FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 3 No. 3, September, 2019, pp 44 –53

KIDNEY FUNCTION AND SOME HEAVY METALS STATUS OF LEATHER TANNERS AT MAJEMA TANNERY, KOFAR WAMBAI, KANO STATE- NIGERIA.

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ABSTRACT
Leather tanners are exposed to toxic chemicals and heavy metals that may be harmful to their health. The present study was aimed at assessing the effect of tanning processes on renal function and some heavy metals status of leather tanners at Majema Tannery Kofar Wambai, Kano. Sixty (60) apparently healthy male individuals were divided into four groups of 15 persons each (i.e control group obtained from Dorayi-Gwale Local Government, non - tanners residing near the tannery but do not participate in the work, moderate tanners with working experience of 0- 10 years and heavy tanners with working experience of 10 years and above). Some kidney function parameters in serum (urea, creatinine and electrolytes i.e Na, K+, Cl- and HCO_3^-), and in urine (albumin and creatinine), serum vitamin D and Lactate Dehydrogenase activities (using NAD as a substrate) were measured by spectrophotometric method. Serum levels of some heavy metals (chromium, cadmium and zinc) were measured using atomic absorption spectrometry. Systolic and diastolic blood pressures were measured using sphygmomanometer. There was significant increase in albuminuria in all the four groups and lactate dehydrogenase for the heavy tanners ($p>0.05$), while serum vitamin D was within normal range. Both heavy and moderate tanners had significantly ($p<0.05$) higher serum chromium and cadmium than control, and non-tanners. Systolic and diastolic blood pressures for all the four groups were within normal range. Thus, there is possibility of renal impairment, if not now, but in the near future for the tanners.

Keywords: Kidney Function; Heavy Metals; Leather Tanners.

INTRODUCTION

Tanning is a process of treating skin and hides of animals to produce leather, which when left untouched are more susceptible to decomposition. It involves series of preparatory steps followed by treating skin and hides for leather production. Environmental concerns in a tannery include the prevention and control of emissions to water, air, and soil. Chemicals are used, some of which may require special treatment in effluent (Reemtsma and Jekel, 1997). Waste water pollution is primarily a byproduct of the initial preparation (or "beamhouse") stage, where in bits of flesh, hair, mold, poop, and other animal byproducts are mixed into wash water and discarded.

Tanning wastes products, if not disposed properly lead to health hazards such as respiratory problems, infections, infertility, and birth defects (Ramasami, 2001). It can also instigate a number of serious cancers in animals throughout the food chain (Heidman, 2005). When inhaled, chromium, one of the heavy metals associated with tanning, acts as a lung irritant and carcinogen, affecting the upper respiratory tract, obstructing airways, and increasing the chances of developing lung, nasal, or sinus cancer (Cot *et al.*, 2003). Other health problems associated with the tanning processes include dermatitis, liver and kidney dysfunctions. This draws attention for effective toxicological investigation on local tanners, focusing on effects to body organs. Therefore, the aim of this research was to assess the effect of tanning processes on kidney function and the levels of some serum heavy metals of leather tanners at Majema Tannery Kofar Wambai, Kano State, Nigeria.

MATERIALS AND METHODS

Experimental Design

This was a cross sectional design to analyze kidney function and some heavy metals status of leather tanners at Majema tannery, Kofar Wambai, Kano Municipal, Kano State-Nigeria. A control group was obtained from Dorayi, Gwale local government area of Kano State. All the subjects were randomly selected. Blood samples of tanners and non-tanners were obtained from Majema Tannery Kofar Wambai, Kano Municipal. Vein puncture was done to all the volunteers with their consent. Blood of ($10Cm^3$) was obtained from their antecubital fossa vein into a plain container. All the containers were then placed in a test tube rack and transported in a cooler to the Department of Biochemistry Bayero University, Kano. A portion of each sample was centrifugated and serum was collected and used for the assays. Early morning urine, which was also collected from the same volunteers, was used to estimate urine albumin and urine creatinine to calculate albuminuria.

Systolic and diastolic blood pressure of each individual whose blood and urine samples were taken by laboratory Practitioners was also measured using a sphygmomanometer (Mercury sphyg sps120, Gen Med. Inc, New Delhi, India). A consent form was given to each person that agreed to volunteer to sign, after which a questionnaire was distributed to the volunteers to fill before the samples were collected. Age, years of exposure, dietary habits, disease condition at the time of blood collections, use of protective gears, smoking and alcohol consumptions were all asked and answered by

each member involved in the research. An ethical clearance was also obtained from the Ministry of Health, Kano State.
A sum total of 60 male participants who were apparently healthy were taking by using Cochran's Sample Size Formula of statistics ($n° = \frac{Z^2pq}{e^2}$). Among the 60 samples, 30 tanners, and 30 non- tanners were randomly selected and used for this study. They were divided into 4 groups: Group A was the control group (n = 15) in which people that were non-tanners and not residing in the tanning area were used. Group B (n = 15) were the heavy workers who were very much exposed (spend more years 10 and above). Group C (n = 15) were the moderate workers who were less exposed (spend less years 0 to 10 years). Group D (n = 15) were the non- tanners but residing in the tanning area.

Methods

Major parameters that were tested for the kidneys were urea, creatinine and electrolytes (sodium, potassium, chloride and bicarbonate) which were detected in the serum. There were also kidney parameters that were measured in the urine; urine albumin and urine creatinine and were used to calculate albuminuria.

Serum Urea was determined by Berthelot, 1967; serum Creatinine by Jaffe, 1964**;** serum Sodium by Trinder ,1951; serum Potassium by Terri, 1958; serum Chloride by Skeggs, 1964; serum Bicarbonate by Vanslyke, 1924. Kinetic determination of serum Lactate Dehydrogenase was carried out using measurement of Urine Creatinine by Rosano, 1990; and measurement of urine albumin by Doumas, 1971. Serum vitamin D was determined by Electro Chemiluminescence Binding Assay using Roche, 2012 method. Heavy Metals Analysis by Atomic Absorption Spectrometry (AAS)

Statistical Analysis

Results of all the parameters are presented as mean ±, standard deviation. Regression and Correlation, and also one–way ANOVA with LSD comparison post hoc test were carried out on all data groups using SPSS® software (Statistical Package for Social Sciences) version 20. The probabilitity of significance was set at $P < 0.05$.

RESULTS AND DISCUSSION

Results of serum kidney function parameters were seen to be normal for CNs, NTs, MTs and HTs, except for urea (figure 1), sodium (figure 3) and albuminuria (figure 6) which were highly elevated in MTs and HTs in particular; and highest in HTs. The elevation of these parameters in the tanners may be either as a result of them being exposed to heavy metals at the tannery due to the years they spent working there (10 years and above); or due to other sources not covered by this research.

Increased serum urea can be caused by increased urea production, decreased urea elimination, or a combination of both. The increase in serum urea may also be as a result of physiological and pathological conditions. The physiological condition comprises of aging and increased dietary protein, while the pathological condition is likely confined to advanced liver diseases (Mehta, 2008). The findings of this research, if not linked with renal function goes in line with those of McWilliams *et al*., 2009. From the regression analysis (table 1), urea had the highest relationship with all the three heavy metals, which means the rise in serum urea levels in tanners may be due to contributions from the presence of these heavy metals. This finding agrees with that of Samir *et al.*, 2014, who proved that heavy metals, especially cadmium cause significant increase in urea.

The levels of sodium also appeared to be elevated in HT (figure 3), just like urea (figure 1). The exposure of the HTs may cause excessive water loss, which leads to hemo concentration of all the blood constituents, leading to the elevation (Esterez *et al*., 2008). This research agrees with the findings of Henry, 2001 which shows that elevation of sodium in the serum has a strong relationship with renal diseases. Sodium contributes to regulating blood pressure and volume; helps transmit impulse for nerve function and muscle contraction; and also regulate acid base balance of blood and body fluids (Kamil *et al*., 2011).

Albuminuria shows early signs of kidney disease even before the blood parameters (Parving *et al*., 2001). Albuminuria levels for all the groups, including control appeared to be higher than the normal reference values (figure 6). It occurs when the kidney leaks small amounts of albumin into the urine, or when there is an abnormally high permeability for albumin in the glomerulus of the kidney (Abid *et al*., 2001). Normally the kidneys do not filter albumin, so if albumin is found in the urine it's then a marker of kidney disease. The overall prevalence of albuminuria in this study is higher than reported by Jorge *et al*., 2005. Another finding with slight variations was recorded by Iwalokun *et al*., 2006. The regression analysis (table 1) for all the three heavy metals (i.e. cadmium, chromium and zinc) also indicates a stronger relationship between albuminuria and heavy metals, indicating that the elevation may be due to toxicity , although lesser than the relationship with urea.

Estimated Glomerular Filteration Rate (eGFR) (figure 10) was found to be slightly elevated in all the four groups, which is considered to be normal since a decline in the eGFR is the basis for renal diseases. eGFR was calculated using the 'Creatinine- Based equation for Modification of Diet in Renal Diseases. Glomerular filtration rate (GFR) is the volume per unit of time at which ultra- filtrate is formed by the glomerulus; approximately 120 ml are formed per minute (Nankivell, 2001). Renal function can be evaluated by measuring the GFR. Renal damage or alterations in glomerular function affect the kidneys' ability to remove metabolic substances from the blood into the urine (Nankivell, 2001). As Glomerular filtration rate declines, a wide range of disorders develops, including fluid and electrolyte imbalance such as hyperkalemia, metabolic acidosis, volume over load and hypophosphatemia (Wallia *et al*., 1986). The regression analysis carried out between eGFR

and the three heavy metals, i.e. cadmium, chromium and zinc (tables 1, 2 and 3 respectively) showed the weakest relationship and lowest percentage difference when compared with albuminuria, urea and SBP and DPB. The findings of this research are in opposition to those of Li *et al*., 2013 who found out that lower eGFR is the worst prognosis to kidney damage.

Systolic and diastolic blood pressure (SBP and DBP) for all the four groups appeared to be within the normal reference values (figure 9). Systolic hypertention is a close marker of cardiovascular diseases and chronic kidney diseases (Carmen *et al*., 2009). The result obtained in this research may be because the blood pressure was taken once without further monitoring. It might also be as a result of variations in food intake, working activities, the places these subjects live, as well as the income they earn (Levey and Coresh, 2012). The regressional analysis between the SBP and DBP when compared with cadmium, chromium and zinc (tables 1, 2 and 3 respectively) showed very little relationship a bit higher than eGFR.

Results of serum lactate dehydrogenase (LDH) also indicate elevation in HTs, above normal reference values (figure 4). The elevation showed that there may be tissue damage, which might not necessarily be kidney, since this is a non - specific enzyme found in almost every tissue in the body. There are five isoforms of LDH, which are enzymatically similar but show different tissue distribution: The major isoenzymes of skeletal muscle and liver, M4, has four muscle (M) subunits, while H4 is the main isoenzymes for heart muscle in most species, containing four heart (H) subunits (Holmes and Goldberg, 2009). Despite the fact that most of the kidney parameters appeared to be normal, the elevation in HTs may be due to the heavy metals toxicity affecting the kidney or another tissue in their system, as studies from the same tannery indicate significant hepatic toxicity which is also in accordance with the findings of Spriet *et al*., 2000, which shows that the total LDH level was elevated in all cases of acute tubular necrosis. Aside from the kidney and liver, others like the heart or muscles might also be faulty, and only further research in this area can show the default.

Vitamin D levels for all the four groups were shown to be within normal range, even though there was significant difference ($P<0.05$) among the groups, with CNs having lowest level and HTs having highest mean serum level (figure 11). Healthy kidneys are rich with vitamin D receptors and play a major role in turning vitamin D into its active form. This helps balance calcium and phosphorus in the body by controlling absorption of these minerals from the food and regulates parathyroid hormone (PTH) (Bolland *et al*., 2014). A study from Oramasionwu *et al*., 2008 showed that intake of vitamin D above threshold can produce over toxicity after some times, and also produce elevated levels in the serum.

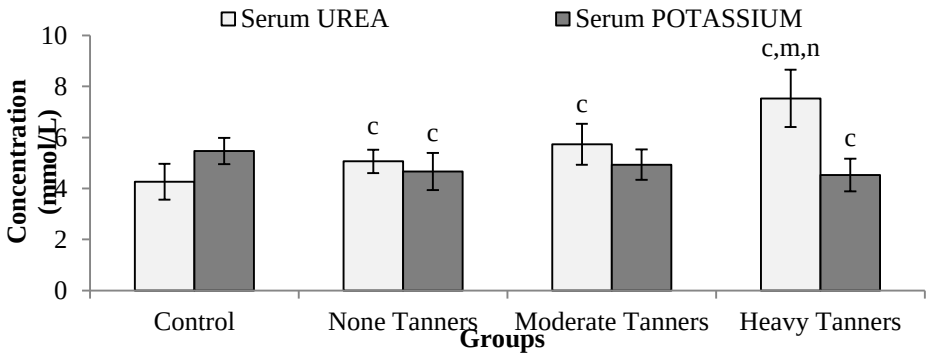


Fig. 1: Serum Urea and Potassium Levels for Control, Non Tanners, Moderate Tanners and Heavy Tanners. Values bearing c, n and m signifies significant differences ($P < 0.05$) when compared with Control, Non Tanners and Moderate Tanners Respectively.

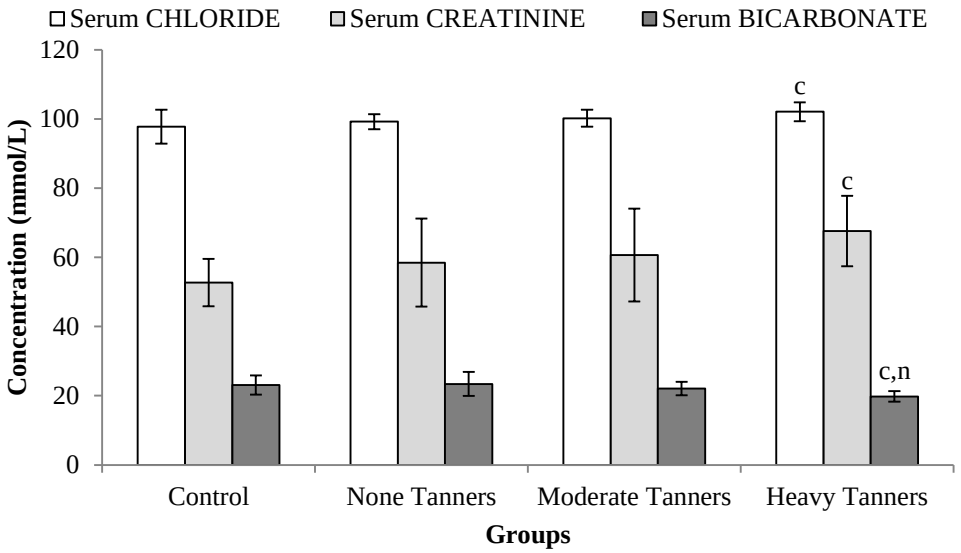


Fig. 2: Serum Chloride, Creatinine and Bicarbonate Levels for Control, Non Tanners, Moderate Tanners and Heavy Tanners. Values bearing c, n and m signifies significant differences ($P < 0.05$) when compared with Control, Non Tanners and Moderate Tanners Respectively.

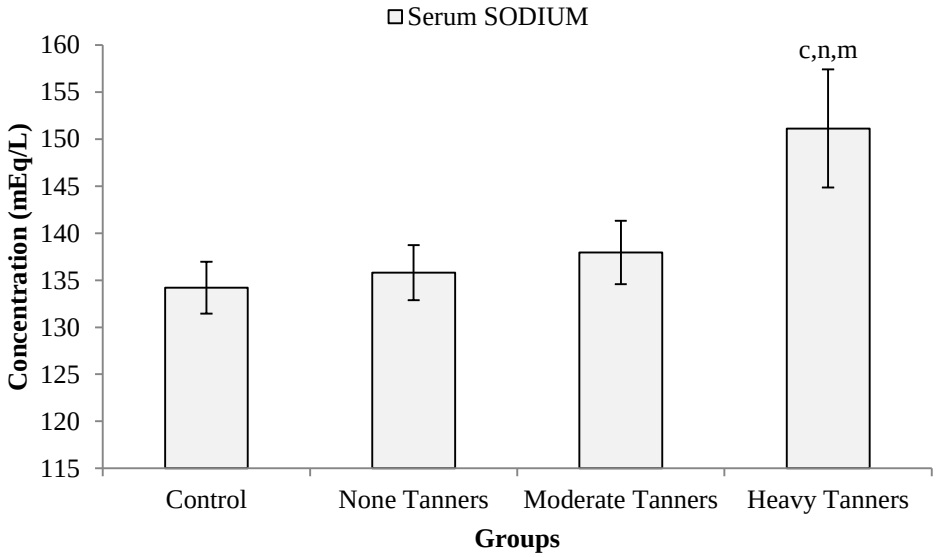
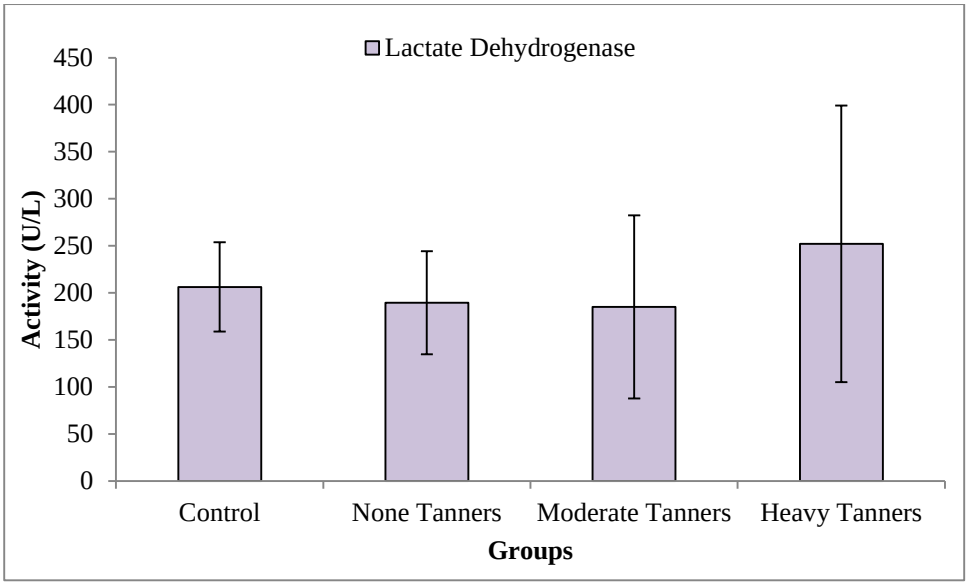


Fig. 3: Serum Sodium Levels for Control, None Tanners, Moderate Tanners and Heavy Tanners. Values bearing c, n and m signify significant differences ($P < 0.05$) when compared with Control, Non Tanners and Moderate Tanners Respectively.



Fi 4: Serum Levels of Lactate Dehydrogenase of Control, Non Tanners, Moderate Tanners and Heavy Tanners.

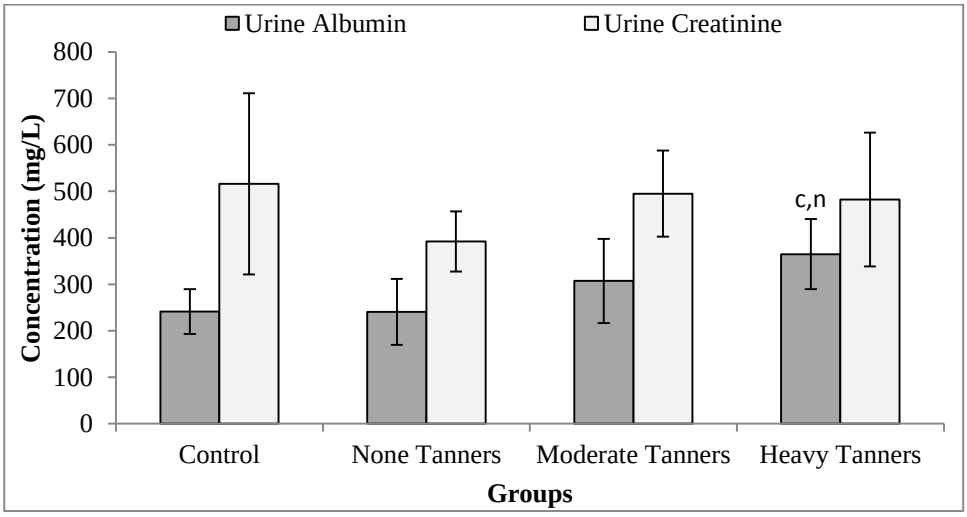


Fig. 5: Levels of urine albumin and urine creatinine for control, Non Tanners, Moderate Tanners and Heavy Tanners. Values bearing c and n signify significant differences ($P < 0.05$) when compared with Control and Non Tanners.

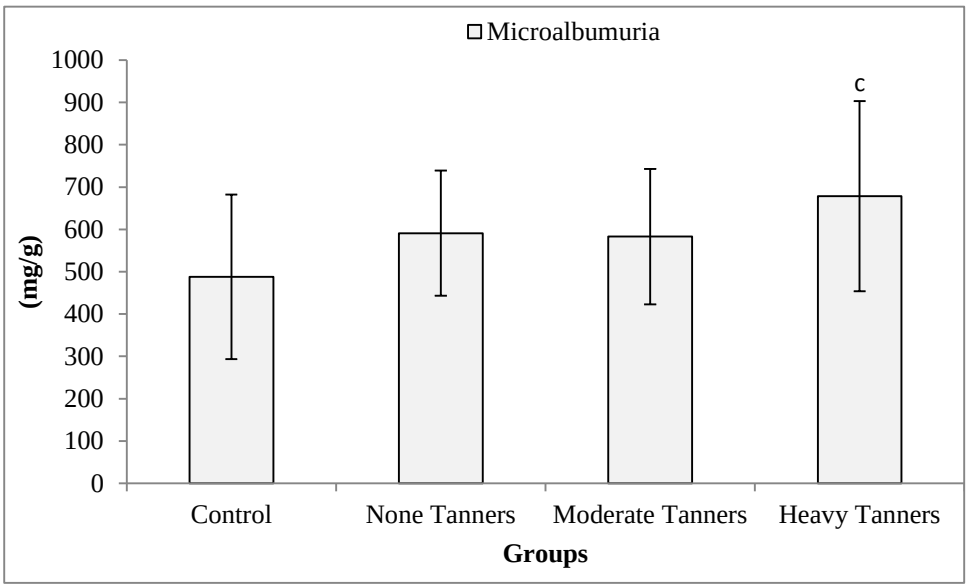


Fig. 6: Levels of Albuminuria for control Non Tanners, Moderate Tanners and Heavy Tanners. Values bearing c signifies significant differences ($P < 0.05$) when compared with Control.

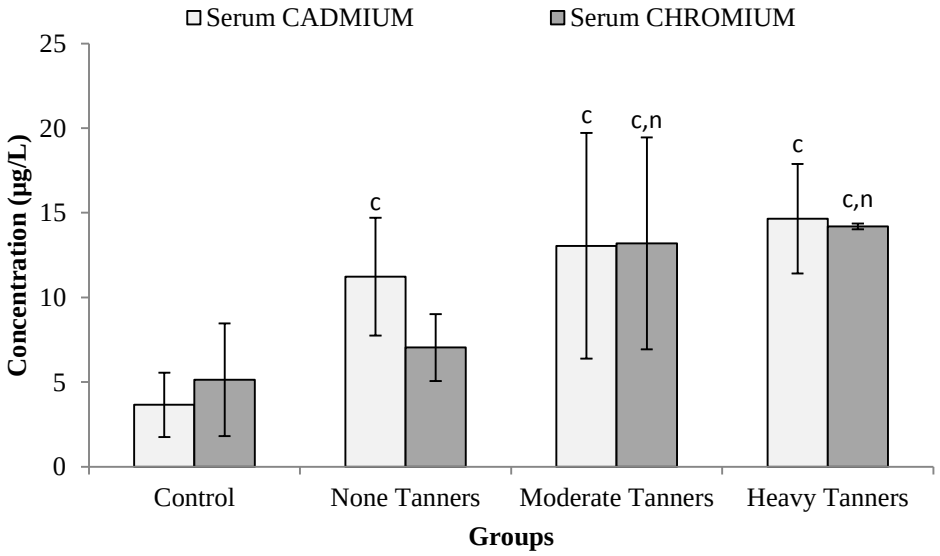


Fig. 7: Serum Cadmium and Chromium Levels for Control, Non Tanners, Moderate and Heavy Tanners. Values bearing c and n signifies significant differences ($P < 0.05$) when compared with Control and Non Tanners.

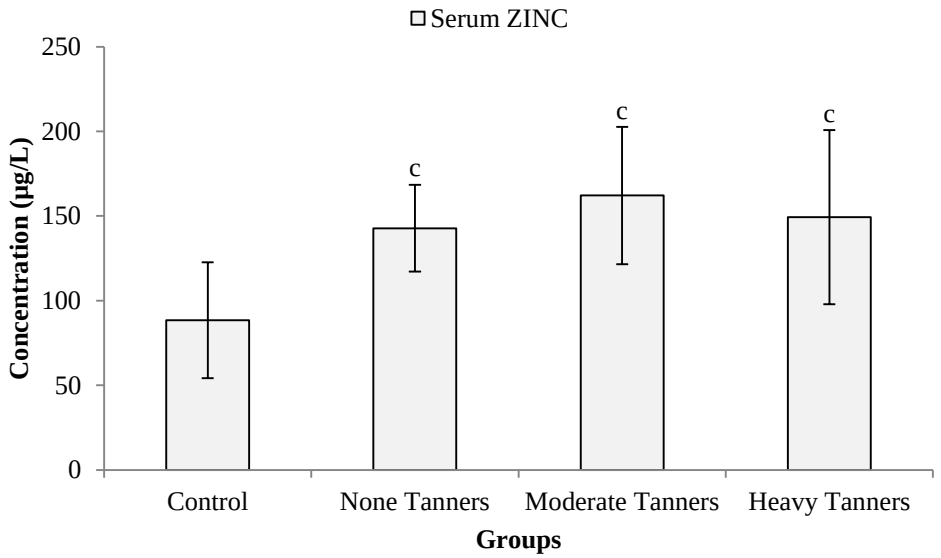


Fig. 8: Serum Zinc Levels for Control, Non Tanners, Moderate and Heavy Tanners. Values bearing c signifies significant differences ($P < 0.05$) when compared with Control.

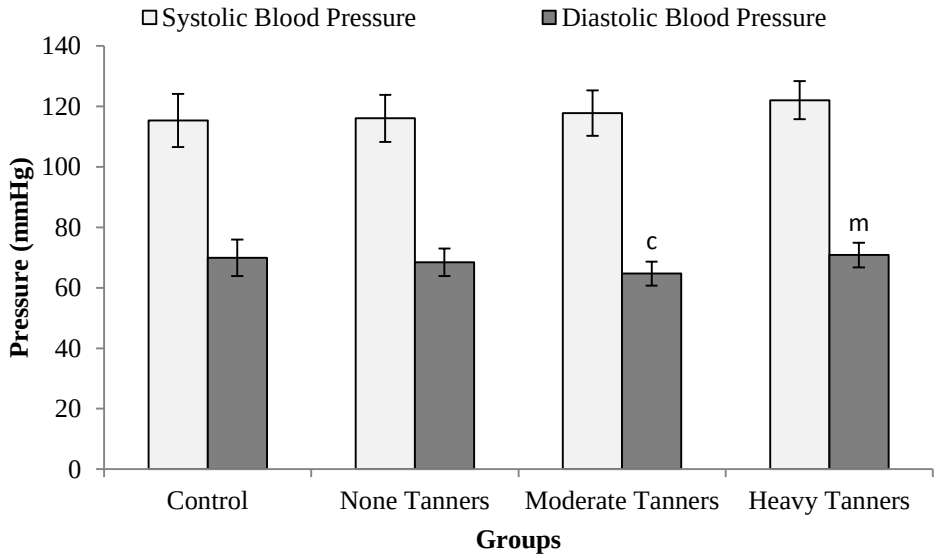


Fig. 9: Diastolic and Systolic Blood Pressure for Control, Non Tanners, Moderate and Heavy Tanners. Values bearing c and m signifies significant differences ($P < 0.05$) when compared with Control and Moderate Tanners.

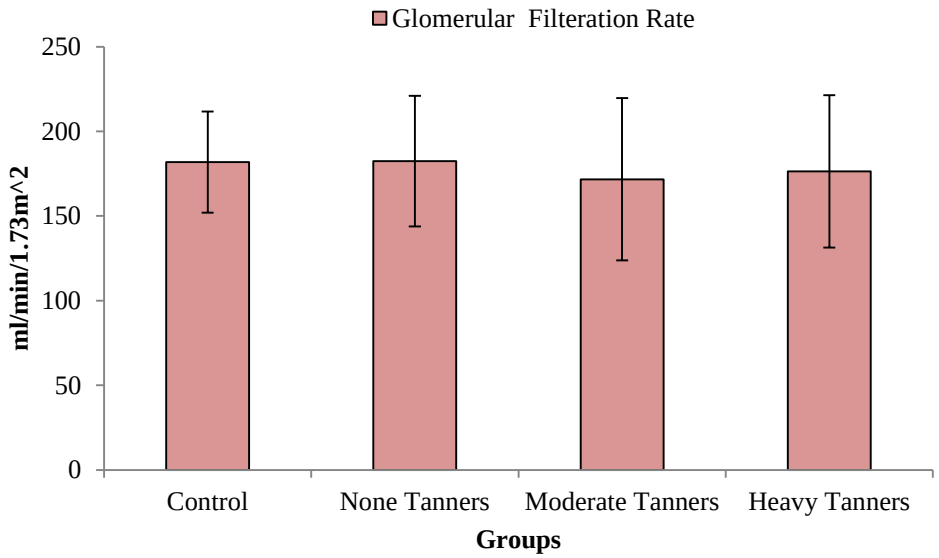


Fig. 10: Glomerular Filteration Rate for Control, Non Tanners, Moderate and Heavy Tanners.

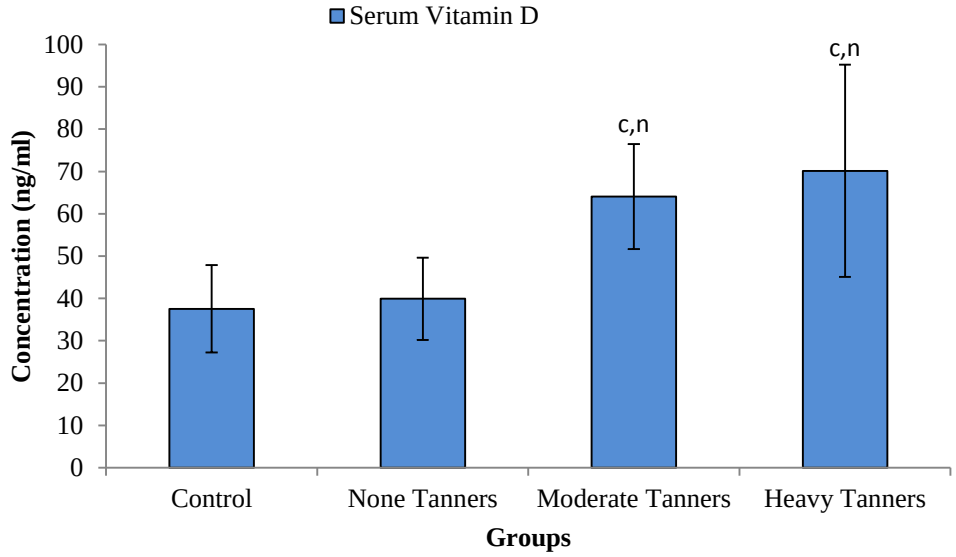


Fig. 11: Serum Vitamin D Levels For Control, Non Tanners, Moderate and Heavy Tanners. Values bearing c and n signifies significant differences ($P < 0.05$) when compared with Control and Non Tanners.

Table 1: Regression Analysis between Cadmium (Cd) and Some Kidney Parameters \ Blood Parameter

Prediction	R	R^2	Standard Error of the Estimate	P
Albuminuria = 0.1 (Cd) + 0.478	0.309	9.5%	0.184	0.160
GFR = 0.234 (Cd) + 175.53	0.035	0.1%	40.45	0.793
Urea = 0.122 (Cd) + 4.346	0.50	24.9%	1.27	0.000
Systolic BP = 0.238 (Cd) + 115.29	0.178	3.2%	7.82	0.173
Diastolic BP = -0.081 (Cd) + 69.351	0.093	0.9%	5.12	0.481

R represents Regression; R^2 represents the percentage difference; P represents the probability distribution between the variables. Standard

Error of Estimate represents the error encountered while carrying out the analysis.

Table 2: Regression Analysis between Chromium (Cr) and Some Kidney Parameters \ Blood Pressure

Prediction	R	R^2	Standard Error of the Estimate	P
Albuminuria = 0.498 (Cr) + 0.009	0.244	5.9%	0.188	0.061
GFR = 0.061 (Cr) + 177.439	0.008	0.0%	40.47	0.951
Urea = 0.171 (Cr) + 3.961	0.625	38.1%	1.14	0.000
Systolic BP = 0.522 (Cr) + 112.66	0.351	12.3%	7.44	0.006
Diastolic BP = -0.29 (Cr) + 68.778	0.30	0.1%	5.20	0.821

R represents Regression; R^2 represents the percentage difference; P represents the probability distribution between the variables. Standard Error of Estimate represents the error encountered while carrying out the analysis.

Table 3: Regression Analysis between Zinc (Zn) and Some Kidney Parameters \ Blood Pressure

Prediction	R	R^2	Standard Error of the Estimate	P
Albuminuria = 0.001 (Zn) + 0.490	0.174	3.0%	0.190	0.184
GFR = 0.038 (Zn) + 172.853	0.045	0.2%	40.43	0.731
Urea = 0.009 (Zn) + 4.478	0.284	8.1%	1.40	0.028
Systolic BP = 0.013 (Zn) + 116.09	0.077	0.6%	7.93	0.558
Diastolic BP = -0.032 (Zn) + 72.789	0.292	8.5%	4.98	0.023

R represents Regression; R^2 represents the percentage difference; P represents the probability distribution between the variables. Standard Error of Estimate represents the error encountered while carrying out the analysis.

REFERENCES

Abid, O., Sun, Q., Sugimoto, K., Mercan, D. and Vincent, J. L., (2001). "Predictive value of microalbuminuria in medical ICU Patients: Results of a pilot study".Chest. 120(6): 1984-8.

Berthelot's Reaction (1967).Chaney, A.L., and Marbach, E.P. "Modified reagents for the determination of urea and ammonia".Clinical Chem., 8:130-132.

Bolland, M.J., Grey, A., Gamble, G.D. and Reid, I.R. (2014). "Vitamin D supplementation Fals: a trial sequential meta-analysis".Lancet Diabetes Endocrinol. 2(7):573-80.

Carmen A.P., Mary A.W., Joachin H.I., Michael G.S., (2009)."Kidney Function and Systolic Blood Pressure New Insights from Cystatin C: Data from Heart and Soul study. "PMC, US. National Library of Medicine, National Institute of Health.

Cot, J. Marsal, A., Manich, A., Celma, P., Choque, R., Cabeza, L., Labastida, L., Lopez, J., Salmeron, J. (2003). "Mininmisation of industrial wastes: Adding value to collagen materials." J.soc, leather technol chem., 87: 97-99.

Doumas, B.T., Watson, W.A. and Biggs, H.G .(1971). "Methods of Measuring Serum/ Urine Albumin."Clin.Chem. Acta.31: 87.

Esterez, J.E., Baquero, E., and Rodrigues, R. (2008). "Anaerobic performance when rehydrating with water or commercially available sports drinks during prolonged exercise in the heat." Applied Physiolgy, Nutrition and Metabolism. 33(2):290-298.

Heidmann, E. (2005).'Leather'.Ullmanns Encyclopedia of industrial Chemistry. London Boomerang Press.Pp: 63-85.

Henry, J.B. (2001). "Clinical diagnosis and management of laboratory methods. 20th ed. Philadelphia. W.B. Saunders company.

Holmes, R. S., and Goldberg, E. (2009). "Computational analysis of mammalian lactate dehydrogenase: Human, mouse, opossum and platypus LDHs." Computational Biology and Chemistry. 33 (5): 379-85.

Iwalokun BA, Ogunfemi MK, Gbajabiamila B, Olukosi YA, (2006)."Incidence and Evaluation of risk factors of microalbuminuria among diabetes and non- diabetes in Lagos, Nigeria."Nig J, Health and Biomed Sci; 5(1) 7-8.

Jaffe, H.R., Cannon, C.D., Winkelman, W.J.(1964). "Clinical Chemistry, Jaffe's Method". 3rd Edition, Harper and Row Hagerstown, Cambridge: 543.

Jorge LG, Mirela JD, Sandra PS, Lu´is HC, Maria LC, Themis Z (2005)." Diabetic Nephropathy: Diagnosis, Prevention, and Treatment. "Diabetes Care; 28:176 –188.

Kamil, P., Regina, B., Jaroslaws, T., Aldona, Z. and Wladyslaw, W. (2011). "The effect of addictive of lewis acid type on lithium-gel electrolyte characteristics".ElectrochemicalActa.57: 58-65.

Langmaier, F., Kolomaznik, K., Sukop, S. and Maldek, M. (1999). "Products of enzymatic decomposition of chrome tannedleather wastes".J Soc leather technol chem, 83(1):187-195.

Levey, A.S. and Coresh, J. (2012). "Chronic kidney diseases". Lancet. 379: 165-180.

Li, Y., Lin, G., Lin, C., Wang, J., Han, C. (2013). "Relation of estimated GFR and BMI to mortality in non dialysis patients with coronary artery diseases: A report from the ET-CHD registry, 1997-2003. Journal of Cardiology. 62 (3): 144-150.

McWilliam A., Suraj T., Ross M., (2009). Laboratory tests of renal function. Anaesthesia & Intensive Care.The urea cycle.Medicine ; 10, 6: 296-99.9. Watford M.

Mehta, A.R. (2008). "Why does the plasma urea concentrations increase in acute dehydration?"Advances in physiology education: 32(4). Pp 336.

Nankivell, B.J. (2001). "Craetinine clearance and the assessment of renal function. Aust prescr. 24: 15-7.

Oramasionwu, G.E., Thacher, T.D., Pam, S.D., Pettifor, J.M, Abrams, S.A. (2008). "Adaptation of calcium absorption during treatment of nutritional rickets in Nigerian childen". The British journal of nutrition. 100(2): 387-92.

Parving, H.H., Lemert, H., Brochner-Mortensen, J., Gomis, R., Andersen, S. and Arner, P., (2001)."The effect of irbesertan on the development of diabetic nephropathy in patients with type 2 diabetes."N. England. J., Med. 345(12):870-8.

Ramasami, T. (2001). "Approach towards aunifiedtheory for tanning: Wilson's dream. J. Am leather chem. Assoc, 96: 290-304.

Reemtsma, A. and Jekel, J., (1997). "Dissolved organics in tannery waste waters and their alteration by a combined anaerobic and aerobic treatment." Water research, 31 (5): 1035-1046.

Roche Diagnostics International Ltd (2012). " Elecsys® Vitamin D total assay Electro-chemiluminescence binding assay (ECLIA) for the in-vitro determination of total 25-hydroxyvitamin D". Rotkreuz, Switzerland.

Rosano, T.G., Ambrose, R.T., Wu, A.H., Swift, T.A. and Yadegari, P. (1990). "Candidate Reference method for determining creatinine in serum: Method development and inter laboratory validation". Clin chem. 36:1951-55.

Samir, H., Mohamed, F., Abdelhamid, H. (2014). "Simultaneous effects of cadmium and Mercury on some biochemical parameters of kidney function in male rats". J. curr.chem. pharm. Sc. 5 (1) 26-30.

Skeggs, L.T. and Hochstrasser, H.C. (1964). Multiple Automatic Analysis. Clin Chem.10:918-936.

Spriet, L.L., Howlett, R.A., Heigenhauser, G.J. (2000). "An enzymatic approach to lactate production in human skeletal muscle during exercise." Med sci sports exerc. 32 (4): 756-63.

Terri, A. E. (1958). "A Colorimetric Method for Determination of Serum Potassium".Clin.Path. 29:86.

Trinder, P. (1951). "A rapid method for the determination of sodium in Serum".Dept of Biochem, Durham. (76): 596-599.

VanSlyke, D.D., (1924).Journal of determination of serum Bicarbonate. Biol. Chem. (7):523.

Wallia, R., Greenberg, A.S. and Piraino, B. (1986). "Serumelectrolyte patterns in end stage renal disease. AMJ Kidney Disease. 8: 94-104.