Role of Vegan Diet in Treatment and Prevention of Different Diseases

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Abstract— Positive impacts of vegan diets on disease control and prevention has been reported in recent studies. This review aimed to summarize the association of vegan diets on human health and their impacts on treating and controlling chronic diseases such as cardiovascular diseases, kidney diseases, and diabetes through a systematic review. A comprehensive search on Science Direct, Google Scholar, Medline, Scopus, and The Cochrane Library was conducted. Results: Overall, literature reported significantly reduced levels of body mass index, glucose, and cholesterol in vegans compared to omnivores. From the perspective of cohort studies, vegans have a low risk of incidence and/or mortality due to heart failure and other diseases. No significant evidence was reported in terms of mortality; however, lower risk of different diseases and improved human health can contribute towards longevity. This comprehensive review report conferred that a vegan diet could significantly reduce the risk of heart disease such as cardiovascular disease, kidney disease, and could also lower the incidence of diabetes and improve the human microbiome.

Index Terms— Vegan diet; cardiovascular disease; diabetes; kidney diseases; human microbiome

1 Introduction

A vegan diet is known as a therapeutic and potentially healthy dietary choice based on plant sources and a devoid of all animal products such as meat, dairy, and eggs [1]. It is a plant-based diet that belongs to eating habits that do not include the intake of all or most animal products and includes enhanced consumption of vegetables, legumes, fruits, nuts, whole grains, and seeds [2]. A vegan diet can be a part of different lifestyles [3] and more or less health-related issues [4, 5]. Populations that do not consume animal-based food due to their cultural or religious practices consist of a major proportion of vegetarians. For example, about 35% of the Indian population strictly consume a plant-based diet. Among vegetarians, about 10% are vegans; however, this percentage is increasing [6]. The introduction should be concise, with no subheadings. Limited figures may be included only if they are genuinely introductory and contain no new results. Appropriate selection of a vegan diet that sufficiently meets the requirements of proteins, iron, calcium, zinc, iodine, vitamin B12 n-3, and fatty acids can be healthful at all life stages [7]. Vegan diet consumption alternately in combination with a regular habitual, balanced omnivorous diet can also help to maintain the nutritional requirements. The increasing demand for unsustainable animal-based products by a growing and wealthier global population is adversely affecting the planet [8]. Plant-based food requires less energy for their production and has less impact on non-renewable environmental resources as well. Policies promoting the adoption of plant-based diets may pave the way to protect the environment while improving the well being of individuals [9].

A large number of epidemiological and clinical research studies have supported the general public perception about the use of a vegan diet for significant health advantages. Nutrition management is an essential key to the prevention and control of chronic diseases [10], including diabetes, obesity, and cardiovascular disease. The research suggested that a balanced vegan diet is suitable for all life cycle phases, from childhood to adolescence. Another study suggests that Western vegetarians possess similar and good health as compared to non-vegetarians [11].

2 The Scope/Importance of the Vegan Diet

The vegan diet has gained enormous interest due to its significant benefits. Numerous reports are stating the nutritional balance and health conditions of vegans [11, 12]. In a comparative study, the average body mass index (BMI) of the vegans was reported as 23.6 relatives to nonvegans who had a mean BMI of 28.8 [13], whereas an ideal BMI is deemed to be 22.5 to 25 [14]. Likewise, vegans are reported with a lower cholesterol level [15], a lower blood pressure level [16], a lower chance of getting diabetes [17], and a lowered risk of cardiovascular disease [18]. Vegan diets also reduce the risk of some cancers, i.e., stomach [19], colon [20], female [21], and prostate [20] cancers. It also reduced the diverticular disease in vegans up to a quarter compared to its occurrence in omnivores [22]. Furthermore, the vegan diet also decreased the hypothyroidism by 10% in vegans than omnivores [23]. It was also reported that the vegan diet reduced the overall death rate by 15%, which statistically significant [24]. Contrarily, other studies conducted with a small group of samples (e.g. [25, 26] found no survival advantage for those consuming a vegan diet.

The present review aims to provide an updated and comprehensive answer to the current developments of the vegan diet from a medical perspective, particularly cardiovascular disease, kidney disease, and human metabolites. It is hoped that the findings will be of use to researchers looking at understanding the role of the vegan diet in the medical perspective, such as treatments and prevention of various diseases

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and their possible mechanisms of action.

3 Role of the Vegan diet in Diseases Control and Their Possible Mechanisms

The vegan diet serves several benefits, such as substantial development in emotional and physical well-being, life quality, and general health [27]. The following section discusses the vegan diet benefits and their mechanism of action for cardiovascular disease, kidney diseases, diabetes, and gestational health.

3.1 Cardiovascular Disease

Cardiovascular disease (CVD) is among the prominent causes of mortality around the globe, accounting for ~ 46% (17.5 million) of noncommunicable disease deaths [28]. CVD is estimated as a leading cause of mortality worldwide by 2030, with up to 23 million deaths [29]. In the United States, ~ 85.6 million people suffer from CVD, and these numbers are rising continuously [30]. Many factors contribute to CVD, such as lifestyle behavior like increased consumption of preserved or processed foods, lower plant consumption, whole grains or fibers, and lack of exercise or physical activities [31].

To prevent and control the risk of CVD and myocardial infarction (MI), a healthy lifestyle adaption can help to lower the risk by 81–94%[32-34]. While the medications can reduce the risk by only 20–30% [35]. Other factors that help prevent and treat CVD involves the intrusions of modifying intermediate risks, such as Hypertension, obesity, prediabetes Mellitus (DM) and dyslipidemia along with a healthy lifestyle, i.e., eating a healthy balanced diet, exercise and no smoking are all important. Among these factors, nutritional balance is considered the most important factor to combat the disability and premature CVD death, relative to other habits such as; physical activities and no smoking [36]. Therefore, much more focus has been given on the incorporation of healthy eating habits in programs and the curriculum for CVD prevention and treatment.

The American Heart Association/American College of Cardiology (AHA/ACC) published the guidelines about nutritional recommendations, which includes the vegan diet among the dietary patterns that help meet the AHA/ACC strategies, in combination with the Mediterranean dietary plans and the Dietary Approaches to Stop Hypertension (DASH) diet. These recommendations put emphasis on increased consumption of plant-based diet or a vegan diet including fruits, legumes, vegetables, and whole grains, but discourage eliminating sugar-sweetened beverages, sweets, red meat, and processed foods which contains a higher amount of salt, sugar, fats, and are low in fiber [37]. Epidemiological studies have shown that the vegan diet contributes to lowering the incidences of several chronic diseases, including CVD and other heart diseases. These studies also reported that the vegan diet reduced the risk factors for type 2 diabetes, hypercholesterolemia, ischemic heart disease, coronary artery disease, and essential Hypertension. With this context over the past decades, interventional studies particularly related coronary artery disease (CAD) indicated that the vegan diet is an effective and safe alternative treatment for CAD. It is incredibly efficient for angina pectoris treatment. It is also revealed that vegan diet treatment can work alone or with standard therapies, including coronary artery bypass grafting (CABG), stenting, and medication. This plant-based diet treatment has excellent advantages of being affordable, having no contraindications or adverse reactions, and have high patient compliance.

3.1.1 Potential Mechanisms of the Vegan Diet to Reduce Risk of CVD

Vegan diets are naturally enriched with cardioprotective micronutrients such as potassium, magnesium, and antioxidants (including vitamin C and lycopene), nitrates, and dietary fibers, which can lower saturated/trans fats. On the other hand, animal-derived foods contain much lower concentrations of potassium, magnesium, antioxidants, and nitrates. Therefore, vegan diets derived from plant sources tend to improve antioxidants level and bioavailability of nitric oxide, and help to decrease hyperglycemia, blood pressure, lipids, obesity, reactive oxygen species, inflammation, homocysteine, and even atherosclerosis as shown below in Figure 1.

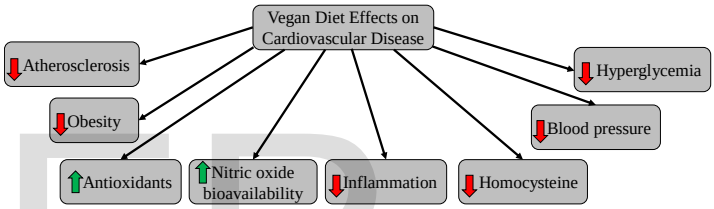

Figure 1: Schematics of vegan diets mechanism to reduce the risk of cardiovascular disease or heart failure

Another potential mechanism of the vegan diet effect is the nutritional regulation of the human gut microbiota. Many researches reported the generation of trimethylamine from the choline/phosphatidylcholine and L-carnitine due to intestinal microbiota metabolism, which further oxidized to form pro-atherogenic trimethylamine-N-oxide (TMAO) [38, 39]. Higher levels of TMAO are observed in people who have suffered from heart failure. [40]. Furthermore, there is an association between TMAO levels and BNP104, which is linked with the severity of heart failure and mortality [38, 40, 41].

Increased incidence/severity of heart failure is associated with red meat products due to their increased L-carnitine content [42-44], and eggs contained increased choline/phosphatidylcholine content [45]. Similarly, poultry, dairy, and fish are also good sources of choline and are linked with high TMAO production. Interestingly, vegan diet metabolized the limited choline/phosphatidylcholine and L-carnitine during digestion and are not reported to produce a substantial amount of TMAO even after ingestion of L-carnitine/choline. [39] Overall, the vegan diet provides a positive effect at the gut microbiome compared to nonvegan diets based on meat derived products, causing deleterious effects on the human gut microbiota [46].

3.2 Diabetes

According to WHO estimates in 2014, a global population of 422 million adults suffered from diabetes, while the International Diabetes Federation (IDF) predicted this to be increased by up to 642 million by 2040 [47, 48]. In the USA, more than 30

million had diabetes, and in the UK, it is over 4.5 million people [47, 49]. In 2010-2011, diabetes cost the annual economic burden of $245 billion on the USA (including $69 billion in direct and $176 billion direct costs, respectively) [50]. In the UK, diabetes cost about £24 billion (including £14 billion indirect and £10 billion direct costs) with the prediction of rising up to £40 billion in total by 2035 [51]. If diabetes is not adequately managed and treated, it can lead to adverse effects on a person's physical and psychological well-being, resulting in several health complications. According to the WHO and IDF suggestions, diabetes can significantly increase the risk of CVD, vision loss because of diabetic retinopathy, lower extremity amputation and nephropathy [47, 48]. In most countries, diabetes (along with its health issues) is associated with a higher risk of mortality [47, 52]. In 2015, approximately 5 million casualties were reported due to diabetes, whereas at a global scale, about 14.5% of all-cause mortality occurred due to diabetes [47]. The countries are having a significant proportion of diabetic patients also have an increased rate of mortality due to diabetes. These countries include China, USA, Russian Federation, and India. In 2015, type 2 diabetes (T2D) was the 7th leading cause of death in the USA alone. [49].

The American Association of Clinical Endocrinologists and the American College of Endocrinology published their latest strategies in 2018 for the better management of diabetes using a plant-based diet, which is considered the balanced diet plan for diabetic patients [53]. According to the IDF reports, the development of T2D is significantly due to a lifestyle based on a low diet plan that includes increased contents of fats and processed food) [47]. WHO highlighted the importance of following standardized and constant management plan by supporting mediations that promote healthy diets [48]. Numerous studies reported the increased meat consumption could lead to T2D [54-56]. Another research study based on a large population size of 340,000 adults and a mean period of 11 years in Europe also stated that increased meat consumption is significantly associated with the occurrence of T2D [57]. This fact remains persistent even when the other risk elements for T2D (such as exercise, smoking, and alcohol intake) were avoided or managed. Therefore, a healthy diet has a significant and clear impact on the treatment and control of T2D.

As vegan diets are based on the consumption of plants and their related products while avoiding all animal-related products. A study reported that the plant-based diet significantly reduced the risk of T2D [58]. Another study also stated that vegan diets could effectively and considerably reduce the incidence of diabetes [17]. Additionally, many other studies reported that the increased consumption of fruits and vegetables, fiber, and whole grains could effectively lower the risk of T2D [59-61].

A vegan diet includes micronutrients, fiber, antioxidants, and unsaturated fatty acids, which provide high defense against diabetes development, as they are considered protective elements against diabetes [58]. A meta-analysis focusing on the vegan diet reported significant improvement in glycated hemoglobin (HbA1c) level within diabetes patients while following the vegan diets [62].

3.2.1 Potential Mechanisms of The Vegan Diet to Lower the Risk of Diabetes

Vegan diet help to lower insulin resistance while increasing glycemic control via several proposed mechanisms. These diets typically contain rich sources of antioxidants, fiber, and magnesium content, that promote insulin sensitivity as shown in Figure 2 [63, 64]. Antioxidants like polyphenols might prevent glucose absorption, lower hepatic glucose output, improve insulin secretion, and glucose uptake [65]. Plants are the only foods that are rich in fiber content; these fibers regulate postprandial glucose response. Intestinal bac-teria are fermented to produce short-chain fatty acids that help to improve glucose response, insulin signaling, and sensitivity [66-68]. Moreover, fiber can reduce the energy density of food particles, enhance satiety, and help to reduce body weight, which in return decreases insulin resistance [69]. These dietary fibers also help to reduce inflammation markers, which can improve insulin resistance [64]. Ulti-mately, plant-based foods are more likely to induce benefi-cial impacts on the metabolic profile of the gut's microbiota, reduced the production of TMAO compound that is associ-ated with insulin resistance [64, 68, 70].

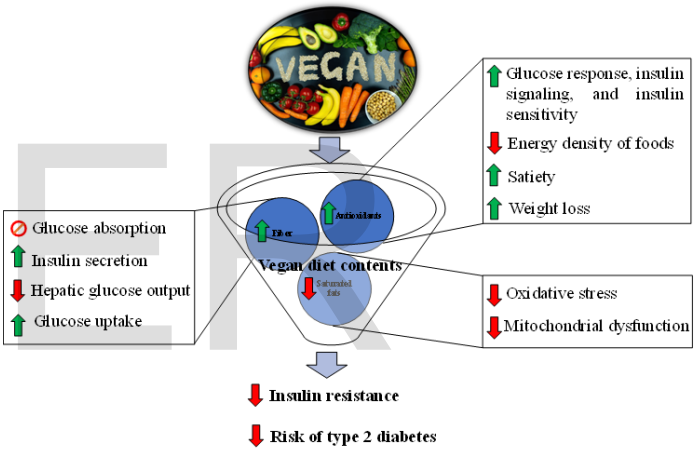

Figure 2: Overview of vegan diets mechanism to reduce the risk of diabetes

According to numerous epidemiologic and metabolic studies, the vegan diet consists of lower saturated fats, ni-trosamines, heme iron, and improved glycation end prod-ucts, that have been associated with insulin resistance. Con-trarily, animal-based food products are rich in saturated fats, which can lead to lipotoxicity, a mechanism in which accumulation of toxic fat metabolites (such as species of di-acylglycerol and ceramide) occurs in hepatic and skeletal muscle cells, damaging insulin signaling and consequently reduce glucose uptake [71-73]. Numerous studies have also reported the correlation of saturated fats with mitochondrial dysfunction, oxidative stress, and insulin resistance [74-76]. Therefore, diets containing increased contents of saturated fats would lead to insulin resistance and inflammation [77].

Vegan diet has also been reported to decrease visceral fats and improve markers of oxidative stress relative to the conventional diet, including animal-derived food products and type 2 diabetic patients [78]. Advanced glycation end products (AGE) are involved in type 2 diabetes [70]. Plant-based foods like vegetables, fruits, legumes, and whole grains contain lower content of these oxidant compounds [79], enhancing insulin resistance in type 2

diabetic patients [80]. Nitrosamines are the compounds that stimulate the generation of reactive oxygen species (ROS), DNA damage, and proinflammatory cytokines, resulting in oxidative stress and, ultimately, insulin resistance [70]. A pro-oxidant substance known as heme iron obtained from animals endorsed insulin resistance through several possible mechanisms such as an increase in oxidative stress lead towards insulin signaling disruption, beta-cell toxicity in the pancreas, re-duced translocation of glucose transporter type 4 channels to the cell membrane, and improved hepatic glucose output [70]. Several studies have reported a positive correlation be-tween dietary heme iron and the increased risk of type 2 di-abetes [81-83].

Another critical aspect of the vegan diet is to promote weight loss and reduce adiposity [84-86], which are positively asso-ciated with insulin resistance. On the other hand, meat con-sumption is directly related to obesity and increased body weight over time [87-89]. Therefore, meat-based products can increase the risk of type 2 diabetes either by weight gain or through mechanisms irrespective of body mass index. Even within the vegan diet pattern, refined forms of grains, and additional sugars result in weight gain and insulin re-sistance [90, 91]. Therefore, whole plant foods or plant-based foods, excluding all forms of animal-based products, refined forms of grains, and additional sugar content could promote insulin sensitivity by losing excessive weight and maintain-ing healthier body weight. However, it is a confirmed fact that the vegan diet improves insulin resistance regardless of the weight loss and/or with statistical adjustment of body mass [2].

3.3 Kidney Diseases

Chronic Kidney Disease (CKD) is one of the prominent causes of mortality in the USA, and significant amounts of medical resources and money are required for its treatment. Therefore, the dietary therapy of CKD has gained interest as its prevalence has been growing. Several epidemiological reports have shown that vegetarians have a lower risk of chronic kidney disease. However, there is an increased risk factor among non-vegetarians, especially those who consume processed and red meats. In recent years, plant-based diets with low-protein content are increasingly used to treat chronic kidney disease. A recent study has reported that chronic kidney disease can be controlled and treated by using a low-protein vegan diet. This diet, augmented with keto analogs, reduces proteinuria, uremia, acidosis, phosphaturia, and slows their progression. The study also reported that low protein vegetarian diet treatment does not cause malnutrition and helps to prevent and treat common comorbidities, i.e., type 2 diabetes and coronary artery disease. Moreover, more plant protein can be consumed than the animal protein without any adverse effects [92].

Several epidemiological studies have reported that people consuming a vegan diet are at a lower risk of CKD than those who consume nonvegan (animal) diets. These studies also suggest that the people who are consuming a vegan diet have improved renal function than those following the nonvegan diet. Moreover, epidemiological studies also showed that the vegan diet also reduced the risk factors for other diseases, i.e., hypertension and type 2 diabetes. Epidemiological studies clearly showed the results of eating habits that increase or decrease the risk of CKD. These studies also reported that the consumption of saturated fat and red meat increases the risk of CKD, whereas consumption of a vegan diet reduces it. Comparative studies on the consumption of proteins derived from animal and plant-based sources have shown a lower risk of CKD, reduced nephropathy progression, kidney injury, and improved metabolic acidosis.

Vegan diet can also help to prevent the changes caused by glomerular sclerotic on health and well-being. Some of the details of such studies discussed below: vegan diet reported to have a lower glomerular filtration rate (GFR). As an increase in GFR plays an essential role in developing renal disease and pathogenesis [93], a diet with a lower GFR decreased the risk of early-stage CKD. In another study, omnivores reported higher diastolic blood pressure and a significant increased urinary albumin excretion rate than vegans. Vegan's also reported with 78% reduced risk of type 2 diabetes and a 75% decreased risk of Hypertension [94]. Since type 2 diabetes and Hypertension are the prominent risk factors that lead to CKD [95, 96]. Therefore, using a vegan diet decreases their risk level, which would further lower the risk of CKD. An uncontrolled diabetic and/or hypertensive patient can easily and rapidly progress to an end-stage kidney disease patient [96].

Another epidemiological study based on the follow-up period of 23-years stated that diets with various protein sources have various risks of CKD: processed and red meat are adversely linked with risk of CKD, while plants derived foods such as legumes and nuts help protect against the advances of CKD. Processed and red meat increased 23% CKD risk, while a higher intake of legumes and nuts could reduce it by 19% and 17%, respectively [97].

Several reports indicated that the use of plant proteins compared to animal proteins could help to lower the risk of mortality and CKD progression [98, 99]. In a meta-study, consisted of six studies, healthy dietary plans with higher contents of legumes, vegetables, nuts, fruits, and whole grains were consistently linked with a decrease in mortality rate and CKD, with a 30% risk reduction rate. Substituting legumes and soy with red meat resulted in a 50%-62% reduced risk for ESRD [100]. Mounting evidence indicates that the plant-based dietary intervention is kidney protective. This was further confirmed from the National Kidney Foundation recommendation that a vegetarian diet as being beneficial to CKD patients [101].

Proteins are a rich source of acid load, phosphate, and nitrogen, reduced consumption of proteins shown a better control of proteinuria and blood pressure, which are important determining factors of the CKD progression [102]. Other than the factors mentioned above, certain complications, such as oxidative stress, acidosis, and mineral metabolism disorders, are also involved in accelerating CKD progression [103] and favorably affected by low-protein diets [103, 104]. In a meta-study of diets with low-protein, CKD patients with a small amount of protein intake shown a 32% reduction in the occurrence of renal death compared with unrestricted or higher intake of proteins [105]. Vegetables and fruits can be utilized as an alternative treatment of CKD without generating hyperkalemia. Their intake in an individual patient over a year with a stage 4 CKD reported reduced

kidney injury without developing hyperkalemia and improved metabolic acidosis [98].

3.3.1 Mechanism of the Vegan Diet to Reduce the Progression of Kidney Damage Potential

Vegan diets are rich in fiber content and can help to reduce kidney injury in CKD patients. CKD is attributed to numerous causes such as lowered consumption of nutrients (acids, sodium protein), increased intake of potassium, decreased phosphorus load, and increased intake of vitamins, antioxidants, fiber, and chemicals such as sulforaphane [106]. An overview of the effects of a vegan diet is presented in Figure 3 and discussed in detail.

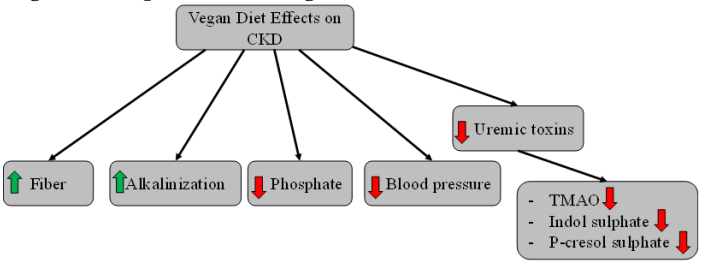

Figure 3: Vegan diet to reduce the progression of kidney damage.

3.3.1.1. Alkalinization

Dietary acid has an independent effect on renal function and albuminuria. An increase in dietary acid load can increase the albuminuria probability while decreasing the renal function [107]. Dietary acid also reported inducing kidney injury in rats with undamaged or reduced nephron mass due to tubulointerstitial injury, governed by endothelin receptors. Researcher's endorsed the fact that renal injury increased with the increase in dietary acid load. At the same time, acidosis levels can be adjusted using a vegan diet or by oral NaHCO3 that could reduce renal injury due to hypertensive nephropathy [108, 109].

3.3.1.2. Blood Pressure

Vegan diet is lowered in sodium content and can reduce the systolic blood pressure in CKD patients, an approach to decrease dietary acid levels to protect kidney functions [108]. Vegan diet, including vegetables and fruits, are the primary source of nitrate, potassium, and fibers. Studies have reported that the potassium in diet could reduce blood pressure [110]. In another study, it was also reported that the fibers intake decreased blood pressure and the inflammatory markers, which could help to reduce the risk of CKD [111].

3.3.1.3. Uremic Toxicants

Vegan diet also modifies the intestinal microbiota, which could help to decrease the nephrotoxic uremic toxins production [112]. The intestinal microbiota contributes to the production of uremic toxicants including p-cresyl sulfate (PCS), indole-3 acetic acid, indoxyl sulfate (IS), and or trimethylamine N-oxide (TMAO), etc., which formed as a result of amines or amino acids breakdown and are normally excreted by the kidneys during normal function. However, they are accumulated in the existence of CKD while producing their deleterious effects [113-115]. Dietary proteins/fibers derived from vegan diets were considerably linked with serum PCS and IS levels [116], beyond their association with kidney function [117]. They can decrease the formation of the uremic toxins by restricting proteolytic bacterial fermentation. A lower intake of protein-fiber diet may help to lower the PCD and IS levels [117].

3.3.1.4. Phosphates

Patients with advanced CKD have rapid progression to ESRD due to their association with hyperphosphatemia [118]. High phosphate intake increases the phosphate burden, causing phosphaturia resulting in secondary kidney damage via interstitial fibrosis and tubular injury [119]. Extreme phosphaturia has been associated with higher inflammation, oxidative stress, renal injury, and reduced renal Klotho [120], which further disturbed the renal function of CKD patients. According to a meta-study, phosphate derived from the vegan diet was mostly available in the form of phytate, which does not exceed the intestinal absorption from 30% to 40% [121] animal-based proteins with greater absorption capacity. Therefore, vegan diets are recommended to control the phosphorus homeostasis in CKD patients, which could reduce the progression of CKD.

3.3.1.5. Fibers

As the vegan diet is rich in fiber content, it is associated with decreasing the risk of incident CKD [122]. Another study reported the inverse relationship between total fiber intake and risk of CKD [123], indicating that a higher fiber intake, derived from vegetables and legumes, may lower the progression of CKD. However, recent studies suggested that a healthy planned diet including vegetables and fruits could reduce the risk of CKD [100].

4. Role of the Began Diet on The Human Microbiome

The human microbiome has gained enormous importance in recent studies. For many years, several studies have revealed that the human gut microbiota affects the host physiology, with new and unique implications for health and disease. These findings suggest that a vegan diet, associated with lower body weight, might be beneficial for microbial diversity and protect against inflammation. Furthermore, vegans also possess significantly greater richness (alpha diversity) than omnivores, particularly in counts of specific Bacteroidetes-related operational taxonomic units (OTUs) [124]. Probably, several health benefits of vegan diets are mediated by the gut microbiota—not only due to the higher relative abundance of those OTUs (including Bacteroidetes, Prevotella, and Roseburia, etc.) but also due to the postbiotic and epigenetic effects [125]. Recently, the consumption of food nutrients with low bioavailability is vital. Larger food particles with whole-plant cell walls or uncooked foods have lower nutrient bioavailability which means that more nutrients can reach the more inadequate gastrointestinal system, hence improve nutrient delivery to the gut microbiota. This helped to sustain development and function of normal gut microbiota [126]. Whole or raw plant foods favored the growth of useful bacteria that breakdown fibers in the colon [127].

5. CAN A VEGAN DIET BE A SOURCE OF A HEALTHY AND SUSTAINABLE DIET AND STEP TOWARDS ENVIRONMENTAL SUSTAINABILITY?

There are numerous environmental issues associated with the vegan diet approach, we have briefly discussed here the main factors as shown in Figure 4.

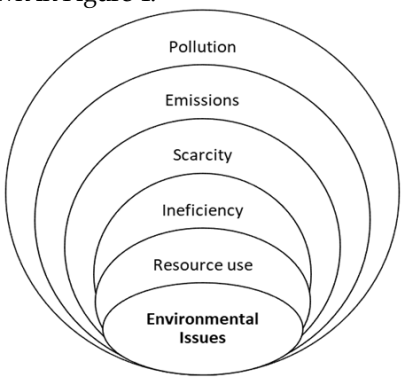

Figure 4: Environmental issues associated with a vegan diet and environmental sustainability

As the animal husbandry is operating at a large scale and using large scale facilities consisting of open and confined animal feeding operations. These operating systems contain many thousands of animals and their total production constitutes the world's poultry (chicken and turkey: 74%), beef (43%), and eggs (68%) [128].

5.1. Resource Usage

Annually, about 60 billion animals are consumed by humans that use plenty of resources for their growth [129]. The animal feed constitutes 55% of corn produced in the USA, 40% of grains, and over 85% of soybeans harvested worldwide. Likewise, almost 50% of the world's annual forage fish catch is used as feed in the aquaculture (46%), pork (24%), and poultry (22%) industries. In this way, most of the land resources, energy, and water used to produce feed crops to maintain the supply of animals. However, these resources could be used to grow food crops more efficiently and can be directly consumed by humans.

5.2. Inefficient Use of Resources

Meat production is highly inefficient [129]. To get 1 kg of edible meat from beef, pork, and chicken through standard industrial procedures, it requires 20, 7.3, and 4.5 kg of feed, respectively. At the global average level, the production of just 1 kg of beef required approximately 15,500 L water, which is 12 times higher than the quantity needed to produce 1 kg of wheat. In land resources, 1 kg of beef requires 15 times more land than the production of 1 kg cereals and 70 times more land than the production of 1 kg of vegetables.

5.3. Resource Scarcity

As the animal raising demands for more feed grains which is intensifying the ecologic pressure on grazing land, which is already scarce [129, 130]. Marginal lands are now also being used in different animal operations where overgrazing can lead to desertification and deforestation. Loss of tropical rain forests is occurring in South America due to the increased production of soybean for factory farms in Europe and other regions. This animal husbandry on a large scale caused damage to wildlife habitats and became a severe threat to biodiversity globally. About 2 billion people are facing a water scarcity issue [131]. Livestock production used almost 15% of the total irrigation water, which is estimated to increase by up to 50% by 2025. In China, increased meat consumption has been considered as the leading cause of exacerbating water scarcity. Therefore, lowering the consumption of animal-based food products and increasing the proportion of plant-based food in the diet can help to reduce the per-person water footprint by half.

5.4. Greenhouse Gas Emissions

Among anthropogenic greenhouse gas emissions, global livestock production contributes about 18%, which is greater than international transport (14%). Global greenhouse gas emissions from livestock production include nitrous oxide (65%), methane (37%), and carbon dioxide (9%) emissions. Moreover, ammonia emissions (64%) emitted from livestock production contribute to air, water, soil pollution, acid rain, and destruction of the ozone layer [130].

5.5. Environmental Pollution

Animal feed production required excessive quantities of fertilizers that are environmentally toxic [132]. The increased concentrations of nitrogen and phosphorous from agricultural runoff (from manure-fertilized fields) and spills are causing an increased incidence of eutrophication and outburst of algae blooms proliferated in lakes and estuaries in the past 30 to 40 years. For example, in the Gulf of Mexico, large areas are converted to dead zones due to eutrophication. Livestock production can also contaminate freshwater with sediment (through soil erosion), pesticides, heavy metals, antibiotics, and pathogens like Salmonella, Campylobacter, and Escherichia coli [133].

6. CONCLUSIONS

We are what we eat, and that significantly affects our health and our environment. An unhealthy and imbalanced diet contributes to different health problems. For example, the western diet causes many diseases like increased cholesterol levels, weight gain, diabetes, cardiovascular disease, Alzheimer's disease, Hypertension, and several cancers. However, these health issues can be avoided or reduced by following vegetarian or vegan diets. Changing the dietary trend from excessive meat consumption to plant-based food would be an environmentally friendly approach. It reduces the unnecessary burden on the ecosystem in terms of resource usage such as inefficiency of land use, soil, air, and water. It also helps to reduce greenhouse gas emissions and, consequently, less environmental pollution. Being human, we all are responsible for the overall well-being of our society and planet Earth. Therefore, we must adopt an appropriate and well-balanced diet approach that keeps us healthy and keep our planetary resources sustainable. Nutrition management is an essential factor that helps to prevent and control chronic diseases. A well-balanced vegan diet could significantly reduce the risk of heart disease such as cardiovascular disease, kidney disease, and

lower the incidence of diabetes and improve the human microbiome. Therefore, it is essential to consume our proportion of grains, fruits, and vegetables.

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