IJPSR (2022), Volume 13, Issue 10 (Research Article)

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 20 February 2022; received in revised form, 10 April 2022; accepted, 24 April 2022; published 01 October 2022

AMELIORATING EFFECT OF TURMERIC ON KIDNEY FUNCTION IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

Anup S. Hendre [1], Sangita R. Patil [1], Ajit V. Sontakke [1] and Rohan S. Phatak [*2]

Department of Biochemistry [1], Directorate of Research [2], Krishna Institute of Medical Sciences, Deemed To Be University, Karad - 415110, Maharashtra, India.

Keywords:

Chronic kidney disease, creatinine, diabetes mellitus, Nephropathy, Plasma proteins, Urea

Correspondence to Author:
Rohan S. Phatak

Research Scholar,
Directorate of Research, Krishna Institute of Medical Sciences, Deemed To Be University, Karad - 415110, Maharashtra, India.

E-mail: phatak.rohan1983@gmail.com

ABSTRACT: Background: Diabetes mellitus is one of the most common metabolic disturbances associated with carbohydrates, lipids, proteins, and relative or absolute insulin depletion. Various long-term complications of diabetes develop due to chronic hyperglycemia and insulin resistance. Chronic kidney disease (CKD) and diabetes mellitus (DM) are major public health problems worldwide. Turmeric is one of the medicinal herbs studied for antioxidant, antibacterial, and antifungal effects. Curcumin has been established to be defensive against nephropathy. **Objective:** The purpose of this study was to assess turmeric's effect on different kidney function parameters in patients with type 2 diabetes mellitus (T2DM). **Materials and Methods:** Two hundred patients with T2DM were selected in randomized control trial, of which 100 subjects were enrolled in the study group, were given 500 mg of raw turmeric powder in capsule form daily along with their antidiabetic drug medication (Metformin) for 3 months period while 100 subjects on medication of antidiabetic drug (Metformin) were selected as a control group. Serum levels of urea, creatinine, total protein, albumin, and globulin were measured at baseline and after 3 months intervention period. **Results:** Showed a significant reduction in serum creatinine and significant improvement in total proteins and albumins in the study group by the end of 3 months of turmeric supplementation. **Conclusion:** Supplementation of turmeric leads to improved plasma proteins and decreased serum urea and creatinine levels in T2DM patients and could be useful in the improvement of kidney function in T2DM.

INTRODUCTION: Diabetes is a metabolic disorder that leads to hyperglycemia due to impaired insulin secretion, insulin function, or both. Type 2 diabetes affects 90-95% of people [1]. Disturbances in insulin production and action, a hormone secreted by the islets of langerhans in the pancreas, are implicated in the disease [2].

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.13(10).4019-24

This article can be accessed online on www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.13(10).4019-24

The signs and symptoms of this disease are the elevated level of blood glucose, decreased peripheral absorption of glucose due to impairment of insulin secretion, and peripheral resistance to insulin [1]. Several pathological processes are involved in the development of diabetes.

Various long-term complications of diabetes develop due to chronic hyperglycemia and insulin resistance. These complications are macro and microvascular abnormalities such as autonomic neuropathy, peripheral neuropathy, retinopathy, cardiovascular symptoms and nephropathy [3-5]. Chronic kidney disease (CKD) leads to decreased

kidney function and/or evidence of kidney damage [6]. Kidney disease, especially in glomerular diseases such as diabetic kidney disease (DKD), is generally reproduced by increased blood concentrations of kidney function test (KFT) parameters such as albumin, urea, creatinine, *etc.* [7]. CKD and DM are major public health problems, and both have worldwide distribution. Diabetic nephropathy is the most common cause of the development of CKD. Approximately 30% of patients with DM have diabetic nephropathy, and with the growing number of DM patients and the aging population, there is likely a parallel increase in CKD incidence. According to the International Diabetes Federation Diabetes Atlas 2014, the number of patients with DM in India is expected to rise to 101.2 million by 2030 unless urgent precautionary measures are taken [8].

A common complication of DM is diabetic nephropathy (DN), which is a main universal health problem [9]. Chronic inflammation and oxidative stress are fundamental providers of the development of DN [10]. A variety of preventable factors, including hypertension, alcoholism, and smoking, also speed up DN progression [11]. Oxidative stress is responsible for developing chronic complications of diabetes mellitus and results from chronic hyperglycemia, increased oxidants and thereby decreased antioxidants [12, 13].

Diabetic individuals are often started on medication such as Metformin and are seen commonly by their providers, therefore increasing medical expenses. Hence to reduce the long-term cost of medication to control diabetes, new cost-effective alternative supplementation help to reduce long-term side effects and expenses for diabetes [14-16]. Many plants have been tested and used in the prevention and management of diabetes and associated complications. Spices form an important class of food adjunct in the human diet. Besides increasing the taste and flavor of foods, spices illustrated a broad range of physiological and pharmacological properties [17-20]. Earlier studies have shown that curcumin's anti-inflammatory and antioxidant treatments may delay the development of glomerulopathy [11]. Curcumin is an active phenolic compound derived from the rhizome of the herb *Curcuma longa*. It has been shown to possess various valuable effects, including anti-inflammatory and antioxidant activities [19]. Curcumin has been established to defend against nephropathy in animal models [21, 22]. Previously, curcumin was accounted to be efficient supplement to prevent glucose-induced oxidative stress in the endothelial cells of diabetic animals [12, 23].

Currently, DN is the main cause of CKD and one of the most significant long-term complications in terms of morbidity and mortality for individual patients with diabetes. There are multiple mechanisms by which curcumin may ameliorate renal damage. Curcumin increases blood urea nitrogen and promotes clearance of creatinine and urea. In addition, curcumin decreases levels of albuminuria and enzymatic, including levels of lactate dehydrogenase (LDH), aspartate transferase, alanine transferase and alkaline and acid phosphatases [24].

Therefore, this study aims to evaluate the effects of curcumin on serum urea, creatinine, total protein, albumin, and globulin in patients with type 2 diabetes mellitus.

MATERIAL AND METHODS: The study was carried out in the Department of Biochemistry, Krishna Institute of Medical Sciences, Karad (Western Maharashtra). The study was approved by Institutional Ethics Committee (Letter Ref: KIMSDU/IEC/244/2013 Dated 06/12/2013). This study was carried out in the form of randomized control trial, which includes all type 2 diabetic patients referred to Krishna Hospital and Medical Research Centre, Karad. A total of 200 subjects with type 2 diabetes were enrolled for the study. They were further categorized into two groups with 100 subjects, including one study group and one control group. The study's objectives and risk factors were explained to volunteers after their written informed consents were obtained.

Inclusion Criteria: Non-insulin-dependent type 2 diabetics aged 35-65 years, with a single drug schedule for this treatment.

Exclusion Criteria: Patients with pregnancy, breastfeeding, using tobacco, alcohol, consuming thyroid, hypolipidemic, antihypertensive, and anticoagulant drug medications were excluded. The study group was given one capsule of 500 mg raw turmeric powder daily post-lunch for 3 months

period. During the study period, antidiabetic drug medication (Metformin) was sustained as usual, and subjects were advised to maintain their normal diet and physical activity.

The blood sample was collected from each subject at baseline and after 3 months intervention period. The collected samples were immediately centrifuged at 3000 rpm for 10 minutes and analyzed for serum urea, creatinine, total protein, albumin, and serum globulin concentrations. Data were analyzed using paired, and unpaired't' tests and values were expressed as Mean ± Standard Deviation.

RESULTS: The results from table 1 indicated that no significant difference in serum urea was observed in controls when compared between baseline and after turmeric intervention for 3 months period (P=0.0621). Also, no significant difference was found in serum urea in the study group when compared between baseline and after 3 months of turmeric intervention (P=0.0523) **Table 1**.

Further, no significant difference in serum urea was observed when compared between the control and study group at baseline (P=0.3059) and after 3 months of intervention of turmeric (P=0.5472) **Table 1**. It was found to be a significant decrease in serum creatinine in both controls (p<0.0001) and the study group (P=0.0407) when compared between baseline and after 3 months intervention period **Table 1**. Whereas no significant decrease was found in serum creatinine of the control and study group when compared between baseline (P=0.2247) and after 3 months of intervention (P=0.2290) **Table 1**.

TABLE 1: SHOWING LEVELS OF SERUM UREA AND SERUM CREATININE IN CONTROL AND STUDY GROUP AT BASELINE AND AFTER 3 MONTHS INTERVENTION OF TURMERIC

Variable	Parameter	Baseline Mean ± SD	After 3 Months period Mean ± SD	Difference Mean ± SD	Paired 't'	Paired 'P'
Control Group	Serum Urea	25.15±4.84	24.55±3.84	0.61±2.80	4.234	0.0621
Study Group		25.63±5.34	24.93±4.99	0.70±2.81	3.283	0.0523
Unpaired 't' & 'P'		t= 1.027	t= 0.6030			
		P= 0.3059	P= 0.5472			
Control Group	Serum	1.15±0.21	1.06±0.12	0.088±0.19	4.730	<0.0001
Study Group	Creatinine	1.12±0.20	1.08±0.11	0.037±0.18	2.073	0.0407
Unpaired 't' & 'P'		t= 1.218	t= 1.207			
		P=0.2247	P= 0.2290			

TABLE 2: SHOWING LEVELS OF SERUM TOTAL PROTEIN, ALBUMIN AND GLOBULIN IN CONTROL AND STUDY GROUP AT BASELINE AND AFTER 3 MONTHS INTERVENTION OF TURMERIC

Variable	Parameter	Baseline Mean ± SD	After 3 Months period Mean ± SD	Difference Mean ± SD	Paired 't'	Paired 'P'
Control Group	Serum Total Protein	7.08±0.21	7.15±0.41	0.067±0.30	2.217	0.0289
Study Group		7.09±0.42	7.14±0.24	0.049±0.32	1.541	0.0126
Unpaired 't' & 'P'		t = 0.7084	t = 0.7578			
		P=0.4795	P= 0.4495			
Control Group	Serum Albumin	4.00±0.25	4.38±0.58	0.37±0.55	6.665	<0.0001
Study Group		4.03±0.23	4.37±0.57	0.34±0.55	6.132	<0.0001
Unpaired 't' & 'P'		t = 0.1234	t = 0.6454			
		P=0.9019	P= 0.5194			
Control Group	Serum Globulin	3.08±0.65	2.77±0.22	0.30±0.10	6.907	<0.0001
Study Group		3.06±0.62	2.77±0.25	0.29±0.06	6.393	<0.0001
Unpaired 't' & 'P'		t = 0.5809	t = 0.05895			
		P=0.5620	P= 0.9531			

We found a significant difference in serum total protein in control group when compared between baseline and after 3 months of intervention (P=0.0289). Also significant decrease in serum total protein was observed in the study group when compared between baseline and after 3 months of intervention (P=0.0126) **Table 2**. No significant difference was found in serum total protein in the control and study group at baseline (P=0.4795) and after 3 months intervention period (P=0.4495).

Table 2. In the case of serum albumin, we found extremely significant differences in both controls ($p<0.0001$) and the study group ($p<0.0001$) compared between baseline and after 3 months turmeric intervention period **Table 2**. However, no significant difference was observed in serum albumin in the control and study group at baseline ($p=0.9019$) and after 3 months of intervention of turmeric ($p=0.5194$) **Table 2**. The extremely significant difference in serum globulin was observed in controls when compared between baseline and after turmeric intervention for 3 months ($P<0.0001$). Also, an extremely significant difference was found in serum globulin in the study group when compared between baseline and 3 months of turmeric intervention ($P<0.0001$) **Table 2**. Further, no significant difference in serum globulin was observed in the control and study group at baseline ($P=0.5620$) and after 3 months of intervention of turmeric ($P=0.9531$) **Table 2**.

DISCUSSION: According to the result, no significant difference in serum urea was observed in controls when compared between baseline and after turmeric intervention for 3 months ($P=0.0621$). Also, no significant difference was found in serum urea in the study group when compared between baseline and 3 months of turmeric intervention ($P=0.0523$). Significant decreases in serum creatinine in both control ($p<0.0001$) and study group ($P=0.0407$) were observed when compared between baseline and after 3 months turmeric intervention period. Zein Shaban Ibrahim *et al.* found that urea and creatinine, the main indicators of DN were increased in rats of the diabetic group compared with levels of the control group. This increase was reversed when the rats were treated with curcumin [11].

Radhia Khan *et al.* found no significant difference in blood urea levels in type 2 diabetes patients treated with curcumin [24]. Curcumin is an active phenolic compound derived from *Curcuma longa, mainly used in Asia as a spice, pigment,* and additive. Several studies have shown that curcumin has wide biological functions, predominantly antioxidant and anti-inflammatory. It has been established as a bi-functional antioxidant; it showed antioxidant activity by scavenging reactive oxygen species and inducing an antioxidant response. The protective effect of curcumin has been assessed in different experimental models, including nephrotoxicity, chronic renal failure, ischemia, and diabetic nephropathy [25-28]. DN is the main cause of end-stage renal disease. Sharma *et al*. found that curcumin administration protects diabetic nephropathy and oxidative stress in animal models [29]. In addition, Soetikno *et al.* assessed the effect of oral curcumin administration in diabetic nephropathy models. They found that curcumin prevents the development of kidney disease in diabetic rats [30]. Treatment of curcumin improves creatinine clearance. In addition, it decreases oxidative stress by scavenging superoxide and hydroxyl radicals. Furthermore, it also boosts the activity of the antioxidant enzymes [31, 32]. Curcumin exhibits a multifunctional antioxidant activity, including the prevention of lipid peroxidation.

Furthermore, it has been found that the phenolic groups present in the structure of curcumin react directly with reactive oxygen species and reactive nitrogen species, leading to the expression of various antioxidants such as superoxide dismutase, catalase, glutathione reductase, glutathione peroxidase *etc.* [33-36]. In the present study, we found a marginal increase in serum total protein and serum albumin in both control and study groups before and after supplementation of turmeric, which clearly indicated that turmeric intervention in type 2 diabetic patients improved protein concentration in blood. But we found a decrease in serum globulin in both the groups before and after turmeric supplementation. Diabetes is characterized by increased plasma glucose levels, which in turn modify blood plasma proteins by a non-enzymatic reaction called glycation.

Protein glycation leads to the formation of toxic molecules called advanced glycation end products (AGEs). Accumulation of AGEs has been accelerated in diabetes and contributes to the pathogenesis of diabetic complications [37, 38]. In diabetes, albumin synthesis and secretion is decreased due to insulin deficiency [39]. In the present study, supplementation of turmeric for 3 months was found to be effective in diabetic patients to improve plasma protein concentrations, which will help improve kidney function in type 2 diabetic patients. This study agrees with the findings of Garkuwa *et al.* [30] and Shatadal *et al.* [31].

who reported the reno-protective effect of curcumin in diabetic rats.

CONCLUSION: Various *in-vitro* and *in-vivo* studies have reported strong supportive evidence for investigating curcumin efficacy against type 2 diabetes mellitus. The data reported in the present study concluded that turmeric has therapeutic potential to counteract diabetes and its complications related to kidney function.

The supplementation of turmeric effectively reduces the blood concentrations of urea and creatinine and improves plasma proteins in type 2 diabetes patients. As a food adjunct, turmeric can be a useful supplement to improve kidney function in type 2 diabetes, which ameliorates associated diabetic complications, including diabetic nephropathy. However, further clinical trials will be needed to evaluate the effects of curcumin and its specific dosage in pre-diabetes and T2DM patients associated with kidney diseases.

ACKNOWLEDGEMENT: Authors acknowledge the immense help received from the scholars whose articles are cited and included in the references of this manuscript. The authors are also grateful to the authors/editors / publishers of all those articles, journals, and books from where the literature for this article has been reviewed and discussed.

Authors' Contribution: All authors have equally contributed in preparing, aligning, and setting the manuscript.

CONFLICTS OF INTEREST: The authors would like to thank the Krishna Institute of Medical Sciences, "Deemed to be a University," for funding the research. (Research Fund Allotment Letter No. KIMSDU/DR/178/2014 Dt. 12/04/2014)

REFERENCES:

1. Jafari S, Sattari R and Ghavamzadeh S: Evaluation the effect of 50 and 100 mg doses of *Cuminum cyminum* essential oil on glycemic indices, insulin resistance and serum inflammatory factors on patients with diabetes type II: A double-blind randomized placebo-controlled clinical trial. J Trad Compl Med 2017; 7(3): 332-8.
2. Atena Mahdavi, Sajjad Moradi, Gholamreza Askari and Bijan Iraj: effect of curcumin on glycemic control in patients with type 2 diabetes: A Systematic Review of Randomized Control Trials. Advances in Experimental Medicine and Biology 2021; 1291: 139-149.
3. Nina Kaludercic and Fabio Di Lisa: Mitochondrial ROS Formation in the Pathogenesis of Diabetic Cardiomyopathy. Front Cardiovas Med 2020; 7(12): 1-15.
4. Deepa Rajendiran, Subbulakshmi Packirisamy and Krishnamoorthy Gunasekaran: A review on role of antioxidants in diabetes. Asian Journal of Pharmaceutical and Clinical Research 2018; 11(2): 48-53.
5. Ganjifrockwala FA, Joseph JT and George G: Decreased total antioxidant levels and increased oxidative stress in South African type 2 diabetes mellitus patients. J Endo Metab Diab South Africa 2017; 22(2): 21-5.
6. Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group: KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl 2013; 3: 1–150.
7. Narva A and Bilous R: Laboratory Assessment of Diabetic Kidney Disease. From Research to Practice / Diabetic Kidney Disease: A Call to Action. Diab Spectrum 2015; 28(3): 162-6.
8. Ansari ZM, Nasiruddin M, Khan RA and Haque SF: Protective Role of Nigella sativa in Diabetic Nephropathy: A Randomized Clinical Trial. Saudi J Kidney Dis Transpl 2017; 28(1): 9-14.
9. Gao Q, Shen W and Qin W: Treatment of db/db diabetic mice with triptolide: A novel therapy for diabetic nephropathy. Nephrol Dial Transplant 2010; 25: 3539-47.
10. Jay C Jha, Claudine Banal, Bryna S. M. Chow, Mark E Cooper and Karin Jandeleit-Dahm: Diabetes and Kidney Disease: Role of Oxidative Stress. Antioxidants & Redox Signaling 2016; 25(12): 657-696.
11. Ibrahim ZS Alkafafy ME, Ahmed MM and Soliman MM: Renoprotective effect of curcumin against the combined oxidative stress of diabetes and nicotine in rats. Mol Med Rep 2016; 13: 3017-26.
12. Darenskaya MA, Kolesnikova LI and Kolesnikov SI: Oxidative stress: pathogenetic role in diabetes mellitus and its complications and therapeutic approaches to correction. Bulletin of Experimental Biology and Medicine 2021; 171: 179-189.
13. Derouiche S, Cheradid T and Guessoum M: Heavy metals, Oxidative stress and inflammation in pathophysiology of chronic kidney disease - a review. Asian J Pharm Tech 2020; 10(3): 202-6.
14. Mansouri A, Vahed A, Shahdadi H, Dashtban F and Arbabisarjou A: The effect of garlic and cumin on blood pressure and glycosylated hemoglobin in patients with type 2 diabetes. Bali Med J 2018; 7(1): 156-60.
15. Pang and Guo-Ming: Herbal medicine in the treatment of patients with type 2 diabetes mellitus. Chinese Medical Journal 2019; 132(1): 78-85.
16. Parvathi P and Geetha RV: Spices and Oral Health. Res J Pharm Tech 2014; 7(2): 235-7.
17. Phatak RS, Pratinidhi AK and Hendre AS: Evaluation of antioxidant and free radical scavenging activities of spices mixture extract as additive with reference to synthetic antioxidant. Der Pharm Lettre 2015; 7(2): 27-34.
18. Hendre AS, Sontakke AV, Phatak RS, Patil SR and Jadhav ST: Role of Cumin in Management of Type 2 Diabetes Mellitus with respect to its Antidiabetic and Antioxidant Property. Int J Res Pharm Sci 2020; 11 (3): 4157-61.
19. Hendre AS, Sontakke AV, Patil SR and Phatak RS: Effect of Cinnamon Supplementation on Fasting Blood Glucose and Insulin Resistance in patients with Type 2 Diabetes. Pravara Med Rev 2019; 11 (2): 4-8.
20. Michael Buenor Adinortey: Phytomedicines used for diabetes mellitus in ghana: a systematic search and review of preclinical and clinical evidence. Evidence-Based

Complementary and Alternative Medicine 2019; Article ID 6021209: 1-23.
21. Javad Sharifi-Rad: Turmeric and its major compound curcumin on health: bioactive effects and safety profiles for food, pharmaceutical, biotechnological and medicinal applications. Frontiers in Pharmacology 2020; 11: 1-23.
22. Aminu Mohammed and Shahidul Islam: Spice-derived bioactive ingredients: potential agents or food adjuvant in the management of diabetes mellitus. Frontiers in Pharmacology 2018; 09(893): 1-28.
23. Jing Li, Ninghua Wu, Xiao Chen, Hongguang Chen, Xiaosong Yang and Chao Liu: Curcumin protects islet cells from glucolipotoxicity by inhibiting oxidative stress and NADPH oxidase activity both *in-vitro* and *in-vivo*. Islets 2019; 6: 152-164.
24. Giulio R Romeo, Junhee Lee, Christopher M Mulla, Youngmin Noh, Casey Holden and Byung-Cheol Lee: Influence of cinnamon on glycemic control in individuals with prediabetes: a randomized controlled trial. Journal of the Endocrine Society 2020; 4(11): 1-13.
25. Habib Yaribeygi, Luis E. Simental-Mendía, Alexandra E. Butler and Amirhossein Sahebkar: Protective effects of plant-derived natural products on renal complications. J of Cellular Physiology 2018; 234(8): 12161-12172.
26. Devaliya R and Shirsat M: A review on indigenous medicinal plants for diabetes mellitus. Research J Pharm Tech 2017; 10(8): 2828-36.
27. Phatak RS, Hendre AS and Durgawale PP: Phytochemical Composition of Methanolic Extract of *Phyllanthus acidus* L (Skeels) Fresh Leaves by GC/MS Analysis. Res J Pharm Tech 2016; 9(5): 559-61.
28. Thejeswari Y and Kumar SR: Amelioration and Affirmation for the Assessment of Curcumin in API and Ayurvedic Herbal Formulation Haridra Capsule by UFLC Discrete Method. Res J Pharm Tech 2013; 6(9): 1051-7.
29. Azam Vanaie, Shahrzad Shahidi, Bijan Iraj, Zahra Dana Siadat, Mansure Kabirzade, Feloria Shakiba, Mohsen Mohammadi and Homeira Parvizian: Curcumin as a major active component of turmeric attenuates proteinuria in patients with overt diabetic nephropathy. J Res Med Sci. 2019; 24(77): 1-6.
30. Garkuwa UA, Wahab AA, Yusuf T, Buhari I, Adamu BY and Adamu GN: Effect of Curcumin on Liver Enzymes and Liver Proteins in Alloxan-induced Diabetic Wistar Rats. The Pharma Chem J 2018; 5(3): 130-4.
31. Shatadal G, Sudip B, Kahkashan R and Parames CS: Curcumin protects rat liver from streptozotocin-induced diabetic pathophysiology by counteracting reactive oxygen species and inhibiting the activation of p53 and MAPKs mediated stress response pathways. Toxicol Rep 2015; 2: 365-76.
32. Hayder M. Alkuraishy, Ali I. Al-Gareeb and Huda Abdulbaki Rasheed: Nephroprotective effect of Curcumin (*Curcuma longa*) in acute nephrotoxicity in Sprague-Dawley rats. J Contemp Med Sci 2019; 5(2): 122-124.
33. Qiudi Tu, Yiwen Li, Juan Jin, Xinxin Jiang Yan Ren and Qiang He: Curcumin alleviates diabetic nephropathy via inhibiting podocyte mesenchymal transdifferentiation and inducing autophagy in rats and MPC5 cells. Pharmaceutical Biology 2019; 57(1): 778-786.
34. Chintha Lankatillake, Tien Huynh and Daniel A: Dias. Understanding glycaemic control and current approaches for screening antidiabetic natural products from evidence-based medicinal plants. Plant Method 2019; 15(105): 1-35.
35. Sanlier, Nevin, Gencer and Feray: Role of spices in the treatment of diabetes mellitus: A minireview. Trends in food science & technology. 2020; 99(4): 441-449.
36. Borse SP, Chippa AS, Sharma V, Singh DP and Nivsarkar,M: Management of Type 2 Diabetes: Current Strategies, Unfocussed Aspects, Challenges, and Alternatives. Medical Principles and Practice 2021; 30: 109–121.
37. Rujman Khan, Xin Yee Ooi, Matthew Parvus, Laura Valdez and Andrew Tsin: Advanced glycation end products: formation, role in diabetic complications, and potential in clinical applications. The Eye and Foot in Diabetes. 2020; 659. DOI: 10.5772/intechopen.89408
38. Dejene Dida Bulbula: Comprehensive Review on Turmeric (*Curcuma longa* l.) as medicinal plant and its nutraceutical quality to human. Cancer Therapy and Oncology 2021; 18 (3): 555990.
39. Masoumeh Asgharpour, Audrey Tolouian, Lakkakula VKS Bhaskar, Ramin Tolouian and Nilofar Massoudi: Herbal antioxidants and renal ischemic-reperfusion injury; an updated review. J Nephropharmacol 2021; 10(1): 03: 1-10.

How to cite this article:
Hendre AS, Patil SR, Sontakke AV and Phatak RS: Ameliorating effect of turmeric on Kidney function in patients with type 2 Diabetes mellitus. Int J Pharm Sci & Res 2022; 13(10): 4019-24. doi: 10.13040/IJPSR.0975-8232.13(10).4019-24.