

Plant-based Diet and Occurrence of Cardiovascular Diseases

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ABSTRACT

The cases of cardiovascular diseases are increasing globally. In the present paper, various research papers have been explored to understand the occurrence of such diseases with the nature of diet. The vegetarian diets are typically rich in plant-based food items. The compositional differences of the plant-based diets particularly being higher in dietary fiber, polyunsaturated fat and phytosterols and lower in energy, protein, total fat, cholesterol, and saturated fat make them more suitable to prevent occurrences of such diseases.

Keyword: Plant-based, Cardiovascular disease, Vegetarian, Heart, Dietary Fiber, Diet

INTRODUCTION

Non-communicable diseases (NCDs) are chronic diseases of long duration which are caused due to the combination of genetic, physiological, environmental and behavioral factors and are not caused by any infectious agents. One in 4 Indians has a risk of dying from an NCD before their life expectancy [1]. **Cardiovascular diseases (CVDs)** are a group of disorders of the heart and blood vessels that include coronary heart disease (CHD), cerebrovascular disease, ischemic heart disease, rheumatic heart disease and other conditions. According to WHO, 17.9 million people die every year due to CVDs, an estimated 31% of all deaths worldwide [2] and of this more than 75% of CVD deaths take place in lower economy nations. WHO's Global Health Estimates reported that ischemic heart disease (IHD) was the top reason of mortality in both 2000 and 2019. It is responsible for the largest increase in deaths – more than 2 million – over the last two decades [3]. Cardiovascular diseases contributed to 28.1% of total deaths in India in 2016 compared with 15.2% in 1990. The IHD and stroke were the predominant type of CVD [4].

Diet plays a crucial role in the onset and progression of these chronic disease. One of the major types of diet is plant-based vegetarian diet. The word vegetarian is derived from the Latin word *vigore* which means giving strength and health. An individual who uses, or advocates the use of vegetable foods, with addition to milk and egg but exclude meats is considered to be a vegetarian. There are various categories under plant-based diet which include lacto-vegetarian, ovo-lacto vegetarian, ovo-vegetarians, fruitarians and vegans [7]. The consumption of milk and milk products along with a variety of plant-based foods including mushrooms can help in meeting the daily requirements for protein [8, 9, 10]. A plant-based diet has higher content of dietary fiber and, micronutrients like vitamins C, and many phytochemicals. There is a trend of fortifying milk and milk byproducts with plant-based dietary fiber [11, 12] and plant-based ingredients like tomatoes [10].

HYPERTENSION-CVD & PLANT-BASED DIET

In 2015, WHO reported that in India, nearly 5.8 million people die from such diseases like CVDs and lung diseases, stroke, cancer and diabetes each year [1]. Hypertension is also considered as a causative factor for heart disease as it

increases the workload on the heart causing structural and functional alteration in the myocardium and leading to changes including hypertrophy of the left ventricle, which can progress to heart failure. It was seen in a study that diet affects measured BP levels, both systolic and diastolic, with vegans and lacto-ovo vegetarians having lower BP than non-vegetarians [18,22,36]. The peril of CVD doubles with each 20 mm Hg increase in systolic BP over 115 mm Hg or each 10 mm Hg increase in diastolic BP over 75 mm Hg[17]. The vegetarian diet has a relatively high PUFA to SFA ratio, are relatively low in total fat, and have a high potassium, magnesium, and fiber content as they are high in fruits, vegetables, legumes, and nuts [20].The fat content of vegetarian diet is more unsaturated in comparison with the fat content of non-vegetarian diet [14,15, 16, 56]. Also, in comparison to other vegetarian diets, the vegan diets which is devoid of all animal products comprise less saturated fat and cholesterol and more dietary fiber [57]. Hence the individuals taking vegan diet carries less concentration of energy dense nutrients due to its dietary fiber content, have lower serum cholesterol, and lower blood pressure which ultimately reduces their risk of heart disease [12, 56]. The defensive role of these foods is also mediated by their tendency to decrease body weight and modulate blood viscosity, along with the blood pressure lowering properties of individual nutrients [19,20]. Hence the vegetarians experience less CHD than the non-vegetarians as they have high plasma HDL, and low LDL cholesterol and this is also true for blood pressure and lower the risk of hypertension[21].

OBESITY-CVD& PLANT-BASED DIET

Obesity and being overweight is considered in category II risk factor in occurrence of cardiovascular disease for which interventions are likely to lower the CVD risk [23]. The increased adiposity is linked up with several other CHD factors such as hypertension, sedentary life style, high cholesterol etc. can lead to development of heart disease [23]. Population studies suggest that vegans and vegetarians consume diets that are higher in carbohydrate and dietary fiber, lower in energy, protein, total fat, cholesterol, and saturated fat, and have a higher polyunsaturated fat to saturated fat ratio compared with the diets of non-vegetarian groups [24,25,26,27]. In this aspect a study revealed that because vegetarian diets are associated to reduce body weight and lower rates of obesity, vegetarians generally have a lower risk of chronic diseases like coronary heart disease, hypertension, and diabetes [28].

PLANT-BASED DIET & ISCHEMIC HEART DISEASE

Mortality from ischemic heart disease (IHD) and cerebrovascular disease is lower in vegetarians than in non-vegetarians [29]. High-fat diets are related to the onset of cardio-vascular disease, cancer and obesity. Large intakes of saturated and trans-fatty acids along with low levels of polyunsaturated fatty acids leads to development of cardiovascular disease. Hence, lower platelet/plasma concentrations of n-3 polyunsaturated fatty acids in vegetarians may implicate to the non-significant difference in mortality from circulatory diseases in vegetarians and non-vegetarians [29].

As Ischemic Heart Disease is most prevalent heart disease, occur when heart do not get enough blood and oxygen. The high dietary fiber content of minimally processed cereals particularly millets play a major role in cholesterol lowering by eliminating LDL from the body and increasing the effects of HDL [30]. Several studies had concluded that the minimal risk of IHD among individuals consuming vegetarian diet have an attenuated levels of risk factors for IHD like LDL-cholesterol concentrations and systolic blood pressure [31,32,33]. The vegetarians had an improved lipid profile than the non-vegetarians, due to a higher ratio of PUFA to SFA ratio in their diet and a lower BMI. The folate present in vegetables has also the prophylactic role against the IHD by decreasing the homocysteine concentrations. The low folic acid intake is related to increased plasma homocysteine concentrations as the elevated homocysteine concentrations may kick in to the higher IHD rates [34].

PLANT-BASED DIET & HEART FAILURE

Diet plays an important role in the initiation and progression of heart failure and cerebrovascular disease [35]. Although there are limited studies, evidence shows the beneficiary role of plant-based foods and vegetarian dietary patterns in prevention as well as intervention in heart failure. Well-balanced vegetarian diets render benefits in precluding and inverting atherosclerosis and in tapering off CVD risk factors. Limited evidence suggests that the cardio vascular benefits seem to be greater with vegan than lacto-ovo-vegetarian diets. A healthy diet and a healthy life style are essential to prevent and deal with Cardio Vascular Diseases. The National Cholesterol Education Program (NCEP), the American Heart Association (AHA), and a host of other health and medical organizations have suggested a diet low in total and saturated fatty acid for reducing risk of cardiovascular disease[5].Replacing the dietary saturated fat with polyunsaturated fatty acids is associated with improved cardiovascular outcomes. Dietary fats like trans-fats and saturated fats associated with an increased risk of CHD, but the polyunsaturated fats are known to be protective against

CHD. Regular intake of fruits and vegetables is protective against hypertension, CHD and stroke. Composite diets such as DASH diets, Mediterranean diet, prudent diet have been demonstrated to reduce the risk of hypertension and CHD [6].

PLANT-BASED DIET & LIPID PROFILE

In the context of Vegetarian Diet and Lipid Profile, a comparative study conducted between the African strict vegetarians and lacto ovo-vegetarians revealed that strict vegetarians exhibit a more favorable serum lipid profile than lacto-ovo vegetarians and plasma AA is inversely related to BP [38]. And when the Nigerian vegetarian, semi vegetarian and non-vegetarian were compared, it shows no substantial deviation between the blood pressure (BP) of the above groups studied, although the vegetarians demonstrated lower systolic blood pressure [39]. The vegetarians had markedly lower serum total cholesterol and triglycerides, than non-vegetarians and the semi vegetarians had blood triglycerides values in between vegetarians and non-vegetarians' levels but these were not remarkable. When it comes to blood glucose in the three groups, no significant difference was seen [39].

Lower level of high-density lipoprotein cholesterol (HDL-C), a high total cholesterol (TC) to HDL-C ratio, and elevated triglyceride (TG) concentrations are said to be as pre disposing factors of cardiovascular risk [40-42]. And this ratio depends upon the quality of fatty acid present in the diet. Fat from animal origin as well as the tropical oils coconut and palm oil, are nutrients typically rich in saturated fatty acids. In contrast to animal fats, plant-based fats, i.e., vegetable oils, are generally rich in unsaturated fatty acids [43,44]. Plant-based sources of PUFA are preponderantly rich in n-6 (omega-6) fatty acids such as linoleic acid and some n-3 (omega-3) fatty acids such as α -linolenic acid. Trans fatty acid from butter, full-fat dairy, and meat from ruminants like beef, sheep, and goat raise LDL-C but also lowers HDL-C concentrations and therefore has the most unfavorable effects amongst dietary fatty acids[44]. There is clear evidence that partial replacement of saturated fatty acid with unsaturated fatty acids, especially vegetable oil containing PUFA mainly linoleic acid and the plant-based α -linolenic acid lowers the risk of CVD, mainly the risk of CHD [46,47,48]. There is a beneficial effect of specific macro- and micro-components of a plant-based diet (vegetable fats, dietary fiber) in the management of dyslipidemia and CVD prevention.[45]

PHYTOSTEROLS & CVD

Phytosterols (PS), comprising plant sterols and stanols, are compounds similar in structure and function to cholesterol. They plant-based natural foods and are found in vegetable oils (especially unrefined oils), vegetable oil-based margarines, seeds, nuts, cereal grains, legumes, vegetables and fruits[44]. PS intake markedly lowers LDL-C and Triglycerides in a dose-dependent manner by 6–12% when consumed 0.6–3.3 g/day without touching HDL-C [51]. The key mechanism for PS mechanism is partial prohibition of intestinal absorption of (dietary and biliary) cholesterol, with various implicit mechanisms involving displacing cholesterol from mixed micelles, by interfering with transport-mediated processes of sterol uptake and by enhancing cholesterol excretion via the transintestinal excretion [52]. It was observed that taking 2 g/day of PS brings down cholesterol absorption by 30–40%, leading to a collateral 10% lowering of circulating LDL-C[49]. With vegetarian or vegan diets, PS consumption can raise up to 600 mg/day[50]. Hence the vegetarian diet through its phytosterols content is helpful in preventing certain chronic diseases.

BEING VEGAN AND RISK OF CVD

The growing evidence revealed that consumption of a vegetarian diet and specific constituents of a vegetarian diet is able to lower the possibility of CVD and mortality. Vegetarian diet reduces the chance of rising symptoms of CVD by modifying serum lipids, bringing down blood pressure, improving glycemic control and insulin sensitivity, by reducing weight, and hence it lowers death [53, 54]. Vegetarian diet has certain vascular effects like thinner carotid Intima-media-thickness and lower brachial artery resistance [54]. A study showed that high consumption of fruit and vegetables displays 48 % protection against CVD risk factors like obesity, hypertension and diabetes. Thus, the higher consumption of fruits and vegetables have a defensive role in the initiation and progression of CVD in human cases having increased rates of untimely coronary artery disease [13]. A meta-analysis and prospective study revealed that vegetarians usually have low incidence of death from ischemic heart disease; and reduced incidence of other chronic disorders like hypertension, stroke, type 2 diabetes, and some cancers compare to their non vegetarian's counterpart due to high consumption of diet based on plants only [53].

CONCLUSION

Both vegetarian and non-vegetarian diet have certain health impacts. Inclusively, the vegetarian diet is proving to be more helpful than the non-vegetarian diet in limiting the initiation and progression of CVD due to its high nutrient

content such as dietary fiber, PUFA and phytosterols by preventing the occurrence of other risk factors such as obesity, hypertension and diabetes. Thus, consumption of good number of fruits, vegetables, whole-grains, legumes, nuts, and various soy and mushroom products can help reduce the risk for CVD. Along with the type of diet taken, other factors like physical activity of the individual, genetic factors, lifestyle also play crucial role in the prevention and development of CVD and the related risk factors.

REFERENCES

- [1]. National Health Portal, Govt. of India (2016), Non-Communicable Diseases <https://www.nhp.gov.in/healthyliving/ncd2019>
- [2]. World Health Organization (2021), Non communicable Diseases. <https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases>
- [3]. The Global Health Observatory, World Health Organization (2021) <https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates>
- [4]. The changing patterns of cardiovascular diseases and their risk factors in the states of India: The Global Burden of Disease Study 1990–2016 by India State-Level Disease Burden Initiative CVD Collaborators. *Lancet Global Health* 2018; 6: e1339–51.
- [5]. Krauss, R.M., et al. (2000). Revision 2000: A Statement for Healthcare Professionals from the Nutrition Committee of the American Heart Association. *Circulation*, volume 102, Issue 18.
- [6]. Reddy, K.S. and Katan, M.B. (2004). Diet, nutrition and the prevention of hypertension and cardiovascular diseases. *Public Health Nutrition*, 7(1a), 167–186.
- [7]. Jayanthi, V. (2001). Vegetarianism in India. *Peritoneal Dialysis International*. 2001;21(3_suppl):322–325.
- [8]. Arora, Simran Kaur. 2022. The Rising Indian Dairy. *Indian Food Industry*. 4(1) 11–14.
- [9]. Kumar, N., Nath, N. and Arora S. K. (2019). Process Optimization and Characterization of 'Sev' (a Traditional Indian Extruded Snack) with the Incorporation of Mushroom Powder. *Journal of Food Science and Technology*. 56(4): 1723–1731.
- [10]. Simran Kaur Arora. (2022). Process Optimization for Whey-Based Tomato Soup. *Acta Scientifica Nutritional Health*. 6 (2) 133–139.
- [11]. Arora, Simran Kaur and Patel, A.A. (2017). Effect of Fiber Blends, Total Solids, Heat Treatment, Whey Protein Concentrate and Stage of Sugar Incorporation on Dietary Fiber-Fortified *Kheer*. *Journal of Food Science and Technology*. 54(11):3512–3520.
- [12]. Arora, S. K. and Patel, A.A. (2015). Development of Yoghurt “Rich-in” Dietary Fiber and its Physico-chemical Characterization. *International Journal of Basic and Applied Agricultural Research* 13 (2): 148–155.
- [13]. Radhika, G.; Sudha, V.; Sathya, R.M.; Ganesan, A.; Mohan, V. (2008). Association of fruit and vegetable intake with cardiovascular risk factors in urban south Indians. *British Journal of Nutrition*. 99(2): 398–405.
- [14]. Vigiouliouk, E.; Kendall, C.W.; Kahleova, H.; Rahelic, D.; Salas-Salvado, J.; Choo, V.L.; et al. (2018). Effect of vegetarian dietary patterns on cardiometabolic risk factors in diabetes: a systematic review and meta-analysis of randomized controlled trials. *Clinical Nutrition*. 38:1133–45.
- [15]. Craig, W.J. (2010). Nutrition concerns and health effects of vegetarian diets. *Nutrition in Clinical Practice*, 25 (6), 613–620
- [16]. Pettersen, B.; Anousheh, R.; Fan, J.; Jaceldo-Siegl, K.; & Fraser, G. (2012). Vegetarian diets and blood pressure among white subjects: Results from the Adventist Health Study-2 (AHS-2). *Public Health Nutrition*, 15(10), 1909–1916.
- [17]. Lewington, S.; Clarke, R.; Qizilbash, N.; Peto, R.; Collins, R. (2002). Prospective Studies Collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet*. 2002;360:1902–1913.
- [18]. Anholm, A.C. (1975). The relationship of a vegetarian diet to blood pressure. *Preventive Medicine*. 4:35
- [19]. Lawrence, J.B.; Ian, L.R.; Armszrong, B.K.; Margetts, B.M.; and Vandongen, R. (2020). Vegetarian diet and blood pressure levels: incidental or casual association? *The American Journal of Clinical Nutrition*. 1988;48:806–810
- [20]. Berkow, S.E.; Barnard, N.E. (2005). Blood Pressure Regulation and Vegetarian Diets, *Nutrition Reviews*, Volume 63, Issue 1, Pages 1–8
- [21]. Gary E Fraser. (2009). Vegetarian diets: what do we know of their effects on common chronic diseases? *The American Journal of Clinical Nutrition*, Volume 89, Issue 5, Pages 1607S–1612S
- [22]. Burr, M.L.; Bates, C.J.; Fehily, A.M.; St Leger, A.S. (1981). Plasma cholesterol and blood pressure in vegetarians. *Journal of Human Nutrition*. Dec;35(6):437–441.
- [23]. Srilakshmi, B. (2014). *Dietetics*. New age International (P) Limited.
- [24]. Key, T.J.; Davey, G.R.; Appleby, P.N. (1999). Health benefits of a vegetarian diet. *Proceedings of the Nutrition Society*. 58:271–275.

- [25]. Kennedy,E.T.; Bowman,S.A.; Spence, J.T.; Freedman,M.; King,J.(2000). Popular diets: correlation to health, nutrition, and obesity. *Journal of American Dietetic Association*. 101:411–420.
- [26]. Thorogood,M.; Roe, L.; McPherson,K.; Mann,J.(1990). Dietary intake and plasma lipid levels: lessons from a study of the diet of health-conscious groups. *British Medical Journal*.300:1297–1301.
- [27]. Davey,G.K.; Spencer,E.A.; Appleby,P.N.; Allen,N.E.; Knox,K.H.; Key,T.J.(2003). EOIC-Oxford: lifestyle characteristics and nutrient intakes in a cohort of 33,883 meat-eaters and 31,546 non-meat-eaters in the UK. *Public Health Nutrition*. 6:259–268.
- [28]. Berkow,S.E.;Barnard,N.(2006).Vegetarian Diets and Weight Status. *Nutrition Reviews*, Volume 64, Issue 4, Pages 175–188
- [29]. Huang,T.;Yang,B.;Zheng,Li,G.;Wahlqvist,M.L.;Li,D.(2012).Cardiovascular disease mortality and cancer incidence in vegetarians:a meta-analysis and systematic review. *Annals of nutrition and metabolism*,60(4),233-240.
- [30]. Arora, S K. 2022. Cereals for prevention of disease conditions for better health. In: Cereals and cereal-based foods. Eds. M. R. Goyal, K. Kaur and J. Kaur., Apple Academic Press, Inc. Canada. 273-291p.
- [31]. Burslem,J.; Schonfeld,G.; Howald,M.A.(1978). Plasma apoprotein and lipoprotein lipid levels in vegetarians. *Metabolism*.1978;27:711–9
- [32]. Lock,D.R.; Varhol,A.; Grimes,S.; Patsch,W.; Schonfeld,G.(1983). ApoA-I/ApoA-II ratios in plasmas of vegetarians.*Metabolism*.32 (12), 1142-1145.
- [33]. Thorogood, M.; Carter, R.; Benfield, L.; McPherson, K.; Mann,J.I.(1987). Plasma lipids and lipoprotein cholesterol concentrations in people with different diets in Britain. *British Medical Journal (Clin Res Ed)*. 295 :351
- [34]. Rastogi,T.;Reddy,K.S.;Vaz,M.;Spiegelman,D.;Prabhakaran,D.;Willett,W.C.; Stampfer, M.J.;Ascherio,A.(2004).Diet and risk of ischemic heart disease in India, *The American Journal of Clinical Nutrition*. 79 (4) 582–592.
- [35]. Kahleova,H.;Levin,S.;Barnard,N.D.(2018).Vegetarian Dietary Patterns and Cardiovascular Disease.*Progress in Cardiovascular Diseases*. 61(1),54-61.
- [36]. Le, L.T.;Sabaté, J.(2014).Beyond meatless, the health effects of vegan diets: findings from the Adventist cohorts. *Nutrients* 6(6):2131–47.
- [37]. Jian,Z.H.;Chiang,Y.C.,et.al.(2014).Vegetarian diet and cholesterol and TAG levels by gender 2014. *Public Health Nutrition*. Volume 18 Issue 4
- [38]. Toohey, M.L.; Harris, M.A.;Williams,D.;Foster,G.; Schmidt,W.D.& Melby,C. (1998) .Cardiovascular Disease Risk Factors are Lower in African-American Vegans Compared to Lacto-Ovo-vegetarians, *Journal of the American College of Nutrition*, 17(5), 425-434.
- [39]. FamoduAA, OsilesiO, Makinde,YO, OsonugaOA(1998)Blood pressure and blood lipid levels among vegetarian, semi-vegetarian, and non-vegetarian native Africans.*Clinical Biochemistry*. 31 (7) 545-549
- [40]. Chapman,M.J.; Ginsberg,H.N.; Amarenco,P.; Andreotti,F.; Boren,J.; Catapano, A.L.; et al.(2011).Triglyceride-rich lipoproteins and high-density lipoprotein cholesterol in patients at high risk of cardiovascular disease: evidence and guidance for management. *European Heart Journal*.32(11):1345–61.
- [41]. Kinoshian, B.; Glick, H.; Preiss,L.; Puder, K.L.(1995).Cholesterol and coronary heart disease: predicting risks in men by changes in levels and ratios. *Journal of Investigative Medicine*. 43(5):443–50.
- [42]. Stampfer, M.J.; Sacks,F.M.; Salvini ,S.;Willett,W.C.;Hennekens,C.H.(1991).A prospective study of cholesterol, apolipoproteins, and the risk of myocardial infarction. *The New England Journal of Medicine*. 325(6):373–81.
- [43]. Zock, P.L.; Blom, W.A.M.; Nettleton, J.A.;Hornstra, G.(2016). Progressing Insights into the Role of Dietary Fats in the Prevention of Cardiovascular Disease. *Current Cardiology Reports*, 18, 111.
- [44]. Trautwein, E Aand McKay,S(2020).The Role of Specific Components of a Plant-Based Diet in Management of Dyslipidemia and the Impact on Cardiovascular Risk.*Nutrients* .12, 2671.
- [45]. Zock, P.L.; Blom,W.A.; Nettleton ,J.A.; Hornstra ,G.(2016). Progressing Insights into the Role of Dietary Fats in the Prevention of Cardiovascular Disease. *Current Cardiology Report*.18(11):111.
- [46]. Harika,R.K.; Eilander ,A.; Alsema,M.; Osendarp ,S.J.; Zock, P.L.(2013). Intake of fatty acids in general populations worldwide does not meet dietary recommendations to prevent coronary heart disease: a systematic review of data from 40 countries. *Annals of Nutrition and Metabolism*. 63(3):229-38.
- [47]. Mensink, R.P.(2016). Effects of Saturated Fatty Acids on Serum Lipids and Lipoproteins: A Systematic Review and Regression Analysis. World Health Organization: Geneva, Switzerland.
- [48]. Schwingshackl, L.; Bogensberger, B.; Benčić, A.; Knüppel, S.; Boeing, H.; Hoffmann, G.(2018).Effects of oils and solid fats on blood lipids: A systematic review and network meta-analysis. *Journal of Lipid Research*.59, 1771–1782.

- [49]. Gylling, H.; Plat, J.; Turley, S.; Ginsberg, H.N.; Ellegård, L.; Jessup, W.; Jones, P.J.; Lütjohann, D.; März, W.; Masana, L. et al. (2014). Plant sterols and plant stanols in the management of dyslipidaemia and prevention of cardiovascular disease. *Atherosclerosis*, 232, 346–360.
- [50]. Jaceldo-Siegl, K.; Lütjohann, D.; Sirirat, R.; Mashchak, A.; Fraser, G.E.; Haddad, E. (2017). Variations in dietary intake and plasma concentration of plant sterols across plant-based diets among north American adults. *Molecular Nutrition & Food Research*. Vol 61(8).
- [51]. Ras, R.T.; Geleijnse, J.M.; Trautwein, E.A. (2014). LDL-cholesterol-lowering effect of plant sterols and stanols across different dose ranges: A meta-analysis of randomised controlled studies. *British Journal of Nutrition*. 112, 214–219.
- [52]. De Smet, E.; Mensink, R.P.; Plat, J. (2012). Effects of plant sterols and stanols on intestinal cholesterol metabolism: Suggested mechanisms from past to present. *Molecular Nutrition & Food Research*. vol 56, 1058–107.
- [53]. Glenn, A.J.; Vigiouk, E.; Seider, M.; Boucher, B.A.; Khan, T.A.; Blanco, M.S.; Jenkins, D.J.A.; Kahleová, H.; Rahelić, D.; Salas-Salvado J., Kendall, C.W.C. and Sievenpiper, J.L. (2019). Relation of Vegetarian Dietary Patterns with Major Cardiovascular Outcomes: A Systematic Review and Meta-Analysis of Prospective Cohort Studies. *Frontiers in Nutrition*. 6:80.
- [54]. Migliaccio, S.; Brasacchio, C.; Pivari, F. et al. (2020). What is the best diet for cardiovascular wellness? A comparison of different nutritional models. *International Journal of Obesity Supplementation*. 10, 50–61.
- [55]. Dominique, A.M. (2013). Vegetarian Diets in Cardiovascular Prevention. *Current Treatment Options Cardiovascular Medicines* 15, 735–745 (2013).
- [56]. Craig, W.J. (2009). Health effects of vegan diets, *The American Journal of Clinical Nutrition*. Volume 89, Issue 5, May 2009, Pages 1627S–1633S.
- [57]. Satija, A.; Hu, F. B. (2018). Plant-based diets and cardiovascular health. *Trends Cardiovascular Medicine*. 28:437–41.