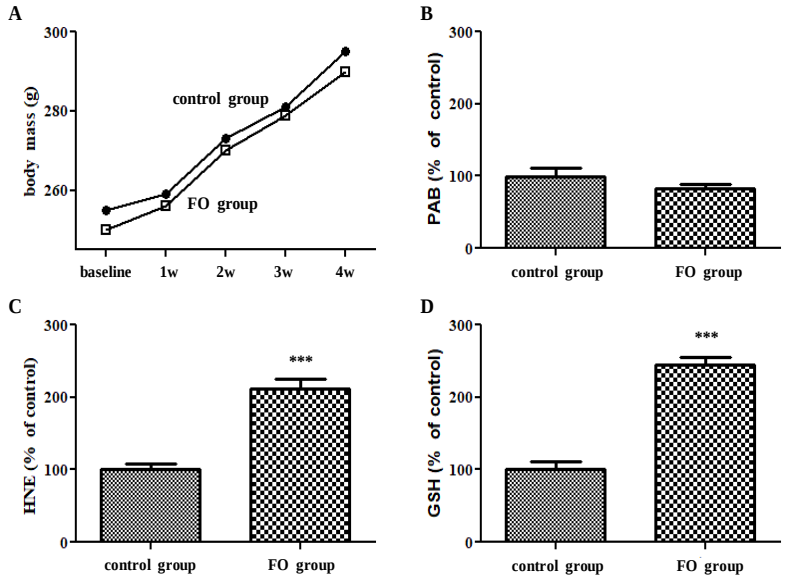

Figure 1. Effect of chronic flaxseed oil treatment (FO) on body mass (**A**) and levels of redox markers (pro/antioxidant balance (PAB) (**B**), products of lipid peroxidation (LPO products) (**C**) and glutathione (GSH) (**D**)) in liver. Data are presented as % of control ± SEM. ***$p < 0.001$.

Although chronic FO treatment did not change the level of PAB (Figure 1 (B, C, D)), it provoked the increase of LPO products concentration that is, most likely, responsible for the GSH elevation. Previous studies point that oils of different origin, including FO, having high amounts of PUFAs of the n-3 family, are predisposed to be oxidized by free radicals [1, 6] and, consequently, to further induce oxidation of other biomolecules. Indeed, presented results of the LPO products level might be associated with the findings of others who reported that enhanced level of LPO product, malondialdehyde, and lipid peroxidation rate promote an oxidative challenge in liver and serum of rats fed with polyunsaturated-n-3-lipids-rich diet [6]. In parallel, FO treatment altered the concentration of GSH, whose upregulation seems to be protective against the free radicals produced during the metabolism of lipids and modified lipoproteins. GSH is also an important redox and cell signaling regulator

capable to alter the function of signal transduction and transcription factor molecules, affecting intermediary metabolism, survival and pathogenesis [7].

CONCLUSION

According to presented data, chronic FO treatment in liver of healthy adult male rats maintains the balance of pro- and antioxidants although it challenges the nonenzymatic component of antioxidant defense system with the increased generation of LPO products. Despite the fact that our findings indicate that applied treatment is relatively safe with no negative outcome on general health of the animals, additional testing is required to confirm obtained results in animals of different age/gender/health status and even higher level species.

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