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# THE INDUCE DAMAGE TO LIVER AND KIDNEY OF WISTAR RAT BY SPENT VEGETABLE OIL AND THE AMELIORATING POTENTIALS OF COCONUT OIL

**Simon I. A[1)*], Solomon M.D.[2)], Sangodare R.S.A[1)], Abubakar A.[1)], Abdulkadir J.[1)], Dabak J.D.[2)]**

*[1)] National Research Institute for Chemical Technology, PMB 1052. Basawa, Zaria, Kaduna State, Nigeria.*
*[2)] Department of Biochemistry University of Jos Plateau State, Nigeria*
*E - mail : adamunistifanuss@gmail.com*

**Abstract**

It has been a regular practice in this part of the world to continually use spent edible oil and consumed it without knowing the harmful effects of such. Heating results in the formation of free reactive oxygen species (ROS) which is responsible for oxidative stress and changes to various organs in the body. The study aimed at investigating the changes caused on liver and kidney by consumption of repeatedly used (spent) oil and possible ameliorating potential of virgin coconut oil (VCO) on spent vegetable oil-induced liver and kidney changes in Wistar albino rats. Blood samples were obtained and assayed for biomarkers of liver and kidney damage; It was observed that spent vegetable oils induced severe damage on liver and kidney. While administration of virgin coconut oil significantly ($p<0.05$) reversed the changes induced by the spent oil as observed in the biomarkers AST, ALT, ALP, Urea, Creatinine, Uric acid, Total serum protein, Albumin. These findings suggest that VCO could ameliorate the adverse effect of consumption of spent oil on liver and kidney indices in rats.

Keywords: Ameliorating; Coconut oil; Kidney; Liver; Spent Vegetable oil; Oxidative stress

## 1. Introduction

Deep fat frying, which involves food immersed in hot oil in the temperature between 140 and 200 °C, is a widely used cooking method due to its ease and distinctive effects on food favour and texture (Nduka et al., 2021; Sebastian et al., 2014). A small amount of oil is absorbed by the food during this process, which results in the certain amount of breakdown products from the oil are obtained by the food being fried (Ngozi et al., 2019). The degradation in the oil quality used by street food vendors during frying operations is an important health concern due to the toxic compounds produced in it. To reduce expenses, oils tend to be used repeatedly for frying. When heated repeatedly, changes in the physical appearance of the oil will occur such as increased viscosity and darkening in colour (Rani et al., 2010), this may alter the fatty acid composition of the oil. Heating causes the oil to undergo a series of chemical reactions like oxidation, hydrolysis and polymerization (Choe & Min, 2007). During this process, many oxidative products such as hydroperoxide and aldehydes are produced, which can be absorbed into the fried food (Choe & Min, 2006). Spent vegetable oils promotes the generation of free radicals such as ketones, aldehydes, alcohols, hydrocarbons, peroxides, epoxides, and cyclic polymers, these may play an important contributory role in pathogenesis of several conditions. (Latha et al., 2010).

Previous research done by Azman et al., (2012) showed that even though night market vendors agreed that repeatedly heated cooking oil is harmful to health, they still continued the practice of using the same cooking oil repeatedly.

Virgin coconut oil (VCO) has become popular due to its beneficial effects. VCO has been shown to have anti-inflammatory, analgesic, and antipyretic properties (Intahphuak et al., 2010). VCO has been shown to decrease lipid levels in serum and tissue as well as LDL lipid peroxidation (Nevin & Rajamohan, 2006). Consumption of VCO enhances antithrombotic effects related to inhibition of platelet coagulation and low cholesterol level (Nevin & Rajamohan, 2008). VCO has been known to have higher antioxidant activity compared to refined coconut oil (Marina et al., 2009). It has also been proven that VCO enhances antioxidant activity and inhibits lipid peroxidation in rats (Nevin & Rajamohan, 2009).

Therefore, it is of great interest for us to investigate whether VCO is able to prevent hypertension in male rats given repeatedly heated palm oil.

## 2. Materials and Methods

The equipments used were Chemistry Auto Analizer Mindray Bs-120, Centrifuge 800D, unheparinized capillary tube, STP 120 Thermoscientific, needles and syringes (21G), plain sample bottles, microm HM340E Thermoscientific, SLEE MPS/P2, cotton wool, surgical gloves and nose mask.

### Sample preparation

Two types of spent vegetable oils were used for this study; Spent Vegetable Oil from fish vendor (SVOF) and Spent Vegetable Oil from beans cake vendor (SVOB). They were obtained from different locations within Jos Metropolis. The VCO was freshly prepared. Single dosage of 14.4mls and double dosage of 28.8mls of spent palm and spent vegetable oils were prepared by mixing with the rat feeds and 1ml of VCO was administered.

### Experimental Animals

The study will cover the used of wistar rats and the assessment of the liver and kidney biomarkers fed with overused palm and vegetable oils for a period of 14 days. The wistar rats will later be administered with 1ml of virgin coconut oil and another round of assessment of the above mentioned parameters will be carried out for the second time to see its ameliorating effect. Wistar Albino rats were weighed between 110-250g which were obtained from the Animal House, University of Jos. They were grouped into nine groups, the first group served as normal control that were fed with normal pellet diet and water ad libitum, while the remaining groups were fed with spent vegetable oil of different concentrations mixed with pellet and later 1 ml of administered virgin coconut oil. The experimental treatment lasted for 28 consecutive days.

The present animal study was approved by the Committee on Animal Ethical Committee and Medical Research Ethics Committee of the University of Jos [Reference No: REF/UJ/FPS/PCL/AEU/2/F17-00379; dated 6th August, 2018]. The laboratory animals were handled and managed in accordance to the Guide for the Care and Use of Laboratory Animal (National Research Council 1996 National Research Council. 1996. Guide for the care and use of laboratory animals. Washington, D.C.: National Academy Press). Not applicable to human and plants studies.

### Methods

In this study, palm oil is heated and cooled repeatedly to mimic the situation that happens where people fry foods, while the spent vegetables oil was bought from two different vendors. Jugular vein blood sample collection was used in collecting the blood from the rats, where isoflurane was used as an anaesthetic agent ARRIVE guidelines were fully complied. The method of Gornal et al (1949) was employed for the determination of serum total protein Urea in serum was measured spectrophotometrically by Berthelot's reaction at 546nm. Determination of serum albumin was carried out according to modified method of Bartholomew and Delaney (1966). The King-Armstrong (1934) method was used in the determination of serum alkaline phosphatase.

Serum AST activity was estimated according to the method of Reitman and Frankel (1957) and Serum Alanine Aminotransaminase (ALT) activity was estimated according to the method of Reitman and Frankel (1957). The method of Hare (1950) was used in the determination of serum creatinine. Concentration of serum uric acid was carried out using Randox Kit.

## 3. Results

Result of effect of VCO on serum total protein and albumin shown on Table 1 indicates that there was significant ($p<0.05$) decrease in the level of the serum total protein and albumin of the rats given spent palm oil and spent vegetable oils compared with the control rats group. The administration of 1 ml

of VCO significantly ($p<0.05$) increased the level of serum total protein and albumin in rats when compared with the rats given spent palm oil and spent vegetable oils.

**Table 1. Effect of Virgin Coconut Oil (VCO) on serum total protein and albumin of rats fed with Spent Palm Oil Single dose (SPOS), Spent Palm Oil Double dose (SPOD), Spent Vegetable Oil Single dose (SVOS) and Spent Vegetable Oil Double dose (SVOD)**

| Group Treatment | Serum Total Protein (g/L) | Albumin (g/L) |
|---|---|---|
| **Baseline** | 77.95±1.22 | 37.17±0.39 |
| **Normal control (NC)** | 77.24±1.02 | 36.51±0.96 |
| **SPOS** | 70.46±1.01[ac] | 30.96±0.43[ac] |
| **SPOD** | 63.72±0.32[abd] | 25.82±0.53[abd] |
| **SPOS + VCO** | 75.71±0.27[bcd] | 35.75±0.26[bcd] |
| **SPOD + VCO** | 65.51±0.14[abd] | 27.64±0.93[abd] |
| **SVOFS** | 67.17±1.20[acfg] | 29.48±0.56[acfg] |
| **SVOBS** | 65.43±0.30[abfh] | 27.06±0.58[abfh] |
| **SVOFD** | 61.07±0.37[abfg] | 24.37±0.35[abfg] |
| **SVOBD** | 59.35±0.33[abfh] | 24.09±0.41[abfh] |
| **SVOFS + VCO** | 70.26±0.27[abfg] | 30.42±0.51[abfg] |
| **SVOBS + VCO** | 68.25±0.44[abfh] | 29.52±0.41[abfh] |
| **SVOFD + VCO** | 63.40±0.36[abeg] | 25.82±0.17[abeg] |
| **SVOBD + VCO** | 59.50±0.18[ab] | 24.02±0.32[ab] |

Values are expressed as mean ± SD, n= 5 for each group
[a] values are significantly different from the NC group ($p<0.05$)
[b] values are significantly different from SPOS ($p<0.05$)
[c] values are significantly different from SPOD ($p<0.05$)
[d] values are significantly different from SPOS + VCO ($p<0.05$)
[e] values are significantly different from SVOBD ($p<0.05$)
[f] values are significantly different from SVOFS+VCO ($p<0.05$)
[g] values are significantly different from SVOBS ($p<0.05$)
[h] values are significantly different from SVOFD+VCO ($p<0.05$)
Note: SPOS= Spent Palm Oil Single Dose, SPOD=Spent Palm Oil Double Dose, SVOFS= Spent Vegetable Oil Fish Vendor Single Dose, SVOFD= Spent Vegetable Oil Fish Vendor Double Dose, SVOBS= Spent Vegetable Oil Beans Cake Vendor Single Dose SVOBD= Spent Vegetable Oil Beans Cake Vendor Double Dose, VCO =Virgin Coconut Oil.

Result of effect of VCO on some liver biomarkers shown on table 2 indicates that there was significant ($p<0.05$) increase in the level of biomarkers (ALT, AST and ALP) of the rats administered spent palm oil and spent vegetable oils compared with the control rats group. The administration of 1ml of VCO significantly ($p<0.05$) decreased the level of biomarkers (ALT, AST and ALP) in rats when compared with the rats given spent palm oil and spent vegetable oils.

**Table 2. Effect of VCO on liver biomarkers of rats fed with Spent Palm Oil Single dose (SPOS), Spent Palm Oil Double dose (SPOD), Spent Vegetable Oil Single dose (SVOS) and Spent Vegetable Oil Double dose (SVOD)**

| Group Treatment | ALT(U/L) | AST(U/L) | ALP(U/L) |
|---|---|---|---|
| **Baseline** | 10.29±0.85 | 11.97±1.16 | 230.00±4.52 |
| **NC** | 9.84±0.40 | 13.82±0.65 | 228.33±1.37 |
| **SPOS** | 16.89±1.20[acd] | 20.56±0.66[acd] | 274.33±1.86[acd] |
| **SPOD** | 24.14±0.13[abcd] | 28.85±0.28[abcd] | 313.00±3.23[abcd] |
| **SPOS + VCO** | 15.58±0.20[abc] | 17.66±0.26[abc] | 225.00±2.37[abc] |
| **SPOD + VCO** | 21.57±0.50[abd] | 29.43±0.37[abd] | 351.00±1.79[abd] |
| **SVOFS** | 20.10±0.97[abf] | 23.33±0.52[abf] | 287.33±1.37[abf] |
| **SVOBS** | 22.41±0.31[abf] | 25.33±0.52[abf] | 320.67±1.37[abf] |
| **SVOFD** | 26.46±0.10[abfg] | 31.30±0.54[abfg] | 373.67±1.37[abfg] |
| **SVOBD** | 29.11±0.35[abfh] | 36.33±1.03[abfh] | 387.33±0.52[abfh] |
| **SVOFS + VCO** | 20.03±0.30[abf] | 21.67±0.52[abfg] | 281.67±2.25[abf] |
| **SVOBS + VCO** | 20.95±0.50[abfh] | 23.00±0.00[abfh] | 310.33±0.52[abf] |

Values are expressed as mean ± SD, n= 5 for each group
[a] values are significantly different from the NC group ($p<0.05$)
[b] values are significantly different from SPOS ($p<0.05$)
[c] values are significantly different from the SPOD ($p<0.05$)
[d] values are significantly different from SPOS + VCO ($p<0.05$)
[f] values are significantly different from SVOFS + VCO ($p<0.05$)

[g] values are significantly different from SVOBS + VCO ($p<0.05$)
[h] values are significantly different from SVOFD + VCO ($p<0.05$)
[i] values are significantly different from SVOBD + VCO ($p<0.05$)

Result of effect of VCO on uric acid, urea and creatinine shown on table 3 indicates that there was significant ($p<0.05$) increase in the level of uric acid, urea and creatinine of the rats given spent palm oil and spent vegetable oils compared with the Control rats group. The administration of 1ml of VCO for 14 days significantly ($p<0.05$) decreased the level of uric acid, urea and creatinine in rats when compared with the rats given spent palm oil and spent vegetable oils.

**Table 3. Effect of VCO on kidney biomarkers of rats fed with Spent Palm Oil Single dose (SPOS) and Spent Palm Oil Double dose (SPOD), Spent Vegetable Oil Single dose (SVOS) and Spent Vegetable Oil Double dose (SVOD)**

| Group Treatment | UA(µmol/l) | Urea(mmol/l) | Creatinine (µmol/l) |
|---|---|---|---|
| **Baseline** | 226.28±2.16 | 4.52±0.32 | 64.31±2.63 |
| **NC** | 227.75±0.31 | 4.59±0.21 | 67.78±0.83[a] |
| **SPOS** | 266.09±1.83[ac] | 5.42±0.15[ac] | 98.54±0.33[ac] |
| **SPOD** | 301.42±1.61[abd] | 8.80±0.12[abd] | 132.86±1.33[abd] |
| **SPOS + VCO** | 268.52±0.67[abd] | 4.97±0.09[abd] | 78.12±0.94[abd] |
| **SPOD + VCO** | 289.29±0.85[abd] | 7.68±0.05[abd] | 123.53±0.94[abde] |
| **SVOFS** | 273.26±0.22[abf] | 6.47±0.04[abf] | 106.87±1.35[abf] |
| **SVOBS** | 285.82±2.30[abf] | 6.89±0.11[abf] | 128.10±1.18[abf] |
| **SVOFD** | 331.71±1.22[abfg] | 9.06±0.09[abfg] | 138.88±0.58[abfg] |
| **SVOBD** | 345.77±1.92[abfh] | 9.86±0.19[abfh] | 142.81±0.78[abfh] |
| **SVOFS + VCO** | 271.44±1.32[abf] | 6.39±0.05[abf] | 107.78±1.61[abf] |
| **SVOBS + VCO** | 276.17±2.28[abfh] | 6.96±0.07[abf] | 118.55±0.80[abfh] |
| **SVOFD + VCO** | 326.08±0.56[abfgi] | 9.09±0.10[abfg] | 139.24±0.60[abfgi] |
| **SVOBD + VCO** | 336.85±1.21[abfh] | 9.84±0.06[abfh] | 141.37±0.05[abfh] |

Values are expressed as mean ± SD, n= 5 for each group
[a] values are significantly different from the NC group ($p<0.05$)
[b] values are significantly different from SPOS ($p<0.05$)
[c] values are significantly different from the SPOD ($p<0.05$)
[d] values are significantly different from SPOS + VCO ($p<0.05$)
[e] values are significantly different from SVOBD ($p<0.05$)
[f] values are significantly different from SVOFS + VCO ($p<0.05$)
[g] values are significantly different from SVOBS + VCO ($p<0.05$)
[h] values are significantly different from SVOFD + VCO ($p<0.05$)

## 4. Discussion

There was a decrease in the serum total protein and albumin of groups rats fed with spend palm oil and repeatedly used (spent) vegetables oils diet, and likewise the double dose of repeatedly used (spent) vegetables oils diet (Table 1) when compared with the normal control groups. Albumin is the major protein present within the blood. Albumin is synthesized by the liver. As such, it represents a major synthetic protein and is a biomarker for the ability of the liver to synthesize proteins. It is only one of many proteins that are synthesized by the liver (Johnston, 1999). When the liver has been chronically damaged, the albumin may be low. This would indicate that the synthetic function of the liver has been markedly diminished. Such findings suggest a diagnosis of cirrhosis. Malnutrition can also cause low albumin (hypoalbuminemia) with no associated liver disease. The fact that there was a significant ($p<0.05$) decrease in the serum total protein and albumin of groups fed with repeatedly used (spent) vegetable oils diets shows that it may alter protein synthesis in the liver, The decrease in serum total protein and albumin levels associated with the test rats indicate impairment in the normal function of the liver, but on oral gavages administration of virgin coconut oil at 1 ml for 14 days there was significant increase in the serum total protein and albumin which shows an increase in the protein synthesis of the liver. There was increase in the level of serum total protein and albumin of groups fed with both fresh vegetable oils diet, which show the presence of all actives phytonutrients that help in increasing the synthesis of protein in the liver.

The plasma ALP, AST and ALT activities of the groups fed with repeatedly used (spent) vegetable oils diets increased when compared with the control groups in, Table 3 and 4. An evidence of hepatic damage was also reported with a significant elevation of aspartate and alanine transaminases, the marker enzymes for liver function in rats that were given combination of heated soy and rapeseed oils (Totani et

al., 2008). The increase in ALP appears to be lipid-dependent, ingestion of fat leads to an increase in ALP synthesis by rat intestinal mucosa [(Glickman et al., 1970); (Izui, 1971); (Kaneko et al., 2008)]. Serum ALP is a sensitive detector for early intrahepatic and extrahepatic bile obstruction. The presence of infiltrative diseases of the liver (Owu et al., 1998). The increase ALP, AST and ALT activities in the serum observed might be due to alterations in membrane architecture of the cells of the liver of rats fed with repeatedly used (spent) vegetable oils diets and hence, an effect on the liver integrity, but on oral administration of VCO there was decrease in level of the serum ALP, AST and ALT which shows that biomarkers leak out and their free circulation is reduced in the liver.

The increase observed in the serum urea, creatinine and uric acid concentrations in groups of rats fed with repeatedly used (spent) palm oil and (spent) vegetables oils diets, and likewise the double dose of repeatedly used (spent) vegetables oils diet (and) when compared with control groups. There was decrease in serum urea, creatinine and uric acid of groups' rats after the administration of VCO, which indicates a recovery process of proper function of the kidney.

## 5. Conclusion

From the results obtained, it is suggested that virgin coconut oil shows has ameliorating potential for the prevention of oxidative stress induced hepato-renal toxicities in spent vegetable oil induced liver and kidney damage in wistar rats. Consumption of spent vegetables oil had deleterious effects on biochemical indices in rats. The effects were more pronounced in rats fed with double dosage of the spent vegetable oil. Therefore, considering the harmful and detrimental effect associated with consumption of spent vegetable oil of any kind as observed from the finding of this work it is therefore imperative to avoid such practice.

### Limitations

There wasn't any control on the type of spent vegetable oil used since it was bought from different vendors that varied in different preparation methods, times and periods used in the frying purposes and the various ingredients used for frying. Secondly, the period of this study might be too short to fully ascertained the ameliorating potentials of the VCO oil on the induce damage to liver and kidney of wistar rat by spent vegetable oils.

### Recommendation

The findings suggest the avoidance of spent vegetable oils in diet due to its possible deleterious effect on health is the best option while also the findings suggested that coconut oil do not have detrimental effects but possibly has ameliorating effect on individual health.

Further research is required for the establishment of detailed ameliorating potential of virgin coconut oil for their hepatorenal protective and antioxidative efficacy.

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