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# THE EFFECTS OF APRICOT ON LARGE INTESTINE OXIDATIVE STRESS ENZYMES IN RATS

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## ABSTRACT

**Aim** The aim of present study is to investigate the effects of four different rates of sun dried organic apricot (SDOA) supplementation on oxidative stress enzymes as Superoxide dismutase (SOD), Malondialdehyde (MDA), Catalase (CAT), Glutathione (GSH) and Glutathione-S transferaz (GST) of large intestines at three different periods in rats. **Method** This study was performed on 90 male and 90 female rats. Rats were randomly divided into five groups for both genders: The control group was fed with standard rat chow, and the others were fed with 1; 2.5; 5 and 10 % SDOA supplemented diet. On the 30$^{th}$ days of study, the rats were humanely killed and than large intestine tissue samples were taken from six rats within each gender and groups (total 30 male and 30 female). This procedure were repeated on 60$^{th}$ and 120$^{th}$ days. **Results** The results of present study were given in tables 1-5 for each gender's and parameters separately. **Conclusion** In conclusion, at least 1% rate and 30 days period SDOA consumption has shown beneficial effects for each gender of rats. Hovewer, it must be emphasized that future studies in human subjects -based on rate/periods- should be carefully designed and carried out.

**KEYWORDS:** Sun Dried Organic Apricot, Large Intestine Oxidative Stress Enzymes, Rat.

## INTRODUCTION

Fruit consumption is important for human health beceause fruits are the sources of many nutrients such as vitamins, minerals, carotenoids, dietary fibre and phytonutrients.[1] Apricot is one of the most important dietary sources of carotenoids and among the Malatya apricot varieties, Kabaaşı has the highest total carotenoid content.[2 3] Fruits, rich in carotenoid content, are important for protection against a variety of degenerative diseases which result of oxidative damages in biological systems (as cell membrane, DNA molecules, lipids, proteins, and other structures).[4] The intrinsic scavenger enzymes as CAT, SOD and GSH and GST were significantly low in some hepatotoxic conditions, MDA is an indicator of lipid peroxidation.[5] It is suggested that the GST enzyme catalyses the reaction via the thiol (-SH) group of GSH, thereby neutralizing and rendering the products more water-soluble.[6] In carcinogenesis, MDA played a key role and it was reported that in colorectal cancer patients, serum and tissue MDA levels were higher than the control group.[7] In rats, the main functions of stomach and intestines, the length of intestines and also some important factors were summarized by Yılmaz *et al*.[8]

To authors' knowledge there is no study reporting about apricot consumption via SOD, MDA, CAT, GST and GSH levels of large intestines in rats. Therefore, the present study aimed to investigate the effects of four different rates and three different periods of SDOA consumption on above enzymes of large intestines of female and male rats.

## MATERIAL AND METHOD

The study protocol was approved by the Ethics Committee of Inonu University, Medical School (2011/A-05). Animals were obtained from the Center of Experimental Animals Research and Reproduction, Inonu University. Guidelines for the Care and Use of Laboratory Animals were considered. During 120 days study period the rats were housed in cages at 21±2 $^{0}$C and 53±3 % humidity with a 12 h-light/dark cycle, the female rats were housed separately from the male rats and there were no recorded side effects, toxicity or mortality.

**Animals:** In the present study, 6 months old 90 male (n=18/group) and 90 female (n=18/group) Sprague Dawley rats were used. The mean body weights of males and females were determined as 318±13.4, 284±15.2 g respectively. At the beginning of the study they were randomly divided into five groups as follows: group 1(control) were fed standard rat chow, other groups were fed with 1, 2.5, 5 and 10 % SDOA supplemented diet ad-libitum. On 30$^{th}$ days of study, large intestine tissue samples were taken from six rats within each

gender and groups (30 female and 30 male). Same procedure were repeated on 60$^{th}$ and 120$^{th}$ days. The large intestine tissue samples were stored at -45 $^{0}$C until the analyses.

**Diet:** Only control groups were fed with standard rat chow and the others were fed with pelleted chow supplemented with SDOA (1;2.5;5 and 10%), pellets were manually produced as a 10 kg per package and pelleted chow and tap water were given *ad libitum*. Kabaaşı variety of SDOA was used as supplementary material which was provided from local market (having organic certificate) in the province of Malatya. Average daily food intake of rats, the contents of standard rat chow and SDOA were given in Yılmaz *et al* study.[8 9 10 11]

**Analyses of large intestine oxidative stress enzymes:** The levels of MDA and GSH measured with a spectrophotometer as previously described by Uchiyama and Mihara[12] Reduced GSH and GST concentrations were measured according to the spectrophotometric Elman's method.[13] The specific activity of SOD enzyme was expressed in units per miligram protein. Proteins in the homogenate were determined by Lowry *et al*'s method.[14] CAT activity was measured according to Aebi's method and results were given as tables 1-5.[15]

**Statistical analyses:** The enzyme levels of rats were expressed as median, minimum and maximum values. Differences among groups were determined by Kruskal-Wallis test. After K-W test, Conover method was used for multiple comparisons. In all tests significance level was considered to be 0.05.

**RESULTS**

The effects of three different periods and four different SDOA supplementation rates in large intestine SOD, MDA, CAT, GSH and GST levels were given with Med (Min-Max) in tables 1, 2, 3, 4 and 5 respectively. In all tables, different ones in 30$^{th}$ day was shown by "x"; different ones in 60$^{th}$ day was shown by "y"; different ones in 120$^{th}$ day was shown by "z". And also, different from control group was shown "a", different from 1% group was shown "b", different from 2,5 %group was shown "c", different from 5% group was shown "d" and different from 10% group was shown "e".

In the present study: The highest SOD levels of females and males were determined as 47,5 in 10% group and as 45,5 in 2,5% groups of 60$^{th}$ days; the lowest as 11,0 and 10,0 in control and 1% groups of 30$^{th}$ days respectively in table 1. The highest MDA levels of females and

males were determined as 387 in 2,5 % group of 120$^{th}$ days and as 506 in 1% group of 30$^{th}$ days; the lowest as 166,0 in 10% group of 60$^{th}$ days and as 176,0 in 2,5% group of 120$^{th}$ days respectively in table 2. The highest CAT levels of females and males were determined as 65,3 and 88,3 in 5% groups of both genders in 60$^{th}$ days; the lowest as 28,8 and 28,4 in control and 10% groups of 30$^{th}$ days respectively in table 3. The highest GSH levels of females and males were determined as 455,0 in 5% group of 30$^{th}$ days and as 391,0 in control group of 120$^{th}$ days; the lowest as 189,0 and 186,0 in control groups of both genders in 60$^{th}$ days respectively in table 4. And the highest GST lewels of females and males were determined as 15,1 in 2,5% group of 120$^{th}$ days and as 9,8 in 10% group of 60$^{th}$ days, the lowest GST lewels of females and males were determined as 5,8 in control group of 30$^{th}$ days and as 3,6 in 1% group of 30$^{th}$ days in table 5.

**Table 1: Effects of three different periods and four different SDOA supplementation rates on large intestine SOD (U/mg protein) levels in rats.**

| | Female | | | | Male | | | |
|---|---|---|---|---|---|---|---|---|
| | 30th days (x) | 60th days (y) | 120th days (z) | | 30th days (x) | 60th days (y) | 120th days (z) | |
| **SOD** | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | p | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | p |
| Control (n=6) | 11,0(10,0-25,0) | [e]22,5(18,0-57,0) | 15,5(12,4-41,0) | 0,095 | 16,5(3,0-23,0) | 42,5(3,0-54,0) | 20,9(3,1-59,6) | 0,076 |
| 1% (n=6) | 15,5(1,0-32,0) | [c,e]19,0(1,0-34,0) | 19,2(7,5-36,3) | 0,787 | 10,0(3,0-19,0)[y] | 40,0(12,0-50,09[x] | 20,6(9,2-32,3) | 0,016* |
| 2,5% (n=6) | 17,5(7,0-28,0) | [b]41,0(15,0-62,0) | 27,8(17,3-35,7) | 0,055 | 19,5(5,0-26,0)[y,z] | 45,5(24,0-57,0)[x,z] | 31,7(12,2-42,1)[x,y] | 0,005* |
| 5% (n=6) | 21,5(9,0-26,0) | [e]34,5(4,0-55,0) | 20,3(14,8-41,9) | 0,580 | 12,5(7,0-24,0)[y] | 44,0(19,0-62,0)[x,z] | 26,3(10,3-33,8)[y] | 0,007* |
| 10% (n=6) | 14,0(9,0-23,0)[y,z] | [a,b,d]47,5(40,0-67,0)[x,z] | 22,0(11,3-40,8)[x,y] | 0,002* | 16,5(12,0-27,0) | 41,0(8,0-45,0)[z] | 11,7(1,1-31,8)[y] | 0,039* |
| **p** | 0,678 | 0,028* | 0,609 | | 0,225 | 0,716 | 0,200 | |

*SOD, in female genders of 60th day: control<10%;1%<2,5%;1 %<10% and 5%<10%; SOD,in female genders of 10% group; 30th day<120th day<60th day. SOD, in 1 % group of male genders;30th day<60th day; in male genders of 2,5% group; 30th day<120th day<60th day; in male genders of 5% group; 30th day<60th day and 120th day<60th day, in male genders of 10% group; 60th day>120th day.*

**Table 2: Effects of three different periods and four different SDOA supplementation rates on large intestine MDA (nmol/g ) levels in rats.**

| | Female | | | | Male | | | |
|---|---|---|---|---|---|---|---|---|
| | 30th days (x) | 60th days (y) | 120th days (z) | | 30th days (x) | 60th days (y) | 120th days (z) | |
| **MDA** | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | P | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | p |
| Control (n=6) | 377,0(174,0-838,0) | 266,5(154,0-432,0) | 233,0(174,0-425,0) | 0,421 | 365,0(238,0-405,0) | 198,0(164,0-921,0) | [c]451,0(198,0-774,0) | 0,140 |
| 1% (n=6) | 286,5(231,0-365,0) | 201,0(151,0-436,0) | 251,0(154,0-335,0) | 0,119 | 506,0(365,0-864,0)[y,z] | 288,0(161,0-402,0)[x] | 251,5(218,0-308,0)[x] | 0,014* |
| 2,5% (n=6) | 253,0(191,0-345,0)[z] | 196,0(154,0-275,0)[z] | 387,0(211,0-620,0)[x,y] | 0,013* | 323,5(245,0-358,0)[z] | 245,0(204,0-322,0) | [a]176,0(144,0-405,0)[x] | 0,034* |
| 5% (n=6) | 271,5(168,0-342,0)[z] | 224,5(154,0-295,0)[z] | 355,0(318,0-476,0)[x,y] | 0,005* | 312,0(161,0-449,0) | 211,0(151,0-650,0) | 256,5(174,0-369,0) | 0,429 |
| 10% (n=6) | 251,5(238,0-442,0) | 166,0(157,0-385,0)[z] | 298,0(204,0-402,0)[y] | 0,038* | 232,5(201,0-482,0) | 221,0(204,0-302,0) | 244,5(178,0-352,0) | 0,931 |
| **p** | 0,246 | 0,577 | 0,062 | | 0,094 | 0,641 | 0,048* | |

*MDA, in female genders of 2,5% group; 30th day<120th day and 60th day<120th day; in female genders of 5% group; 30th day<120th day and 60th day<120th day; in female genders of 10% group; 60th day<120th day. MDA, in male genders of 120th day;2,5%<control group, in male genders of 1% group; 30th day>60th day and 30th day>120th day; in male genders of 2,5% group; 30th day>120th day.*

**Table 3: Effects of three different periods and four different SDOA supplementation rates on large intestine CAT (K/g protein) levels in rats.**

| | Female | | | | Male | | | |
|---|---|---|---|---|---|---|---|---|
| | 30th days (x) | 60th days (y) | 120th days (z) | | 30th days (x) | 60th days (y) | 120th days (z) | |
| **CAT** | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | p | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | p |
| Control (n=6) | 28,8(21,8-33,9) [b,d] | 35,3(22,5-54,8) | 38,1(28,0-48,1) | 0,112 | [b,c,e]48,6(36,4-51,4) | [d,e]49,3(31,1-56,2) | 45,5(30,5-57,4) | 0,747 |
| 1% (n=6) | 39,4(20,2-63,7) [a,d] | 36,8(20,2-56,5) | 40,5(32,0-53,2) | 0,816 | [a,d]32,2(17,5-52,3) | [c,d]39,6(34,1-56,8) | 48,5(31,7-56,8) | 0,228 |
| 2,5% (n=6) | 36,6(26,6-49,4) [d] | 37,3(14,6-61,8) | 50,2(38,8-88,3) | 0,079 | [a,d]30,2(23,3-38,0)[y,z] | [b,d,e]55,0(38,9-58,2)[x] | 50,5(40,8-61,7)[x] | 0,003* |
| 5% (n=6) | 54,1(43,0-71,4) [a,b,c,e] | 65,3(35,6-91,2) | 53,8(35,1-69,8) | 0,459 | [b,c,e]50,5(41,3-82,6)[y] | [a,b,c,e]88,3(54,8-114,1)[x,z] | 66,9(31,3-74,0)[y] | 0,022* |
| 10% (n=6) | 40,7(38,1-53,4) [d] | 45,3(36,3-50,8) | 39,0(33,2-47,7) | 0,240 | [a,d]28,4(17,9-32,8)[y,z] | [a,c,d]37,6(26,0-43,5)[x,z] | 48,1(36,5-61,2)[x,y] | 0,002* |
| **p** | 0,009* | 0,166 | 0,092 | | 0,0016* | 0,001* | 0,495 | |

*CAT in female genders of 30th day; 5%>control; 5%>1%; 5%>2,5%; 5%>10%; 1%>control. CAT in male genders of 30th day; control>1%; control>2,5%; control<10%; 5%>1%;5; %>2,5%; 5%>10%. CAT in male genders of 60th day; control<5%; control>10%;1 %<2,5%;1 %<5%;2,5 %<5%; 2,5%>10%;5 %>10%. CAT in male genders of 2,5% group; 30th day<60th day and 30th day<120th day. CAT in male genders of 5% gruop; 30th day<60th day and 120th day<60th day. CAT in mele gendres of 10% group; 30th day<60th day<120th day.*

**Table 4: Effects of three different periods and four different SDOA supplementation rates on large intestine GSH (nmol/g ) levels in rats.**

| | Female | | | | Male | | | |
|---|---|---|---|---|---|---|---|---|
| | 30th days (x) | 60th days (y) | 120th days (z) | | 30th days (x) | 60th days (y) | 120th days (z) | |
| **GSH** | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | p | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | p |
| Control (n=6) | [e]445,5(250,0-570,0)[y] | 189,0(173,0-231,0)[x,z] | 391,0(333,0-417,0)[y] | 0,003* | 189,0(179,0-308,0)[z] | 186,0(160,0-212,0)[z] | 391,0(263,0-417,0)[x,y] | 0,004* |
| 1% (n=6) | [e]432,5(288,0-583,0)[y] | 195,5(173,0-327,0)[x,z] | 394,0(333,0-442,0)[y] | 0,003* | 214,5(192,0-276,0)[z] | 199,0(173,0-231,0)[z] | 388,0(288,0-436,0)[x,y] | 0,002* |
| 2,5% (n=6) | [e]432,5(231,0-583,0)[y] | 205,0(173,0-224,0)[x,z] | 404,0(353,0-500,0)[y] | 0,003* | 272,5(20,0-288,0)[y] | 189,0(160,0-244,0)[x,z] | 269,0(250,0-455,0)[y] | 0,016* |
| 5% (n=6) | [e]455,0(321,0-526,0) | 256,5(173,0-641,0) | 413,0(308,0-506,0) | 0,082 | 208,5(179,0-231,0)[z] | 237,5(160,0-308,0)[z] | 375,0(282,0-391,0)[x,y] | 0,003* |
| 10% (n=6) | [a,b,c,d]230,5(205,0-263,0)[z] | 240,5(154,0-378,0)[z] | 400,5(365,0-513,0)[x,y] | 0,004* | 224,0(212,0-250,0)[z] | 211,5(160,0-391,0)[z] | 375,0(269,0-455,0)[x,y] | 0,008* |
| **p** | 0,014* | 0,483 | 0,760 | | 0,272 | 0,458 | 0,330 | |

*GSH in female genders of 30th day; 10%<control=1%=2,5%=5%. GSH, control group of female genders; 30th day>60th day and 120th day>60th day. GSH in same genders of 1 % group;30th day>60th day and 120th day>60th day. GSH in same genders of 2,5% group; 30th day>60th day and120th day>60th day. And GSH in same genders of 10% group; 30th day<120th day and 60th day<120th day. GSH in male*

*genders of control group; 30th day<120th day and 60th day<120th day. GSH in same genders of 1% group; 30th day<120th day and 60th day<120th day. GSH in same genders of 2,5% group;30th day>60th day and 120th day>60th day. GSHin same genders of 5% group; 30th day<120th day and 60th day<120th day. And GSHin same genders of 10 % group; 30th day<120th day and 60th day<120th day.*

**Table 5: Effects of three different periods and four different SDOA supplementation rates on large intestine GST (U/g protein) levels in rats.**

| | **Female** | | | | **Male** | | | |
|---|---|---|---|---|---|---|---|---|
| | 30th days (x) | 60th days (y) | 120th days (z) | | 30th days (x) | 60th days (y) | 120th days (z) | |
| **GST** | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | p | Med (Min-Max) | Med (Min-Max) | Med (Min-Max) | p |
| Control (n=6) | 5,8(3,7-6,1)$^{y,z}$ | 8,8(5,4-14,1)$^{x}$ | 9,8(6,1-11,4)$^{x}$ | 0,011* | 5,3(3,9-5,5)$^{y,z}$ | 8,0(5,8-10,9)$^{x}$ | 7,5(5,8-9,3)$^{x}$ | 0,003* |
| 1% (n=6) | 6,1(4,7-6,9)$^{y,z}$ | 7,8(7,0-9,4)$^{x,z}$ | 10,6(8,9-13,7)$^{x,y}$ | <0,001* | 3,6(2,6-9,0)$^{y}$ | 7,6(7,4-11,4)$^{x}$ | 7,0(6,5-9,0) | 0,017* |
| 2,5% (n=6) | 6,3(3,9-7,7)$^{y,z}$ | 8,2(7,3-10,4)$^{x,z}$ | 15,1(7,7-20,5)$^{x,y}$ | 0,002* | 5,2(2,3-5,6)$^{y,z}$ | 8,0(6,5-8,6)$^{x}$ | 7,2(6,2-9,0)$^{x}$ | 0,003* |
| 5% (n=6) | 6,4(4,5-8,6) | 9,0(2,4-15,3) | 8,6(7,0-14,8) | 0,121 | 4,9(3,0-7,5)$^{y,z}$ | 8,4(5,1-9,8)$^{x}$ | 7,7(7,0-11,4)$^{x}$ | 0,030* |
| 10% (n=6) | 5,9(3,9-9,4) | 8,7(7,9-12,3) | 9,3(5,8-11,6) | 0,098 | 4,1(3,7-5,1)$^{y,z}$ | 9,8(8,4-16,3)$^{x,z}$ | 7,7(4,7-9,4)$^{x,y}$ | <0,001* |
| **p** | 0,470 | 0,812 | 0,079 | | 0,265 | 0,174 | 0,627 | |

*GST in female genders of control group; 30th day<60th day and 30th day<120th day. GSTin same genders of 1 % group; 30th day<60th day<120th day. And also GSTin same genders of 2,5% group; 30th day<60th day<120th day. GST in male genders of control group; 30th day<60th day and 30th day<120th day. GST in same genders of 1% group; 30th day<60thday. GST in same genders of 2,5% group; 30th day<60th day and 30th day<120th day. GSTin same genders of 5% group; 30th day<60th day and 30th day<120th day. And also, GSTin same genders of 10% group;30th day<120th day<60th day.*

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## DISCUSSION

We previously focused on the effects of SDOA consumption on some serum mineral levels,[9] some hematological parameters[10] serum proteins and liver enzymes[11] as the crucial factors in rats. In the study reported here, we focused on the potential role of SDOA consumption on large intestine oxidative stress enzymes as SOD, MDA, CAT, GSH and GST levels in rats.

In females, SOD values were shown differentiation by rates and periods; the highest values were determined in 5% group of 30$^{th}$ days, in 10% group of 60$^{th}$ days, and in 2,5% groups of 120$^{th}$ days in table 1. The highest SOD values of males were shown in 2,5% group of rats in all three periods. In males same differentiation were not determined. That may be say, in females to obtain the highest SOD valuable 10% rate and 60 days, and in males the same time and 2,5 % rate is ideal. In females, the highest MDA values were determined in control groups in 30$^{th}$ and 60$^{th}$ days, and in 2,5% group on 120$^{th}$ days in table 2. Same differentiation were determined in males of MDA; their highest MDA values were shown in 1% group of 30$^{th}$ and 60$^{th}$ days and in control group of 120$^{th}$ days in table 2. In fameles except 120 days, apricot consumption were not significant effect on MDA levels and in males 1% rates and 30 days is ideal. In females and males, the highest CAT values were determined in 5% groups of all three periods in table 3. Therefore, as ideal 5% rate and 60 days apricot consumption has effect on CAT levels of both genders. In females, the highest GSH values were determined in 5% groups of all three periods. In males, the highest GSH values were shown in 2,5% group of 30$^{th}$ days, in 5% group of 60$^{th}$ days and in 1% group of 120$^{th}$ days in table 4. In this case, 5% rate was ideal on GSH levels of females and different rates/periods were significantly effective on GSH levels of males. In females, the highest GST values were determined in 5% groups of 30$^{th}$ and 60$^{th}$ days and in 2,5% groups of 120$^{th}$ days. In males, the highest GST values were shown in control group of 30$^{th}$ days, in 10% group of 60$^{th}$ days and in 5, 10% groups of 120$^{th}$ days in table 5. Therefore, for GST levels of both genders, any ideal rate and period of apricot consumption may not say.

The highest SOD levels of present study of both genders were a bit near with control group of Parlakpınar *et al* study in table 1. On the other hand, the highest MDA and CAT levels of present study of both genders were quite significantly lower than all groups of same study in table 2, 3. But nevertheless, results of same study were belongs to ischemia-reperfusion model of rats and should not be overlooked that there are different types of heart and colon tissue.[16] The highest SOD levels of present study of both genders were lower than Vardi *et al* study,

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the highest MDA and GSH levels of present study of both genders were quite significantly higher and CAT levels of present study of both genders were quite higher than all groups of same study.[17] (Table 2, 3, 4)

There were determined significant fluctuations of both genders's enzyme levels by rate and/or periods, and this may be due to the sensitivity of the method used for analyzes, intra-day and inter-day changes of the used chemicals can be caused. Additionally, these differentiations may be related some biologycal important factors such as sex, metabolism, continuous feeding period and also enzyme saturation. Of course, this study is intended as a preliminary study, and there is not any condition that causes increased oxidative stress in colonic tissue, therefore, it is usual to be short discussion.

## CONCLUSION

The results presented in this study suggest that, at least 1% rate and 30 days period SDOA consumption has shown beneficial effects for each gender of rats. This results may have an importance for treatment, prevention and/or elimination of risk factors of some large intestine pathologies. It was concluded that conducting similar studies in humans would be very useful.

## DISCLOSURE OF CONFLICTS OF INTEREST

The authors declares no conflict of interest.

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