Effect of Physalis and Choline on Lipid Profile and Antioxidant Activity in Hepatic Toxicity Rats

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Abstract: Forty male Sprague-Dawley rats weighing 120+6g were divided into five groups. The first group kept as normal control (-ve) group (n= 8 rats) which fed on basal diet only. The rest of rats were administered paracetamol drug at a single dose of 2 g/kg by stomach tube to induce liver injury then classified into four groups. One of them acted as control (+ve) and the other three treated groups were physalis extract (600 mg/kg b. w), choline (1000 mg/kg bw) and physalis extract with choline (600 mg/kg b. w +1000 mg/kg bw). Results showed that rats fed diet contains physalis extract or choline or physalis extract with choline showed a significant increase in body weight gain, food intake and FER, and also serum total protein and high density lipoprotein cholesterol (HDLc). Moreover, they had a significant increase in liver glutathione S-transferase, superoxide dismutase, catalase, glutathione peroxidase and glycogen compared to rats of control (+ve) group. On the other side, they showed a significant decrease in aspartate and alanine amino transferase, alkaline phosphatase & gamma glutamyle transferase enzymes, total bilirubin and cholesterol (CHO) in serum. Also, they showed a significant decrease in CHO/HDLc ratio and also, malondialdehyde, cholesterol and total lipids in liver compared to rats of control (+ve) group. Rat group which fed physalis extract with choline in diet showed improvement of nutritional results, liver function parameter, lipid profile and also antioxidant activity.

Key words: Physalis -choline – paracetamol – liver disease – rats.

INTRODUCTION

Liver is a major organ, regulates many important metabolic functions, and any injury causes distortion of these metabolic functions. The liver is responsible for the metabolism of drugs and toxic chemicals, and therefore is the primary target organ for nearly all toxic chemicals (Wolf 1999). Natural antioxidants could prevent the deleterious effects of toxic agents by scavenging free radicals and other reactive oxygen species or by modulation of the inflammatory response. Liver-protective herbal drugs contain a variety of chemical constituents like phenols, coumarins, lignans, essential oil, monoterpenes, carotinoids, glycosides, flavanoids, organic acids, lipids, alkaloids and xanthones derivatives (Qiu et al., 2007 and Sindhu et al., 2012).

Paracetamol is a well-known antipyretic and analgesic agent, which produces hepatic necrosis at higher doses. The toxicities produced by certain hepatotoxins and carcinogens have been postulated to be due to the formation of chemically reactive metabolic products. Free radical mediated reactions are involved in the inflammatory response in liver (Nirmal et al., 2010).

Physalis alkekengi is an annual, herbaceous plant which belongs to Solanaceae family. Physalis fruit and other aerial parts are used in the treatment of intestinal and digestive problems and used as antimutagenic, anticoagulant, antispasmodic, antileucemis agents (Shariff et al., 2006 and Helvaci et al., 2010).

Choline is a chemical similar to the B-vitamins. Although the human body can make some choline it is generally recognized that it is important to get dietary choline as well. Choline serves various functions in our bodies as in the structure of cell membranes, protecting livers from accumulating fat, as the precursor molecule for the neurotransmitter acetylcholine, and more (Zeisel et al., 1995). Choline has been shown to protect the liver from certain types of damage, and can help reverse damage that has already occurred. Additionally, it may help lower cholesterol and homocysteine levels associated with cardiovascular disease, and may also help protect against some types of cancers (Buchman et al., 2001).

The present study was performed to evaluate the effect of Physalis and choline on some liver functions, lipid profile and antioxidant activity in hepatic toxicity rats induced by Paracetamol.

MATERIALS AND METHODS

Materials:

Forty male Sprague-Dawley rats weighing 120+6g were purchased from Farm of experimental animals in Helwan, Egypt. The basal diet consisted of protein (13%), fat (4%), salt mixture (3.5%), vitamin mixture (1%), choline (0.2%), cellulose (5%) and the remainder was starch (Reeves et al., 1993). Physalis alkekengi was obtained from local markets in Cairo, Egypt and was authenticated by a botanist. Paracetamol drug was obtained...
from Kahira Pharm & Chem. Ind. Co., Cairo- Egypt. Choline was obtained from El-Gomhorya Company for Chemical and Pharmaceutical, Cairo, Egypt. Kits for biochemical analysis were purchased from the Gamma Trade Company for Pharmaceutical and Chemicals, Dokki, Egypt.

**Methods:**

**Preparation Of Physalis Extract:**

Physalis fruits were washed with tap water, chopped into small pieces, dried with hot air oven (40–60°C) and grinded to powder (A.O.A.C. 2005). To prepare the methanol extract, 100 gram of physalis powdered was added to 1000 ml of 70% methanol (v/v) at room temperature for 20 hours with slowly rotated during this time. After filtration, ethanol was evaporated at low pressure at 30 centigrade degree (WHO 1983). The methanol extract was dissolved in normal saline and was immediately administered to rats at dose 500 mg/kg body weight by stomach tube.

**Experimental Design:**

The experimental rats were divided into five groups after adaptation period (7day). The first group which kept as control (-ve) group (n= 8 rats) which fed on basal diet only. The rest of rats were administered paracetamol drug at a single dose of 2 g/kg by stomach tube to induce liver injury then classified into four groups (Rafael et al., 1999). One of them acted as control (+ve) and the other three treated groups were physalis extract (500 mg/kg body weight), choline (1000 mg/kg b. w by stomach tube) and physalis extract with choline (500 mg/kg b. w + 1000 mg/kg b. w).

Feeding and growth performance were carried out by determination of daily food intake, body weight gain and feed efficiency ratio (FER) according to Chapman et al., (1950). The rats were sacrificed at the end of the experiment (60days) for collection of blood samples which centrifuged at 3000 rpm/ 15 minutes to obtain serum. The livers of rats were also collected for some biochemical analysis.

Serum aspartate and alanine amino transferase, alkaline phosphatase and gamma glutamyle transferase (AST, ALT, ALP & γGT) enzymes activity, were estimated according to Reitman and Frankel (1957), Draper and Hadley (1990), Kind and King (1954), respectively. Also, serum total bilirubin and total protein were determined according to Jendrassik (1938) and Weichselbaum (1946), respectively.

Serum cholesterol (CHO), triglycerides (TG) and high density lipoprotein cholesterol (HDL-c) were determined by using enzymatic colorimetric methods (Abell et al., (1952), Buccolo and David (1973), and Kostener 1977, respectively). Low density lipoprotein cholesterol (LDL-c), very low density lipoprotein cholesterol (VLDL-c) and CHO/ HDL-c were calculated according to Fruchart (1982) and Castelli and levitar, (1977). Liver cholesterol, total lipids and glycogen were determined according to Richmond (1973), Folch et al., (1957) and Rerup and Lundquist (1967), respectively. Liver glutathione S-transferase(GST), superoxide dismutase (SOD), catalase, glutathione peroxidase (GPX) and malondialdehyde (MDA) were estimated according to Ellman (1958), Beuchamp and Fridovich,(1971), Cohen et al., (1970),Weiss et al .,(1980) and Uchiyama and Mihara (1978), respectively.

**Statistical Analysis:**

Collected data were presented as mean ±SDM and statistically analyzed using one way analysis of variance (ANOVA).Student "t" test was used for significance. Differences were considered significant at p< 0.05 according to Artimage and Berry (1987).

**RESULTS AND DISCUSSION**

Body weight gain, food intake and feed efficiency ratio of the experimental rats were presented in table 1. Obtained data showed that the control (+ve) had highly significant decrease in body weight gain, food intake and FER at p<0.001&0.01 while rats fed diet contains physalis extract or physalis extract with choline had non significant differance compared to rats of control (-ve) group . On the other side, rats fed diet contains choline showed a significant reduction in FER at p<0.01 compared to rats of control (-ve) group. Rats fed diet contains physalis extract or choline or physalis extract with choline showed a significant increase in body weight gain, food intake and FER compared to rats of control (+ve) group.

The improvement of weight gain and FER in rats fed physalis may be attributed to the biologically active components as physalins, withanolides, phytosterols and polyunsaturated fatty acids as linoleic acid and oleic acid. Among its major components are high amounts of vitamins A, B and C as well as the presence of essential minerals, magnesium, calcium, potassium, sodium and phosphorus which are classified as macronutrients, while the Iron and Zinc are considered as micronutrients (Zhao et al.,2006 and Szefer and Nriagu, 2007). The fatty acids composition and high amounts of polyunsaturated fatty acids found in oils extracted from physalis peruviana L. make this fruit ideal for nutrition (Ramadan and Morsel, 2003). It is known that choline is an essential nutrient for optimum animal growth through building and maintaining cell structure and function.
Choline is associated with the metabolism and synthesis of glycine, betaine, cysteine, serine, methionine and many other methyl containing biological compounds (Zeisel et al., 1995).

### Table 1: Body weight gain, food intake and FER of the experimental rat groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>Control -ve</th>
<th>Control +ve</th>
<th>Physalis extract</th>
<th>Choline</th>
<th>Physalis extract +choline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight (g)</td>
<td></td>
<td>105.16±10.10‌</td>
<td>51.31±5.32‌</td>
<td>98.81±9.18‌</td>
<td>88.16±9.11‌</td>
<td>103.21±11.21‌</td>
</tr>
<tr>
<td>Food intake (g/w)</td>
<td></td>
<td>18.87±1.27‌</td>
<td>14.32±1.04‌</td>
<td>17.21±1.24‌</td>
<td>16.71±1.03‌</td>
<td>18.66±1.26‌</td>
</tr>
<tr>
<td>FER</td>
<td></td>
<td>0.092±0.001‌</td>
<td>0.059±0.003‌</td>
<td>0.095±0.001‌</td>
<td>0.087±0.005‌</td>
<td>0.092±0.004‌</td>
</tr>
</tbody>
</table>

Significant with control group * P<0.05 ** P<0.01 *** P<0.001

Mean values in each raw having different superscript (a, b, c, d) are significant

The treatment effect of physalis extract or choline feeding rats was represented in table 2. The activities of serum AST, ALT, ALP and γGT enzymes were significantly increased at p<0.001 in control (+ve) while AST, ALT and ALP were significantly increased at p<0.01 in choline group compared to rats of control (-ve) group. However, physalis extract group showed only significant increase in ALP at p<0.01 but physalis extract with choline group showed non significant increase in these enzymes compared to rats of control (-ve) group. Rats fed diet contains physalis extract or choline or physalis extract with choline showed a significant decrease in AST, ALT, ALP and γGT enzymes compared to rats of control (+ve) group.

The obtained results were agreed with Nirmal et al.,(2010) who recorded that paracetamol intoxication in normal rats elevated the levels of AST, ALT, ALP and total bilirubin, indicating acute hepatocellular damage and biliary obstruction. The reversal of increased serum enzymes in rats fed physalis and choline may be due to the prevention of the leakage of intracellular enzymes by its membrane stabilizing activity. This is in agreement with the commonly accepted view that serum levels of transaminases return to near normal. Chang et al., (2008) recorded that pre-treatment with Physalis peruviana L. (Solanaceae) aqueous extract at doses150, 300, and 600 mg/kg body weight significantly prevented the increase in serum glutamic pyruvic transaminase , glutamic oxaloacetic transaminase and alkaline phosphatase enzymes, which are the major indicators of liver hepatitis. Buchman et al., (2001) reported that choline is an essential nutrient required by the body to make several important compounds necessary for healthy cell membranes. This nutrient helps form phosphatidyl choline which is the primary phospholipid of cell membranes.

### Table 2: Serum AST, ALT, ALP and γGT enzymes of the experimental rat groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>Control -ve</th>
<th>Control +ve</th>
<th>Physalis extract</th>
<th>Choline</th>
<th>Physalis extract +choline</th>
</tr>
</thead>
<tbody>
<tr>
<td>AST(µ /ml)</td>
<td></td>
<td>75.81±8.17‌</td>
<td>159.61±16.21‌</td>
<td>85.14±8.84‌</td>
<td>99.81±9.60‌</td>
<td>82.11±8.84‌</td>
</tr>
<tr>
<td>ALT(µ /ml)</td>
<td></td>
<td>60.71±7.27‌</td>
<td>123.96±14.08‌</td>
<td>75.19±8.21‌</td>
<td>88.11±9.13‌</td>
<td>72.91±8.41‌</td>
</tr>
<tr>
<td>ALP(µ /ml)</td>
<td></td>
<td>55.81±5.76‌</td>
<td>145.87±15.61‌</td>
<td>70.14±8.24‌</td>
<td>69.96±7.81‌</td>
<td>54.31±6.01‌</td>
</tr>
<tr>
<td>γGT(µ /ml)</td>
<td></td>
<td>10.21±1.33‌</td>
<td>17.36±1.35‌</td>
<td>11.22±1.28‌</td>
<td>11.14±1.61‌</td>
<td>9.99±1.20‌</td>
</tr>
</tbody>
</table>

Significant with control group * P<0.05 ** P<0.01 *** P<0.001

Mean values in each raw having different superscript (a, b, c, d) are significant

Serum total bilirubin and protein obtained from experimental rats were tabulated in table 3. The value of total bilirubin for control (+ve) was significantly increase at p<0.001 while total protein was significantly decrease at p<0.001 for control (+ve) but the treated groups with physalis extract or choline or physalis extract with choline showed a significant increase in total bilirubin at p<0.001& 0.01 compared to rats of control (-ve) group. Physalis extract or choline or physalis extract with choline groups showed a significant decrease in total bilirubin and a significant increase in total protein compared to rats of control (+ve) group.

It has also been reported that many of plants which are rich in phenolic compounds and flavonoids, are widely used as antioxidant (Abd El-Ghany and Nanees 2010). The decrease in serum bilirubin after treatment with the extract of the physalis in liver damage induced by paracetamol indicated the effectiveness of the physalis in normalized functional status of the liver (Yihui et al., 2012). Chromatography analysis has shown that Physalis alkekengi contains zeaxanthin and beta cryptoxanthin esters or carotenoid esters which can be used as food additives or nutraceuticals (Pintea et al., 2005).

### Table 3: Serum total bilirubin and total protein of the experimental rat groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>Control -ve</th>
<th>Control +ve</th>
<th>Physalis extract</th>
<th>Choline</th>
<th>Physalis extract +choline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total bilirubin(mg/dl)</td>
<td></td>
<td>0.59±0.08‌</td>
<td>2.30±0.67‌</td>
<td>0.88±0.11‌</td>
<td>0.69±0.22‌</td>
<td>0.78±0.09‌</td>
</tr>
<tr>
<td>Total protein (g/dl)</td>
<td></td>
<td>6.71±0.79‌</td>
<td>4.96±0.55‌</td>
<td>6.14±0.77‌</td>
<td>5.96±0.86‌</td>
<td>6.51±0.58‌</td>
</tr>
</tbody>
</table>

Significant with control group * P<0.05 ** P<0.01 *** P<0.001

Mean values in each raw having different superscript (a, b, c, d) are significant.
The lipid profile of the experimental rats was tabulated in table 4&5. Serum CHO and CHO/HDLc were significantly increased at p<0.001 but HDLc was significantly decreased at p<0.001 in control (+ve) compared to rats of control (-ve) group. Physalis extract or choline or physalis extract with choline groups showed no significant difference in CHO, HDLc and CHO/HDLc compared to rats of control (-ve) group. However, they showed a significant decrease in CHO and CHO/HDLc and a significant increase in HDLc compared to rats of control (+ve) group as shown in table (4).

The observed effects of physalis on lipid profile and CHO/HDLc could be related to antioxidant activity which might attribute to those identified compounds such as physalins, flavones, alkaloids, and so on (Osho et al., 2010). It is believed that choline helps in the production of lipotropic agents, converts fats into useful products, and aids in the production of HDL cholesterol. The mechanism may be the ability of choline to be transformed into betaine. Choline deficiency in mice and humans is associated with increased plasma homocysteine concentration that elevates cardiovascular disease risk (Chiuve et al., 2007).

### Table 4: Serum CHO, HDLc and CHO/HDLc of the experimental rat groups.

<table>
<thead>
<tr>
<th>Groups Variables</th>
<th>Control (-ve)</th>
<th>Control +ve</th>
<th>Physalis extract</th>
<th>Choline</th>
<th>Physalis extract +choline</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHO(mg/dl)</td>
<td>100.96±8.89a</td>
<td>175.96±10.31ab</td>
<td>101.29±11.14a</td>
<td>117.78±12.27ab</td>
<td>106.21±11.41ab</td>
</tr>
<tr>
<td>HDLc(mg/dl)</td>
<td>33.91±3.41ab</td>
<td>18.78±1.01a</td>
<td>32.67±4.11a</td>
<td>26.96±4.29a</td>
<td>31.70±3.28a</td>
</tr>
<tr>
<td>CHO/ HDLc</td>
<td>2.96±0.55a</td>
<td>9.36±1.68ab</td>
<td>3.16±0.59a</td>
<td>4.36±0.88a</td>
<td>3.35±0.67a</td>
</tr>
</tbody>
</table>

Mean values in each raw having different superscript (a, b, c, d) are significant

**Significant with control group**: *P<0.05 **P<0.01 ***P<0.001

Serum T.G, LDLc and VLDLc were significantly increased at p<0.001 in control (+ve) group and at p<0.001 in choline group but Physalis extract and physalis extract with choline groups showed no significant difference compared to rats of control (-ve) group. Physalis extract or choline or physalis extract with choline groups showed a significant decrease in T.G, LDLc and VLDLc compared to rats of control (+ve) group as shown in table (5).

The obtained results were agreed with Choi and Hwang (2005) who noticed that three plant extracts (Piper cubeba, Physalis angulata & Rosa hybrida) flower results in an increase in antioxidant enzyme activity and HDL-cholesterol, and a decrease in malondialdehyde, which may reduce the risk of inflammatory and heart HDL-cholesterol of the Physalis angulata group was significantly increased. Yihui et al., (2012) recorded that extract of Calyx seu Fructus Physalis the fraction B was proved to be an active fraction for lowering lipid in vivo and in vitro experiments, which could significantly decrease the serum cholesterol and TG levels in mouse model of hyperlipidemia, and remarkably decrease the increase of TG in primary mouse hepatocytes induced by high glucose lipids

When choline stores are inadequate, there is a diminished capacity to methylate homocysteine to methionine, and plasma levels of homocysteine increase. Elevated levels of homocysteine have been associated with greater risk for several chronic diseases and conditions including cardiovascular disease. The choline supplementation was as effective as folic acid in lowering fasting homocysteine levels which causes cardiovascular disease. The choline and HDLc showed a significant decrease in T.G, LDLc and VLDLc of the experimental rat groups.

### Table 5: Serum T.G, LDLc and VLDLc of the experimental rat groups.

<table>
<thead>
<tr>
<th>Groups Variables</th>
<th>Control(-ve)</th>
<th>Control +ve</th>
<th>Physalis extract</th>
<th>Choline</th>
<th>Physalis extract +choline</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.G(mg/dl)</td>
<td>73.61±7.14a</td>
<td>131.51±13.50***</td>
<td>78.18±7.99a</td>
<td>93.60±8.23***</td>
<td>80.17±9.11***</td>
</tr>
<tr>
<td>LDLc(mg/dl)</td>
<td>52.31±5.14a</td>
<td>130.87±11.10a</td>
<td>52.95±6.22a</td>
<td>72.68±9.17a</td>
<td>58.47±7.11a</td>
</tr>
<tr>
<td>VLDLc(mg/dl)</td>
<td>14.75±2.71a</td>
<td>26.31±2.71a</td>
<td>15.68±1.02a</td>
<td>18.75±2.03a</td>
<td>16.05±1.18a</td>
</tr>
</tbody>
</table>

Mean values in each raw having different superscript (a, b, c, d) are significant

**Significant with control group**: *P<0.05 **P<0.01 ***P<0.001

Liver cholesterol and total lipids were significantly increased at p<0.001 but glycopren was significantly decreased at p<0.001 in control (+ve) group compared to rats of control (-ve) group. Liver total lipids were significantly increased at p<0.05 in physalis extract or choline groups but glycopren was significantly decreased at p<0.05 in choline group compared to rats of control (-ve) group. However, liver cholesterol and total lipids were significantly decreased but liver glycopren was significantly increased in rats fed diet contains physalis extract or choline or physalis extract with choline compared to rats of control (+ve) group as shown in table (6).

The results obtained in this study suggest the treated effects of *Physalis and choline* against hepatic toxicity. Some evidence indicates that many medicinal plants have been found to be useful to successfully manage hyperlipidemia (Lin et al., 2005). Choline is needed for hepatic secretion of certain lipoproteins. When deprived of dietary choline, most adult men and postmenopausal women developed signs of organ dysfunction as fatty liver or muscle damage (Zeisel et al 1995 and da Costa et al., 2004).
Table 6: Liver cholesterol, total lipids and glycogen of the experimental rat groups.

<table>
<thead>
<tr>
<th>Groups Variables</th>
<th>Control (–ve)</th>
<th>Control (+ve)</th>
<th>Physalis extract</th>
<th>Choline</th>
<th>Physalis extract +choline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>4.33±0.79&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.15±1.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.11±1.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.17±0.88&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.81±0.89&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total lipids (mg/dl)</td>
<td>34.96±4.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>59.71±6.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40.28±4.19&lt;sup&gt;c&lt;/sup&gt;</td>
<td>42.16±4.21&lt;sup&gt;c&lt;/sup&gt;</td>
<td>39.21±3.99&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Glycogen (mg/100g)</td>
<td>6.11±1.21&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.15±0.81&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.09±1.25&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.99±1.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.81±1.07&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Significant with control group * P<0.05 ** P<0.01 *** P<0.001
Mean values in each raw having different superscript (a, b, c, d) are significant

The antioxidant effect of physalis extract or choline was represented in table (7). Liver GST, SOD, catalase and GPX were significantly lower at p<0.001 in control (+ve) and at p<0.01, 0.05 in choline group compared to rats of control (-ve) group. Liver GST was significantly lower at p<0.05 in physalis extract and physalis extract with choline groups compared to rats of control (-ve) group. Rats fed diet contains physalis extract or choline had a significant increase in liver GST, SOD, catalase and GPX compared to rats of control (+ve) group. Liver MDA level is widely used as a marker of free radical mediated lipid peroxidation injury. Liver MDA was significantly increased in at p<0.001 control and at p<0.05 in physalis extract or choline extract with choline groups compared to rats of control (-ve) group although showed a significant increase compared to rats of control (+ve) group.

It has been hypothesized that physalis extract affords hepatic protection by decreased production of free radical derivatives. Biochemical assays of liver homogenate showed that Physalis peruviana L. (Solanaceae) aqueous extract at 150 to 600 mg/kg significantly enhanced superoxide dismutase, catalase, glutathione peroxidase concentrations, and diminished the level of thiobarbituric acid reactive substances (Chang et al., 2008). Aqueous extract from the roots of Physalis angulata Linneu exerts powerful anti-inflammatory and immunomodulatory activities, interfering with the cyclooxygenase pathway, lymphocyte proliferation and NO production (Bastos et al., 2008).

Table 7: Liver GST, SOD, catalase, GPX and MDA of the experimental rat groups.

<table>
<thead>
<tr>
<th>Groups Variables</th>
<th>Control (–ve)</th>
<th>Control (+ve)</th>
<th>Physalis extract</th>
<th>Choline</th>
<th>Physalis extract +choline</th>
</tr>
</thead>
<tbody>
<tr>
<td>GST(µ /mg)</td>
<td>0.99±0.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.49±0.01&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.91±0.08&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.66±0.07&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.87±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>SOD(µ /mg)</td>
<td>59.61±6.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>29.16±3.17&lt;sup&gt;d&lt;/sup&gt;</td>
<td>52.14±5.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>49.67±5.34&lt;sup&gt;b&lt;/sup&gt;</td>
<td>61.14±7.19&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Catalase(µ /mg)</td>
<td>36.17±4.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.31±2.11&lt;sup&gt;d&lt;/sup&gt;</td>
<td>34.98±4.27&lt;sup&gt;a&lt;/sup&gt;</td>
<td>30.11±2.99&lt;sup&gt;d&lt;/sup&gt;</td>
<td>34.21±3.61&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>GPX(µ /mg)</td>
<td>44.91±5.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24.21±3.10&lt;sup&gt;d&lt;/sup&gt;</td>
<td>42.11±5.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>35.67±3.71&lt;sup&gt;c&lt;/sup&gt;</td>
<td>40.71±4.12&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>MDA(nmol/g)</td>
<td>11.14±1.39&lt;sup&gt;c&lt;/sup&gt;</td>
<td>20.61±2.14&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.96±1.96&lt;sup&gt;c&lt;/sup&gt;</td>
<td>15.71±1.20&lt;sup&gt;d&lt;/sup&gt;</td>
<td>13.10±2.17&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Significant with control group * P<0.05 ** P<0.01 *** P<0.001
Mean values in each raw having different superscript (a, b, c, d) are significant

In conclusion, the present results revealed that Physalis extract scavenges free radicals that are produced by paracetamol increases the activity of antioxidant-defense system while choline is lipotropic preventing abnormal fat accumulation and essential for numerous biological functions.

Therefore, dietary consumption of physalis extract with choline may be used as best potential antioxidant and hepatoprotective in paracetamol induced liver toxicity.

REFERENCES


