Annals of Medical Research
DOI: 10.5455/annalsmedres.2019.10.645 2020;(27)2:527-32

Original Article

Effects of sun dried organic apricot on serum total cholesterol, high density lipoprotein-cholesterol, triglyceride and total antioxidant capacity levels in rats

Ismet Yilmaz[1], Ismail Temel[2], Songul Aydemir[3]

[1]Inonu University, Faculty of Pharmacy, Department of Pharmacology, Malatya Turkey
[2]Inonu University, Faculty of Medicine, Department of Biochemistry, Malatya Turkey
[3]Inonu University, Faculty of Science and Art, Department of Biology, Malatya Turkey

Abstract

Aim: In this study, we aimed to investigate the effects of sun dried organic apricot (SDOA) consumption on serum Total Cholesterol (TC), High-Density Lipoprotein-Cholesterol (HDL-C), Triglyceride (TG) and Total Antioxidant Capacity (TAC) levels in rats

Material and Methods: 120 males, 120 females rats were divided in to four groups according to their SDOA rates (1%, 2.5, 5 and 10) in chow (to be 24 rats in each gruop), and feding periods. At 120 days periods, the control group was fed with standard rat chow and the others were fed with 1%, 2.5, 5 and 10 SDOA supplemented diet. At the end of 30th, 60th, 120th days; 8 rats which each genders/ groups were sacrified by diethyl ether inhalation anesthesia, app. 8-10 mL blood samples were taken by intracardiac puncture and obtained serum samples were maintained at -20 ° C until the day of analysis.

Results: After statistical analysis, TC levels of male rats; HDL-C levels of female rats increased in paralel with the feding process. Both TC and HDL-C levels of female rats were significantly higher than those of males. Although there were a significant decreases in TG levels of both sexes at the end of feding periods, there was no significant difference between TG levels of both genders.

Conclusion: It is thought that increases in TC and HDL-C levels are caused by rats affected by long-term feding periods. In addition, the significant difference between TC and HDL-C levels of male and female rats are thought to be affected by gender-specific reference values. The decrease in TG levels in both sexes is considered to be due to the increased energy needs of rats as well as the effect of SDOA-added feeds.

Keywords: Sun Dried Organic apricot; cholesterol; triglyceride; total antioxidant capacity; rat

INTRODUCTION

Nutrition experts are widely recommending fruits and vegetables consumption for their preventive and/or protective effects on several chronic diseases (1). It has been reported that, in the development of dyslipidemias, saturated fatty acids (SFA) and dietary cholesterol intake has been shown an increase on serum TC and LDL-C levels; so the replacement of saturated fat with polyunsaturated fatty acids (PUFA) has beneficial effect on lipid levels. Researchers have been emphasized that, high total cholesterol (TC), high low-density lipoprotein cholesterol (LDL-C), and low high-density lipoprotein cholesterol (HDL-C) are risk factors for developing Cardio Vascular Dsiseases (CVD). For adult population, the evidence indicates that high TG and low HDL-C levels are associated with increased prevalence of overweight/ obesity. Therefore, changes in body weight may partially account for the trends in TG and HDL-C levels in men, and similar trends in women could be to some extent explained by the increase in simple sugars intake (2).

According to 2013 FAO data; Turkey is among the leading countries of the World either amount and or variety of fresh vegetables and fruit production (3). Among these fruits, apricot, which is widely cultivated in Malatya region of Turkey, is consumed both fresh and dried, and it is also exported in significant amounts. High vitamin, carbohydrate and mineral contents increase the nutritional value of apricot; rich fiber content helps

Received: 17.10.2019 **Accepted:** 17.12.2019 **Available online:** 06.03.2020
Corresponding Author : Ismet Yilmaz , Inonu University, Faculty of Pharmacy, Department of Pharmacology, Malatya Turkey
E-mail: yilmaz.ismet@inonu.edu.tr

to maintain its nutritional value after drying (4). Fibrous foods are important components of healthy eating; Helps the digestive system to function regularly, to develop saturation sensation, to stabilize blood sugar, to prevent cancer, to lower cholesterol levels, to solve constipation, obesity and diabetes. In addition to the vitamins and minerals it possesses, many vegetables and fruits are a complete source of healing with rich fiber ratios, apricot, one of these fruits, meets 28% of the daily needs of an adult person with a fiber content of approximately 7-8 g / 100 g (5-8). In addition, regular daily consumption of vegetables and fruits increases total antioxidant capacity (TAC), decreases lipid peroxidation and reactive oxygen species formation, thus preventing atherosclerosis and reducing the risk of coronary heart disease (CHD) (9). The World Health Organization (WHO) recommends that people consume at least five portions (approximately 400 g) of fruit and vegetables per day to protect them from many chronic diseases such as cancer, cardiovascular disease, obesity and diabetes (10).

Cholesterol is one of the important building blocks of our body and it is also used in cell membrane structure, production of hormones for growth, reproduction and synthesis of vitamin D, synthesis of bile acids necessary for digestion of foods, but blood cholesterol and triglyceride levels need to be balanced for healthy life. Similarly, triglyceride is predominantly an important lipid fraction that reflects the body's energy balance and has a significant contribution in determining blood cholesterol and triglyceride levels which are closely associated with disorders of lipid metabolism. For this reason, nutritionists recommend a diet predominantly of vegetables and fruits rather than animal foods to maintain TC and TG levels at normal levels (11-13).

In our literature research, no record was found on about the effects of SDOA consumption over 120 days on serum lipid parameters and TAC levels in rats. Therefore, here we aimed to evaluate the effect of SDOA feeding on serum TC, HDL-C, TG and TAC levels.

MATERIAL and METHODS

The study protocol of this study was approved by the Ethic Committee, Faculty of Medicine, University of Inonu, Malatya, Turkey (2009/13). Rats were provided by the Experimental Animal Research and Production Center of Inonu University. During a 120-days study period, female rats were housed seperately from male rats (to prevent estrus of female rats from being affected by the smell of testosterone metabolites in male urine.). They had free access to chow and water during study periods, no toxic and side effects or death were observed. Totally 240 of Sprague Dawley (~ 5 monthly years old) rats were used. They were randomly divided into five groups, leading to 24 rats in each group of both genders. The control group (group-1) was fed with standard rat chow and the others were fed with 1%, 2.5%, 5% and 10% SDOA-supplemented diet. They were housed at room temperature (21 °C ± 2 °C) with relative humidity of 53% ± 3% with a 12 h light/ dark cycle. At the beginning of the study, the average body weight of male and female rats were 321 g ± 24.6 g and 210 g ± 21.4 g, respectively. On the 30th day, eight rats from each groups of both gender (totally 40 female and 40 male) were anaesthetized by inhalation of diethyl ether and 7–10 mL of blood samples were taken by intracardiac puncture. Blood samples were centrifuged at 3000xg for 10 min and the extracted serum samples were stored at –20 °C until analysis of serum lipids and TAC levels. On the 60th and 120th day, this procedure was repeated.

Diet

The normal rat chow was purchased from Korkutelim, Antalya, Turkey. The Kabaaşi variety of SDOA, which was provided from a local market in Malatya, Turkey (having organic certificate), was used as a supplementary diet. Nutrient and mineral composition of SDOA and the daily average food consumption of the male and female rats were determined as described by Yılmaz et al. (1). The SDOA-supplemented diet was freshly prepared in 10 kg batches manually.

Measurement of biochemical parameters

Serum TC, HDL-C and TG levels were measured by using original Abbott kits on the Abbott Architect c16000 clinical autoanalyser (Abbott Diagnostics, Abbott Park, Illinois, ABD). Serum TAC levels were determined using the colorimetric ELISA method developed by Erel O. (In this method, used the dark blue-green ABTS [diammonium-2,2'-azinobis (3-ethyl-benzothiazoline-6-sulfonate)] radical is reduced to the colorless to ABTS form by the action of reducing antioxidants present in the test sample. The color change was proportional to the total amount of antioxidant present in the sample and was absorbance change measured by at 660 nm, and the results were calculated as the equivalent of trolox (mmol / L), a stable vitamin E analog (14).

Statistical analysis

All numerical data were analyzed with MedCalc statistical program (MedCalc Software version 11.4.4. Belgium), MS Excel program was used for graphing drawings, and results were expressed as mean ± standard deviation (±SD). Kolmogorov-Smirnov test was used to determine normal distribution. In multiple group comparisons, non-parametric data were analyzed by Kruskal Wallis Analysis of Variance; parametric data were evaluated with one- and two-way ANOVA tests. Tukey-Kramer post-hoc analysis test was used to determine the differences among the groups and Student's t test was used to determine the differences between the gender groups. $P < 0.05$ was chosen as the level of statistical significance.

RESULTS

According to our results: The difference between the third stage HDL-C levels of female rats was determined individually from D3 group (5%); The difference between the first-term TAC levels was seen to be affected individually by the D4 (10% ratio) group (Figure 1; Table

Table 1. Effect of feeding periods on test parameters of male (M) and female (F) rats. [*Independent evaluation of SDOA rates].

Parameters	Groups (n)	Mean ± SD	F - Test	(P)	Different Groups
	1 - S1 (39)	58±10			(2)(3)
M-Chol (mg/dL)	2 - S2 (39)	64±11	5.20	0.007	(1)(3)
	3 - S3 (36)	63±09			(1)(2)
	1 - S1 (39)	74±13			
F-Chol (mg/dL)	2 - S2 (39)	77±10	0.57	0.565	No
	3 - S3 (40)	76±17			
	1 - S1 (39)	17±3.1			
M-HDL-C (mg/dL)	2 - S2 (39)	16±2.5	1.97	0.145	No
	3 - S3 (36)	18±2.0			
	1 - S1 (39)	22±3.7			(2)(3)
F-HDL-C (mg/dL)	2 - S2 (39)	25±3.4	6.62	0.002	(1)(3)
	3 - S3 (40)	24±4.6			(1)(2)
	1 - S1 (35)	54±12			(2)(3)
M-TG (mg/dL)	2 - S2 (37)	46±11	7.73	< 0.001	(1)(3)
	3 - S3 (38)	44±11			(1)(2)
	1 - S1 (37)	53±12			(2)(3)
F-TG (mg/dL)	2 - S2 (35)	52±11	3.44	0.036	(1)(3)
	3 - S3 (36)	47±10			(1)(2)
	1 - S1 (39)	3.8±0.3			(2)(3)
M-TAC (mg/dL)	2 - S2 (39)	6.4±0.8	300	< 0.001	(1)(3)
	3 - S3 (40)	4.3±0.2			(1)(2)
	1 - S1 (40)	4.4±0.4			(2)(3)
F-TAC (mg/dL)	2 - S2 (38)	3.9±0.3	29.49	< 0.001	(1)(3)
	3 - S3 (40)	4.2±0.3			(1)(2)

Table 2. Effect of gender on test parameters of male and female rats. [*Independent evaluation of SDOA rates and feeding periods].

Groups	n	Mean ± SD	t - test	(P)
M-Chol	114	62 ± 10	8.88	< 0,001
F-Chol	118	75 ± 13		
M-HDL-C	114	17 ±2.6	14.71	< 0,001
F-HDL-C	118	24 ± 4.1		
M-TG	110	48± 12	1.57	0,119
F-TG	108	51± 11		
M-TAC*	92	4,3 ± 0,7	1.35	0,179
F-TAC	118	4,2 ± 0,4		

* Abnormal data in the second period causing a dramatic increase in TAC levels in male rats were not taken into account.. The significance of the difference between the two independent groups was evaluated by student-t test.

1). The dramatic increase in the TAC levels of male rats in the second period: It was observed that the increase in D1 and D2 groups (1% and 2.5% ratio) was in the opposite direction to SDOA doses and mostly with the control group (Figure 1). It is not clear whether the experimental conditions are effective in the emergence of this situation which cannot be explained fully. However, when the results of these groups are not taken into account: it is seen that the differences between the ratio groups and the feeding periods disappear (Table 2).

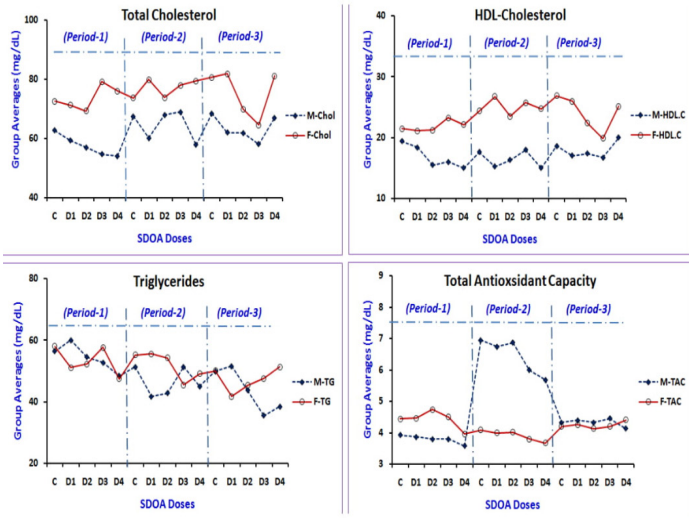

Figure 1. Different feeding periods (Period-1: 30 days, Period-2: 60 days, Period-3: 120 days) and different rates C=Control, D1=1% SDOA, D2=2,5% SDOA, D3=5% SDOA, D4=10% SDOA on serum Total Cholesterol (TC), HDL-Cholesterol (HDL-C), Triglycerides (TG) and Total Antioxidant Capacity (TAC) levels of male and female rats fed with SDOA (Sun Dried Organic Apricot). In the lower right part of the figure, there is a dramatic increase caused by abnormal increase in the second period Total Antioxidant Capacity levels of male rats

DISCUSSION

Turkey is far ahead in the world apricot production, and at foremost Malatya province, in the different regions of country many apricots species have been cultivated (3, 15). Munzuroglu et al. stated that the vitamins and selenium contents of apricot species cultived in Malatya province are show significant differences according to geographical regions, and also Görünmezoğlu emphasized that the antioxidant properties of apricot varieties have been changed according to apricot species (4, 16). Vardı et al. stated that, 10% sun dried organic apricot supplemented feed intake in rats, prevent oxidative damage caused by methotrexate induced intestinal toxicity, increase antioxidant enzyme activities and decrease in lipid peroxidation levels and improvement in histological parameters (17). Parlakpınar et al. have expressed that in experimental model of rats ischemia / reperfusion injury, 10% and 20% SDOA-supplemented feed has a higher heart-protective effect as compared to the standard meal (18). We see that the antioxidant effect expressed in both studies above does not reflect TAC levels of our study. Presumably, the low SDOA rates are chose in this study and the ability of rats to synthesize a potent antioxidant of as vitamin C may be prevent the expected differences in TAC levels.

Nutrition guidelines indicate that a diet rich in vitamin E and unsaturated fatty acids is effective in maintaining cardiovascular health by reducing circulating exogenous and endogenous triglyceride levels (19, 20). Kutlu et al. reported that the addition of apricot seed oil to the diet in the experimental atherogenesis model showed anti-hyperlipidemic effect, reduced lipid peroxidation and improved antioxidant defense system in rats (21). Undoubtedly, poly-unsaturated fatty acids as well as the rich E-vitamin content of apricot kernel contribute significantly to this effect, SDOA also contributes to the increase in TAC levels due to the significant content of beta carotene and phenolic compounds (22, 23). Fresh apricot loses a significant portion of vitamin C content while drying, but vitamin E, a potent antioxidant, is found in the kernel rather than the fruit of the apricot. Therefore, the total antioxidant capacity of dried apricots remains relatively weak and cannot be expected to make a significant contribution to TAC levels.

In the present study, regardless of SDOA rates, the effects of feeding time were examined (Table 1); Cholesterol levels in male rats and HDL-C levels in female rats seem to be affected similarly. Accordingly, both sexes have significant increases in both the second and third periods compared to the first period. In general, cholesterol levels are parallel to growth; Considering that HDL-C levels are mostly under the control of estrogen hormone: At least some of the rats can be interpreted that they have not completed their developmental process yet. On the other hand, when the change in triglyceride levels is examined: There is a decreasing tendency in both genders in the opposite direction to the feeding process (Figure 1). It is known that feeding dietary fiber is effective in reducing the risk of CHD by lowering blood cholesterol and triglyceride levels in humans (24). However, in the case of rats: it should not be ignored that the standard feed used in the study contains a significant amount of fiber (25). In this case, it can be said that the decrease in triglyceride levels is caused by the effect of the nutritional fiber content of SDOA in addition to the fiber in the feed (4) in the increasing energy requirement of the rats in the developmental process.

Mesomya et al. reported that age and sex were effective during standard feeding on serum cholesterol and triglyceride levels in rats, especially in 4 - 8 months old female rats showed significant increases in serum cholesterol levels and fluctuations in triglyceride levels of both sexes (26). It is pleasing for us that the age of the rats used in our study and our results exhibit substantially similar results to those of Mesomya et al. While lipid-restricted nutrition causes a decrease in circulating exogenous triglyceride levels; carbohydrate-rich diet induces de-novo triglyceride synthesis, and resulting in

an increase in endogenous triglyceride amounts. Due to its structural function, despite its very stable cholesterol levels, triglyceride which is an important energy molecule, is easily affected by metabolic activities and follows a fluctuating course. And also, in triglyceride levels, even under the same dietary conditions, daily, monthly and even seasonal changes of 20–40% may ocur (27). Kawano et al. stated that overnutrition and obesity cause insulin resistance, so causing hepatic triglyceride build-up and ultimately liver steatosis (28), likewise, Tomizowa et al. suggest that a high carbohydrate diet causes triglyceride deposition in hepatocytes and that increased triglyceride can be considered as a marker for non-alcoholic fatty liver disease (NAFLD) (29). In addition, Nordestgaard et al. described that, high plasma triglyceride levels as an independent risk factor for cardiovascular disease (30). On the other hand, both the National Cholesterol Education Program (NCEP) and the International Diabetes Federation (IDF) identify that "high triglyceride levels as risk factors for metabolic syndrome" (13, 24). Consequently, they all agree: to raise HDL-C levels and to lower LDL and triglyceride levels to reduce the risk of ChronicHeart Disease (CHD).

CONCLUSION

On serum lipid levels, regarding the effect of SDOA consumption according to gender, (regardless of the rate and duration of changes); females had significantly higher TC and HDL-C levels than males; and TG levels of both genders were not different (Table 2). Although the initial TAC levels of females were significantly lower (Fig.1), the difference between the sexes disappeared -when the abnormal TAC levels of males in the second period were not taken into account-. (Table1 and 2). Increases in TC and HDL-C levels are thought to be due to the long-term feeding period of rats that are still in growing periods (5-6 months of age). In addition, the difference between TC and HDL-C levels in male and female rats is likely to be influenced by gender-specific reference values. It can be said that the decrease in TG levels of both sexes is caused by the combined effect of SDOA supplementation in chow with the increasing energy need of the rats's growing process.

Competing interests: The authors declare that they have no competing interest.

Financial Disclosure: This study was supported by Inonu University Scientific Research Projects Unit (IUBAP) as the project number (2010/74).

Ethical approval: This study was supported by Inonu University Scientific Research Projects Unit (IUBAP) as the project number (2010/74). We would be thank them for your kindly financial support.

Ismet Yilmaz ORCID: 0000-0001-8680-3098
Ismail Temel ORCID: 0000000160494741
Songul Aydemir ORCID: 0000000279210662

REFERENCES

1. Yılmaz I, Temel I, Gursoy S, et al. The effects of apricot on serum proteins and liver enzymes in rats. J Food Nutrit Res 2013;52:101-6.
2. Ramazauskiene V, Petkeviciene J, Klumbiene J, et al. Diet and serum lipids: changes over socio-economic transition period in Lithuanian rural population. BMC Public Health 2011;11:447.
3. FAO Statistical Yearbook 2013: World Food and Agriculture. http://www.fao.org/docrep/ 018/i3107e/ i3107e03.pdf
4. Görünmezoğlu Ö. Kayısı ve İncir Meyvelerinin Antioksidan Kapasitelerinin Araştırılması. Adnan Menderes Üniversitesi, Yüksek Lisans Tezi. 2008, Aydın.
5. Healthy Eating. Apricot Nutrition Facts. https://www.healthy-eating-centre.com/apricot-nutrition-facts.html (ET: 20-12-2018).
6. Carter P, Gray LJ, Troughton J, et al. Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis. BMJ 2010;341:4229.
7. Scarborough P, Morgan RD, Webster P, et al. Differences in coronary heart disease, stroke and cancer mortality rats between England, Wales, Scotland and Northern Ireland: the role of diet and nutrition. BMJ 2011;263: 1-7.
8. Joshipura KJ, Hu FB, Manson JE, et al. The effect of fruit and vegetable intake on risk for coronary heart disease. Annals of Internal Medicine 2001;134:1106-14.
9. Hartley L, Igbinedion E, Holmes J, et al. Increased consumption of fruit and vegetables for the primary prevention of cardio vascular diseases. Cochrane Database of Systematic Reviews 2013;6:CD009874.
10. WHO Fruit and vegetables for health. Report of a joint FAO/WHO Workshop held 1–3 September 2004, Kobe/ Japan. Geneva, World Health Organization, 2005.
11. Hall JN. Moore S, Harper SB, et al. Global variability in fruit and vegetable consumption. American Journal of Preventive Medicine 2009;36:402-9.
12. Kahlon TS, Smith GE. Invitro binding of bile acids by bananas, peaches, pineapple, grapes, pears, apricots and nectarines. Food Chemistry 2007;101:1046-51.
13. NCEP (National Cholesterol Education Program). Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (AdultTreatment Panel III) final report. Circulation 2002;106:3142-421.
14. Erel O. A novel automated method to measure total antioxidant response against potent free radical reactions. Clin Biochem 2004;37:112-9.
15. Unal RM. Kayısı Araştırma raporu. T.C. Fırat Kalkınma Ajansı, Malatya, 2010
16. Munzuroglu O, Karatas, F, Geckil H. The vitamin and selenium contents of apricotfruit of different varieties cultivated in different geographical regions. Food Chem 2003;83:205-12.
17. Vardi N, Parlakpinar H, Ozturk F, et al. Potent protective effect of apricot and beta-carotene on methotrexate

induced intestinal oxidative damage in rats. Food Chem Toxicol 2008;46:3015-22.
18. Parlakpinar H, Olmez E, Acet A, et al. Beneficial effects of apricot-feeding on myocardial ischemia-reperfusion injury in rats. Food Chem Toxicol 2009; 47:802-808.
19. Bhupathiraju SN, Tucker KL. Coronary heart disease prevention: Nutrients, foods, and dietary patterns. Clin Chim Acta 2011;412:1493-514.
20. Dreher ML. Dietary Patterns and Whole Plant Foods in Aging and Disease. 2018. http://public.eblib.com/choice/publicfullrecord.aspx?p=5295049 (ET: 31-12-2018).
21. Kutlu T, Durmaz G, Ates B, et al. Protective effect of dietary apricot kernel oil supplementation on cholesterol levels and antioxidant status of liver in hyper cholesteremic rats. J Food Agric & Environ 2009;7:61-5.
22. Huang Z, Wang B, Eaves DH, et al. Total phenolics and antioxidant capacity of indigenous vegetables in the southeast United States: Alabama Collaboration for Cardiovascular Equality Project. Int J Food Sci Nutr 2007;18:29.
23. Durmaz G, Alpaslan M. Antioxidant properties of roasted apricot (Prunus armeniacaL.) kernel. Food Chem 2007;100:1177-81.
24. IDF (Internatioanl Diabetes Federation) The IDF Consensus Worldwide Definition of the Metabolic Syndrome. 2006. http://www.idf.org/webdata/docs/IDF_Meta_def_final.pdf (ET: 20-12-2018).
25. Altromin. Maintenance diet for rats and mice. https://altromin. com/products /standarddiets /rats/1320 (ET: 31-12-2018).
26. Mesomya W, Hengsawadi D, Cuptapun Y, Jittanoonta P and Thalang VN. Effect of Age on Serum Cholesterol and Triglyceride Levels in the Experimental Rats. Kasetsart J Nat Sci 2001;35:144-8.
27. Kelly GS. Seasonal variations of selected cardiovascular risk factors. Altern Med Rev, 2005;10: 307-20.
28. Kawano Y, David CE. Mechanisms of hepatic triglyceride accumulation in non-alcoholic fatty liver disease. Journal of Gastroenterology, 2013;4:434-41.
29. Tomizawa M, Kawanabe Y, Shinozaki F, et al. Triglyceride is strongly associated with nonalcoholic fatty liver disease among markers of hyper lipidemia and diabetes. Biomedical Reports 2014;2:633-6.
30. Nordestgaard BG, Varbo A. Triglycerides and cardiovascular disease. Lancet 2014;384:626-35.