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PLANT-BASED DIETS IN CHRONIC KIDNEY DISEASE: BENEFITS, MECHANISMS, AND PRACTICAL CONSIDERATIONS

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ABSTRACT

Chronic kidney disease (CKD) is a progressive condition with high morbidity and mortality, commonly associated with diabetes and hypertension. While nephrologists have traditionally avoided vegetable-based diets in CKD due to concerns over potassium content and nutritional adequacy, emerging evidence supports their safety and potential benefits when properly planned. This review examines the role of plant-based diets in CKD prevention and management. Well-designed vegetarian and vegan diets provide adequate protein intake, correct essential amino acid balance through cereal-legume combinations, and avoid malnutrition or protein-energy wasting in CKD stages 3–4 and in patients on hemodiafiltration. Plant-based diets exert pleiotropic effects relevant to CKD: they reduce dietary acid load and metabolic acidosis, lower intestinal absorption of phosphorus due to phytate-bound forms, modulate gut microbiota toward increased saccharolytic bacteria and short-chain fatty acid production, and decrease uremic toxin generation. Additional benefits include reduced blood pressure, lower inflammation and oxidative stress, improved lipid profiles, and slower decline in estimated glomerular filtration rate. Practical challenges such as hyperkalemia, hyperphosphatemia, and deficiencies in vitamin B12, iron, zinc, and long-chain n-3 fatty acids can be mitigated through cooking techniques like boiling and blanching, dietary counseling, and targeted supplementation. The evidence indicates that plant-based diets are a viable and effective strategy for both preventing CKD progression and managing its complications. Concerns about hyperkalemia and malnutrition appear outdated, supporting the integration of plant-based nutrition into nephrology care with appropriate monitoring.

KEYWORDS: Chronic disease, Kidney, Hypertention, counselling, Stages

INTRODUCTION

The kidneys are two bean-shaped organs, each about the size of a fist. They are located just below the rib cage, one on each side of the spine. Healthy kidneys filter about a half cup of blood every minute, removing wastes and extra water to make urine. Chronic kidney disease (CKD) is a progressive disease with no cure and high morbidity and mortality that occurs commonly in the general adult population, especially in people with diabetes and hypertension. Preservation of kidney function can improve outcomes and can be achieved through non-pharmacological strategies (eg, dietary and lifestyle adjustments) and chronic kidney disease-targeted and kidney disease-specific pharmacological interventions. A plant-dominant, low-protein, and low-salt diet might help to mitigate glomerular hyperfiltration and preserve renal function for longer, possibly while also leading to favourable alterations in acid-base homoeostasis and in the gut microbiome.

Nephrologists classically do not recommend vegetable-based diets since they have been considered nutritionally inadequate and dangerous for the management of patients with CKD, due to their high potassium (K) content (Joshi *et al.*, 2021). But vegetable-based diets are sufficient for a balanced protein intake, and for several reasons have shown to reduce mortality in non-CKD patients (Tharrey *et al.*, 2018). Although it is a common belief that plant-based diets are deficient in all the essential amino acids, it has been shown that it is not necessarily and studies has supported the idea that well-balanced and diverse vegetable-based diets can be nutritionally adequate and beneficial (Dybvik *et al.*, 2023). Plant-based diets have been prescribed in chronic kidney disease without any adverse effects. Thus, it is unlikely that malnutrition or protein-energy wasting will occur with these diets in renal patients (Carrero *et al.*, 2020). A study in CKD stage 3–4 patients in which a vegan diet, composed of a prespecified combination of cereals and legumes, to ensure the intake of all essential amino acids, demonstrated no signs of nutritional deficiency after an average follow-up of 13 months; and it was proposed that this diet is cheaper and more palatable alternative to conventional low-protein diets (Mocanu *et al.*, 2021).

CKD patients following plant-based diets do not need supplementation with keto-analogues or essential amino acids if they consume at least 0.6 g/kg/day of protein, while unrestricted vegan diets can readily attain $0.7–0.9$ g/kg/day of protein, enough for CKD or non-CKD populations (Cases *et al.*, 2019). Vegetarian patients on hemodiafiltration have also been able to attain even higher amounts of protein intake, estimated at 1.1 to 1.25 g/kg/day of protein, without any signs of malnutrition (Kandouz *et al.*, 2016). Vegetable-based diets are

not only nutritionally adequate, but also have pleiotropic effects that may be beneficial for the treatment of CKD patients.

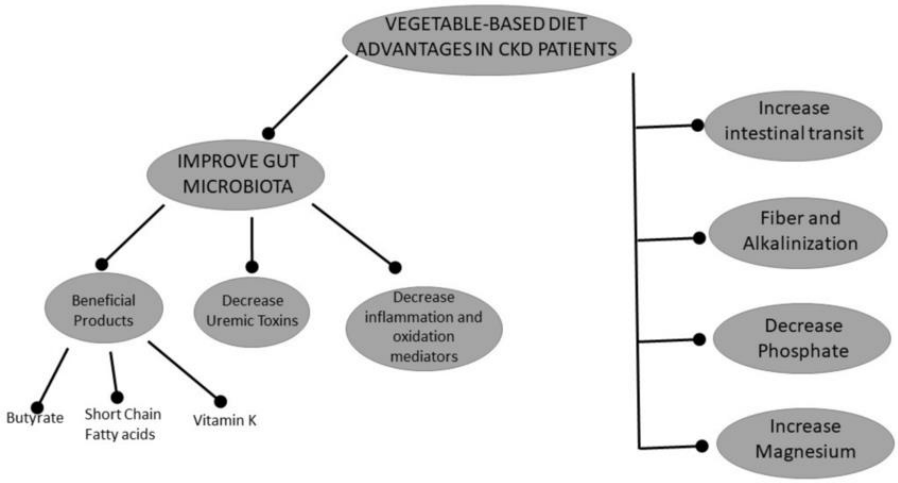

Figure 1. Scheme of the beneficial effects of a plant-based diet, through its direct nutritional contribution or the changes it produces in the intestinal microbiota.

Source: Carrero et al. (2020).

VEGETABLE-BASED DIETS

Vegetable-based diets show several beneficial effects on renal patients such as decreased blood pressure, prevent metabolic disease, delay CKD progression, decreased mortality etc. Vegetable-based diets can also favor some harmful events, such as hyperkalemia, Intestinal Motility, Inflammation and Oxidative Stress, Microbiota-Derived Uremic Toxins, Hyperphosphatemia, Metabolic Acidosis and Gut Microbiota (Chauveau *et al.*, 2019).

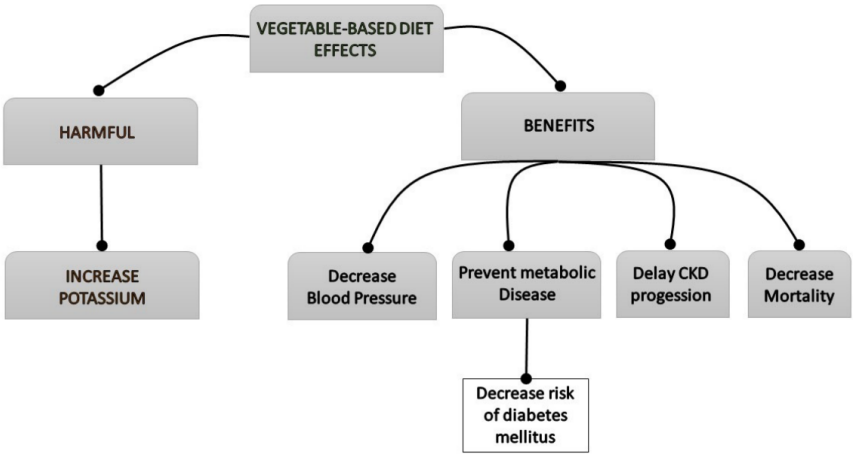

Figure 2. Flowchart of the clinical effects of the vegetable-based diet on the patient with chronic kidney disease (CKD).

Source: Carrero et al. (2020).

MACRO- AND MICRONUTRIENT INTAKE IN PLANT-BASED DIETS

There are some concerns about the nutritional adequacy of plant-based diets, particularly vegan diets which exclude all forms of animal foods in their entirety. While the absorption and availability of specific micronutrients (such as iron, vitamin A and zinc) may be lower in plant than animal foods, obtaining recommended levels of these micronutrients can still be achieved with an appropriately planned vegan diet that includes a variety of different plant foods. As for other micronutrients such as vitamin D and vitamin B12, which are mostly found in animal sources, vegans may consider the consumption of fortified foods and — in the specific case of vitamin D — adequate sun exposure. Accordingly, individuals who consume a vegan diet should remain aware of potential micronutrient insufficiencies (Chauveau *et al.*, 2019).

Vegan diets generally meet protein intake recommendations, though they are usually lower in this respect than less restrictive forms of plant-based diets. However, it should be noted that current research in this area is based on a small number of cohort studies. According to a systematic review, vegan diets are typically associated with relatively low intakes of vitamins B2, B12, D, iodine, zinc, calcium and selenium. Intake of vitamin B12 (important for several bodily functions including a healthy nervous system) was found to be significantly lower in vegans. Vegan diets are characterized by lower consumption of saturated fat and higher consumption of beneficial unsaturated fat. It also found that such diets are not associated with a risk of insufficient intake of vitamins A, B1, B6, B9 (folate), C, E, iron, phosphorus, magnesium or copper in adult populations (Chauveau *et al.*, 2019).

VEGETARIAN DIETS AND GUT MICROBIOTA

A healthy gut microbiota is essential for the health and well-being of the host. In CKD, there is a dysbiotic gut microbiota characterized by a reduced diversity and an imbalance with a decrease in commensal bacteria and an increase in pathobionts and uremic toxins-producing bacteria (Cigarran-Guldris *et al.*, 2017; Rysz *et al.*, 2021). Thus, restoring a healthy gut microbiota in uremic patients is an area of increasing research in nephrology. Dietary habits are the key modifiers of gut microbiota, depending on the duration of the diet and its nutritional composition (Cosola *et al.*, 2019). The metabolism of colonic bacteria is regulated by the availability of nutrients and, specifically, the fiber content and the rate of dietary fiber vs. nitrogen (Rossi *et al.*, 2015). A fiber-rich diet, such as a vegetarian/vegan diet, reduces protein fermentation, increases the carbohydrate fermentation, and may improve the dysbiosis associated with CKD by promoting the expansion of saccharolytic bacteria (bifidobacteria

and lactobacilli) and the reduction in pathogenic bacteria species (El Amouri *et al.*, 2021). A fiber-rich diet also increases the production of short-chain fatty acids (SCFA) ($<$6C), such as acetate, propionate, or butyrate by commensal bacteria that provide energy to the gut microbiota, allowing amino acids that reach the colon to be incorporated into the bacterial proteins and be excreted in feces, instead of being fermented to uremic toxins (Nogal *et al.*, 2021). Dietary fiber, by increasing intestinal motility, reduces the time for fermentation of amino acids, improves the composition of the dysbiotic microflora, and enhances the excretion of human and bacterial byproducts, thus reducing the formation and/or accumulation of uremic toxins (Khosroshahi *et al.*, 2019).

VEGETARIAN DIET AND METABOLIC ACIDOSIS

Metabolic acidosis is a common complication of CKD resulting from the inability of the kidney to excrete the daily dietary acid load. Metabolic acidosis increases the risks of hypertension, heart failure, muscle wasting, bone loss, chronic inflammation, progression of renal failure, and death (Zhu *et al.*, 2022; Fukasawa *et al.*, 2022; Kraut and Madias, 2016). Western diets are largely acid-producing since they are deficient in fruits and vegetables and rich in animal proteins (Carnauba *et al.*, 2017). Such diets can induce metabolic acidosis in individuals with reduced glomerular filtration rate (GFR), including otherwise healthy elderly persons, while proteins of animal origin (rich in sulfur-containing amino acids) increase the dietary acid load, worsening acidosis in CKD patients (Toba *et al.*, 2019). Foods such as meat, eggs, cheese, and grains increase the net acid load, whereas fruits and vegetables reduce it.

PHOSPHORUS AND A VEGETARIAN DIET

Hyperphosphatemia is an independent risk factor for mortality in CKD patients. Hyperphosphatemia results from a positive phosphorus balance in renal patients, which results in a compensatory secondary hyperparathyroidism and an increase in fibroblast growth factor-23 levels (FGF-23) (Chauveau *et al.*, 2019). Typical western diets, which are usually rich in proteins, mostly from animal sources, are rich in phosphate. In addition, a nonnegligible amount of phosphorus is also provided by hidden preservatives or additives added to processed and fast foods (de Fornasari *et al.*, 2017). The bioavailability of phosphorus varies widely according to sources. The intestinal absorption rate of phosphorus from animal sources reaches 80%, whereas intestinal absorption from a vegetarian source, which is mostly in the form of phytate, does not exceed 30% to 40% (Calvo *et al.*, 2019). This is due to the fact that the accumulation of phosphorus in plants is in the form of

phytates, which is necessary for their enzymatic hydrolysis by phytase; however, it is absent in mammals, which makes the released phosphorus available for absorption.

EFFECTS OF A VEGETARIAN DIET ON INFLAMMATION AND OXIDATIVE STRESS

Low-grade inflammation and oxidative stress are common findings in CKD, and have been associated with the progression of renal dysfunction, as well as other complications of CKD, such as atherosclerosis, cardiovascular risk, or protein-energy wasting (Miyamoto *et al.*, 2016). The type of diet is key to the modulation of inflammation. Diets rich in fruits and vegetables, vitamins, and antioxidants have been associated with lower levels of inflammatory markers (Shin *et al.*, 2019). In contrast, a western diet (rich in animal proteins and fats) stimulates the overgrowth of proteolytic bacteria, which results in dysbiosis, the accumulation of proteolytic-derived uremic toxins, and may promote CKD progression. In experimental studies, a diet rich in undigestible fiber improves the markers of oxidative stress, and reduces inflammation and kidney damage in CKD rats (El Amouri *et al.*, 2021) and similar results have been reported in CKD patients (Lu *et al.*, 2017). Vegetarian diets have been associated with a reduction in inflammation (Haghighatdoost *et al.*, 2017).

PROGRESSION OF CHRONIC KIDNEY DISEASE

The consumption of fruits and vegetables by reducing the dietary acid load and improving metabolic acidosis may slow the reduction of eGFR in patients with CKD. Diets rich in vegetables and an increase in total fiber intake are associated with reductions in the progression of CKD, attributed to several causes: reduced consumption of nutrients such as protein, sodium, or acids, increased potassium over sodium intake, decreased phosphorus load, and increased intake of fiber, antioxidants, vitamins, and chemicals such as sulforaphane that have been linked to improved outcomes in patients with CKD (Goraya *et al.*).

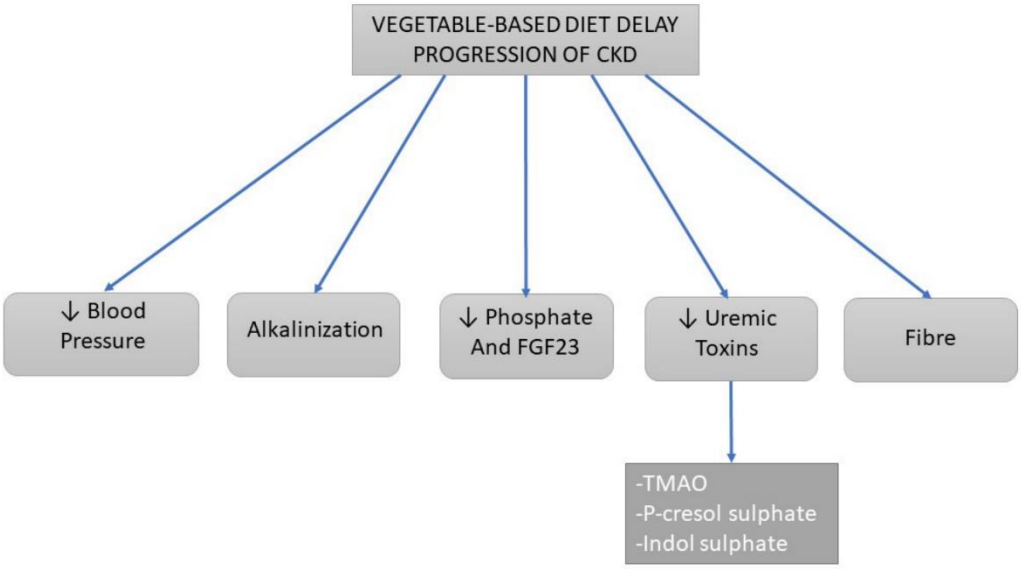

Figure 3. Scheme of the actions of the vegetable-based diet on the progression of kidney damage in patients with CKD.

Source: Carrero et al. (2020).

DIETARY SODIUM AND BLOOD PRESSURE

A vegetable-based diet, reduced the systolic blood pressure in CKD patients, suggesting a possible advantage of this diet poorer in sodium over alkali administration as a strategy to reduce dietary acid levels for kidney protection.

Fruits and vegetables are a main source of fiber, potassium, and nitrate. Studies have reported that dietary potassium by reducing blood pressure and dietary fiber through decreasing inflammatory markers and blood pressure may protect against CKD (Fu *et al.*, 2022). Vegetables, especially leafy greens, are rich sources of nitrates, and the nephroprotective effect of these foods is related to their nitrate content (Hsu *et al.*, 2019). Although the main source of nitric oxide (NO) is generated from L-arginine, recent research indicates that NO is also generated by the nitrate–nitrite–NO pathway from dietary nitrate or nitrate supplementation (Mirmiran *et al.*, 2016).

PRACTICAL COOKING COUNSELLING FOR VEGETABLES

CKD patients have dietary restrictions in fruits and vegetables but, if cooked with the appropriate technique, its mineral content can be reduced. These restrictions are responsible for the noncompliance of the patients with the dietary recommendations since they are pushed to introduce completely new food habits (Ceccanti *et al.*, 2022). Cooking techniques can promote the safe intake of legumes and vegetables, while avoiding hyperphosphatemia or hyperkalemia, but with these techniques also some healthy and essential nutrients can be lost,

such as Mg and Zn. Oral supplements can be required, when necessary, to avoid these deficiencies (Acal *et al.*, 2019). Phosphorus, potassium, and sodium are the three most difficult minerals to control when kidney function is severely compromised. However, the amount in foods can be reduced by up to 80% owing to some cooking techniques, especially blanching and boiling. Using frozen or canned foods plus washing can also flush them out in the same proportion. Therefore, a healthy diet that ensures the intake of essential amino acids, mineral-rich fruits, vegetables, legumes, and dairy products, can be maintained keeping the intake of these three elements in a safe range with appropriate dietary counseling. Although there is no consensus on the maximum amount of K and P per serving of food in each stage of CKD, there are foods, such as raw legumes, whose content in these minerals is so high that they can only be consumed after following certain preparation recommendations (Cases *et al.*, 2019).

POTENTIAL RISKS OF A VEGAN DIET IN CKD

A strict vegetarian diet can be poor in long-chain n-3 fatty acids, zinc, iron, and vitamin B12. Although some studies indicate a higher risk of osteoporosis in vegetarians than in the general population, differences in bone mineral density between vegetarians and the general population are not clinically relevant (Chuang *et al.*, 2020). However, osteoporosis and bone-mineral disorders are common among CKD patients and the effects of a vegan diet on the risk of fractures is evaluated. Vitamin B12 is monitored and supplemented in the patients if needed. Although the iron content in vegetarian and nonvegetarian diets are similar, the bioavailability of iron from plants is lower (low heme iron content or scarcely bioavailable iron, e.g., chelated by phytates) (Khalid *et al.*, 2022). This can be relevant in CKD patients who have increased hepcidin levels, impairing iron absorption. Similarly, a diet without an animal source of food can be poor in zinc, as this element is less abundant in plant-based food than in meats, and poorly absorbed because of the presence of fibers and phytate. A vegetarian diet can also be poor in vitamin D, which needs to be monitored and supplemented as needed (Gluba-Brzózka *et al.*, 2017). A vegetarian diet should also be controlled to ensure an adequate consumption of all essential amino acids by a careful combination of legumes and cereals.

CONCLUSION

In conclusion, plant-based diets should be recommended for the prevention of CKD. Concerns of hyperkalemia related to plant-based diets may be outdated and unsupported by

the current body of literature. Healthcare providers in general medicine and nephrology can consider plant-based diets as an important tool for prevention and management of CKD.

REFERENCES

1. Acal, I., Cigarran, S., Sanjurjo, A., Latorre, J., Menéndez, N., Rodriguez, B. and Vazquez-Oderiz, L.R.A. (2019). Influence of culinary techniques of different vegetables products. Implications for chronic kidney disease patients. *J. Renal Nutr.* 20: 1-19.
2. Calvo MS, Sherman RA, and Uribarri J. (2019). Dietary Phosphate and the Forgotten Kidney Patient: A Critical Need for FDA Regulatory Action. *Am J Kidney Dis.* 73(4):542-551.
3. Carnauba RA, Baptistella AB, Paschoal V. and Hübscher GH. (2017). Diet-Induced Low-Grade Metabolic Acidosis and Clinical Outcomes: A Review. *Nutrients.* 9(6):538.
4. Carrero, J.J., González-Ortiz A, Avesani CM, Bakker SJL, Bellizzi V, Chauveau P, Clase CM, Cupisti A, Espinosa-Cuevas A, Molina P, Moreau K, Piccoli GB, Post A, Sezer S and Fouque D. (2020). Plant-based diets to manage the risks and complications of chronic kidney disease. *Nat Rev Nephrol.* 16(9):525-542.
5. Cases, A., Cigarrán-Guldris, S., Mas, S. and Gonzalez-Parra, E. (2019). Vegetable-Based Diets for Chronic Kidney Disease? It Is Time to Reconsider *Nutrients* 11: 1263; doi:10.3390/nu11061263.
6. Ceccanti C, Guidi L, D'Alessandro C. and Cupisti A. (2022). Potassium Bioaccessibility in Uncooked and Cooked Plant Foods: Results from a Static In Vitro Digestion Methodology. *Toxins (Basel).* 14(10):668.
7. Chauveau P, Koppe L, Combe C, Lasseur C, Trolonge S. and Aparicio M. (2019). Vegetarian diets and chronic kidney disease. *Nephrol Dial Transplant.* 34(2):199-207.
8. Chuang TL, Lin CH. And Wang YF. (2020). Effects of vegetarian diet on bone mineral density. *Tzu Chi Med J.* 33(2):128-134.
9. Cigarran Guldris, S. and González Parra, E. (2017). Cases Amenós, A. Gut microbiota in chronic kidney disease. *Nefrología* 37: 9–19.
10. Cosola C, Rocchetti MT, Sabatino A, Fiaccadori E, Di Iorio BR, and Gesualdo L. (2019). Microbiota issue in CKD: how promising are gut-targeted approaches? *J Nephrol.* 32(1):27-37.
11. de Fornasari ML. and Dos Santos Sens YA. (2017). Replacing Phosphorus-Containing Food Additives with Foods Without Additives Reduces Phosphatemia in End-Stage Renal Disease Patients: A Randomized Clinical Trial. *J Ren Nutr.* 27(2):97-105.

12. Dybvik, J.S., Svendsen, M. and Aune, D. (2023). Vegetarian and vegan diets and the risk of cardiovascular disease, ischemic heart disease and stroke: a systematic review and meta-analysis of prospective cohort studies. *Eur J Nutr* 62: 51–69.
13. El Amouri, A. Snauwaert E, Foulon A, Vande Moortel C, Van Dyck M, Van Hoeck K, Godefroid N, Glorieux G, Van Biesen W, Vande Walle J, Raes A. and Eloot S. (2021). Dietary Fibre Intake Is Associated with Serum Levels of Uraemic Toxins in Children with Chronic Kidney Disease. *Toxins (Basel).* 13(3):225. doi: 10.3390/toxins13030225.
14. Fu L, Zhang Q, S, Zhang Q. and Tan M. (2022). Associations between dietary fiber intake and cardiovascular risk factors: An umbrella review of meta-analyses of randomized controlled trials. *Front Nutr.* 9:972399.
15. Fukasawa, H., Kaneko, M. and Uchiyama, Y. (2022). Lower bicarbonate level is associated with CKD progression and all-cause mortality: a propensity score matching analysis. *BMC Nephrol* 23, 86 https://doi.org/10.1186/s12882-022-02712-y
16. Gluba-Brzózka A, Franczyk B. and Rysz J. (2017). Vegetarian Diet in Chronic Kidney Disease—A Friend or Foe. *Nutrients.* 9(4):374.
17. Goraya N, Munoz-Maldonado Y, Simoni J. and Wesson DE. (2019). Fruit and Vegetable Treatment of Chronic Kidney Disease-Related Metabolic Acidosis Reduces Cardiovascular Risk Better than Sodium Bicarbonate. *Am J Nephrol.* 49(6):438-448.
18. Haghighatdoost, F., Bellissimo, N., Totosy de Zepetnek, J.O. and Rouhani, M.H. (2017). Association of vegetarian diet with inflammatory biomarkers: A systematic review and meta-analysis of observational studies. *Public Health Nutr.* 20, 2713–2721.
19. Hsu C-N, Lu P-C, Lo M-H, Lin I-C, and Tain Y-L. (2019). The Association between Nitric Oxide Pathway, Blood Pressure Abnormalities, and Cardiovascular Risk Profile in Pediatric Chronic Kidney Disease. *International Journal of Molecular Sciences.* 20(21):5301.
20. Joshi S, McMacken M, and Kalantar-Zadeh K. (2021). Plant-Based Diets for Kidney Disease: A Guide for Clinicians. *Am J Kidney Dis.* 77(2):287-296.
21. Kandouz, S., Mohamed, A.S., Zheng, Y., Sandeman, S. and Davenport, A. (2016). Reduced protein bound uraemic toxins in vegetarian kidney failure patients treated by haemodiafiltration. *Hemodial. Int.* 20, 610–617.
22. Khalid W, Arshad MS, Ranjha MMAN, Rózánska MB, Irfan S, Shafique B, Rahim MA, Khalid MZ, Abdi G and Kowalczewski PL. (2022). Functional constituents of plant-based foods boost immunity against acute and chronic disorders. *Open Life Sci.* 17(1):1075-1093

23. Khosroshahi, H.T., Abedi, B., Ghojazadeh, M., Samadi, A. and Jouyban, A. (2019). Effects of fermentable high fiber diet supplementation on gut derived and conventional nitrogenous product in patients on maintenance hemodialysis: A randomized controlled trial. *Nutr. Metab. (Lond.)*, 16, 18.
24. Kraut, J.A. and Madias, N.E. (2016). Metabolic Acidosis of CKD: An Update. *Am. J. Kidney Dis.* 67, 307–317.
25. Lu, L., Huang, Y.-F., Wang, M.-Q., Chen, D.-X., Wan, H., Wei, L.-B. and Xiao, W. (2017). Dietary fiber intake is associated with chronic kidney disease (CKD) progression and cardiovascular risk, but not protein nutritional status, in adults with CKD. *Asia Pac. J. Clin. Nutr.* 26: 598–605.
26. Mirmiran, P.; Bahadoran, Z.; Golzarand, M.; Asghari, G. and Azizi, F. (2016). Consumption of nitrate containing vegetables and the risk of chronic kidney disease: Tehran Lipid and Glucose Study. *Ren. Fail.* 38, 937–944.
27. Miyamoto, Y., Hanna, D.L., Zhang, W., Baba, H. and Lenz, H.-J. (2016). Molecular Pathways: Cachexia Signaling—A Targeted Approach to Cancer Treatment. *Clin. Cancer Res.* 22:3999–4004.
28. Mocanu CA, Simionescu TP, Mocanu AE, and Garneata L. (2021). Plant-Based versus Animal-Based Low Protein Diets in the Management of Chronic Kidney Disease. *Nutrients.* 13(11):3721. doi: 10.3390/nu13113721.
29. Nogal A, Valdes AM, and Menni C. (2021). The role of short-chain fatty acids in the interplay between gut microbiota and diet in cardio-metabolic health. *Gut Microbes.* 13(1):1-24.
30. Rossi, M., Johnson, D.W., Xu, H.; Carrero, J.J., Pascoe, E., French, C. and Campbell, K.L. (2015). Dietary protein–fiber ratio associates with circulating levels of indoxyl sulfate and p-cresyl sulfate in chronic kidney disease patients. *Nutr. Metab. Cardiovasc. Dis.* 25: 860–865.

    Rysz J, Franczyk B, Ławiński J, Olszewski R, Ciałkowska-Rysz A, and Gluba-Brzózka A. (2021). The Impact of CKD on Uremic Toxins and Gut Microbiota. *Toxins (Basel).* 13(4):252. doi: 10.3390/toxins13040252.
31. Shin D, Lee KW, Brann L, Shivappa N. and Hébert JR. (2019). Dietary inflammatory index is positively associated with serum high-sensitivity C-reactive protein in a Korean adult population. *Nutrition.* 63-64:155-161.
32. Tharrey, M., Mariotti, F., Mashchak, A., Barbillon, P., Delattre, M. and Fraser, G.E. (2018). Patterns of plant and animal protein intake are strongly associated with

cardiovascular mortality: The Adventist Health Study-2 cohort. *Int. J. Epidemiol.* 47:1603–1612.

33. Toba, K., Hosojima, M. and Kabasawa, H. (2019). Higher estimated net endogenous acid production with lower intake of fruits and vegetables based on a dietary survey is associated with the progression of chronic kidney disease. *BMC Nephrol* 20, 421
34. Zhu A, Whitlock RH, Ferguson TW, Nour-Mohammadi M, Komenda P, Rigatto C, Collister D, Bohm C, Reaven NL, Funk SE. and Tangri N. (2022). Metabolic Acidosis Is Associated With Acute Kidney Injury in Patients With CKD. *Kidney Int Rep.* 7(10):2219-2229.