Effect of Combination of Cauliflower and Q10 on Liver Injury in Experimental Rats

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Abstract: Sixty male Sprague-Dawley rats administered paracetamol drug at a single dose of 2 g/kg by stomach tube to induce liver injury then classified into control (+ve), cauliflower powder (10% of the basal diet), cauliflower extract (500 mg/kg, p.o), Q10 (10 mg/kg, p.o), cauliflower powder with Q10 and cauliflower extract with Q10 for 60 days. Blood and liver samples were collected for biochemical analysis. The obtained results revealed that administration of cauliflower powder or extract with or without Q10 or Q10 only to hepatic injury rat groups revealed increase of feeding and growth performance as increase of final weight, body weight gain, food intake and feed efficiency ratio compared to control +ve group. Administration of cauliflower powder or extract with or without Q10 to hepatic injury rat groups revealed significant decrease in liver function enzymes and lipid fractionations (cholesterol, TG, LDLc and VLDLc) and significant increase of serum HDLc compared to control +ve group. Administration of cauliflower powder or extract with Q10 showed reduction of the higher values of serum total bilirubin and albumin/globulin ratio and increase the values of serum total protein, albumin and globulin. Also, they showed significant decrease of liver cholesterol, total lipid and MDA but significant increase in liver antioxidant enzymes, triglyceride and glycogen compared to control +ve group. This study concluded that administration of cauliflower and Q10 showed synergistic effect in improvement in liver function and antioxidant enzymes in paracetamol induced liver toxicity.

Key words: Cauliflower • Paracetamol • Liver • Q10 • Rats

INTRODUCTION

In the last decades, special attention has been paid towards edible plants, especially those that are rich in secondary metabolites (phytochemicals). Nowadays, there is an increasing interest in the antioxidant activity of such phytochemicals present in diet [1]. Cauliflower (Brassica oleracea L.) belongs to the family Brassicaceae and is an important vegetable grown all over the world and has a wide variety of uses directly as a vegetable or as an ingredient in salads, soups and so forth. Cauliflower produces an edible head of malformed and condensed flowers (the curd) whose stalks are short, fleshy and closely crowded. Heads of high quality cauliflower are white to cream in colour, firm and compact [2, 3]. Cauliflower is so closely related to broccoli that both are designated as the same variety of the cruciferous family, which not only share the wonderful phytochemicals, but also contain nutritive value of vitamin A, thiamine, riboflavin, niacin, vitamin C, calcium, iron, phosphorous and fat to help fight diseases [4]. Cauliflower is known to contain compounds capable of accelerating the biotransformation of concurrently ingested drugs, as it contains the active compounds indole and sulforaphane. Both compounds are capable of inducing cytochrome P-450 and several enzymes catalyzing conjugation reactions [5]. Coenzyme Q-10 (CoQ-10) is a vitamin-like substance found throughout the body, but especially in the heart, liver, kidney and pancreas. It is eaten in small amounts in meats and seafood. Coenzyme Q-10 can also be made in a laboratory and is used as medicine. Q10 is an excellent antioxidant that is protective for a liver and is also an important component of healthy metabolism. It protects the mitochondria and cell membrane from oxidative damage and helps generate ATP, the energy source for cells [6, 7].
The present work was carried out to study the effect of combination of Q10 and cauliflower (Brassicaceae) on liver function, lipid fractionation and antioxidant enzymes levels in paracetamol induced liver injury in experimental rats.

**MATERIALS AND METHODS**

**Materials:** Sixty male Sprague-Dawley rats weighing 170±6g were purchased from Farm of Experimental Animals in Helwan, Egypt. The basal diet was prepared according to Reeves et al. [8]. Paracetamol drug was obtained from Kahira Pharm &Chem. Ind. Co., Cairo, Egypt. Q10 was obtained from Mepaco, Egypt and given to rats at dose of 10mg/kg orally all over the period of the experiment. Kits for biochemical analysis were purchased from the Gamma Trade Company for Pharmaceutical and Chemicals, Dokki, Egypt. Fresh cauliflower (Brassica oleracea L.) is purchased from local market, Cairo, Egypt.

**Methods**

**Preparation of Cauliflower Powder and Extract:** Cauliflower were dried at 60°C, then crushed into powder and added as 10% of the basal. To prepare cauliflower extract, 5kg cauliflower powder was extracted by 70% ethanol on cold until exhaustion. The solvent was distilled in rotary evaporator at 55°C till dryness and dissolved in double distilled water for final administration [9]. The rat dose of methanol cauliflower extract was 500 mg/kg body weight by stomach tube.

**Biological Design:** After one week of adaptation period, rats were administered paracetamol drug at a single dose of 2 g/kg by stomach tube to induce liver injury [10]. Liver injured rats were randomly classified into six groups (10 rats each). The first group kept as control (+ve) fed basal diet and the other groups administered cauliflower powder, cauliflower extract, Q10, cauliflower powder with Q10 and cauliflower extract with Q10 for 60 days. Feeding and growth performance were carried out by determination of daily food intake (FI), final weight (FW), body weight gain (WG) and feed efficiency ratio (FER) according to method of Chapman et al. [11]. At the end of the experiment (60 days), rats were sacrificed for collection of blood and liver samples for biochemical analysis.

**Biochemical Analysis:** Serum aspartate and alanine amino transferase, alkaline phosphatase and gamma glutamyle transferase (AST, ALT, ALP& GT) enzymes activity was estimated according to Reitman and Frankel [12], Draper and Hadley [13] and Kind and King [14], respectively.

Total bilirubin, total protein, albumin and globulin were determined according to Jendrassik [15], Weichselbaum [16], Doumas et al. [17] and Henry [18], respectively. Serum cholesterol (CHO), triglycerides (TG) and high density lipoprotein cholesterol (HDL-) were determined by using enzymatic colorimetric methods described by Abell et al. [19], Buccolo and David [20] and Kostener [21], respectively. Low density lipoprotein cholesterol (LDL-) and very low density lipoprotein cholesterol (VLDL-) were calculated according to Fruchart [22]. Liver cholesterol, total lipids, triglyceride (TG), glycogen superoxide dismutase (SOD), glutathione S-transferase (GST), glutathione peroxidase (GPX), catalase and malondialdehyde (MDA) were determined according to the following: Richmond [23], Folch et al. [24], Scheletter and Nussel [25], Rerup and Lundquist [26], Beuchamp and Fridovich [27], Ellman [28], Weiss et al. [29], Cohen et al. [30] and Uchiyama and Mihara [31], respectively.

**Statistical Analysis:** Collected data were presented as mean ±SD 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 [32].

**RESULTS AND DISCUSSION**

Administration of cauliflower powder or extract with or without Q10 to hepatic injury rat groups revealed significant increase of FW, BWG, FI and FER compared with control group. Administration of cauliflower powder or extract with Q10 to hepatic injury rats showed higher values of FW, BWG, FI and FER compared to rats groups which administered cauliflower powder or extract or Q10 as shown in Table 1. Several reports found that cauliflower is a great source of dietary fiber, which is essential for optimal digestion by smoothly moving through the intestines. Cauliflower also contains a compound called glucoraphin, which protects stomach and intestines from certain health conditions such as cancer and ulcers. In addition to folate, cauliflower is also loaded with other important B vitamins like niacin, riboflavin, pantothenic acid and thiamine and vitamin K. Those Vitamins is very important in the metabolism of fats, carbohydrates and protein [33]. CoQ10, or coenzyme Q10, is a fat-soluble substance found in the energy-producing parts of cells. Antioxidant activity of CoQ10 may improve the way muscles metabolize carbohydrates and lipids and also improved muscular endurance and decreased metabolic stress [34].
Table 1: Mean values ± SD of FW, BWG, FI and FER of the experimental rat groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Variables</th>
<th>Control +ve</th>
<th>powder</th>
<th>Extract</th>
<th>Q10</th>
<th>Powder+Q10</th>
<th>Extract+Q10</th>
</tr>
</thead>
<tbody>
<tr>
<td>FW (g)</td>
<td>200.96±10.31a</td>
<td>253.38±13.12b***</td>
<td>262.92±15.71b***</td>
<td>239.31±16.41a***</td>
<td>270.72±20.21b***</td>
<td>270.96±23.20b***</td>
<td></td>
</tr>
<tr>
<td>BWG (g)</td>
<td>30.55±4.20a</td>
<td>79.77±7.16b***</td>
<td>90.61±9.18b***</td>
<td>64.35±6.71b***</td>
<td>95.61±9.14b***</td>
<td>99.41±8.11b***</td>
<td></td>
</tr>
<tr>
<td>FI (g/w)</td>
<td>13.75±1.21bc</td>
<td>17.77±1.71a***</td>
<td>18.24±1.31a***</td>
<td>16.90±1.51a***</td>
<td>18.81±1.64a***</td>
<td>18.55±1.73a***</td>
<td></td>
</tr>
<tr>
<td>FER</td>
<td>0.03±0.001a</td>
<td>0.074±0.004a***</td>
<td>0.082±0.001a***</td>
<td>0.063±0.004a***</td>
<td>0.084±0.002a***</td>
<td>0.089±0.003a***</td>
<td></td>
</tr>
</tbody>
</table>

Significant with control (−ve) group * P<0.05 ** P<0.01 *** P<0.001
Values with the same letters in raw indicate non-significant difference (P<0.05) and vice versa.

Table 2: Mean values ± SD of serum ALT, AST, ALP and γGT of the experimental rat groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Variables</th>
<th>Control +ve</th>
<th>powder</th>
<th>Extract</th>
<th>Q10</th>
<th>Powder+Q10</th>
<th>Extract+Q10</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALT(µ/ml)</td>
<td>85.41±5.77a</td>
<td>49.01±3.24bc***</td>
<td>48.77±4.76bc***</td>
<td>52.77±6.01bc***</td>
<td>47.41±5.15bc***</td>
<td>42.77±3.18bc***</td>
<td></td>
</tr>
<tr>
<td>AST(µ/ml)</td>
<td>97.01±9.61a</td>
<td>60.71±7.10bc***</td>
<td>61.11±6.22bc***</td>
<td>67.41±7.01bc***</td>
<td>59.61±6.14bc***</td>
<td>50.14±5.11bc***</td>
<td></td>
</tr>
<tr>
<td>ALP(µ/ml)</td>
<td>109.66±11.21b</td>
<td>75.22±6.99bc***</td>
<td>69.41±6.13bc***</td>
<td>72.19±7.96bc***</td>
<td>65.77±6.80bc***</td>
<td>60.11±6.71bc***</td>
<td></td>
</tr>
<tr>
<td>γGT(µ/ml)</td>
<td>15.77±2.11a</td>
<td>8.96±1.14c***</td>
<td>8.11±1.30c***</td>
<td>9.66±1.20c***</td>
<td>8.77±1.16c***</td>
<td>8.33±1.15c***</td>
<td></td>
</tr>
</tbody>
</table>

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

Administration of cauliflower powder or extract with or without Q10 to hepatic injury rat groups revealed significant decrease of serum ALT, AST, ALP and γGT compared to control group. There were no significant differences among hepatic injury rat groups which administrated of cauliflower powder or extract or Q10 or cauliflower powder with Q10. The hepatic injury rat group which administrated cauliflower extract with Q10 revealed significant decrease of serum ALT, AST and ALP compared to rat groups which administrated of cauliflower powder or Q10 as shown in Table 2. These results were clarified by Maria et al. [35], they reported that phenolic compounds were higher in Brassica vegetables in which flavonols were always the major compounds. In addition consumption of Brassica vegetables has been related to human health due to their phytochemicals, such as glucosinolates and phenolic compounds that induce a variety of physiological functions including antioxidant activity, enzymes regulation and apoptosis control and the cell cycle. The decrease in the hepatocellular damage indicated by decreasing the release of the enzyme ALT compared to the liver injury control group. Galati and O’Brien [36] and Morsy et al. [37] found that oral administration of Brassicaceae caused a significant decrease in serum ALT levels in rats with hepatotoxic lesions induced by N-nitrosodiethyl amine and carbon tetrachloride. The observed enhancement level by Brassica vegetables was due to their content of glucosinolates, flavonoids and other phenolics. Kwong et al. [38] reported that Q10 is a cofactor upon which other enzymes depend for their function. It appears to be a coenzyme for a number of cell enzymes including enzymes within the mitochondrial oxidative phosphorylation pathway which produces adenosine triphosphate (ATP). This is fundamental to energy production within cells and it undoubtedly has antioxidant activity.

Administration of Q10 or cauliflower powder or extract only or with Q10 to hepatic injury rat groups revealed significant decrease of serum total bilirubin and albumin/globulin ratio compared to control +ve group. Administration of cauliflower powder or extract only or with Q10 to hepatic injury rat groups revealed significant increase of serum total protein and globulin compared to control +ve group. Administration of cauliflower powder or extract with Q10 showed reduction of the higher values of serum total bilirubin and albumin/globulin ratio and increase the values of serum total protein, albumin and globulin compared to control +ve group as illustrated in Table 3. The alteration in serum albumin is found more commonly in chronic liver disease. Therapeutic/prophylactic administration of an antioxidant leads to an increase in the level of albumin in the serum [39]. Sulfur-containing phytochemicals as glucosinolates and S-methyl cysteine sulfoxide are present in all Brassica oleracea vegetables. These compounds show quite different toxicological effects and appear to possess anticarcinogenic properties [40]. Low dose of CoQ10 succeeded in reversing Doxirubicin induced nephrotoxicity to control levels as levels of blood urea nitrogen and serum creatinine [41].
Table 3: Mean values ± SD of total bilirubin, total protein, albumin, globulin and albumin/globulin of the experimental rat groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Variables</th>
<th>Control +ve</th>
<th>Powder</th>
<th>Extract</th>
<th>Q10</th>
<th>Powder + Q10</th>
<th>Extract + Q10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total bilirubin (mg/dl)</td>
<td>1.95±0.50(^\ast)</td>
<td>0.95±0.31(^{**})</td>
<td>0.89±0.22(^{***})</td>
<td>1.03±0.34(^{**})</td>
<td>0.91±0.12(^{**})</td>
<td>0.87±0.11(^{***})</td>
</tr>
<tr>
<td></td>
<td>Total protein (g/dl)</td>
<td>5.02±0.77(^{**})</td>
<td>7.24±0.98(^{**})</td>
<td>7.31±0.87(^{**})</td>
<td>6.04±0.64(^{**})</td>
<td>7.33±0.85(^{**})</td>
<td>7.51±0.75(^{**})</td>
</tr>
<tr>
<td></td>
<td>Albumin (g/dl)</td>
<td>3.21±0.47(^{**})</td>
<td>3.41±0.33(^{**})</td>
<td>3.39±0.44(^{**})</td>
<td>3.01±0.37(^{**})</td>
<td>3.51±0.40(^{**})</td>
<td>3.64±0.33(^{**})</td>
</tr>
<tr>
<td></td>
<td>Globulin (g/dl)</td>
<td>1.81±0.25(^{**})</td>
<td>3.83±0.34(^{**})</td>
<td>3.55±0.22(^{**})</td>
<td>3.03±0.41(^{**})</td>
<td>3.82±0.52(^{**})</td>
<td>3.87±0.47(^{**})</td>
</tr>
<tr>
<td></td>
<td>A/G</td>
<td>1.77±0.14(^{**})</td>
<td>0.89±0.22(^{**})</td>
<td>0.95±0.13(^{**})</td>
<td>0.99±0.12(^{**})</td>
<td>0.91±0.10(^{**})</td>
<td>0.94±0.14(^{**})</td>
</tr>
</tbody>
</table>

Significant with control (-ve) group * P<0.05 ** P<0.01 *** P<0.001
Values with the same letters in raw indicate non- significant difference (P<0.05) and vice versa

Table 4: Mean values ± SD of serum CHO, TG, HDLc, LDLc and VLDLc of the experimental rat groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Variables</th>
<th>Control +ve</th>
<th>Powder</th>
<th>Extract</th>
<th>Q10</th>
<th>Powder + Q10</th>
<th>Extract + Q10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CHO (mg/dl)</td>
<td>195.61±19.66(^{**})</td>
<td>155.40±15.14(^{**})</td>
<td>150.67±13.17(^{**})</td>
<td>149.53±12.31(^{**})</td>
<td>125.60±1.11(^{**})</td>
<td>130.16±12.14(^{**})</td>
</tr>
<tr>
<td></td>
<td>TG (mg/dl)</td>
<td>149.50±13.61(^{**})</td>
<td>79.61±8.21(^{**})</td>
<td>85.61±8.64(^{**})</td>
<td>90.61±9.91(^{**})</td>
<td>80.35±8.64(^{**})</td>
<td>82.63±7.88(^{**})</td>
</tr>
<tr>
<td></td>
<td>HDLc (mg/dl)</td>
<td>20.66±2.19(^{**})</td>
<td>30.94±3.61(^{**})</td>
<td>33.77±311(^{**})</td>
<td>34.11±4.01(^{**})</td>
<td>32.21±4.11(^{**})</td>
<td>35.40±4.31(^{**})</td>
</tr>
<tr>
<td></td>
<td>LDLc (mg/dl)</td>
<td>145.04±14.21(^{**})</td>
<td>108.53±13.21(^{**})</td>
<td>99.78±10.12(^{**})</td>
<td>97.29±9.16(^{**})</td>
<td>77.32±8.01(^{**})</td>
<td>78.23±7.31(^{**})</td>
</tr>
<tr>
<td></td>
<td>VLDLc (mg/dl)</td>
<td>29.91±3.11(^{**})</td>
<td>15.12±2.14(^{**})</td>
<td>17.12±1.31(^{**})</td>
<td>18.13±1.42(^{**})</td>
<td>16.07±1.51(^{**})</td>
<td>16.53±1.32(^{**})</td>
</tr>
</tbody>
</table>

Significant with control (-ve) group * P<0.05 ** P<0.01 *** P<0.001
Values with the same letters in raw indicate non- significant difference (P<0.05) and vice versa

Administration of Q10 or cauliflower powder or extract only or with Q10 to hepatic injury rat groups revealed significant decrease of serum cholesterol, TG, LDLc and VLDLc and significant increase of serum HDLc compared to control +ve group. There were non significant differences in serum lipid fractionation between rat groups which administered cauliflower powder or extract with or without Q10. Also, there were non significant differences in serum lipid parameters. Cauliflower may help decrease cholesterol, particularly LDLc, or cholesterol because it is an excellent source of dietary fiber and phytonutrient that reduce the liver cells' production of which is the main transporter or carrier of LDL cholesterol to tissues. In addition, folate in cauliflower helps to lower the amount of circulating homocysteine that is a lower level of total homocysteine is linked to cardiovascular disease [42, 43]. Also, levels of total cholesterol were lower in animals fed the diet with addition of fresh cooked cauliflower as compared to rats given hypercholesterolemic diet with addition of raw vegetable. Soluble fibers of cauliflower reduce serum cholesterol by altering the composition of enterohepatic bile acid pools and by increasing the faecal loss of total bile acids [44]. Q10 is highly efficient in preventing lipid, protein and DNA oxidation and it is continuously regenerated by intracellular reduction systems. Dietary CoQ\(_\text{10}\) has been shown to be taken up into the blood and distributed in LDL and HDL [45, 46].

Administration of cauliflower powder or extract only or with Q10 or Q10 only to hepatic injury rat groups revealed significant increase of liver antioxidant enzymes (liver SOD, catalase, GST and GPX) and significant decrease in MDA compared to control +ve group. There were non significant differences in liver SOD, GST and MDA among all rat groups which administered cauliflower powder or extract with or without Q10 or Q10 only. The most favourable effects appeared in groups administered cauliflower powder or extract with Q10 compared to other groups as presented in Table 5. Essentially similar results were obtained. Fresh cauliflower is a good source of vitamin which is an antioxidant that has been proven to be able to cope with free radicals, enhance immune function or immune system. Cauliflower is also rich in minerals, such as manganese, copper, iron, calcium and potassium. Manganese is a cofactor for antioxidant enzymes in the body as superoxide dismutase. Cruciferous vegetables act as a good source of natural antioxidants due to the high levels of carotenoids, tocopherols and ascorbic acid and strong epidemiological evidence shows that these compounds may help to protect the human body against damage by reactive oxygen species [40]. All tissues from diabetic animals exhibited increased oxidative stress and disturbances in antioxidant defense when compared with normal controls. Treatment with the lipophilic compound...
Table 5: Mean values ± SD of liver SOD, GST, GPX, catalase and MDA of the experimental rat groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Control +ve</th>
<th>Powder</th>
<th>Extract</th>
<th>Q10</th>
<th>Powder + Q10</th>
<th>Extract + Q10</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOD (µ/mg)</td>
<td>17.41±2.33</td>
<td>35.61±4.71</td>
<td>38.41±5.72**</td>
<td>34.20±4.76**</td>
<td>36.65±4.99**</td>
<td>37.41±4.8**</td>
</tr>
<tr>
<td>GST (µ/mg)</td>
<td>2.11±0.44</td>
<td>4.69±1.05**</td>
<td>4.72±1.02**</td>
<td>4.88±1.03**</td>
<td>5.16±1.21**</td>
<td>6.60±1.31**</td>
</tr>
<tr>
<td>GPX (µ/mg)</td>
<td>19.71±1.66</td>
<td>37.22±3.89**</td>
<td>41.40±4.66**</td>
<td>40.55±4.89**</td>
<td>42.63±4.69**</td>
<td>51.70±5.19**</td>
</tr>
<tr>
<td>Catalase (µ/mg)</td>
<td>15.41±2.11</td>
<td>40.11±4.22**</td>
<td>38.47±4.81**</td>
<td>39.14±4.96**</td>
<td>49.21±5.65**</td>
<td>45.31±5.61**</td>
</tr>
<tr>
<td>MDA (nmol/g)</td>
<td>19.66±3.10</td>
<td>11.61±1.18**</td>
<td>10.41±1.45**</td>
<td>10.61±1.31**</td>
<td>11.22±1.4**</td>
<td>9.30±1.05**</td>
</tr>
</tbody>
</table>

Significant with control (-ve) group * P<0.05 ** P<0.01 *** P<0.001
Values with the same letters in raw indicate non-significant difference (P<0.05) and vice versa

Table 6: Mean values ± SD of liver cholesterol, total lipids, triglyceride and glycogen of the experimental rat groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Control +ve</th>
<th>Powder</th>
<th>Extract</th>
<th>Q10</th>
<th>Powder+Q10</th>
<th>Extract+Q10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholesterol (mg/100g)</td>
<td>7.14±1.20</td>
<td>4.11±0.44**</td>
<td>4.22±0.45**</td>
<td>5.01±1.11**</td>
<td>4.33±0.66**</td>
<td>4.54±0.15**</td>
</tr>
<tr>
<td>Total lipids (mg/100g)</td>
<td>63.60±8.66</td>
<td>40.42±6.71**</td>
<td>47.22±7.88**</td>
<td>45.62±7.01**</td>
<td>41.40±6.43**</td>
<td>40.11±5.61**</td>
</tr>
<tr>
<td>Triglyceride (mg/100g)</td>
<td>1.56±0.24</td>
<td>2.56±0.36**</td>
<td>2.17±0.28**</td>
<td>2.41±0.25**</td>
<td>2.60±0.24**</td>
<td>2.49±0.33**</td>
</tr>
<tr>
<td>Glycogen (mg/100g)</td>
<td>3.66±0.89</td>
<td>4.55±1.21</td>
<td>4.39±1.11</td>
<td>4.03±1.03</td>
<td>5.40±1.31</td>
<td>5.71±1.21</td>
</tr>
</tbody>
</table>

Significant with control (-ve) group * P<0.05 ** P<0.01 *** P<0.001
Values with the same letters indicate non-significant difference (P<0.05) and vice versa

coenzyme Q10 reversed diabetic effects on hepatic glutathione peroxidase activity, on renal superoxide dismutase activity, on cardiac lipid peroxidation and on oxidized glutathione concentration in brain. However, treatment with coenzyme Q10 also exacerbated the increase in cardiac catalase activity, which was already elevated by diabetes [47].

Administration of cauliflower powder or extract only or with Q10 or Q10 to hepatic injury rat groups revealed significant decrease of liver cholesterol and total lipids and significant increase in triglyceride compared to control +ve group. There were no significant differences in liver cholesterol, total lipid, triglyceride and glycogen among all experimental rat groups. Rat groups which administered cauliflower powder or extract with Q10 revealed significant decrease of liver cholesterol and total lipid and significant increase in triglyceride and glycogen compared to control +ve group as presented in Table 6. The mechanism of hypocholesterolemic effects of cauliflower in diet was discussed by many authors. Polyphenols in cauliflower are slowing down metabolism of cholesterol in the liver, reducing excretion of VLDL to blood, which leads to lower cholesterol accumulation in the aorta [48]. Cauliflower in diet can reduce of the reabsorption of bile acids at the terminal ileum for enterohepatic recycling and increase in catabolism of cholesterol to bile acids. The reduction in cholesterol might be due to the stress response which stimulates the synthesis of steroid hormones via hypothalamic–pituitary system [49]. CoQ10 is an integral component of the mitochondrial oxidative phosphorylation system and is a lipid-soluble redox carrier between particular respiratory enzyme complexes in the electron transport chain in the mitochondrial inner membrane [7]. From this study, it is concluded that administration of Cauliflower with CoQ10 showed the most favourable effect in paracetamol induced liver injury because of their synergistic effects.

REFERENCES