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Evaluation of Impact of Daily Laurus Nobilis Tea Consumption on the Lipid Profile and on the Increased Anti-Oxidant Activity In Healthy Volunteers

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Abstract

Background We investigated whether Laurus nobilis tea consumption affects lipid profile and oxidative stress in healthy volunteers.

Methods Plasma concentrations of serum lipid profile parameters and Catalase, Uric acid, carbonylated proteins and superoxide dismutase levels were measured.

Results We found a significant positive correlation between Delta- high-density lipoprotein cholesterol and Delta-Uric Acid (R = 0.396, p = 0.036) as well as Delta-Triglyceride and Delta- carbonylated proteins (R = 0.438, p = 0.020). Also, there was a negative correlation between Delta- Low-density Lipoprotein cholesterol and Delta- superoxide dismutase (R= -0.479, p = 0.009).A significant positive correlation between Delta- Low-density Lipoprotein cholesterol, Delta- triglyceride down and Delta- Low-density Lipoprotein Receptor up (p = 0.017, p = 0.038 respectively).In addition, a statistically significant negative correlation between the mean levels of Delta-Low-density Lipoprotein cholesterol down and of Delta-Low-density Lipoprotein receptor (p = 0.013). A statistically significant negative correlation between the mean concentrations of Delta-Low-density Lipoprotein cholesterol down and of Delta-Low-density Lipoprotein receptor up was observed (p = 0.010). The mean levels of Delta-triglyceride down and Delta-Low-density Lipoprotein receptor showed a significantly negative correlation (p = 0.005). There has been a significant increase in Low-density Lipoprotein Receptor levels over the period of study as it went from 444.54 (±241.03 pg/mL)$_{day\ 0}$ to 634.00 (± 290.19 pg/mL)$_{day\ 11}$ (p=0.000). Our study showed a significantly negative correlation only between Delta- superoxide dismutase up (superoxide dismutase Day11 - superoxide dismutase Day0) and age (p = 0.03), where Delta is the difference in the level of parameters between day 11 and day 0.

Conclusion These findings highlight that the infusion of Laurus nobilis can be added to foods to enhance or regulate Low-density Lipoprotein Receptor activity levels with an elevation of HDL-cholesterol serum concentration concomitant to high antioxidant activity.

Trial registration Not applicable

Introduction

Laurus nobilis is an evergreen tree of Lauraceae family commonly used for culinary and medicinal purposes. It is thought to have its origin in the Mediterranean region and in Asia [1, 2]. In Tunisia, this plant is a common species and is locally called "Rand". It is particularly widespread in Tunisia by the riverside, on mountains and on wet cliffs. It mainly grows in the humid and sub-humid bioclimatic areas, especially in the north western regions such as Ain Draham, Tabarka, Kef and Cap-Bon [3].

Laurus nobilis is a species and aromatic substance of industrial importance, used in foods, drugs, and cosmetics. The fresh plant and its dried leaves have been widely used for cooking and for food preservation [4–6]. It is known in the field of herbal medicine and in vitro studies that Laurus nobilis have

beneficial effects such as antibacterial, antifungal, anti-diabetes and anti- inflammatory properties [7–10]. Consequently, it has been used to treat rheumatic diseases, skin rashes and gastrointestinal problems [5,11,12). The leaves of Laurus nobilis have been used to treat neurological disorders including epilepsy, neuralgia, and parkinsonism [4,5]. In addition, it has been used as a carminative, astringent, diaphoretic, emetic, diuretic and emmenagogue agent preventing migraine [9, 13, 14].

A previous study has established that Laurus nobilis presented high levels of chemical compounds that possess antioxidant activities such as the scavenging activity, reducing lipid peroxidation [15]. In addition, it was found that consumption of dried aqueous extracts of Laurus nobilis improves glucose and insulin metabolism as well as circulating blood lipids in patients with type 2 diabetes [16].

Moreover, according to traditional Tunisian medicine, Laurus nobilis is widely used as a medicinal plant in the treatment of several diseases in particular against respiratory diseases and also against diabetic diseases and digestive disorders, In this context, and according to the Tunisian tradition, the therapeutic use of Laurus nobilis was most often in the form of an infusion obtained from the fresh or dried plant.

To the best of our knowledge, there is no scientific data that highlights the therapeutic effects of Laurus nobilis infusion on healthy human and in particular, its impact on the lipid profile and its impact on the increased anti-oxidant activity in blood plasma. Such property is interesting in the prevention of cardiovascular diseases. In biology, oxidation reactions can also damage various components of cells, this oxidative damage is associated with aging and certain diseases such as cardiovascular ones.

It was hypothesized that consumption of this tea would lead to great benefits, reflected by changes in peripheral biomarkers. Thus, the purpose of this study was to investigate the effect of Laurus nobilis tea consumption and its relationship with lipid profile and oxidative stress in humans.

Materials And Methods

Subjects

This study was conducted in the Department of Occupational Medicine, Farhat Hached University Hospital Sousse (Tunisia). The study was approved by the Human Research Ethics Committee at the Faculty of Medicine of Sousse (Tunisia). The selection criteria included participants who were non-smokers, non-vegetarian, non-pregnant women, who were not taking any medication for other health conditions or nutritional supplements, and who were not suffering from any chronic pathology, or psychiatric disorders. The volunteers gave their informed consent prior to participation. Exclusion criteria were: Presence of cardiovascular disease, diabetes, asthma, food allergies, major gastrointestinal problems, hypertension or medication known to affect lipid metabolism.

The study included 30 healthy volunteers (6 men and 25 women). The mean women's age was 46.71± (9.87 years) and men's mean age was 34.04± (7.87 years) (Table 1).

Table 1
Characteristics of healthy volunteers.

Total number	**30**
Sex (M/F)	5/25
Age [years]	37.00 ± 9.84
Weight [kg]	70.06 ± 12.36

Study design

The study protocol was conducted over a period of ten days. Participants were recruited from the region of Sousse governorate between August 2018 and October 2019. Enrollment stopped when a total of 30 subjects met the inclusion criteria.

After an overnight fast, baseline measurements including height and weight were taken. Baseline blood samples were collected from a peripheral vein of the non-prevailing arm. Three different tubes were used to save the blood samples. They were respectively coated with EDTA, heparin and sodium fluoride /potassium oxalate. 11 hours later during the night, volunteers consumed Laurus nobilis tea prepared by infusing 5 g of dried Laurus nobilis leaves in 100 ml of boiling water for 15 min. The mix was filtered through a strainer. The same consumption procedure was undertaken over the course of 10 consecutive days and at the same time (9 pm). We fixed the daily dose of Laurus nobilis tea at 5 g which is the weight of 2 spoons, in accordance to the traditional use of this plant. Subjects enrolled in the study were instructed not to change their normal daily routine including, foods, and exercise activities. They were informed of the importance of keeping their same daily routine. All volunteers were aware of the necessity of following the instructions they received before the study.

On day 11, no special events that might have interacted with the study protocol were recorded. During the same day, second blood samples were collected. Plasma and serum samples were immediately centrifuged (10 min, 3000 rpm, 4 °C) and analyzed.

Glycemia, triglycerides, total, high density lipoprotein cholesterol (HDL) and Low-density lipoprotein (LDL) cholesterol, Total and direct bilirubin, alkaline phosphatase (ALP), gamma- glutamyltransferase (Y-GT), serum uea and serum creatinine, serum of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were assessed at the biochemistry department of Farhat Hached University Hospital-Sousse. All parameters were tested using Beckman Coulter Dx600 analyzer. The measurement principle of glycemia was potentiometric and the rest of the parameters were assessed following spectrophotometric technique [17].

The assays for measurement of Uric acid (UA), carbonylated proteins (CP) were assessed following spectrophotometric technique and superoxide dismutase (SOD) and Human Low-density lipoprotein-

receptor (LDL-R) using ELISA kits from abcam and R&D systems designed in the quantitative sandwich enzyme immunoassay technique with catalog numbers: ab202410 and 752905.0 respectively.

Approval by Medical Research and Ethical Committee

The scientific content and ethical dimensions of the research protocols and consent forms were approved by the Medical Research and Ethical Committee of Faculty of Medicine Sousse (CEFMS 29/2019).

Statistical analysis

Shapiro-Wilk normality test was used to examine if the studied variables were normally distributed. Descriptive statistics were used to show the population characteristics (means, median, standard deviations, ranges and frequencies).

Comparison of biological parameters between baseline and day 11 were performed by using paired t-test when variables were normally distributed and Wilcoxon's signed ranks test as a non-parametric test in the other cases. In order to have an idea on the relation between lipid profile and markers of stress, a Pearson correlation was performed.

Logistic binary regressions were performed for multivariate analysis. For all tests, significance level was fixed at $p < 0.05$.

IBM® SPSS® 21.0 was used for data entry and analysis.

Results

A total of 30 healthy volunteers (5 men and 25 women), were selected for the study. Women's and men's average age were 37.00± (9.84 years) and 46.71 (± 9.87 years) respectively (Table 1).

Influence of Laurus nobilis intake on lipid profile response

The comparison between baseline and day 11, indicated that blood cholesterol, Triglyceride and LDL cholesterol concentrations were reduced after consumption of Laurus nobilis leaves tea, but the difference was not statistically significant (p=0.9; p= 0.7; p=0.6 respectively). However, HDL cholesterol levels increased significantly after 10 days in subjects taking 5 g of Laurus nobilis tea per day, (p= 0.01) (Fig.1).

Influence of Laurus nobilis intake on LDL-R.

There was a significant increase in LDL-R levels after consumption of Laurus nobilis tea (p=0.000) (Table2).

	Before Tea consumption	After Tea consumption	*p value*
Mean LDL-R (pg/mL)	444.54± 241.03	634.00± 290.19	**0.000**

Table 2
Mean levels of mean LDL-R before and after tea consumption.

Influence of Laurus nobilis intake on some markers of oxidative stress

Figure 2 shows a significant increase of SOD and uric acid levels after a 10 day consumption of 100 mL of Laurus nobilis tea [(Mean SOD levels (U/mg) $_{(Day0)}$=72.32± 26.39 vs Mean SOD levels (U/mg) $_{(Day11)}$=84.85± 38.65 ; p=0.039) and (Mean Uric acid (µmol/L) $_{(Day0)}$= 245.62±90.70 vs Mean Uric acid (µmol/L) $_{(Day11)}$= 209.96±50.77; p=0.042)]. However, the mean levels of blood CP concentrations were reduced after consumption of Laurus nobilis tea [Mean PC (nmol/mg protein) ($_{Day0}$) =0.91±0.17 vs Mean PC (nmol/mg protein) ($_{Day11}$) =0.78±0.24]. The difference was statistically significant (p=0.023) (Fig. 2).

Pearson's correlation analysis between antioxidant parameters, oxidative markers and lipidic profile

There was a significant positive correlation between Delta-HDL cholesterol (HDL cholesterol $_{(Day11)}$- HDL cholesterol $_{(Day0)}$ and Delta-UA (UA $_{(Day11)}$- UA cholesterol $_{(Day0)}$ levels (R= 0.396, p=0.036) as well as Delta-TG (Triglyceride $_{(Day11)}$- Triglyceride $_{(Day0)}$ and Delta-CP (CP $_{(Day11)}$- CP $_{(Day0)}$ levels (R= 0.438, p=0.020). In addition, we found a significant negative correlation between Delta-LDL cholesterol (LDL cholesterol $_{(Day11)}$- LDL cholesterol $_{(Day0)}$ and Delta-SOD (SOD $_{(Day11)}$-SOD $_{(Day0)}$ levels (R= -0.479, p=0.009) (Table3).

	Delta-SOD	Delta-UA	Delta-CP
Delta-HDL cholesterol	*R*= -0.27	***R*= 0.396**	*R*= 0.304
	p=0.159	***p*=0.036**	*p*=0.116
Delta-TG	*R*= -0.116	*R*= 0.280	***R*= 0.438**
	p=0.548	*p*=0.149	***p*=0.020**
Delta-CHO	*R*= 0.75	*R*= 0.151	*R*= -0.011
	p=0.701	*p*=0.442	*p*=0.957
Delta-LDL cholesterol	***R*= -0.479**	*R*= -0.27	*R*= -0.27
	***p*=0.009**	*p*=0.159	*p*=0.159
Delta: Difference of plasma concentrations before and after tea consumption			

Table 3
Correlation between antioxidant capacity parameters, oxidative markers and lipidic profile.

Correlation between elevation of LDL-R and decrease of LDL cholesterol and Triglyceride levels

Different correlations were conducted primarily with a binary variable selecting patients with elevated levels LDL-R versus patients with unchanged or decreased LDL-R levels and secondarily with other binary variables selecting patients with reduced levels of LDL cholesterol and triglyceride versus patients with unchanged or increased levels of LDL cholesterol and triglyceride. This model showed a significant positive correlation between Delta-LDL cholesterol, Delta-triglyceride down and Delta-LDL-Rup concentrations (p= 0.017, p= 0.038 respectively). On the other hand, there was a negative correlation between Delta-LDL cholesterol down, Delta-LDL-R and Delta-LDL-R up (p= 0.013, p=0.010). In addition, a significant negative correlation was found between Delta- triglyceride down and Delta-LDL-R (p= 0.013, p=0.010) (Table 4).

	Delta-LDL R	**Delta-LDL R up**
Delta-LDL cholesterol	*R*= -0.16, *p*= 0.44	*R*= 0.44, *p*= **0.017**
Delta-LDL cholesterol down	*R*= -0.45, *p*= **0.013**	*R*= -0.47, *p*= **0.010**
Delta- triglyceride down	*R*= -0.54, *p*= **0.005**	*R*= 0.39, *p*= **0.038**
Delta: Difference of plasma concentrations before and after tea consumption		

Table 4

Correlation between concentrations of Delta-LDL cholesterol, Delta-LDL cholesterol down, Delta-triglyceride down, Delta-LDL-R and Delta-LDL-R up.

Effects of some extrinsic factors on some markers of oxidative stress

We found a significant negative correlation only between Delta-SOD up (SOD $_{(Day11)}$-SOD $_{(Day0)}$ and age (p=0.03) as shown in Table 5.

	Age	Gender	N	Mean± SD	*p value*
Delta-SOD-up(UI/mg protein)	*R*=**-0.40**	Men	6	0.83±0.41	0.44
	p= **0.03**	Women	24	0.67±0.48	
Delta-UA-up	*R*=-0.16	Men	6	0.60±0.55	0.47
(µmol/L)	*p*= 0.39	Women	24	0.42±0.50	
Delta-CP-down	*R*=0.09	Men	6	0.80±0.44	0.30
(nmol/mg protein)	*p*= 0.61	Women	24	0.54±0.51	
Results are expressed as mean ± SD, SOD = superoxide dismutase, LDLC = low-density lipoprotein, TC = total cholesterol, TG = triglyceride, UA= Uric acid, CP= Carbonylate protein and HDL-C = high-density lipoprotein, Delta: Difference of plasma concentrations before and after tea consumption					

Table 5
Influence of gender and the age on the oxidative stress profile.
Moreover, women have lower concentrations of the rest of antioxidant capacity markers compared to men with no statistical difference. Also, age did not significantly affect the markers of oxidative stress.

However, gender and age did not significantly affect the other markers of oxidative stress (Table 5).

Discussion

This is the first reported study to determine the effect of Laurus nobilis tea infusion on Lipidic profile and oxidative stress in healthy individuals.

In this study, we aimed to explore the effect of daily consumption of Laurus nobilis tea during 10 days on lipid biomarkers including the Total cholesterol, Triglyceride, LDL cholesterol and HDL cholesterol, LDL-receptor and on some markers of oxidative stress.

Total cholesterol, Triglyceride and LDL cholesterol levels decreased non-significantly. It seems that Laurus nobilis tea consumption might impact lipid metabolism through an increase of HDL cholesterol [17].

Our findings, are consistent with Khan et al. results [16]. There has been a reduction of serum concentrations of total cholesterol and LDL cholesterol and the increase in HDL cholesterol levels in patients with type II diabetes who were consuming capsules containing powdered Laurus nobilis.

The present study showed an increase in HDL levels after Laurus nobilis tea leaves consumption, which has recently been recognized to have an important cardioprotective properties [18, 19]. Also, Parthasarathy et al. suggested that HDL may have a protective role against atherogenic diseases by preventing the formation of the oxidatively modified LDL [20]. Mackness et al. discussed the protective role of HDL against atherosclerosis problem through preventing the accumulation of lipid peroxides on LDL [21].

Our findings showed an increase in SOD activity indicating that Laurus nobilis could be contributing to the reduction of the level of Reactive Oxygen Species (ROS) as well as influencing the enzymatic activities of SOD. This result is consistent with that of Casamassima et al. who have shown that the administration of Laurus nobilis tea in Rabbit under Fat-Enriched Diet improved SOD activity [22].

Considering this finding, the increased uric acid plasma levels is an adaptive response to the increased oxidative stress [23]. [Because Uric Acid (UA) is capable of preventing H_2O_2-induced inactivation of SOD [24], Sevanian et al. suggest that UA may function as a potent antioxidant by scavenging free radicals and also by stabilizing ascorbate in biological fluids [25]. Our results are consistent with the above findings. UA is the end product of purine metabolism; it can act as a pro-oxidant, particularly when present in high concentrations and may thus be a marker of oxidative stress [26, 27]. On the other hand, it may also have a therapeutic role as an antioxidant [28, 29] hence, the decrease of oxidative stress given that xanthine-oxidase reaction can generate superoxide radicals under hypoxemic conditions [30, 31]. Some studies showed that consumption of Laurus nobilis is associated with Xanthine oxidase (XO) inhibition activity [32]. The increase in UA could be explained by the above finding in case of laurus nobilis consumption.

In addition, our results showed that Laurus nobilis tea consumption could reduce the oxidative damage through the Protein carbonyl (PC) levels. Furthermore, it suggested that there is a significant relationship between lipidic markers and some biomarkers of oxidative stress.

To the best of our knowledge, this is the first study that evaluates the association between the two factors. Several important implications can be drawn. HDL-C levels were positively associated with serum uric acid levels. This result suggests that these two markers have a similar effect. Even though HDL-C has been postulated to exert an important anti-oxidative function and to be a powerful protector against risk factors of cardiovascular diseases [33, 34], it has also been indicated that UA has an anti-oxidant property. In fact, Waring et al. showed that high UA concentrations are accompanied by increased serum anti-oxidant capacity during acute physical exercise in healthy subjects [35].

The linear relationship between HDL-C levels and serum uric acid implies a hypothesis that UA might have synergistic interactions with lipidic markers such as HDL cholesterol.

Consumption of Laurus nobilis tea caused the increase in uric acid levels which caused the increase in HDL cholesterol. This synergistic effect of these two parameters could be considered as a marker of protection against certain cardiovascular diseases. As we have shown in the present study, Mahdy Ali et al. similarly reported the positive correlation between HDL cholesterol and UA level hence demonstrating a protective effect of HDL cholesterol against risk of heart diseases [36].

However, some controversies have been reported regarding the correlation between HDL cholesterol and UA concentrations.

The study by Peng et al showed the serum HDL-C levels were inversely associated with serum uric acid levels [37]. Similar results were yielded by a recent study by Ali et al. [38]. Our analysis has shown a controversial result with the above findings. Several studies have found that an elevated UA level was associated with the risk of cardiovascular and considered it a factor of hypertensive disease [39]. Elevated UA levels was found to be associated with increased cardiovascular morbidity and mortality. A threshold value of UA < 6.0 mg/dL (< 360 µmol/L) seems to better identify true "healthy subjects" according to Desideri et al. and other authors [40–44]. UA levels serve as a biomarker of anti-oxidative and oxidative stress. When present in high serum concentrations, they may contribute to the pathogenesis of severe illnesses.

Our results demonstrated positive significant correlation between TG and CP confirming that the decrease of lipid will lead to the reduction of oxidative stress. They are consistent with those of Yesim et al. who reported the positive correlation between TG and carbonyl levels indicating that oxidative stress may affect the lipids, proteins and erythrocytes [45] Uzun et al. showed that plasma triglycerides were positively correlated with plasma CP [46].

Protein carbonyl is indicative of oxidative damage to proteins as it is responsible for the genesis of reactive oxygen species (ROS) [47]. On the basis of the measurement of protein carbonyl, it has been suggested that the accumulation of oxidized proteins is associated with atherosclerosis [48]. Thus, we suggest that Laurus nobilis tea consumption may have an impact on TG levels which lead to a reduction of oxidative biomarker such as CP. This effect confirms the anti-oxidant activity of Laurus nobilis and its impact on lipid profile's amelioration.

Additionally, we found that Laurus nobilis tea consumption reduces LDL cholesterol with an increase of SOD levels. Our hypothesis is that the LDL cholesterol -reduced activity by Laurus nobilis may be related to the antioxidative action of SOD. LDL cholesterol is a major lipoprotein of cholesterol and is an important risk factor of atherosclerosis formation [49]. Ngestiningsih et al. showed a significant reduction of LDL cholesterol levels in the group who received SOD supplementation treatment [50]. Accordingly, Laurus nobilis enhances the antioxidant activity of SOD leading to a decrease in LDL cholesterol levels. Our results were in accordance with these findings.

The research developed by Mondola et al. showed that SOD inhibits the activity of HMG Co-A reductase in the liver cells of rats. This enzyme plays an important role in the biosynthesis of cholesterol. This

inhibition of HMG Co-A reductase will lead to reduced cholesterol synthesis. Consequently, this will lead to activate the LDL-R pathway accompanied by a high amount of LDL cholesterol which binds to a receptor on the cell surface of hepatocytes, thereby lowering LDL cholesterol in blood [49].

Based on these findings, Laurus nobilis has an increased effect on LDL-R levels and reduced LDL cholesterol concentrations. It is a well-known fact that when there are more LDL receptors, more LDL is taken up from the blood by the liver, leading to low plasma LDL levels [51]. The consumption of Laurus nobilis infusion may enhance LDL-R levels. To our knowledge, this is the first study to assess the impact of laurus nobilis on inducing LDL-R activity. Studies have shown that the increase in expression of LDL-R resulting in an increase in clearance of LDL from plasma is put through the inhibition of the synthesis of Cholesterol, which is itself done through inhibition of HMG CoA reductase. The latter is the rate-limiting enzyme in the cholesterol biosynthetic pathway [52, 53]. Accordingly, it is proposed that Laurus nobilis tea could affect HMG-CoA reductase causing the induction of LDL-R activity which is a major mechanism by which treatment with laurus nobilis reduces the LDL cholesterol level. Numerous randomized trials have demonstrated that lower LDL-C levels by upregulation of the LDL-R reduce the risk of cardiovascular events [54–56].

Furthermore, in this study, a reduction of serum triglyceride (TG) levels which was accompanied with a higher LDL-R levels was observed after consumption of Laurus nobilis tea and therefore it is confirmed that Laurus nobilis does affect HMG-CoA reductase. The lower plasma TG level associated with a higher LDL-R plasma level was consistent with studies that yielded similar results [57]. The transport of triglycerides from the liver to the peripheral tissues is ensured by the very low-density lipoprotein (VLDLs) containing apolipoprotein B100 (apo B100). They are quickly eliminated via the LDL-receptor. Since the LDL receptor recognizes apo B and apo E of LDL and apo B100 is the main apolipoprotein in VLDL and LDL, Apo B100 will therefore have an interaction between LDL receptor and VLDL receptor [57, 53]. It was demonstrated that lowering plasma triglyceride levels reduces the risk of cardiovascular disease [57]. In agreement with the above results, we made the hypothesis that the consumption of the infusion of Laurs nobilis increases the activity of LDL-receptor contributing to the elimination of triglyceride due to their affinity to apo B100 contained in VLDL transporters of TG.

These relationships are still significant regardless of adjustment for known risk factors and confounding variables including only age. Indeed, our results show that oxidative stress is influenced by many factors such as gender. In general, only women have lower concentration of total antioxidant capacity compared to men although this effect is not significant. Comparable results were noted by Landry et al. [58]. Similarly, Frank et al. have shown a positive statistically significant relationship between age and SOD [59].

In our study higher age was associated with less increase in SOD activity from day 0 to day 11 which was statistically significant.

That is to say, the increase in antioxidant activity of SOD is more marked in younger subjects than in older ones because the beneficial effect observed on the increase in antioxidant activity of SOD is inversely correlated with age.

The research on natural substances ameliorating lipid profile for prevention of some cardiovascular diseases has a particular therapeutic importance. The identification of dietary components that could be added to foods to regulate lipid profile has notably gained special interest. According to a few authors, Laurus nobilis my help to prevent cardiovascular disease risk factors and its bioactive compounds would have positive effects on blood lipid metabolism [22, 20, 60]. The reduction in lipid biomarker levels may be due to the flavonoids and glycosides contained in Laurus nobilis leaves [61, 62].

Few studies showed that the functional properties of some of the plant extracts are mainly due to the presence of phenolic compounds [63]. The active components of Laurus nobilis are under study. According to previous studies, the total polyphenolic compounds content of Laurus nobilis leaves was found to be 6.7 mg gallic acid equivalents (GAE)/100 g [64]. Muchuweti et al. [64] revealed the presence of other phenolic compounds such as cafeic, vanillic and ferulic acids in Laurus nobilis leaves extracts. These compounds may play a key role on antioxidant activity.

A recent study has revealed that kaempferol-3-O-glucoside, quercetin, rutin and phenolic acids such as caffeic, and chlorogenic acids were found to have the highest antioxidant activity. These compounds serve as scavengers of free radicals [65]. As a result, our hypothesis on protective effects on ROS of Laurus nobilis was confirmed.

Our findings would be consistent with the idea that Laurus nobilis infusion would act as a protector of oxidative stress to prevent its related diseases particularly the cardiovascular ones. Laurus nobilis could be considered as a possible new antioxidant ingredient for the medical food or functional food. Furthermore, the role of Laurus nobils on inhibiting cholesterol synthesis in liver and enhancing LDL-receptor activity leading to reduced serum LDL cholesterol levels could be used as a novel therapeutic approach to reduce rates of cardiovascular events. As we known, the LDLR is the primary pathway for removal of cholesterol from the circulation and its activity is meticulously governed by intracellular cholesterol levels [53].

The ability of Laurus nobilis tea to enhance LDLR activity and to induce higher HDL cholesterol levels needs further work to support our findings and to determine the exact mechanism of increase in LDL R.

In conclusion, our results suggest that the infusion of Laurus nobilis can be added to foods to lower or regulate blood lipidic profile resulting in high antioxidative stress properties. Infusion of Laurus nobilis tea can be particularly utilized for prevention of cardiovascular diseases.

Limitations and directions for future research

The results from this study, require replication with larger sample sizes. Additional studies are needed to confirm these results and also to identify the active components within the Laurus nobilis leaves.

Further investigations of the beneficial effects of Laurus nobilis tea on human lipidic status would also be strengthened by the involvement of placebo group and a group with cardiovascular diseases. To the best of the authors' knowledge, this is the first study that explores the effect of Laurus nobilis tea on lipidic status. Further investigations with longer follow up periods are certainly warranted.

Conclusion

The present study partially supports that a 10-day Laurus nobilis tea consumption in healthy volunteers has a beneficial effect in preventing cardiovascular diseases. This is mainly endorsed by the ability of Laurus nobilis to increase HDL and LDL-R levels. It also has a concomitant antioxidant property since it increases the antioxidant activity of some blood markers. It can additionally modulate, even partially, the plasma level of cholesterol, Triglyceride and LDL cholesterol. However, more powerful studies with larger clinical trials using different groups namely placebo and patient groups, variable doses, and conducted over an extended treatment period is required.

Abbreviations

Total cholesterol, TC; Triglyceride, TG ; High density lipoprotein cholesterol, HDL cholesterol; Low-density lipoprotein cholesterol, LDL cholesterol; Total bilirubin, TB ; Direct bilirubin, DB; Alkaline Phosphatase, ALP; Gamma- Glutamyltransferase, Y-GT; Alanine Aminotransferase, ALT; Aspartate Aminotransferase, AST; Uric acid, UA; Carbonylated Proteins, CP; Superoxide Dismutase, SOD; Human Low-density lipoprotein- receptor, LDL-R; Delta, Differences between levels from day 11 and day0;Reactive Oxygen Species, ROS; Xanthine oxidase, XO; Very low-density lipoprotein, VLDLs; Apolipoprotein B100, apo B100; Gallic acid equivalents, GAE;

Declarations

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Ethical Approval and Consent to participate

The scientific content and ethical dimensions of the research protocols and consent forms were approved by the Medical Research and Ethical Committee of Faculty of Medicine Sousse (CEFMS 29/2019).

Consent for publication

Not applicable

Availability of data and materials

All the data related to this research are available in the text, tables or figures

Competing interests

The authors declare that they have no conflicts of interest.

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Authors' contributions

Chahra Chbili., and Maher Maoua. are responsible for design and development of the study; Chahra Chbili., and Maher Maoua. contributed to data analysis and interpretation; Chahra Chbili., and Maher Maoua. contributed to writing the article or critical analysis leading to significant changes to the intellectual content; Chahra Chbili., Maher Maoua., Mejda Selmi., Sawssen Mrad., Hajer Boudriga., Hedi Khairi., Khalifa Limem., Nejib Mrizek., Saguem Saad., and Maha Ben Fredj. contributed to final approval of the version submitted after critical review.

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Figures

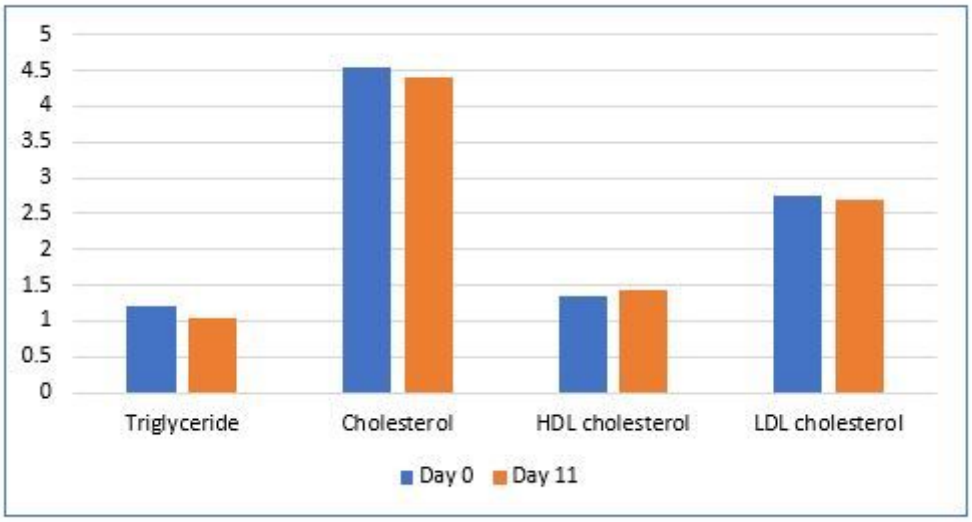


Figure 1

Blood Triglyceride, Cholesterol, HDL cholesterol and LDL cholesterol mean levels before and after consumption Tea

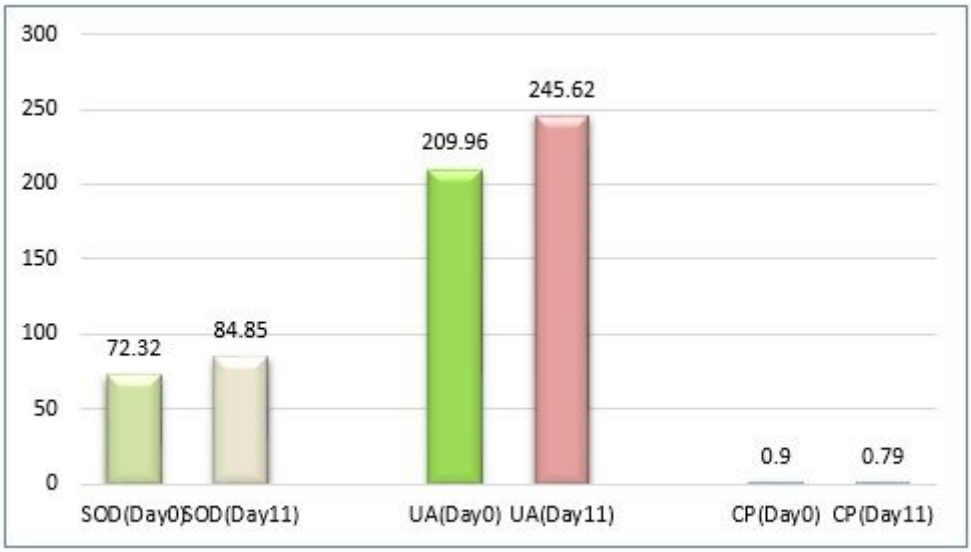


Figure 2

Mean levels of SOD, UA and CP before and after consumption tea