Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 8 Issue 1 January 2024

Research Article

Exploration of Hypotensive and Hypolipidemic Effect of Beetroot (*Beta vulgaris* l.) Based Metabiotic Drink

Ramneek Kaur[1]*, Kiran Grover[2], Priya Katyal[3] and Sonika Sharma[4]

[1]*Student, Food and Nutrition, Department of Food and Nutrition, Punjab Agricultural University, Ludhiana, India*

[2]*Professor-Cum-Head, Department of Food and Nutrition, Punjab Agricultural University, Ludhiana, India*

[3]*Microbiologist, Department of Microbiology, Punjab Agricultural University, India*

[4]*Professor, Department of Food and Nutrition, Punjab Agricultural University, Ludhiana, India*

***Corresponding Author:** Ramneek Kaur, Student, Food and Nutrition, Department of Food and Nutrition, Punjab Agricultural University, Ludhiana, India

DOI: 10.31080/ASNH.2023.08.1338

Received: August 11, 2023

Published: December 12, 2023

Abstract

The present study was conducted by selecting 90 mild to moderate hypertensive and hyperlipidemic male subjects in the age group of 40-60 years. The subjects were divided into three groups i.e., Control- C; Experient 1 - E1 and Experiment 2- E2 with thirty each to evaluate the effectiveness of metabiotic drink-based intervention in reducing blood pressure and lipid profile. A dose of 30 ml of beetroot juice and beetroot based metabiotic drink was supplemented to the Experimental groups E1 and E2 for the period of three months. Nutrition counselling sessions for both the experimental groups E1 and E2 was done at an interval of 15 days. A brochure containing information on nitrate rich foods, benefits of beetroot based metabiotic drink and lifestyle modifications was developed and distributed. The data revealed that the subjects were sedentary workers having family medical history of diabetes followed by hypertension and hyperlipidemia. The results of intervention showed that beetroot based metabiotic drink significantly reduced the systolic and diastolic blood pressure in E2 group compared to E1 and control group. Total cholesterol levels varied among groups, with potential for reduction in the E2 group. HDL levels showed some variations, but the impact of the intervention was not consistent across all groups. Serum triglyceride levels remained relatively stable, with slight reductions observed in the experimental groups during the first intervention point. Hence, the study suggests that beetroot-based metabiotic drinks need to be popularized for the prevention and management of hypertension. However, further research is needed to confirm these findings and explore the long-term effects in such intervention.

Keywords: Beetroot Juice; Metabiotic Drink; Hypertension; Hyperlipidemia; Nutrition Counselling

Introduction

Cardiovascular diseases (CVDs) are a prominent contributor to global mortality and morbidity, placing a significant strain on healthcare systems [1]. Hypertension and hyperlipidaemia are major risk factors for cardiovascular diseases (CVDs), with high blood pressure and elevated lipid levels contributing to the development and progression of these conditions [2]. The prevalence of these conditions remains a significant concern in public health, with cardiovascular diseases being the leading cause of death worldwide. Traditional therapeutic approaches for these conditions include lifestyle modifications, pharmacotherapy, and dietary interventions. However, there is growing interest in exploring natural and alternative interventions, such as beetroot (*Beta vulgaris* L.), which has gained attention due to its rich content of bioactive compounds with potential hypotensive and hypolipidemic effects [3].

Beetroot fermentation is a natural process that preserves the nutritional content of the vegetable by converting starches into lactic acid bacteria. This process improves digestion, boosts the immune system, and promotes gut health. Fermentation has led to the emergence of "metabiotics," which are food products that undergo controlled fermentation to enhance their bioavailability and bioactivity [4]. Beetroot is rich in dietary nitrates, antioxidants, and dietary fibers, which have been shown to improve cardiovascular health. The fermentation process can enhance the bioactivity of beetroot compounds, increasing their concentration, modifying their chemical structures, and promoting the growth of beneficial bacteria.

Recent research has investigated the potential of beetroot juice as a therapeutic intervention for hypertension and hyperlipidemia. Studies have reported positive effects on blood pressure regulation, with beetroot juice consumption associated with significant reductions in both systolic and diastolic blood pressure [5]. Additionally, beetroot's bioactive compounds, particularly betalains and flavonoids, have been shown to possess lipid-lowering properties through various mechanisms. Beetroot is also believed to have anti-inflammatory properties, which can help reduce the risk of certain chronic diseases. Consuming beetroot juice or eating boiled beetroot can help lower blood pressure, improve exercise performance, and reduce levels of bad cholesterol. Additionally, beetroot's probiotic-rich content, created during fermentation, can promote gut health. Recent research has focused on fermentation processes to develop beetroot-based metabiotic drinks to enhance its potential therapeutic benefits [6].

This research aims to explore the hypotensive and hypolipidemic effects of a beetroot-based metabiotic drink, combining the health-promoting properties of beetroot with the potential benefits of fermentation. By fermenting beetroot juice, bioactive compounds present in the raw material may undergo biochemical transformations, leading to the production of metabolites with enhanced physiological activities. This exploratory investigation seeks to evaluate the effectiveness of the beetroot-based metabiotic drink as a therapeutic intervention for individuals with hypertension and hyperlipidemia.

Material and Methods

Development of beetroot juice

Beetroot was washed under running water followed up by sterilized washing in lukewarm water that included 0.01% KMS (potassium metabisulphite). Peel was removed and beetroots were cut into small cubes and juice extraction was done through juicer mixer. The resulting juice was placed into sterilized glass bottles after being twice processed through a muslin filter. Boiled cool water at same proportion of beetroot juice is added along with 1.5% salt and 7% lemon juice. Further pasteurization at 82.7°C for 10-15 seconds was done (Figure 1).

Beetroot (1 Kg)
↓
Washing with 0.01% KMS solution
↓
Peeling and calyx removal
↓
Extraction of juice (600 ml)
↓
Boiled cooled water (600 ml)
↓
1.5% salt and 7% lemon juice
↓
Pasteurization at 82.7°C for 10-15 seconds

Figure 1: Development of beetroot juice.

Development of beetroot-based metabiotic drink

The study used a standard procedure [7] to develop a beetroot-based metabiotic drink, which involved pasteurizing beetroot juice, inoculating a Lactic consortium co-culture, centrifuging, and fermenting at 37°C for 48 hours.

Beetroot (1 Kg)
↓
Washing with 0.01% KMS solution
↓
Peeling and calyx removal
↓
Extraction of juice (600 ml)
↓
Boiled cooled water (600 ml)
↓
1.5% salt and 7% lemon juice
↓
Pasteurization at 82.7° C for 10-15 seconds
↓
Selective fermentation by (*Lactic consortium*)
↓
Pasteurized juice inoculated with 5% (v/v) co-culture of *Lactic consortium*
↓
Incubation at 37°C for 48 hours
↓
48 hours grown 10^8 cfu mL^{-1} inoculum
↓
Bottling and storage in refrigerator at 5°C till further use

Figure 2: Development of beetroot based metabiotic drink.

The beetroot-based metabiotic drink was prepared using a systematic (7) (Figure 2) and scientific approach. The process involved procuring high-quality beetroot, washing and sterilizing it, extracting juice, pasteurizing it, inoculating a lactic consortium, and fermenting it at controlled temperatures. This comprehensive approach ensures the desired microbial environment and maintains hygiene standards.

Selection of the subjects

A total of 90 mild to moderate hypertensive (systolic blood pressure ranged between 120-159 and diastolic blood pressure ranged between 80-99 mmHg)/ hyperlipidemic (Cholesterol 200 mg/dL to 239 mg/dL; LDL- 130 mg/dL to 159 mg/dL) male subjects in the age group of 40-60 years were selected from Deepak Heart Institute, Ludhiana and Delhi Heart Institute and Multi-specialty Hospital, Bathinda, Punjab. The written consent to participate in the study was taken from the subjects. The ethical approval to conduct the intervention study was also granted by institutional ethical committee. The subjects were divided into three groups i.e., C-control group; E_1-Experiment 1 and E_2-Experiment 2 To check the efficiency between standardized metabiotic beetroot based fermented drink and beetroot juice optimum doses of 30 ml were supplemented to both groups for the period of three months.

The complete study was divided into two periods i.e., pre-intervention period and postintervention period. All the observations were kept in record before and after the intervention period. The study aimed to determine the effectiveness of these treatments.

Data collection

The demographic information, eating habits, food intake, physical activity, and anthropometric measurements of individuals were elicited. Blood pressure [8] and blood samples were analysed for lipid profile (serum total cholesterol [9], triglycerides [10], and HDL-C [11]) examined. LDL-C [12] and VLDL-C [12], and anthropometric measurements were recorded.

Educational brochure and nutrition counselling

An educational brochure with special reference to beetroot juice/ metabiotic drink was developed. Special emphasis was given to the risk factors associated with hypertension/cardiovascular disease, nitrate rich foods, lifestyle modification and hypotensiveand hypolipidemic effects of beetroot juice and metabiotic drink. Nutrition counselling session of both experimental groups E_1 (group supplemented with beetroot juice) and E_2 (group supplemented with beetroot based metabiotic drink) was done at an interval of fifteen days for a period of three months which makes a total of 6 sessions of 15-30 minutes.

Beetroot based metabiotic drink intervention

Subjects were divided into three groups of thirty subjects each. The total subjects were divided into three groups of thirty each. One group was kept as control (C) without any supplementation. Two groups were treated as experimental groups. E_1 and E_2. The subjects in group E1 and E2 was supplemented with 30ml of beetroot juice and 30 ml of beetroot based metabiotic drink respectively.

Groups	No. of subjects (n = 90)	Duration	Treatment
C (Control)	n =30	12 weeks	No supplementation
E_1 (Experiment 1)	n = 30	12 weeks	Supplemented with beetroot juice and nutrition counselling was done.
E_2 (Experiment 2)	n = 30	12 weeks	Supplemented with beetroot based metabiotic drink and nutrition counselling was done.

Table 1: Distribution of subjects in groups for intervention purpose.

Statistical analysis

The data on all variables, including the subjects' anthropometric measurements, biochemical analyses, and food and nutrition intake, were statistically evaluated. For different parameters, mean values, standard deviations, percentage distributions, and one-way analyses of variance were determined. The parameters were compared between the pre- and post-intervention periods using a paired t-test. To compare the difference between control group, Treatment 1-Beetroot juice, Treatment -2 - Fermented beetroot based metabiotic drink LSD test is used after one way ANOVA.

Results and Discussions

General information

The lifestyle habits of respondents are presented in table 2. The data showed that the majority of the subjects (64%) belonged to the age group 50-60 years, while 36 percent of the subjects fell into the 40-50 age range. Cardiovascular diseases, also known as CVDs, are the leading cause of death in adults, 65 years of age and older [13], The proportion of individuals who reported doing clerical, supervisory, tourism, some form of manual labor and household tasks was 65, 18, 16, 4, and 31 percent respectively. In addition, out of the total working individuals, it was found that the majority of subjects (53%) used cars followed by two-wheelers (13%) to get to work and only 1 percent of subjects were using public transport or go by walk. It was observed that 43.4 percent of subjects had stressful environments at their home or work due to one or the other reasons. In the present study, 56.6 percent of the participants experienced restful sleep, whereas the remaining 43.4 percent were subjected to sleep deprivation. The findings indicate that a significant proportion of the participants (38.9%) reported sleeping for a duration of 6-7 hours per day. Additionally, 37.8 percent participants reported sleeping for 7-8 hours, while nearly quarter (23.3%) reported for sleeping more than 8 hours. There exists a direct association between sleeping for less than 5 and 6 hours and the occurrence of Hypertension and Coronary Heart Diseases [14].

Based on the analysis of dietary patterns, it was observed that a

Particulars	Number of subjects	Percentage
Age(years)		
40-50	32	36
50-60	58	64
Work involved in job*		
Desk	59	65.6
Supervision	17	18.9
Touring	15	16.8
Physical Activity	4	4.5
Household work	28	31.2
Mode of transport		
Two-wheeler	12	13.4
Car	48	53.4
Walk	1	1.2
Home/Work Atmosphere		
Stressed	39	43.4
Peaceful	51	56.6
Sound sleep		
Yes	26	28.9
No	64	71.1
Sleep hours		
6-7	35	38.9
7-8	34	37.8
>8	21	23.3
Food habits		
Vegetarian	30	33.4
Non vegetarian	53	58.8
Ova vegetarian	7	7.8

Table 2: General information of the subjects (n = 90).

*Multiple responses.

majority of individuals, including 58 percent, adhere to a non-vegetarian diet, but a minority of 33 percent do identify as vegetarians. Only 7 percent of subjects reported to eat eggs and egg products. Non-vegetarianism increased the risk of bleeding and stroke by 20 percent while reducing the risk of ischemic heart disease by 13 percent when combined with fish consumption [15].

Anthropometric profile of the subjects

Obesity diagnosis requires considering basic anthropometric profiles (Table 3) such as height, weight, BMI. The average height of respondents was 168.092 ± 10.09 cm, with no impact from the intervention. The mean weight of the selected individuals exceeded the ICMR (2023) reference. The reduction in BMI was 2.3 kg/m^2.

BMI (Kg/m^2) Principal cut-off points	BMI (Kg/m^2) Additional cut-off points	Classifications
<18.5	<18.5	Underweight
<18.5	17.00-18.49	Mild thinness
	16.00-16.99	Moderate thinness
	<16.00	Severe thinness
18.50-24.99	18.50-24.99	Normal
25.00-29.99	25.00-29.99	Pre-obese
≥30.00	≥30.00	Obese
≥30.00	30.00-34.99	Obese Class I
	35.00-39.99	Obese Class II
	≥ 40.00	Obese Class III

Table 3: International Classification of Body Mass Index (WHO, 2004).

The body mass index was 28.57 ± 11.93 kg/m^2, above the recommended range of 18.5 to 24.99kg/m^2.

Biochemical profile of the subjects

Table 4 and Table 5 contains information on the biochemical profiles of selected subjects. Before and after the procedure, individual markers including total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very high-density lipoprotein (VLDL) and triglycerides is checked. In a study involving 90 subjects, the impact of nutrition intervention on their biochemical profiles was assessed across three different experimental conditions labelled as Control (C), Experiment 1 (E1), and Experiment 2 (E2), with each group consisting of 30 individuals. The study measured various parameters before and after the intervention to evaluate its effectiveness. For systolic blood pressure (BP), the Control group showed a minor reduction, which was statistically non-significant (p = 1.69), whereas both E1 and E2 groups exhibited significant reductions (p = 0.002 and p = 0.001, respectively) in systolic blood pressure. This suggests that the nutrition intervention had a positive effect on reducing systolic blood pressure in the experimental groups.

Regarding diastolic BP, the Control group again showed a negligible change (p = 0.05), whereas both E_1 and E_2 groups displayed significant reductions (p = 0.0005 and p = 0.0001, respectively). This indicates a notable improvement in diastolic BP due to the nutrition intervention in the experimental groups. When it comes to lipid profiles, there were significant changes in total cholesterol levels for E_2 groups.

Particulars	Control (C) n = 30		Paired t value	Experiment 1 (E_1) n = 30		Paired t value	Experiment 2 (E_2) n = 30		Paired t value	Standard value
	Pre intervention	Post intervention		Pre intervention	Post intervention		Pre intervention	Post intervention		
Systolic BP	142.7 ± 19.70	138.80 ± 20.75	1.69 NS	153.36 ± 13.8	138 ± 14.62	0.002*	136.46 ± 7.9	126.20 ± 6.22	0.001*	120-80
Diastolic BP	89.96 ± 10.6	89.00 ± 9.51	0.05 NS	91.4 ± 5.2	86.86 ± 6.26	0.0005*	88.26 ± 4.6	82.13 ± 5.53	0.0001*	90-60
Total Cholesterol	214.70 ± 33.2	214.33 ± 34.85	0.32 NS	213.83 ± 35.6	210.20 ± 36.68	0.19 NS	209.33 ± 29.8	199.06 ± 30.68	0.02*	<200 a
LDL	116.37 ± 38.6	115.76 ± 38.25	0.26 NS	127.9 ± 30.2	125.03 ± 35.43	0.28 NS	116.6 ± 25.7	110.86 ± 26.05	0.01*	<100 a
HDL	47.37 ± 15.6	47.37 ± 14.38	0.00 NS	44.26 ± 4.2	44.26 ± 5.34	0.00 NS	50.93 ± 15.6	47.46 ± 16.07	0.32 NS	40-60 a
VLDL	50.93 ± 26.3	50.56 ± 27.23	0.25 NS	41.63 ± 10.7	48.56 ± 15.08	0.32 NS	41.72 ± 18.9	48.23 ± 20.24	0.09 NS	2-30 a
Triglycerides	187.08 ± 60.9	178.08 ± 62.57	0.20 NS	180.5 ± 32.5	175.93 ± 30.85	0.06 NS	174.64 ± 24.6	175.40 ± 23.09	0.02*	<100 a

Table 4: Impact of beetroot based metabiotic drink intervention on the biochemical profile of the selected subjects (n = 90).

Values are Mean ± S.D.

**Values are significant at 1% level, *Values are significant at 5%; NS- Values are non-significant

a-NCEP (2001)

C-Control group with no intervention, E_1 - Experiment 1 with beetroot juice-based intervention, E_2 - Experiment 2 with metabiotic drink-based intervention.

Whereas results were non-significant for control and E_1 group. However, for LDL cholesterol, there were no significant changes in the Control group and the E_1 whereas E_2 group showed significant reductions. HDL cholesterol and VLDL cholesterol levels remained fairly stable across all groups, with no significant changes. Triglyceride levels also displayed no significant changes in control and E_1 groups whereas results were significant for E_2 group.

On post intervention comparison among different it was observed that results were significant for Systolic blood pressure and Diastolic blood pressure. For lipid profile parameters results were non-significant.

Systolic blood pressure

The provided data (Table 6) presents information related to systolic blood pressure (BP) across different conditions. In terms of Systolic BP, the control group showed a slight decrease from 142.7 to 138.8 mm/Hg, which was non-significant (NS), while the E_1 and E_2 groups demonstrated significant decreases from 153.36 to 138 mm/Hg and 136.46 to 126.3 mm/Hg, respectively (Figure 3). This suggests that the intervention had a more pronounced effect on reducing systolic BP in the E_1 and E_2 groups. In total 12 percent decline of systolic blood pressure in subjects supplemented with beetroot based metabiotic drink can be seen as compared to control group. It's noteworthy that the standard systolic BP range typically falls within 120-80 mm/Hg.

Subjects	Subjects	Systolic blood pressure (mm/Hg)	P value
C (n = 30)	E_1	138 ± 14.62	.838^{NS}
	E_2	126.20 ± 6.22	.002*
E_1 (n = 30)	C	138.80 ± 20.75	.838^{NS}
	E_2	126.20 ± 6.22	.003*
E_2 (n = 30)	C	138.80 ± 20.75	.002*
	E_1	138 ± 14.62	.003*

Table 6: Comparison on impact of metabiotic based intervention on the systolic BP among different groups (n = 90).
**Values are significant at 1% level;*Values are significant at 5%; NS- Values are non-significant
C – Control group with no intervention, E_1 - Experiment 1 with beetroot juice-based intervention, E_2 - Experiment 2 with standardized metabiotic drink-based intervention.

In summary, the data reveals variations in systolic BP across different conditions, with condition E_2 exhibiting the lowest mean systolic BP, followed by condition E_1, and the control groupwith the highest mean systolic blood pressure proves the effectiveness of beetroot based metabioticdrink.

Diastolic blood pressure

The results of the study in table 7 present the diastolic blood pressure measurements for three different conditions C (control group), E1 (Experiment 1: Intervention with beetroot juice), and E2 (Experiment 2: Intervention with beetroot based metabiotic

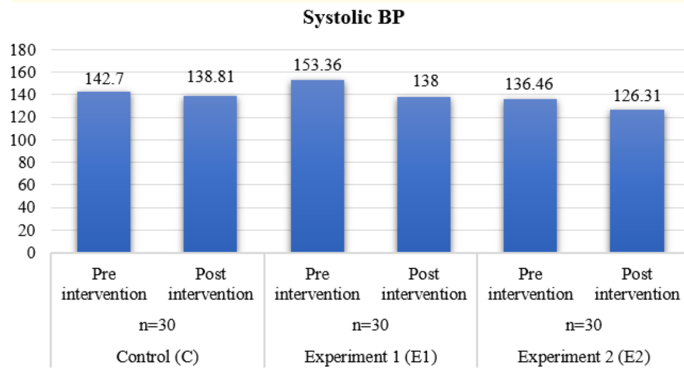

Figure 3: Impact of intervention on systolic blood pressure in different groups.

drink). The diastolic blood pressure values were found to be within a relatively narrow range across the conditions. For Diastolic BP, the C group exhibited a minor decrease from 89.96 to 89 mm/Hg, which was not statistically significant. In contrast, both E1 and E2 groups showed significant reductions from 91.4 to 86.86 mm/Hg and 88.26 to 82.13 mm/Hg, respectively (Figure 4). This indicates that the intervention effectively lowered diastolic BP in both experimental groups. Notably, the analysis of variance revealed a significant difference among the control group and beetroot based metabiotic drink supplemented group with p-value of 0.002. This suggests that the conditions have a measurable impact on diastolic blood pressure. It is important to mention that the observed diastolic blood pressure values across all conditions fall within the standard range of 90-60 mmHg, indicating none of the conditions led to high or low blood pressure. These findings underscore the potential influence of different conditions on diastolic blood pressure and prompt further investigation into the factors contributing to these variations.

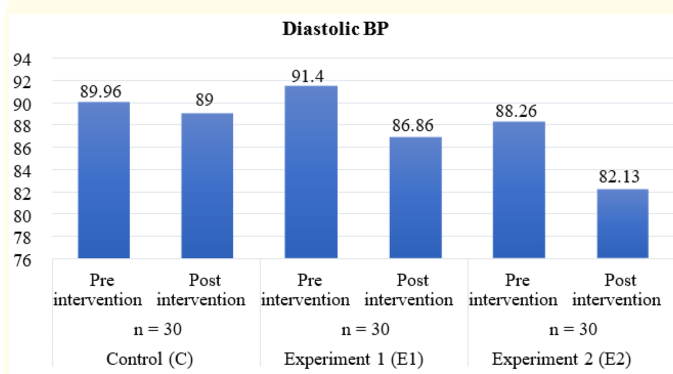

Figure 4: Impact of intervention on diastolic blood pressure in different groups.

Conclusion

Both experimental groups experienced a significant reduction in systolic blood pressure, suggesting the efficacy of the intervention. Diastolic blood pressure decreased significantly in the experimental groups, highlighting the potential benefits of beetroot-based metabiotic drink. Total cholesterol levels varied among groups, with potential for reduction in the E_2 group. HDL levels showed some variations, but the impact of the intervention was not consistent across all groups. Serum triglyceride levels remained relatively stable, with slight reductions observed in the experimental groups during the first intervention point.

Recommendations

Beetroot based metabiotic drink need to be popularised for prevention and management of hypertension. Further, doses and duration of beetroot based metabiotic drink need to be evaluated intensively for its hypotensive and hypolipidemic effect.

Bibliography

1. Torquati L., *et al*. "Shift work and the risk of cardiovascular disease: A systematic review and meta-analysis including dose-response relationship". *Scandinavian Journal of Work, Environment and Health* 44 (2017): 229-238.
2. Rajagopalan S and Landrigan PJ. "Pollution and the Heart". *New England Journal of Medicine* 385 (2021): 1881-1892.
3. Chen SE., *et al*. "An exploration of the relationship between income and eating behavior". *Agricultural and Resource Economics Review* 41 (2012): 82-91.
4. Marco ML., *et al*. "Health benefits of fermented foods: microbiota and beyond". *Current Opinion in Biotechnology* 44 (2017): 94-102.
5. Webb AJ., *et al*. "Acute blood pressure lowering, vasoprotective, and antiplatelet properties of dietary nitrate via bioconversion to nitrite". *Hypertension* 51 (2008): 784-790.
6. Wruss J., *et al*. "Compositional characteristics of commercial beetroot products and beetroot juice prepared from seven beetroot varieties grown in Upper Austria". *Journal of Food Composition and Analysis* 42 (2015): 46-55.
7. Kajal. "Exploration of nutritional and antioxidant potential of beetroot (*Beta vulgaris* L.) based metabiotic drink". M.Sc. thesis, Punjab Agricultural University, Ludhiana (2023).
8. Maclead J. "Davidson's Principles and Practice of Medicine". 14th edition., ELBS/Churchill Livingstone (1984).
9. Richmond W. "Preparation and Properties of a Cholesterol Oxidase from Nocardia sp. and Its Application to the Enzymatic Assay of Total Cholesterol in Serum". *Clinical Chemistry* 249 (1973): 292-303.
10. Fossati P and Principe L. "Qualitative Determination of Triglycerides in Serum or Plasma by Enzymatic DHBC Calorimetric Method". *Clinical Chemistry* 28 (1982): 2077-2080.
11. Lopes-Virella MF., *et al*. "Cholesterol Determination in High-Density Lipoproteins Separated by Three Different Methods". *Journal of Clinical Chemistry* 23 (1977): 882884.
12. Friedewald ET., *et al*. "Estimation of the Concentration of Low-Density Lipoprotein Cholesterol in Plasma, Without Use of the Preparative Ultracentrifuge". *Clinical Chemistry* 18 (1972): 499-502.
13. North BJ and Sinclair DA. "The Intersection between Aging and Cardiovascular Disease". *Circulation Research* 110 (2012): 1097-1108.
14. Nagai M., *et al*. "Sleep Duration as a Risk Factor for Cardiovascular Disease: A Review of the Recent Literature". *Current Cardiology Reviews* 6 (2010): 54-61.
15. Tong TY., *et al*. "Risks of Ischaemic Heart Disease and Stroke in Meat Eaters, Fish Eaters, and Vegetarians Over 18 Years of Follow up: Results from the Prospective EPIC-Oxford Study". *BMJ* 366 (2019): 14897.