ORIGINAL ARTICLE

COMPARISON OF SERUM LIPID PARAMETERS IN NORMAL, DIABETIC AND TURMERIC TREATED DIABETIC RATS

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Background: Alteration in lipid profile is a common complication of diabetes leading to life threatening conditions**.** Aim of this study was to compare serum lipid profile parameters in control, diabetic and diabetic animals given turmeric powder and to determine the improvements in lipid profile in diabetic rats with the use of turmeric powder. **Methods:** In this experimental study, carried out at Postgraduate Medical Institute Lahore, 45 albino rats were randomly divided into three equal groups (normal control, diabetic and diabetic receiving turmeric therapy). Initially, Alloxan was administered to all the animals except normal control to produce diabetes. After confirmation of diabetes, one diabetic group was selected to be treated with turmeric powder dissolved in water in dosage of 250 mg/Kg body weight. Blood samples were obtained from rats after 12-hour fasting period at the start of experiment after confirmation of diabetes, week eight and week twelve. **Results:** When comparison was made, mean values of lipid profile parameters were significantly higher for diabetic control and diabetic animals receiving turmeric therapy as compared to normal control during week eight but the difference between both the diabetic groups was also significant. By the end of week twelve the difference between normal control and diabetic animals receiving turmeric therapy became non-significant with improvement in lipid profile parameters of diabetic rats receiving turmeric powder. **Conclusion:** Therapy with turmeric powder induces improvement in lipid profile of diabetic rats with dyslipidemia.

Keywords: Curcumin, Diabetes Mellitus, Lipid parameters

Pak J Physiol 2025;21(4):26–9, **DOI:** https://doi.org/10.69656/pjp.v21i4.1874

INTRODUCTION

According to the report of 'International Diabetes Federation' approximately 537 million individuals in between 20 to 79-year of age are having diabetes, expected to rise by 783 million in 2045.[1] Middle East and South East Asia are becoming high disease prevalent countries due to sedentary life styles, obesity and unhealthy diets.[2,3]

Alteration in lipid profile parameters (dyslipidemia) is common in diabetics, exhibiting poor glycemic control.[4,5] Deficiency of insulin and impaired insulin sensitivity are the reasons to develop altered lipid metabolism.[6] Increased levels of total serum cholesterol, serum phospholipids and low serum HDL cholesterol are major risk factors for development of cardiovascular complications in diabetic individuals.[7] By providing proper diet regimen, making appropriate lifestyle changes including exercise and keeping the stability of blood glucose levels in normal range, complications associated with diabetes (dyslipidemia) can be prevented.[7,8]

Turmeric plant since primordial times is found to have medicinal properties and is commonly available in tropical (Asian) countries.[9] According to the recent research Curcumin, an active ingredient of turmeric is helpful to maintain normal blood lipid levels by controlling the absorption, transport and excretion of cholesterol.[10] Turmeric is believed to maintain cholesterol homeostasis by increasing the expression of enzyme CYP7A1, which is involved in cholesterol metabolism.

Through its anti-inflammatory and anti-oxidant effects, turmeric (curcumin) is able to prevent development of intractable complications induced by diabetes like atherosclerosis and ischemic heart disease.[11] By reducing the levels of inflammatory indicators (hs-CRP, TNF-α and IL-6), curcuminoids have protective effect on the beta cells of pancreas and improvement in insulin resistance thus beneficial to maintain blood glucose levels of diabetics and indirectly preventing the abnormal alterations in serum lipid levels.[12]

This study was focused to compare some of main serum lipid profile parameters among normal, untreated diabetic, and diabetic rats on turmeric therapy, and to find out some dietary supplement which can reduce the chances of having complications like dyslipidemia in diabetic patients.

MATERIAL AND METHODS

Forty-five Sprague-Dawley rats with average age of 11 weeks, were selected for this study. Sample size was calculated using resource equation method for one-way ANOVA by using the formula n= DF/k+1 to obtain maximum number of animals per group. Rats were acclimatized in animal house of Post-Graduate Medical Institute, Lahore for one week. All the rats had free

access to the rat chow diet and water. Animals were kept at 24±5 °C with 12-hour light/dark cycle. Total duration of this experiment was 4 months, approval was granted by Ethical Committee of Animal Sciences of the Institute.

After completion of acclimatization period, all 45 rats were randomly divided into 3 equal groups of 15 using simple random sampling with balloting method. All animals except normal controls were administered intraperitoneal injection of alloxan 130 mg/Kg body weight as one-time dose, dissolved in normal saline after overnight fast. Diabetes was confirmed in animals after 5–7 days of alloxan injection on tail vein blood with glucometer. Aimals having blood glucose levels >200 mg/dL were included in the experiment.

For the next 12 weeks, healthy rats of normal control group and the animals of diabetic control group were given normal synthetic rat diet and 3 mL distilled water per day. The third group animals were given powdered rhizomes of *Curcuma longa* (turmeric) 250 mg/Kg body weight per day dissolved in 3 mL of distilled warm water.

Blood samples (1.5–2.5 mL per animal) of all animals were taken from saphenous vein after a fasting period of 12 hours. Blood was collected initially when diabetes was confirmed, then after 8 weeks and finally by the end of 12th week.[13] Total serum cholesterol, total serum phospholipids, LDL-c and HDL-c were measured by direct quantitative (enzymatic colorimetric method).[14] Automated chemistry analyser was used for tests performed in Chemical Pathology Lab of PGMI Lahore.

Data analysis was done using SPSS-23. Quantitative data were expressed as Mean±SD. To compare lipid profile parameters among groups, one-way ANOVA was used. For comparison of all the possible pairs of means, Post hoc Tukey test was applied, and $p \leq 0.05$ was considered statistically significant.

RESULTS

At the start of experiment, mean total serum cholesterol level for animals in healthy control group was 73±7 mg/dL, which remained in normal range during twelve-week time period and was 64±7 mg/dL at the end. The total serum cholesterol level for diabetic group and diabetic animals having turmeric therapy, increased to 143±13 mg/dL and 131±15 mg/dL respectively, after induction of diabetes. The total serum cholesterol level of rats receiving turmeric declined during experiment with mean total serum cholesterol level 91±12 mg/dL at week 8 and 64±19 mg/dL at last day of study. An increase in total serum cholesterol level for diabetic control animals was recorded with mean total serum cholesterol level 214±22 mg/dL at the end (Table-1).

When comparison was made among groups at different times, it was observed that mean total serum cholesterol levels were significantly different ($p<0.001$). By the end of week eight, diabetic control animals and those having turmeric therapy had significantly higher mean values ($p<0.001$) as compared to normal control, and the difference between the diabetic control and turmeric receiving diabetics was also significant ($p<0.001$). Mean total serum cholesterol level of diabetic control animals raised significantly as compared to normal control ($p<0.001$) at the end of the experiment and was also significantly higher from the diabetic animals receiving turmeric powder ($p<0.001$). The difference between normal control and diabetics having turmeric treatment was found insignificant ($p=0.987$), at the end of week 12. (Table-1).

The mean total serum phospholipids level of animals in normal control group was 103±8 mg/dL at the start and 92±7 mg/dL at the end. The serum phospholipids level increased to 110±11 mg/dL and 126±14 mg/dL for the other two groups after diabetes. The serum phospholipids level gradually decreased for animals receiving turmeric throughout the experiment with mean value 90±15 mg/dL by the end of week 12. Gradual increase in serum phospholipids level of diabetic control animals was observed with mean serum phospholipids level 129±21 mg/dL and 170±38 mg/dL at week 8 and 12. (Table-2).

The pair-wise comparison explained a higher mean value in turmeric treated animals as compared to the other two groups ($p<0.001$ respectively) and the difference between normal control and diabetic control was not significant ($p=0.297$) at the start of study. At week 8 the diabetic control had significantly higher average of total serum phospholipids by 31.4 mg/dL and 26.9 mg/dL ($p<0.001$) as compared to normal control and animals receiving turmeric therapy. By the end of week 12, mean serum phospholipids level of animals in diabetic control increased by 78.5 mg/dL as compared to normal control ($p<0.001$) and was significantly higher by 80.9 mg/dL from diabetic treated animals ($p<0.001$). The difference of 2.4 mg/dL between diabetics and diabetics with turmeric treatment was recorded which was insignificant ($p=0.957$).

At the start of experiment, the mean value of LDL/HDL ratio observed for animals in healthy control group was 2.83±0.60, which declined a bit during 12-week time and was 2.44±0.49 at the end. The LDL/HDL ratio for animals in other two groups increased to 5.80±1.78 and 7.72±4.69 respectively after diabetes. The LDL/HDL ratio of animals declined for diabetic animals having turmeric treatment during the experiment with mean value of 4.53±2 at week 8 and 2.62±1 at the end. The LDL/HDL ratio for diabetic control animals was observed to be increased with mean LDL/HDL ratio 11.06±5.7 at week 8 and 19.18±6.9 at week 12. When groups were compared at different measurement times, the mean ratios were found statistically significant ($p<0.001$). (Table-3).

Initial pair-wise comparison done by post-hoc Tukey test showed a higher mean value of LDL/HDL ratio in diabetic control animals and those receiving turmeric when compared to healthy control animals (p<0.05 and <0.001 respectively). The diabetic control animals had significantly higher average ratio (p<0.001) as compared to the other two groups by week 8, and the difference between the normal control group and diabetic turmeric treated group was not significant (p=0.319). By the end of week 12, the mean LDL/HDL ratio of diabetic control animals was higher by 16.74 compared to normal control (p<0.001) and was significantly higher by 16.56 from rats having turmeric therapy (p<0.001). The difference of 0.18 between normal control and turmeric receiving diabetic animals was observed which was not statistically significant (p=0.991).

Table-1: Comparison of total serum cholesterol levels of animals at given times (mg/dL, Mean±SD)

Animal Groups	start of study (after diabetes)	8th week	12th week
Healthy control	73±7	69±6	64±7
Diabetic control	143±13	185±15	214±22
Diabetic+turmeric treated	131±15	91±12	64±19
p	<0.001	<0.001	<0.001

Table-2: Comparison of serum phospholipids levels of animals at given times (mg/dL, Mean±SD)

Animal groups	start of study (after diabetes)	8th week	12th week
Healthy control	10±8	98±9	92±7
Diabetic control	110±11	129±21	170±38
Diabetic+turmeric treated	126±14	102±17	90±15
p	<0.001	<0.001	<0.001

Table-3: Comparison of LDL/HDL-cholesterol ratio of animals at given times (mg/dL, Mean±SD)

Animal groups	start of study (after diabetes)	8th week	12th week
Healthy control	2.83±0.60	2.66±0.70	2.44±0.49
Diabetic control	5.80±1.78	11.06±5.70	19.18±6.99
Diabetic+turmeric treated	7.72±4.69	4.53±2.01	2.62±1.03
p	<0.001	<0.001	<0.001

DISCUSSION

This study's findings emphasize the notable dyslipidemia linked to diabetes and illustrate the possibility of turmeric powder as a therapeutic measure to alleviate these metabolic disorders. The enhanced blood lipid profile characteristics reported in diabetic control rats at week eight correspond with established data that hyperglycaemia intensifies lipid irregularities by facilitating lipolysis, augmenting free fatty acid flow, and disrupting lipoprotein metabolism.[15] Notably, the diabetic group receiving turmeric exhibited a significant reduction in lipid parameters compared to the untreated diabetic group by week eight, suggesting an early but partial therapeutic effect. However, the normalization of lipid profiles in the turmeric-treated group by week 12, were close to the non-diabetic controls emphasizing the time the time-dependent efficacy of turmeric in restoring metabolic homeostasis.[16]

Curcumin, the bioactive compound of turmeric is ascribed for the gradual modification of lipid picture after extended use due to its influence on lipid metabolism through different mechanisms.[17] Another study indicates that the expression of peroxisome proliferator-activated receptor gamma (PPAR-γ) and liver X receptors (LXRs) both essential regulators of cholesterol release and lipoprotein metabolism, are increased in response to curcumin.[18] Helping to lower oxidative stress is curcumin's antioxidant properties. By lowering lipid peroxidation and enhancing the body's natural antioxidant defences, this oxidative stress is vital in the development of dyslipidemia connected to diabetes.[19] By week twelve, the lipid levels are seen to rise in diabetic control group whereas the turmeric treated diabetic group has significant decrease in lipid profile. The findings conform to the study by Muhammed WI, with the difference that dyslipidemia was introduced by intraperitoneal dexamethasone.[20]

These results support earlier studies showing curcumin's ability to lower total cholesterol, triglycerides, and LDL-C while raising HDL-C in diabetic mice.[21] A meta-analysis[22] of preclinical studies stressing the duration-dependent efficacy of phytochemicals in metabolic diseases supports the conclusion that sustained administration is necessary for attaining clinically significant outcomes as observed in the current study. The normalization of lipid markers in the turmeric-treated group matches clinical observations showing better cardiovascular risk profiles in diabetic patients on curcumin supplementation.[23]

Despite these positive results, the study used an animal model which does not fully reflect human metabolic complexity. Future research should look into turmeric's translational potential in human trials, particularly with relation to long-term effects on diabetic dyslipidemia and cardiovascular outcomes. Clinical trials with the use of purified curcumin instead of raw turmeric powder can produce much better effects.

CONCLUSION

The improvements in lipid profile parameters (total serum cholesterol, phospholipids, and LDL/HDL ratio) are observed in this study with the use of turmeric powder when comparison was made among normal control, diabetic control, and diabetic rats treated with turmeric (curcuminoids).

REFERENCES

1. International Diabetes Federation (IDF) IDF Diabetes Atlas. 10th ed. International Diabetes Federation; Brussels, Belgium: 2021. Available from: https://diabetesatlas.org/idfawp/resourcefiles/2021/07/IDF_Atlas_10th_Edition_2021.pdf
2. Mayer-Davis EJ, Lawrence JM, Dabelea D, Divers J, Isom S, Dolan L, *et al.* Incidence trends of type 1 and type 2 diabetes among youths, 2002–2012. N Engl J Med 2017;13;376(15):1419–29.
3. Shepherd M, Shields B, Hammersley S, Hudson M, McDonald TJ, Colclough K, *et al.* Systematic population screening, using

biomarkers and genetic testing, identifies 2.5% of the UK pediatric diabetes population with monogenic diabetes. Diabetes Care 2016;39(11):1879–88.
4. Kim ES, Jeong JS, Han K, Kim MK, Lee SH, Park YM, *et al*. Impact of weight changes on the incidence of diabetes mellitus: a Korean nationwide cohort study. Sci Rep 2018;8(1):3735.
5. Stojanović M, Cvetanović G, Anđelković Apostolović M, Stojanović D, Rančić N. Impact of socio-demographic characteristics and long-term complications on quality of life in patients with diabetes mellitus. Cent Eur J Public Health 2018;26(2):104–10.
6. Oboza P, Ogarek N, Olszanecka-Glinianowicz M, Kocelak P. Can type 1 diabetes be an unexpected complication of obesity? Front Endocrinol 2023;14:1121303.
7. Latha VA, Mondu SS, Eshwar MD, Polala AR, Nandanavanam S, Dodda S. Dyslipidemia among diabetes mellitus patients: A case-control study from a tertiary care hospital in South India. Cureus 2023;15(2):e35625.
8. Visseren FLJ, Mach F, Smulders YM, Carballo D, Koskinas KC, Bäck M, *et al*. ESC Guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J 2021;42(34):3227–337.
9. Salgintas HH, Donmez N, Ozsan M. The effect of curcumin on the antioxidant system in diabetic rats. J Hell Vet Med Soc 2021;72(4): 3279–84.
10. Yang J, Zou J, Mai H, Hong T, Liu H, Feng D. Curcumin protects against high-fat diet-induced nonalcoholic simple fatty liver by inhibiting intestinal and hepatic NPC1L1 expression via down-regulation of SREBP-2/HNF1α pathway in hamsters. J Nutr Biochem 2023;119:109403.
11. Islam MZ, Akter J, Hossain MA, Islam MS, Islam P, Goswami C, Nguyen HTT, Miyamoto A. Anti-inflammatory, wound healing, and anti-diabetic effects of pure active compounds present in the Ryudai gold variety of *Curcuma longa*. Molecules 2024;29(12):2795.
12. Júnior ASS, Aidar FJ, Santos JLD, Estevam CDS, Santos JDM, de Oliveira E Silva AM, *et al*. Effects of resistance training and turmeric supplementation on reactive species marker stress in diabetic rats. BMC Sports Sci Med Rehabil 2020;12.45.
13. Ahrens Kress AP, Zhang Y, Kaiser-Vry AR, Sauer MB. A comparison of blood collection techniques in mice and their effects on welfare. J Am Assoc Lab Anim Sci 2022;61(3):287–95.
14. Siddiqui, KS, Poljak, A, Ertan H, Bridge W. The use of isothermal titration calorimetry for the assay of enzyme activity: Application in higher education practical classes. Biochem Mol Biol Educ 2022;50(5):519–26.
15. Rao H, Jalali JA, Johnston TP, Koulen P. Emerging roles of dyslipidemia and hyperglycemia in diabetic retinopathy: Molecular mechanisms and clinical perspectives. Front Endocrinol 2021;12:620045.
16. Labban RSM, Alfawaz HA, Almnaizel AT, Al-Muammar MN, Bhat RS, El-Ansary A. Garcinia mangostana extract and curcumin ameliorate oxidative stress, dyslipidemia, and hyperglycemia in high fat diet-induced obese Wistar albino rats. Sci Rep 2021;11(1):7278.
17. Yaribeygi H, Maleki M, Butler AE, Jamialahmadi T, Gumpricht E, Sahebkar A. The beneficial effects of curcumin on lipids: possible effects on dyslipidemia-induced cardiovascular complications. Curr Med Chem 2024;31(42):6957–70.
18. Deng Z, Yang K, Cai X, Mei H, Xiao H, Gao W. The beneficial effects of curcumin supplementation on blood lipid levels among patients with metabolic related diseases in Asia area: a systematic review and meta-analysis of randomized controlled trials. Front Sustain Food Syst 2023;7:1167913.
19. Khutami C, Sumiwi SA, Khairul Ikram NK, Muchtaridi M. The effects of antioxidants from natural products on obesity, dyslipidemia, diabetes and their molecular signaling mechanism. Int J Mol Sci 2022;23(4):2056.
20. Mohammed WI. Hypolipidemic and anti-oxidant effects of curcumin in dexamethasone-induced dyslipidemia in rats. Egypt J Basic Clin Pharmacol 2021;8:9.
21. Musazadeh V, Roshanravan N, Mohammadizadeh M, Kavyani Z, Dehghan P, Mosharkesh E. Curcumin as a novel approach in improving lipid profile: An umbrella meta-analysis. Nutr Metab Cardiovasc Dis 2022;32(11):2493–504.
22. Behl T, Upadhyay T, Singh S, Chigurupati S, Alsubayiel AM, Mani V, *et al*. Polyphenols targeting MAPK mediated oxidative stress and inflammation in rheumatoid arthritis. Molecules 2021;26(21):6570.
23. Rafiee S, Bagherniya M, Askari G, Sathyapalan T, Jamialahmadi T, Sahebkar A. The effect of curcumin in improving lipid profile in patients with cardiovascular risk factors: A systematic review of clinical trials. The effect of curcumin in improving lipid profile in patients with cardiovascular risk factors: A systematic review of clinical trials. Adv Exp Med Biol 2021;1291:165–77.

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Received: 12 Jul 2025 **Reviewed:** 26 Dec 2025 **Accepted:** 31 Dec 2025

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JL: Conceptualizing, data collection, literature review, drafting manuscript **AZ:** Critically reviewing the manuscript
MJS: Interpretation of data **SM:** Statistical analysis **IQ:** Editing of manuscript **SN:** Literature review

Conflict of Interest: None to declare **Funding source:** None to declare