International Journal of PharmaO2
Journal Home Page: http://www.ijpo.in/
(IJPO: A Peer-reviewed Bi-monthly online journal)

Research Article

Effects of Palm Kernel Oil, Olive Oil, Crude Oil and Honey on Renal Function of Male Albino Rats

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ARTICLE INFO

Article history:
Received: 12/02/2021;
Revised: 08/03/2021
Accepted: 07/04/2021;
Available online: 01/05/2021.

Key Words:
Crude oil,
Histology,
Honey,
Olive oil,
Palm kernel oil,
Renal function.

Please cite this article as: Imo, C., *et al*. (2021). Effects of Palm Kernel Oil, Olive Oil, Crude Oil and Honey on Renal Function of Male Albino Rats. 3(3), 0121-0129.

ABSTRACT

This study investigated the effects of palm kernel oil, olive oil, crude oil and honey on renal function of male albino rats. These chemical substances are used in traditional medicine for various purposes, including as antidote for poisons. Thirty healthy male albino rats were purchased and used in this research study. The animals were randomly placed into five groups (n=6). The animals were administered the corresponding chemical substances for a period of three weeks. They were later sacrificed and their blood samples and kidneys collected for biochemical and histological analysis respectively. Urea increased in all the groups administered the different chemical substances compared to the control. The increase is statistically significant ($p<0.05$) in groups 4 and 5, and non-significant ($p>0.05$) in groups 2 and 3 when compared to the control (group 1). Creatinine increased non-significantly ($p>0.05$) in all the test groups compared to the control. Sodium decreased non-significantly ($p>0.05$) in group 2, but increased non-significantly ($p>0.05$) in groups 3, 4 and 5 compared to the control. Potassium increased non-significantly ($p>0.05$) in group 2, but increased significantly ($p<0.05$) in groups 3, 4 and 5, while chloride increased significantly ($p<0.05$) in groups 2, 3 and 5 and non-significantly ($p>0.05$) in group 4 compared to the control. Photomicrographs of histoarchitectural state of the renal tissues showed some forms of alterations in some parts of the tissues of the test animals when compared with the control. This study showed that long term administration of palm kernel oil, olive oil, crude oil and honey, as used in this study could cause certain alteration to renal functions. The order of renal intoxication caused by the administration of the chemical substances is crude oil > honey > olive oil > palm kernel oil.

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Introduction

Currently, different chemical substances, including palm kernel oil, olive oil, crude oil and honey are used in traditional medicine for various reasons such as in management or treatment of certain diseased conditions. Some people also use these substances as antidote for poison.

Palm kernel oil is edible oil which is extracted from the kernels of the fruits of tropical palm tree (Hartley, 1997; Ugbogu *et al*., 2006). Palm kernel oil has high energy content and is underutilized as edible oil in Nigeria. In some regions such as Central Africa and Southeast Asia, it is a common cooking oil and becoming popular in some areas due to its low manufacturing cost compared to some other cooking oils (Ugbogu *et al*., 2006; Akubugwo and Ugbogu, 2007). According to Sutapa and Analava (2009), the consumption of palm kernel oil as a source of dietary fat does not pose any additional risks for coronary artery disease when consumed in realistic amounts as part of a healthy diet. Oxidized palm kernel oil has been reported to induce reproductive toxicity and organ toxicity particularly of the kidneys, lungs, liver and heart (Sutapa and Analava, 2009).

Olive oil appears to be a functional food with various components such as monounsaturated fatty acids that are known to possess nutritional benefits. It has been reported by Moreno and Mitjavilab (2003) that an increased consumption of monounsaturated fatty acids instead of polyunsaturated fatty acids reduces the risk of atherosclerosis due to its ability to decrease the circulating lipoprotein's sensitivity to peroxidation. In an experimental study, olive oil phenolic compounds showed strong antioxidant properties against oxidation of lipids, DNA and LDL (Covas *et al*., 2006). Hydroxytyrosol (2-(3,4 dihydroxyphenyl) Ethanol, DPE), one of the phenolic compounds present in extra virgin olive oil has been suggested to be an active antioxidant which contributes to the beneficial properties of olive oil (Deiana *et al*., 1999).

Crude oil has been described by Orisakwe *et al*. (2004) as a complex mixture of over 6000 potentially different hydrocarbons and metals. Crude petroleum contains hundreds of compounds and the chemical composition varies among geologic formations (Coppock *et al.,* 1995). In Nigeria, crude oil is predominantly found in the riverine areas. For a long period till now, the use of crude oil has been practiced by the local population for the management or treatment of various ailments such as gastrointestinal disorders, burns, foot rot, leg ulcers and poisoning, and also used against witchcraft (Umezurike *et al.,* 2016). Knowledge of human responses to acute exposures to petroleum components comes from studies with several solvents containing benzene and petroleum. There is a concern that workers and other individuals exposed to crude oil might have an increased incidence of some organ damage due to toxicities associated with it. After absorption through pulmonary or gastrointestinal routes, crude oil is transported in plasma: initially bound to albumin and other larger proteins to the liver (Umezurike *et al.,* 2016).

Honey is a natural product with very complex chemical composition. It is composed mostly of glucose and fructose. It contains more than 180 substances, including amino acids, minerals, vitamins and enzymes (Lopez-Garcia *et al*., 1999; Merken and Beecher, 2000). Though it is well used in nutrition, it is not well recognized as a medicine, yet it is one of the oldest medicines known and has continued to be used (Jones, 2001). Honey has been known for so many properties, including as an antioxidant, anti-inflammatory and antitumor. It possesses a considerable hydroxyl radical scavenging activity and prevents the depletion of the antioxidant enzymes. It has been reported to normalize kidney functions and protect the liver from intoxication (Bariliak *et al.,* 1996).

In traditional medicine, palm kernel oil, olive oil, crude oil and honey are used for various purposes, including as antidote for poisons. This study is therefore essential because it will provide information on the effects of using these chemical substances on the renal function. This warrants research into the effects of palm kernel oil, olive oil, crude oil and honey on renal function of male albino rats.

Materials and Methods

Chemicals

Crude oil, olive oil, honey and palm kernel oil were obtained from Port Harcourt, Wukari, Kurmi L.G.A., and Umuahia, Nigeria respectively.

Experimental animals

Thirty healthy male albino rats of seven weeks of age were used in this research study. The rats were purchased and kept at the experimental animal house, Department of Biochemistry, Federal University Wukari, Nigeria. The albino rats were allowed access to feed and water *ad libitum* throughout the period of the experiment. Standard laboratory protocols for animal studies were followed. All methods were performed in accordance with the relevant guidelines and regulations.

Experimental design

The thirty male albino rats were randomly placed into five groups of six rats each. Group 1 rats served as normal control (they were not administered any chemical substance), while rats in groups 2, 3, 4 and 5 served as the test animals. The rats in groups 2, 3, 4 and 5 received palm kernel oil (5 ml/kg bw), olive oil (5 ml/kg bw), crude oil (5 ml/kg bw) and honey (5 ml/kg bw) respectively for three weeks prior to animal sacrifice. The corresponding chemical substances were administered to the rats once daily through oral route.

Blood collection

After administration of the chemical substances to the test rats, all the rats were starved overnight, anaesthetized using chloroform and sacrificed by cervical dislocation. Blood samples were collected from each rat through cardiac puncture and dispensed into plain sample tubes and allowed to clot for about fifteen minutes. The samples were centrifuged at 4000 rpm for 10 minutes. The supernatant (serum) was collected by simple aspiration with Pasteur pipette and dispensed into clean tubes for the biochemical analysis. The kidney of all the test animals were also harvested for histological analysis.

Biochemical and histological analysis

The biochemical parameters selected were creatinine, urea and electrolytes such as chloride, potasium and sodium. Urea, potassium and creatinine were determined using an auto-analyzer (Reflotron Plus). Chloride and sodium were determined using the method of Schonfeld and Lowellen (1964) and Tietz (1976) respectively.

The kidneys of the rats were harvested and fixed in 10% formalin. The kidneys were processed using an automatic tissue processor, embedded in paraffin wax, and sections cut using a rotary microtome. The sections were stained by haematoxylin and eosin (H&E) method, and were examined. Photomicrograph of the kidney sections were taken.

Statistical analysis

The biochemical analysis results were analyzed statistically using One-Way Analysis of Variance (ANOVA) and further with Duncan's multiple comparison with the use of Statistical Package for Social Sciences (SPSS) version 21. The means were compared for significance at $p \leq 0.05$ and the group results were presented as mean ± SD (n=6).

Results and Discussion

The result of the biochemical analysis is presented in the Table 1.

Urea increased in all the groups administered the different chemical substances compared to the control. The increase was statistically significant ($p<0.05$) in groups 4 and 5, and non-significant ($p>0.05$) in groups 2 and 3.

Creatinine increased non-significantly ($p>0.05$) in all the test groups compared to the control. Sodium decreased non-significantly ($p>0.05$) in group 2, but increased non-significantly ($p>0.05$) in groups 3, 4 and 5 compared to the control. Potassium increased non-significantly ($p>0.05$) in group 2, but increased significantly ($p<0.05$) in groups 3, 4 and 5 compared to the control, while chloride increased significantly ($p<0.05$) in groups 2, 3 and 5 and non-significantly ($p>0.05$) in group 4 compared to the control.

Table 1: Concentration of selected biochemical indices of kidney function in rats administered palm kernel oil, olive oil, crude oil and honey

Parameters	Group 1 (Normal control)	Group 2 (Palm kernel oil: 5 ml/kg bw)	Group 3 (Olive oil: 5 ml/kg bw)	Group 4 (Crude oil: 5 ml/kg bw)	Group 5 (Honey: 5 ml/kg bw)
Urea (mmol/L)	5.03 ± 1.35[a]	6.72 ± 1.61[a,b]	5.64 ± 2.05[a]	11.09 ± 1.83[c]	8.96 ± 0.60[b,c]
Creatinine (µmol/L)	47.43 ± 2.24[a]	54.47 ± 4.20[a]	56.03 ± 13.00[a]	67.20 ± 13.42[a]	56.47 ± 12.24[a]
Sodium (mmol/L)	239.27 ± 9.47[a]	224.37 ± 19.71[a]	254.13 ± 15.20[a]	269.60 ± 21.95[a]	254.10 ± 38.19[a]
Potassium (mmol/L)	5.00 ± 0.09[a]	5.68 ± 0.48[a,b]	6.21 ± 0.92[b]	6.87 ± 0.31[b]	6.71 ± 0.88[b]
Chloride (mmol/L)	119.67 ± 5.25[a]	162.87 ± 31.81[b]	164.40 ± 27.76[b]	150.03 ± 19.69[a,b]	181.03 ± 2.66[b]

Result represent mean ± standard deviation of group serum result obtained (n=6).
Mean in the same row, having different letters of the alphabet are statistically significant ($p<0.05$).

Photomicrographs of the kidney sections are presented below:

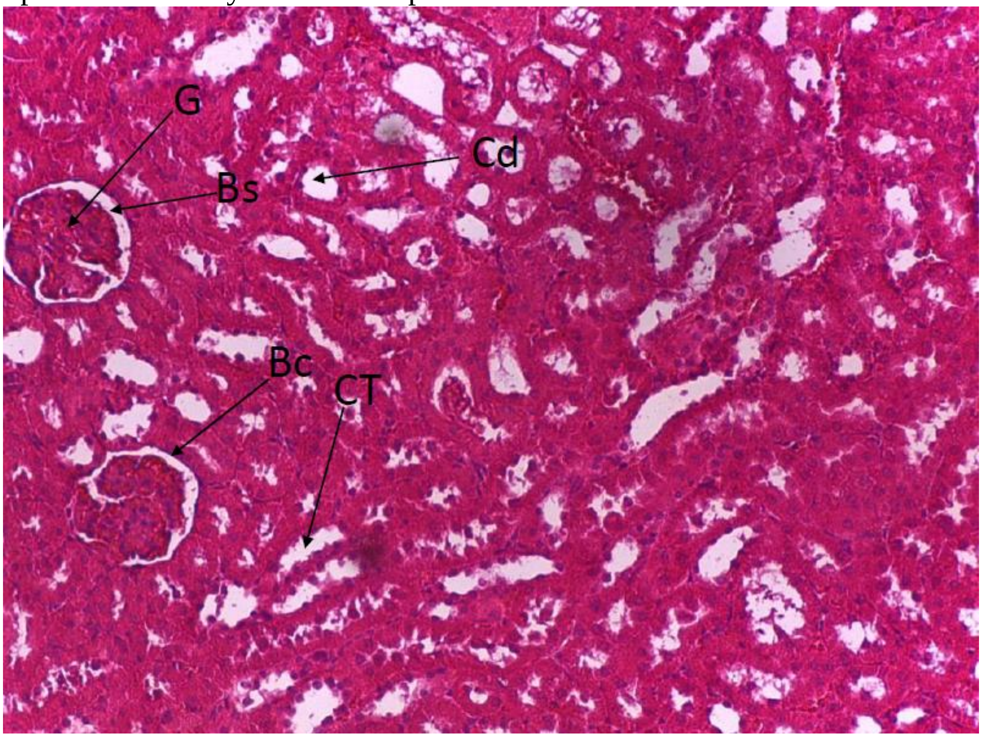

Fig. 1: Photomicrograph from kidney section of normal rat (group 1) showing normal histoarchitecture of the renal tissue. The normal glomerulus (G), Collecting duct (Cd), Bowman's capsule (Bc), Convoluted tubule (CT) and Bowman's space (Bs) are shown.

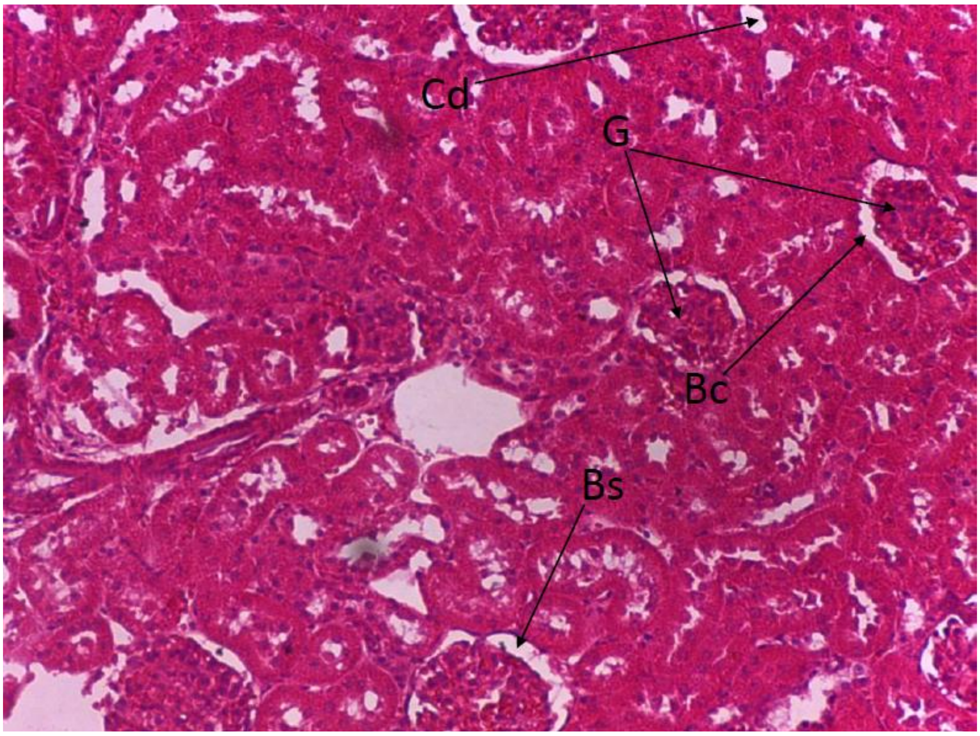

Fig. 2: Photomicrographs from kidney section of rat administered palm kernel oil showing normal glomerulus (G), Collecting duct (Cd), Bowman's capsule (Bc), and Bowman's space (Bs). However, some areas of the renal tissue appear to be mildly distorted.

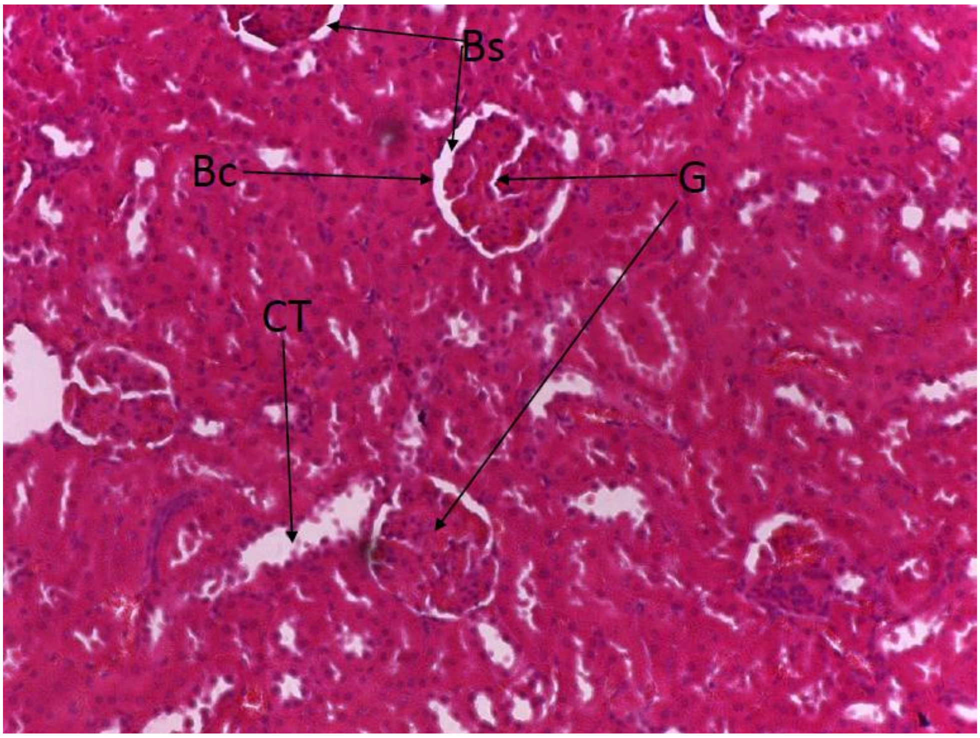

Fig. 3: Photomicrographs from kidney section of rat administered olive oil showing normal glomerulus (G) and Bowman's capsule (Bc). Some collecting ducts (Cd) and Bowman's spaces (Bs) appeared mildly shrunken.

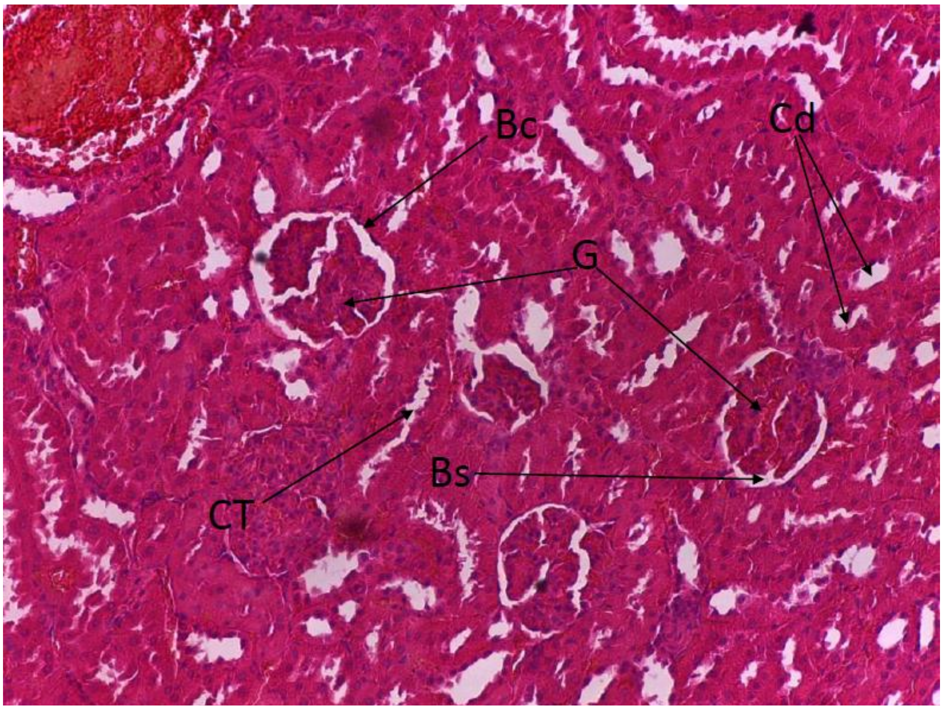

Fig. 4: Photomicrographs from kidney section of rat administered crude oil showing evidence of infiltrations in some arears of the renal tissue. Although, the glomerulus (G) and Bowman's space (Bs) appeared normal.

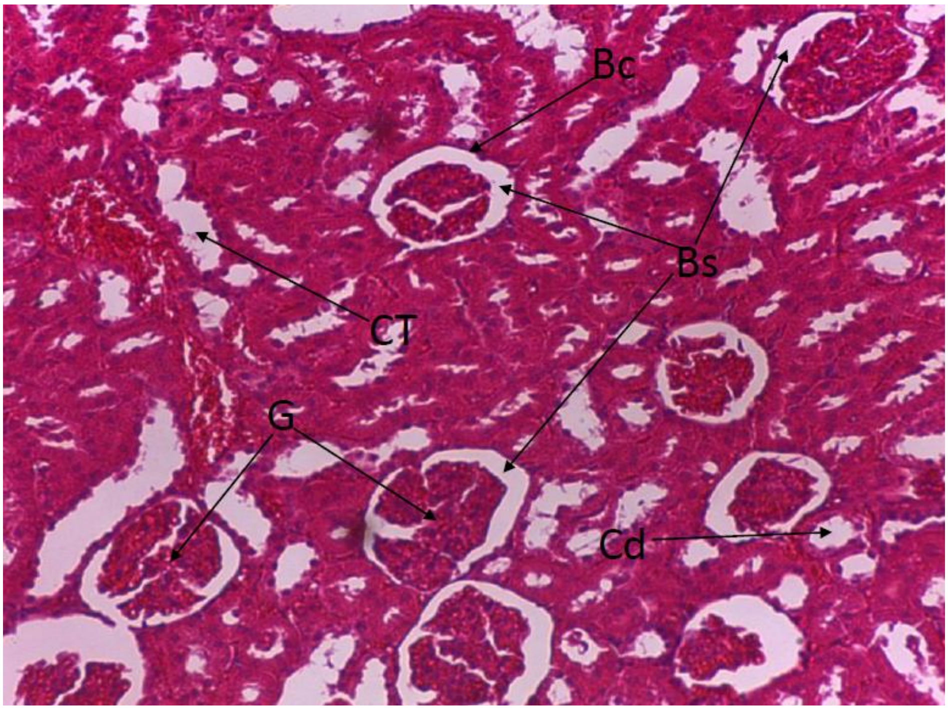

Fig.5: Photomicrographs from kidney section of rat administered honey showing some normal and some shrunken glomerulus (G). Most of the Bowman's spaces (Bs) and some of the convoluted tubules (CT) are enlarged.

The kidney helps in maintaining homeostasis of the body by reabsorbing important materials such as electrolytes and excreting waste products. The absorption and excretion of materials by the kidney is very essential for life. Amino acid deamination takes place in the liver, where ammonia is converted into urea and excreted through urine whereas, creatinine phosphate metabolism is an energy generating process that takes place in the skeletal muscle and produce creatinine as a waste which is equally excreted via urine. Renal diseases/impediments which diminish the glomerular filtration and tubular reabsorption rate for urea, creatinine and electrolytes will lead to their retention in the blood and hence their level of presence in the blood can be used as biomarkers for kidney dysfunction. In this study, creatinine, urea, sodium, potassium and chloride were used as indices of kidney function. From the present study, the evident significant ($P<0.05$) elevation of serum urea in rats administered crude oil and honey, as well as the significantly ($P<0.05$) raised potassium and chlorides levels could be attributed to the damaged of nephron structural integrity (Khan and Siddique, 2012; Yacout *et al*. 2012). However, the result did not show any significant ($P<0.05$) variation in creatinine and sodium ion levels when compared to the normal rats.

Urea and creatinine are well known general markers of renal function. Urea is a product of general cellular metabolism while creatinine is a specific product of muscle breakdown. A high level of serum urea is indicative of acute renal dysfunction, while a high level of serum creatinine is indicative of chronic renal dysfunction (Shaikh and Gautam, 2014). There was an increase of urea level in all the groups administered the chemical substances (Table 1). The increase was statistically significant ($p<0.05$) in groups 4 and 5, and non-significant ($p>0.05$) in groups 2 and 3. The increase in urea suggests alteration of kidney function and this may be due to the inability of the kidney to filter urea up to normal levels (Shaikh and Gautam, 2014). The result of group 4 is in tandem with the work of Uhegbu *et al.* (2015) where similar substances were used. The non-significant increase in urea level in groups 2 and 3 when compared to the control is indicative of mild negative effects of palm kernel oil and olive oil on the kidney. There was an indicative of more renal toxicity in the group administered crude oil and honey than the groups administered olive oil and palm kernel oil.

The retention of creatinine in the blood is indicative of kidney impairment (Okpala *et al.*, 2014). In this study, Creatinine increased non-significantly ($p>0.05$) in all the test groups compared to the control. However, this non-significant alteration showed that creatinine was retained in the blood as a result of the chemical substances administered to the animals. The effect is more evident in group 4 administered crude oil which also agreed with the work of Uhegbu *et al.* (2015), showing an indication of kidney impairment. Hence, according to Imo and Uhegbu (2015) an elevation in urea and creatinine levels may possibly be attributed to the damage of nephron structural integrity. It is therefore obvious that some structural integrity of the test animals has been compromised.

Electrolytes are chemicals with either positive or negative charges. This means they can interact with water or cellular signals. When electrolytes such as sodium, potassium and chloride in the blood are balanced, they suggest a balance in some organ’s functions, such as the kidneys. Crook (2007) reported that abnormal concentration of some electrolytes in the plasma or serum is an indication of kidney function impairment. High increase in sodium level is associated with high blood pressure, while a significant decrease in sodium indicates a low blood pressure. The result of this study (Table 1) indicates that apart from palm kernel oil which showed the potency of reducing the serum sodium level, olive oil, crude oil and honey have the ability to increase sodium level. Potassium is the primary intracellular electrolyte that modulates electrical signaling within the cell, controlling vesicles and channels. Potassium increased non-significantly ($p>0.05$) in group 2, but increased significantly ($p<0.05$) in groups 3, 4 and 5 compared to the control. This is an indication of hyperkalemia (elevated potassium levels) and maybe be associated with alteration of kidney function and also indicates that membrane channels may be possibly affected by exposure to the chemical substances (Uhegbu *et al.*, 2015). Chloride is essential for the control of osmotic pressure and acid/base equilibrium. Elevated serum chloride concentrations may be seen in conditions such as urinary obstruction, dehydration and congestive heart valve (Tietz, 1976). From this study, chloride increased significantly ($p<0.05$) in groups 2, 3 and 5 and non-significantly ($p>0.05$) in group 4 compared to the control. These alterations in serum chlorides levels in all the test animals when compared to the control is a clear indication of alterations in acid/base balance and may cause alteration of the renal function of the test animals.

Different forms of alterations in some parts of the tissues of the test animals when compared with the control were observed in the photomicrographs of histoarchitectural states of the kidney sections (Figure 1-5). The different forms of alteration observed is believed to be due to the effects of the different chemical substances administered to the test animals. These alterations showed that despite the acclaimed medicinal effects of these chemical substances in traditional medicine, they possess the ability of interfering with the histoarchitectural state of the kidneys when administered for a long time. The alterations may have contributed to the imbalance of the serum levels of the electrolytes evaluated, including the elevation of urea and creatinine levels in the test animals.

Conclusion

Administration of palm kernel oil, olive oil, crude oil and honey in the test animals caused various levels of alterations in renal functions which was evident based on the alterations of the indices of renal functions evaluated in this study. Long term exposure of the chemical substances for the period used in this study is therefore discouraged. The order of renal intoxication caused by the administration of the chemical substances is crude oil > honey > olive oil > palm kernel oil.

Conflict of Interests

The authors declare that they have no conflict of interests.

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