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A Study on Lipid Peroxidation and Coronary Artery Disease

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Abstract: Atherosclerosis, which causes the coronary arteries to thin or become blocked, is the main cause of coronary artery disease (CAD), which is a major cause of death and disability globally. The oxidative breakdown of lipids, a process known as lipid peroxidation, is crucial in the development of coronary artery disease (CAD). Exploring the molecular indicators of lipid peroxidation and its implications for disease development and therapy, this research analyzes the link between CAD and lipid peroxidation. The results demonstrate a robust association between the severity of CAD and higher levels of lipid peroxidation by-products, including malondialdehyde (MDA). In order to enhance clinical results, the research suggests antioxidant treatments and stresses the importance of early oxidative stress marker detection.

Keywords: Lipid peroxidation, coronary artery disease, oxidative stress, malondialdehyde (MDA), atherosclerosis, antioxidants, cardiovascular health

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INTRODUCTION

A major contributor to healthcare costs worldwide, coronary artery disease (CAD) continues to rank among the most common cardiovascular illnesses (World Health Organization, 2021). The main cause of coronary artery disease (CAD) is the gradual constriction of coronary arteries caused by the accumulation of atherosclerotic plaques. This eventually reduces blood supply to the heart muscle and increases the likelihood of a myocardial infarction (Libby et al., 2019). New evidence points to oxidative stress as a key player in coronary artery disease (CAD) development and progression.

Lipid peroxidation, a major consequence of oxidative stress, involves the degradation of polyunsaturated fatty acids in cellular membranes, resulting in the generation of reactive aldehydes such as malondialdehyde (MDA) (Halliwell & Gutteridge, 2015). These reactive by-products not only exacerbate vascular inflammation and endothelial dysfunction but also promote plaque instability, significantly contributing to CAD progression (Steinberg, 2009). By understanding the intricate links between lipid peroxidation and CAD, healthcare professionals can identify novel therapeutic targets to mitigate disease progression. This study aims to explore the biochemical pathways connecting lipid peroxidation to CAD and evaluate potential interventions to counteract these processes.

The growing body of evidence linking oxidative stress to CAD underscores the importance of assessing lipid peroxidation markers in clinical settings. Elevated levels of MDA and other oxidative by-products have been correlated with increased atherosclerotic plaque formation and cardiovascular events (Siti et al., 2015). These markers can serve as early warning indicators, aiding in the timely identification of at-risk

individuals. Moreover, studies have suggested that chronic oxidative stress contributes to the transition from stable atherosclerotic plaques to vulnerable plaques, thereby increasing the risk of acute coronary syndromes (Madamanchi & Runge, 2013).

Efforts to mitigate oxidative stress in CAD have focused on the potential of antioxidant therapies, lifestyle changes, and dietary interventions. Nutritional antioxidants such as vitamins C and E, polyphenols, and other bioactive compounds have been shown to counteract lipid peroxidation and reduce cardiovascular risk (Riccioni et al., 2012). While some studies have demonstrated the efficacy of antioxidants in attenuating oxidative stress, others highlight the complexity of oxidative pathways and the need for personalized therapeutic strategies. This study seeks to contribute to the growing field of oxidative stress and CAD by shedding light on the role of lipid peroxidation and exploring novel interventions for its management.

DATA AND PROCEDURE

A calculation for MDA

One way to find out how much MDA is in a sample is to do the TBA test. Degradation of peroxidised lipids28 and the enzymatic metabolism of prostaglandins and thromboxanes29 both produce malondialdehyde (MDA). The fact that it is formed from polyunsaturated fatty acids (PUFAs) with two or more double bonds is well-established, and it has been suggested that it mostly comes from fatty acids with three or more double bonds30. The TBA techniques are based on the fact that when MDA and TBA combine at low pH and high temperature, a coloured complex called the MDA TBA complex is formed. This complex has an absorption maximum at 532-535 nm, which may be detected using visible absorption spectrophotometry. In chapter III, the whole experimental procedure was detailed.

Analysing Nitric Oxide Levels

An acidic chemical reaction involving sulfanilamide and N-1-napthylethylenediamine dihydrochloride is the basis of the Griess reagent system, as shown in the technique chapter. Rapid breakdown of nitric oxide to nitrate and nitrite occurs in an aqueous solution. It is easy to measure nitrite using a spectrophotometer and Griess Reagent. This approach effectively determines total NO generation by first quantitatively converting nitrate to nitrite using metallic cadmium. Then, nitrate is quantified using Griess reagent. In Chapter III, the experimental procedure was laid out in great detail.

Determination of OxLDL Autoantibodies

A modified published approach, as described in chapter ill, is used to test autoantibodies against ox-LDL. Everything is done in triplicate for every sample and is the same, with the exception of the antigen coating on the microtiter plates (Nunc). Two plates were used: one with 24-hour copper-oxidized LDL and the other with native LDL coating. Following that, antigen (5 µg/mL) in PBS is added to two plates and left to incubate at 4°C for 16 hours. Add 0.27 mmol/L of EDTA and 20µmol/L of butylated hydroxytoluene to PBS to halt the oxidation of natural LDL. In all three washes, phosphate-buffered saline (PBS) with 0.5% Tween 20 is used. Bovine serum albumin is used to obstruct the plates after washing. The blood samples are pipetted onto plaques after they have been diluted to a 1:20 ratio in a PBS solution containing bovine

serum albumin, EDTA, butylated hydroxytoluene, and Tween 20. After rinsing the plates six times, they are placed in an incubator set at 4°C for the night. The next step is to incubate the plates at 4°C for 4 hours using a diluted 1:4000 solution of Organon, a rabbit antihuman monoclonal antibody that is peroxidase conjugated with IgG inside the previous buffer. After washing the plates, they are incubated for 5 minutes with the peroxidase substrate, which consists of o-phenylenediamine and H2O2. Enzyme activity is halted by adding 50 µL of 2 M H2SO4, and ELISA reader absorbances are recorded at 492 nm. We double-check every step of the process. One way to find out how reactive an antibody is to copper-oxidized LDL is to subtract its binding affinity to native LDL from it.

RESULTS

A consolidated data profile is attached here based on experimental results from tables V.1 to V.6 of this study. "The goal is to have a comprehensive idea of the levels of lipid peroxidation, specifically MDA, NO, NO: MDA, and auto antibody against ox- LDL, comparing different age groups of male and female.

Regarding the levels of lipid peroxidation in men and women aged 20–40, the following information is provided: MDA levels are 3.5±0.8 and 3.7±0.5, NO levels are 9.0±1.1 and 8.5±1.0, NO: MDA levels are 2.6±0.8 and 2.3±0.7, and auto antibodies against ox-LDL are 45.5±12 and 50.4±18.3.

In respect of lipid peroxidation levels in male and female age group of 41-60 years: MDA levels are 4.1±1.3 and 4.5±0.9;

NO levels are 8.5±1.2 and 8.0±1.6;

NO: MDA levels are 2.1±0.95 and 1.95±0.95;

Auto antibodies against ox-LDL levels are 51.9±12.4 and 54.1±15.5.

In respect of lipid peroxidation levels in male and female age group of 61-80 years: MDA levels are 5.0±1.1 and 5.4±1.0;

NO levels are 7.5±1.5 and 7.9±1.8;

NO: MDA levels are 1.5±0.78 and 1.46±0.98;

Auto antibodies against ox-LDL levels are 55.6±10.9 and 58.9±21.5.

In view of the above comparative findings in respect of same age group of males and females, no significant changes are observed between them.

Table 1: Levels of serum lipid peroxidation in males aged 20–40 years (Mean ± SD)

	No.	No. (µmol/L)	MDA (µmol/L)	NO:MDA	Auto antibody against ox-LDL (U/L)
Control	55	9.0±1.1	3.5±0.8	"2.6±0.8	45.5±12
Diabetic	50	7.8±1.6	5.4±1.8*	1.7±0.90	75.5±11.4
Over weight	55	7.3±1.4	5.6±1.6.	1.5±0.83	65.6±21.6

Table 2: The average values of serum lipid peroxidation in women aged 20–40

	No.	No. (µmol/L)	MDA (µmol/L)	NO:MDA	Auto antibody against ox-LDL (U/L)
Control	55	8.5±1.0	3.7±0.5	2.3±0.7	50.4±18.3
Diabetic	50	7.7±1.1	5.1±1.7**	1.6±1.1	70±22.8
Over weight	55	8.6±1.1	5.0±1.I	1.7±0.83	59.8±17.9

Table 3: The average values of serum lipid peroxidation in males aged 41 to 60 years

	No.	No. (µmol/L)	MDA (µmol/L)	NO:MDA	Auto antibody against ox- LDL (U/L)
Control	55	8.5±1.2	4.1±1.3	2.1±0.95	51.9±12.4
Diabetic	50	7.7±2.9	5.8±2.2**	1.6±1.1	77±12.5
Overweight	55	7.9±1.2	5.0±0.9	1.6±0.83	78.5±13.I
Hypertensive	45	6.6±1.1.	5.0±1.9*	1.3±0.89	78.0±15.7

Table 4: Plasma lipid peroxidation levels in women aged 41 to 60 years (Mean± SD)

	No.	No. (µmol/L)	MDA (µmol/L)	NO:MDA	Auto antibody against ox- LDL (U/L)
Control	80	8.0±1.6	4.5±0.9	1.95±0.95	54.1±15.5
Diabetic	75	6.5±1.0	6.1±1.9..	1.2±0.6	71.8±18.1
Overweight	80	8.2±1.2	4.8±0.9	1.8±0.83	63.3±13.8
Hypertensive	75	6.4±1.0·	5.5±1.0·	1.2±0.68	77.2±15.6*

Table 5: The average, median, and standard deviation of serum lipid peroxidation values in men aged 61–80

	No.	No. (µmol/L)	MDA (µmol/L)	NO:MDA	Auto antibody against ox- LDL (U/L)
Control	198	7.5±1.5	5.0±1.1	1.5±0.78	55.6±10.9
Diabetic	80	8.7±1.7	6.2±1.6..	1.5±0.8	88.1±12.7**
Overweight	80	8.0±1.9	6.2±1.5·	1.3±0.78	79.5±15.1·
Hypertensive	75	6.4±1.s*	6.1±1.6..	1.1±0.74	091.8±11.5*

Table 6: Average values of serum lipid peroxidation in women aged 61 to 80 years

	No.	No. (µmol/L)	MDA (µmol/L)	NO:MDA	Auto antibody against ox- LDL (U/L)
Control	135	7.9±1.8	5.4±1.0	1.46±0.98	58.9±21.5
Diabetic	80	7.4±0.7	5.8±1.6	1.3±0.7	75±12.6*
Overweight	80	7.3±0.55	6.0±0.93.	1.3±0.53	91.2±21.6...
Hypertensive	85	6.5±1.2*	6.0±1.4	1.1±0.62..	95±15.9...

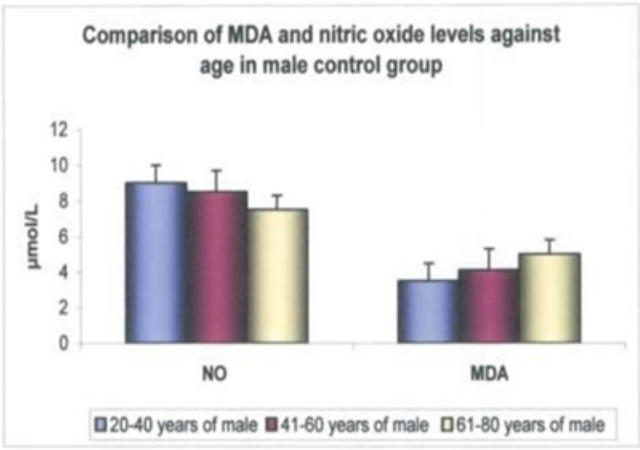

Figure 1: Depicting a correlation between age and levels of malondialdehyde and nitric oxide in a male control group

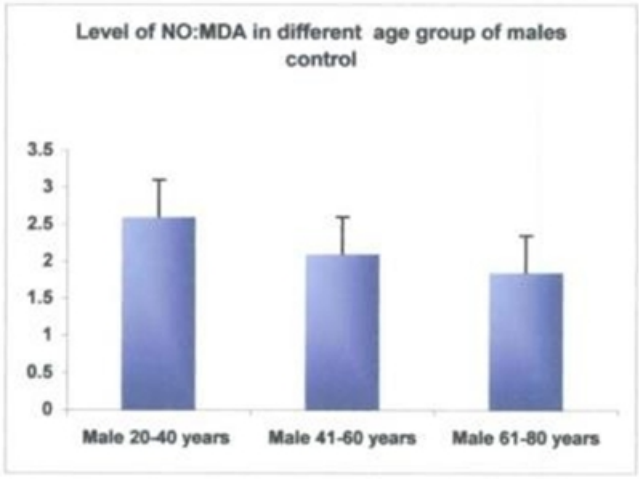

Figure 2: Shown here shows a correlation between the age of the male control group and the levels of NO: MDA and nitric oxide.

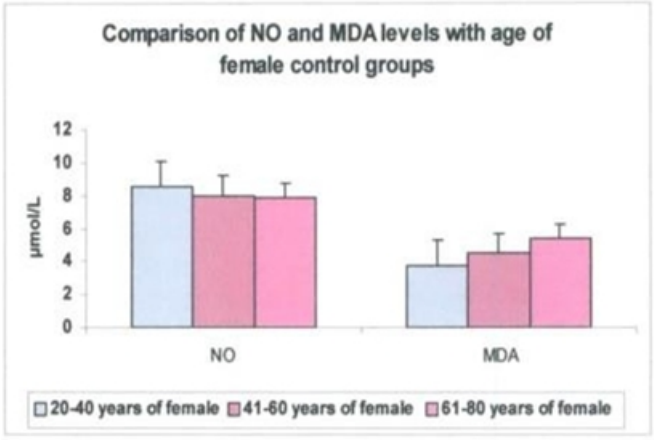

Figure 3: Displaying NO: MDA levels in females of different ages

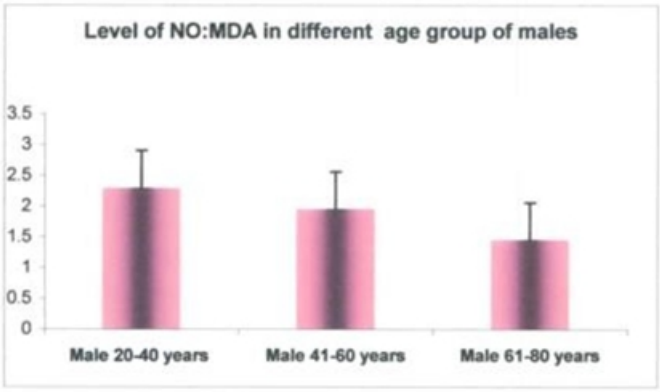

Figure 4: Displaying the NO: MDA levels in various age groups of women

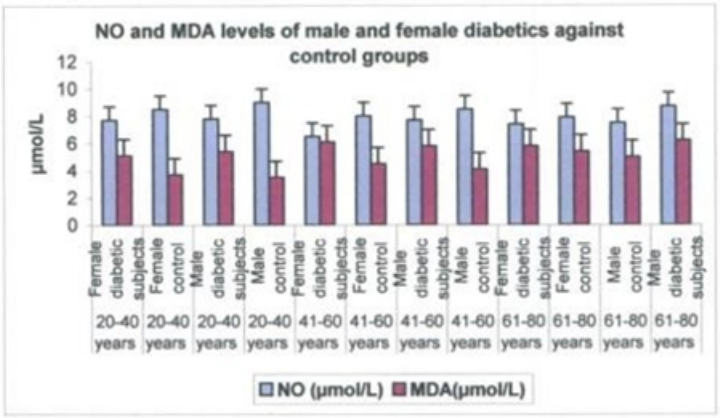

Figure 5: Comparing NO and MDA levels in diabetic men and women to a control group

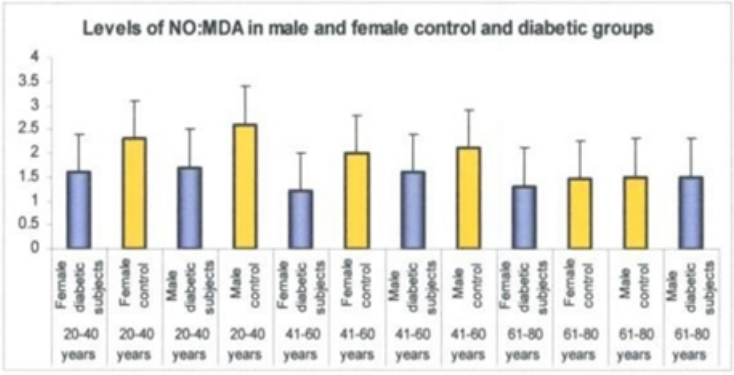

Figure 6: Displaying the NO: MDA oncentrations in the diabetes and control groups of both sexes

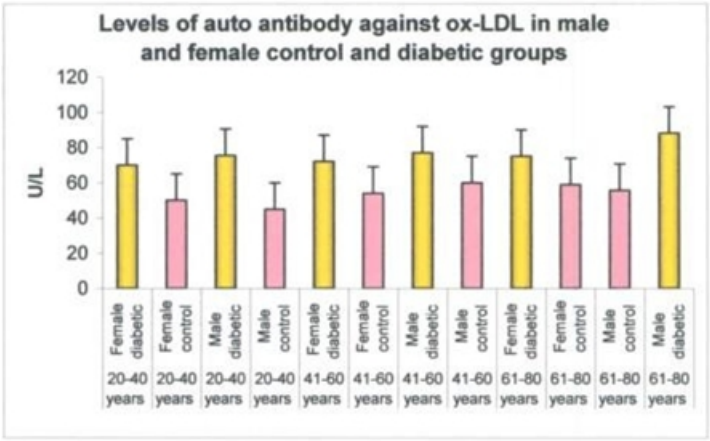

Figure 7: Displays the amounts of autoantibodies against ox-LDL in both the control and diabetes groups of males and females.

In order to obtain a complete picture of the levels of lipid peroxidation (i.e., MDA, NO, NO), a consolidated information profile is attached here to the experimental findings of this research that are included in tables:measuring MDA and autoantibodies against ox-LDL in male and female diabetics of varying ages compared to control groups via video Fig.

For male and female diabetics in the 20-to 40-year-old age bracket, the lipid peroxidation levels are as follows: MDA levels are 5.4±1.8 and 5.1±1.7, NO levels are 7.8±1.6 and 7.7, NO: MDA levels are 1.7±0.90 and 1.6±1.1, and auto antibodies against ox-LDL levels are 75.5±11.4 and 70.6±22.8, respectively.

Considering the levels of lipid peroxidation in male and female diabetics aged 41-60 years: 5.8±2.2 and 6.1±1.9 for MDA, 7.7±2.9 and 6.5±1.0 for NO, 1.6±1.1 and 1.2±0.6 for NO: MDA, and 77±12.5 and 71.8±18.1 for auto antibody against ox-LDL, respectively.

Regarding the levels of lipid peroxidation in male and female diabetics aged 61-80 years: 6.2±1.6 and 5.8±1.6 for MDA, 8.7±1.7 and 7.4±0.7 for NO, 1.5±0.8 and 1.3±0.7 for NO: MDA, and 88.1±12.7 and 75±12.6 for auto antibody against ox-LDL, respectively.

Considering the combined results for both male and female diabetics in the same age brackets, the MDA

is noticeably higher ($p<0.01$) than in the control group." Except for the fact that it has grown with age in the case of male-female people, no other noteworthy changes have been seen in regard to other metrics, including auto antibody against ox-LDL. Regarding the aforementioned, it is clear that the NO:MDA ratio declined with age, but MDA levels rose in females aged 41–60 compared to other age groups, and NO levels and autoantibodies against ox-LDL levels fell.

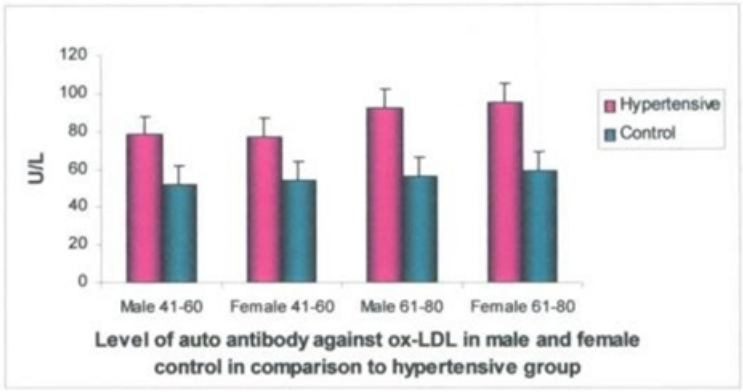

Figure 8: Comparing the levels of autoantibodies against ox-LDL in the hypertension group with the control group of males and females

This study's experimental results are presented in tables. For a better understanding of the levels of lipid peroxidation, including MDA, NO, NO:MDA, and autoantibody against ox-LDL, we have compiled a data profile that compares male and female hypertensive patients of different ages to control groups. Fig.

Regarding the levels of lipid peroxidation in hypertensive males and females aged 41 to 60 years: 5.0±1.9 and 5.5±1.0 for MDA, 6.6±1.1 and 6.4±1.0 for NO, 1.3±0.89 and 1.2±0.68 for NO: MDA, and 78.0±15.7 and 77.2±15.6 for autoantibodies against ox- LDL, respectively.

Among hypertensive males and females aged 61 to 80 years, the following lipid peroxidation levels were measured: MDA levels were 6.1±1.6 and 6.0±1.4, NO levels were 6.4±1.5 and 6.5±1.2, NO: MDA levels were 1.1±0.74 and 1.1±0.62, and auto antibody against ox-LDL levels were 91.8±11.5 and 95±15.9.

The results show that compared to the control group, male and female hypertension patients of the same age had considerably higher MDA levels ($p<0.05$) and significantly lower Nitric Oxide (NO) levels ($p<0.01$). In comparison to the control group, the NO:MDA level is also noticeably reduced ($p<0.01$). In contrast to the control groups, the age groups of 61-80 year old males and females had substantially greater levels of antibody against ox-LDL ($p<0.01$). With regard to all other metrics, no further noteworthy changes have been detected.

CONCLUSION

The findings of this study underscore the pivotal role of lipid peroxidation in the pathophysiology of coronary artery disease. Elevated markers of lipid peroxidation, such as MDA, not only serve as indicators of oxidative stress but also play a direct role in exacerbating vascular damage and atherosclerosis. Addressing lipid peroxidation through lifestyle modifications, dietary interventions, and

antioxidant therapies may offer promising avenues for reducing the burden of CAD. Future research should focus on the clinical application of oxidative stress markers and the development of targeted treatments to improve patient outcomes in coronary artery disease management.

References

1. Ayala, A., Muñoz, M. F., & Argüelles, S. (2014). Lipid peroxidation: production, metabolism, and signaling mechanisms of malondialdehyde and 4- hydroxy-2- nonenal. Oxidative medicine and cellular longevity, 2014.
2. Banerjee, M., & Vats, P. (2014). Reactive metabolites and antioxidant gene polymorphisms in type 2 diabetes mellitus. Redox biology, 2, 170-177.
3. Bastani, A., Rajabi, S., Daliran, A., Saadat, H., & Karimi-Busheri, F. (2018). Oxidant and antioxidant status in coronary artery disease. Biomedical Reports, 9(4), 327-332.
4. Bhat, M. A., Mahajan, N., & Gandhi, G. (2012). Oxidative stress status in coronary artery disease patients. Int J Life Sc Bt Pharm Res, 1, 236-243.
5. C. E., ... & Barrett, J. C. (2005). Biomarkers of oxidative stress study II: are oxidation products of lipids, proteins, and DNA markers of CCl4 poisoning?. Free Radical Biology and Medicine, 38(6), 698-710.
6. Davies, S. S., & Roberts II, L. J. (2011). F2-isoprostanes as an indicator and risk factor for coronary heart disease. Free Radical Biology and Medicine, 50(5), 559-566.
7. Dwivedi, S., Purohit, P., Misra, R., Pareek, P., Goel, A., Khattri, S., ... & Sharma, P. (2017). Diseases and molecular diagnostics: a step closer to precision medicine. Indian Journal of Clinical Biochemistry, 32(4), 374-398.
8. Hajar, R. (2017). Risk factors for coronary artery disease: historical perspectives. Heart views: the official journal of the Gulf Heart Association, 18(3), 109.
9. Kadiiska, M. B., Gladen, B. C., Baird, D. D., Germolec, D., Graham, L. B., Parker,Lobo, V., Patil, A., Phatak, A., & Chandra, N. (2010). Free radicals, antioxidants, and functional foods: Impact on human health: Pharmacognosy Reviews, 4(8), 118.
10. Ninić, A., Bogavac-Stanojević, N., Sopić, M., Munjas, J., Kotur-Stevuljević, J., Miljković, M., ... & Spasojević-Kalimanovska, V. (2019). Superoxide dismutase isoenzymes gene expression in peripheral blood mononuclear cells in patients with coronary artery disease. Journal of Medical Biochemistry, 38(3), 284.
11. Pourkeramati, A., Mehrjardi, E. Z., Tezerjani, M. D., & Seifati, S. M. (2020). Association of GSTP1, GSTT1 and GSTM1 Gene Variants with Coronary Artery Disease in Iranian Population: A Case-Control Study. International journal of general medicine, 13, 249.
12. Pourkeramati, A., Mehrjardi, E. Z., Tezerjani, M. D., & Seifati, S. M. (2020). Association of GSTP1,

GSTT1, and GSTM1 gene variants with coronary artery disease in Iranian population: a Case-Control Study. International Journal of General Medicine, 13, 249.

13. Simeunovic, D., Odanovic, N., Pljesa-Ercegovac, M., Radic, T., Radovanovic, S., Coric, V., ... & Savic- Radojevic, A. (2019). Glutathione transferase P1 polymorphism might be a risk determinant in heart failure.

14. Torkzaban, A., Naeini, A. A., Hassanzadeh, A., & Namdari, M. (2020). A case- control study is a relationship between serum vitamin C and uric acid levels, antioxidant status, and coronary artery disease: clinical nutrition research, 9(4), 307.

15. Zhao, E., & Zhao, Y. (2015). Lack of association between GSTP1 Ile105Val polymorphism and coronary heart disease risk: a meta-analysis. International journal of clinical and experimental medicine, 8(10), 18488.