Effect of Oyster Mushroom on Kidney in Stress Induced Depressed Rats

Nasim Jahan¹, Sharmin Akther ², Nahid Sultana ³

Abstract

Background: Depression is associated with stressful condition which may cause kidney damage. Oyster mushroom (plurotus florida) may have free radical scavenging activity thereby can be used for the prevention and treatment for kidney damage. Objective: to observe the effect of oyster mushroom (plurotus florida) on kidney in restraint stress induced depressed rats. Methods: This experimental study was conducted from July 2012 to June 2013 in the Department of Physiology, Sir Salimullah Medical College (SSMC), Mitford, Dhaka. Thirty Wister albino male rats, aged 90 to 100 days, weighing 150 to 180g (initial body weight) were used in the present study. Then they were divided into Group I (Control group, without mushroom n=20) and Group II (Experimental group, depressed rats supplemented with mushroom n=10). Control group without mushroom again subdivided into Group Ia (baseline control n=10) and Group Ib (depressed control n=10). All groups of animals were received basal diet for 28 consecutive days started from the 1st day of the study period. Group Ib (depressed control) and group II (depressed mushroom supplemented) were housed under controlled condition in rat immobilizer (made up of steel wire, measuring 9” x 2.75” of light weight) for 6 hour/day for 28 days for the development of stress induced depression. In addition, only group II received oyster mushroom extract (200 mg/kg body weight, orally) for the same period. One rat of Group Ib (depressed control) was expired after 10 days for unknown cause. All 29 rats were sacrificed on day 30. Then blood sample and kidneys specimen were collected. Initial (initial bw) and final body weights (final bw) were measured. Then estimation of blood glucose and serum urea levels were done by standard laboratory technique. Histology of kidney was done by standard laboratory procedure. Statistical analysis was done by using SPSS windows Version -16. One way ANOVA and Bonferroni tests were done as applicable. Results: In this study blood glucose level and serum urea level was significantly higher and abnormal histological structure was found in stress induced depressed rats. After taking mushroom extract for 28 days all the parameters were improved. Conclusion: From this study it can be concluded that oyster mushroom(Pleurotus florida) which is excellent edible and nutritious, may have renoprotective effect. Keywords: Renoprotective, Depression, Oyster mushroom, free radicals.

Introduction

Chronic stress decreases the immune response and increases the blood pressure. These problems can lead to serious illnesses such as heart attacks, kidney disease, cancer, stroke and rheumatoid arthritis¹,². It has been stated that stress as an emotional factor is associated with anxiety, depression and


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Recently, oxidative stress has been proposed as a contributing factor in the pathogenesis of depression. Again, significantly lower plasma concentrations of several key antioxidants (vitamin-E, zinc and coenzyme Q), as well as lower antioxidant enzyme activity, have been reported in major depression. Depression is a neuropsychiatric illness that has been estimated to be the third among the global burden of diseases.

Some researchers observed significant reduction of body weight after 2 hr immobilization stress in rats. Again, depressed rats showed reduced motor activity, reduced appetite and increased sleep.

Some other investigators observed that serum urea, creatinine and uric acid levels were significantly increased after 2 weeks treatment with oxidative stress induced by mercuric chloride (0.5 mg/kg bw). In a longitudinal study (5 days to 11 years) it has been shown that the individuals with depressive symptoms may develop rapid declines in kidney function and hospitalization occur with acute kidney injury during follow-up.

However, the traditional antidepressants drugs are available but have some side effects such as, relapse, delayed onset of action, sexual dysfunction, weight gain, cardiovascular and gastrointestinal complications etc.

Some researchers observed that the medicinal mushroom Ganoderan exerts some protective effects in rats with chronic glomerulonephritis induced by Adriamycin (ADR). Ganoderan reduced 24-hours urinary protein excretion, serum creatinine and cholesterol levels and also improved the pathological changes of kidney tissue in rats. Some other researchers found that feeding of 5% oyster mushroom powder reduced body weight significantly in hypercholesterolemic rats. Again serum bilirubin, creatinine and blood urea nitrogen (BUN) levels were decreased in both hypercholesterolemic and mushroom fed hypercholesterolemic rats, but those were nonsignificant.

However, reactive oxygen species (ROS) play a key role in the pathophysiological processes of renal diseases. Thus, antioxidants are expected to decrease the vulnerability of the kidney to oxidative challenges. Polyphenols, abundant in grapes, some vegetables, fruits and tea may act as ROS scavengers, iron chelators and enzyme modulators. Again, resveratrol found in grapes or other polyphenols decreased kidney damage by ischaemia-reperfusion.

However, some researchers observed hepatoprotective, antidepressant and hypoglycaemic effects of Oyster mushroom in rats in our country. In addition, mushrooms have antihypertensive, and lipid lowering effect and it also plays a role in the development and function of the central nervous system. Currently, there is increasing incidence of renal failure with consequence of high morbidity and mortality in our country. Oyster mushroom with high nutritive and medicinal value is cultivated and harvested in Bangladesh all over the year. It is reasonably cheap, easily available and relatively safe in comparison to other mushroom. But little is known about the effect of this mushroom on kidney of stress induced depressed rats in Bangladesh as well as in other countries. It is expected that the finding of this study will be beneficial for depressed patient with renal injury. Moreover, the findings of this study may also be helpful to make this mushroom acceptable among the people as a good food for the prevention of kidney damage.

Therefore, the present study has been designed to observe the effect of Oyster mushroom (Pleurotus florida) on kidney in restraint stress induced depressed rats.

**Methods**

This experimental study was conducted from July 2012 to June 2013 in the Department of Physiology, SSMC, Mitford, Dhaka. Thirty Wister albino male rats, age 90 to 100 days, weighing 150 to 180 g (initial body weight) were used in the present study. The animals were purchased from the animal house of Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka. Ethical permission was taken from the Institutional ethics committee.
committee of SSMC, Dhaka. Prior to the study the animals were acclimatized for 14 days under 12 hours dark and light schedule. During this period they had free access to food and water ad libitum. Then they were divided into two groups. Group I(Control group, without mushroom n=20) and Group II (Experimental group, depressed rats supplemented with mushroom n=10). Control group without mushroom again subdivided into Group Ia,( baseline control n=10) and Group Ib(depressed control n=10) group. All groups of animals were received basal diet for 28 consecutive days started from the 1st day of the study period. Group Ib(depressed control) and group II (depressed mushroom supplemented) were housed under controlled condition in rat immobilizer (made up of steel wire, measuring 9” x 2.75” of light weight)8 for 6 hour/day for 28 days for the development of stress induced depression.In addition, only group II received oyster mushroom extract22 (200 mg/kg body weight, orally) for the same period. One rat of Group Ib (depressed control) was expired after 10 days for unknown cause. All 29 rats were sacrificed on day 30. Then blood samples were collected from heart and after that kidneys were removed. To observe stress induced depression, their initial (initial bw) and final body weights (final bw) were measured and blood glucose level was estimated23 in the laboratory of Department of Physiology, SSMC. Moreover, to detect kidney function, serum urea level was measured24 in the Department of Biochemistry, BSMMU. To find out the histological changes of kidney, histological slides were prepared in the Department of Pathology and were observed under the microscope in the Department of Physiology, SSMC. Data were expressed as Mean ±SD and percentage. Statistical analysis was done by using SPSS windows Version -16. One way ANOVA and Bonferroni tests were done as applicable. p value <0.05 was considered as significant.

**Preparation of mushroom extract22**

Oyster mushroom was collected from National Mushroom Development and Extension Center (NMDEC), Savar, Dhaka. Fresh mushroom was dried in the sun and finally in the oven and then crushed into powder with a mechanical grinder. Mushroom powder was extracted with ethanol, filtered and evaporated to obtain mushroom extract.

**Results**

The mean ± SD of percent (%) changes of body weights were significantly (p<0.001) lower in group Ib and group II in comparison to that of group Ia and again in group Ib (p<0.01) in comparison to that of group II. (Table I). Again, the mean ± SD of blood glucose and serum urea levels were significantly (p<0.001) higher in group Ib in comparison to those of group Ia and group II. However, these levels were almost similar and the differences were not statistically significant between group Ia and group II (Table II).

Table III shows the distribution of rats by histological changes in kidney. In this study,

**Table I: Initial and final body weight of rats and percent change of body weight in different groups of rats (n=29)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group Ia (n=10)</th>
<th>Group Ib (n=9)</th>
<th>Group II (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial body wt (g)Day-1</td>
<td>162.83±9.13</td>
<td>165.08±8.32</td>
<td>163.67±9.33</td>
</tr>
<tr>
<td>Final body wt (g)Day-30</td>
<td>185.17±10.44</td>
<td>180.33±8.76</td>
<td>181.33±11.32</td>
</tr>
<tr>
<td>% of change from final (F) to initial (I) body wt [(F-I)/I×100]</td>
<td>13.72±0.85</td>
<td>9.25±0.94*</td>
<td>10.77±1.57*</td>
</tr>
</tbody>
</table>

Values are means ±SD. Statistical analysis was done by ANOVA test and then Bonferroni test was performed to compare between groups. Final body wt (Gr.Ia vs Ib & Gr.II) (*p>0.05 Gr.Ib vs Gr. II). % change of body wt (+p<0.001 Gr. Ia vs Gr.Ib & Gr.II) ("p<0.01 Gr.Ib vsGr.II). Group Ia, Baseline control, Group Ib=depressed control, Group II =depressed mushroom supplemented.
histological examination of kidney revealed normal features in 100% of rats in Group Ia and abnormal histological findings were observed in 77.8% of rats in Group Ib. Again 90% of rats in Group II showed almost normal structure whereas 10% showed abnormal histological findings in kidney.

Table IV shows observation of histological findings of kidney of rats.

In Group Ia (baseline control) renal structure was normal. Glomerulus consists of capillaries lined by fenestrated endothelium and glomerular tuft is supported by mesangial cells. Again normal tubular epithelial cell structure and no lymphocyte cell infiltration were seen. (Figure 1, 2, 3). In group Ib (depressed control) moderate histological changes (enlarged hypercellular glomeruli, proliferation of endothelial and mesangial cells, interstitial edema and infiltration by leucocytes) were found (Figure 4, 5). In group II (depressed mushroom supplemented) normal histological findings were observed in 9 rats (Figure 6, 7), but presence of minimal degenerative changes of endothelial and mesangial cells, interstitial edema, infiltration of lymphocytes and sclerotic changes were found in one rat.

Table II: Fasting blood glucose and serum urea levels in different groups of rats (n=29)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group Ia (n=10)</th>
<th>Group Ib (n=9)</th>
<th>Group II (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting blood glucose (mmol/L)</td>
<td>5.23 ± 0.65 *</td>
<td>8.10 ± 0.64 *</td>
<td>5.04 ± 0.69 *</td>
</tr>
<tr>
<td>Serum urea (mmol/L)</td>
<td>13.4 ± 2.8</td>
<td>30.9 ± 5.34</td>
<td>9.1 ± 0.99</td>
</tr>
</tbody>
</table>

Values are means ±SD. Statistical analysis was done by ANOVA test and then Bonferroni test was performed to compare between groups. Fasting blood glucose ("p<0.001 Gr. Ia vs Ib&Gr.II) ("p<0.001 Gr.Ib vs Gr. II). Group I = Baseline control, Group Ib = depressed control, Group II = depressed mushroom supplemented.

Table III: Distribution of rats by histological changes in kidney (n=29).

<table>
<thead>
<tr>
<th>Histological features</th>
<th>Group Ia n(%)</th>
<th>Group Ib n(%)</th>
<th>Group II n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>10 (100%)</td>
<td>2 (22%)</td>
<td>9 (90%)</td>
</tr>
<tr>
<td>Abnormal</td>
<td>0 (0%)</td>
<td>7 (77.8%)</td>
<td>1 (10%)</td>
</tr>
</tbody>
</table>

Statistical analysis was done by Fisher’s exact test. Group Ia = Baseline control, Group Ib = depressed control, Group II = depressed mushroom supplemented.

Table IV: Histological observation of kidney in different groups of rats (n=29)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Observation</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia(n=10) (Baseline control group)</td>
<td>Architecture of - glomerulus,- renal tubules Orientation of -lining epithelium</td>
<td>Normal histological findings Glomerulus consists of capillaries lined by fenestrated endothelium Glomerular tuft is supported by mesangial cells</td>
</tr>
<tr>
<td>Ib(n=9) (Depressed control group)</td>
<td>Enlarged, hypercellular glomeruli, Proliferation of endothelial and mesangial cells, interstitial edema, Infiltration by leucocytes, Presence of tubular necrosis, Loss of lining epithelium of tubules</td>
<td>Moderate histological changes</td>
</tr>
<tr>
<td>Group II (n=10) Depressed mushroom supplemented</td>
<td>Restoration of normal architecture of glomerulus and renal tubules, Glomeruli become normal in size. Interstitial edema subsides, Decreased proliferation of endothelial and mesangial cell, less or absence of tubular necrosis, less or absence of lymphocytic infiltration</td>
<td>Normal histological findings in 9 rats but presence of glomerular and tubular necrosis in 1 rat. minimal degenerative changes of endothelial and mesangial cells, interstitial edema infiltration of lymphocytes and sclerotic changes were found in one rat.</td>
</tr>
</tbody>
</table>
Discussion
In the present study, the percent changes of body weight in different groups of rats were almost similar to the findings reported by the various investigators but they used tulsi as supplementation.

Figure 1: Normal architecture of kidney tissue of baseline control rats (X 100).

Figure 2: Enlarged hypercellular glomeruli, proliferation of endothelial and mesangial cells of depressed control rats (X 400).

Figure 3: Interstitial edema and infiltration by leucocytes of depressed control rats (X400)

Figure 4: Normal histological findings of kidney tissue of depressed mushroomsupplemented rats(x100)

Figure 5: Normal histological findings of kidney tissue of depressed mushroomsupplemented rats(x100)

Figure 6: Presence of minimal degenerative changes of endothelial and mesangial cells in 1 rat of depressed mushroom supplemented group (x400)

Figure 7: Presence of interstitial edema, infiltration of lymphocytes and sclerotic changes in 1 rat of depressed mushroom supplemented group (x400)
Again, blood glucose level in this study was found higher in depressed control group than that of depressed mushroom supplemented group which is almost similar to that of baseline control group. Several studies have shown that like pea nut and tulsi,mushroon has also blood glucose reducing effect \textsuperscript{17,25}.

In present study, serum level of urea was significantly higher in depressed control group than that of depressed mushroom supplemented and baseline control groups. Again, serum urea level was compared between depressed control and depressed mushroom supplemented group and the difference was highly significant. Similar findings were also reported by different researchers but they use virgin olive oil supplementation \textsuperscript{9}.

Again, in this study histological changes such as, enlarged hypercellular glomeruli, proliferation of endothelial and mesangial cells, interstitial edema and marked lymphocytic infiltration and also degeneration of tubular epithelial cells were observed in most of the depressed control rats. Similar type of observation was also made by some other researchers \textsuperscript{12}.

However, 90\% of depressed mushroom supplemented rats showed almost normal histological architecture of kidney. Different researchers of other countries observed almost similar type of findings by using different nuts and herbal plants \textsuperscript{12}.

It has been postulated that in restraint stress suppression of weight gain may be due to depression and anorexia \textsuperscript{26}. Again, increased level of glucocorticoid in chronic stress decreases glucose uptake by the cells and increases rate of gluconeogenesis which results in increased blood glucose level \textsuperscript{27}.

Depression may cause excessive formation of ROS that stimulate mesangial cells contraction. So, there is decreased GFR (glomerular filtration rate) and increased serum urea level \textsuperscript{28}.

Again, depressed rats showed glomerular hypercellularity, tubular necrosis, loss of lining epithelium of tubules, infiltration of lymphocytes and hyaline casts in the tubules may be due to increased production of free radicals \textsuperscript{12}.

Moreover, polyphenols, active components of mushroom may have cytoprotective action on the glomerular mesangial cells \textsuperscript{29}.

Again, B-glucan of mushroom improves mood state \textsuperscript{30} and have anti-depression activity \textsuperscript{17}. Different researchers suggested that the active components of Oyster mushroom increase the activities of some antioxidant enzymes such as catalase (CAT), superoxide dismutase (SOD) and glutathione peroxidase (GPX) and these antioxidant activities of mushroom may cause reduction of renal cell necrosis, stabilization of cell membrane and may protect the kidney architecture by scavenging free radicals \textsuperscript{31,32}. In the present study, it was observed that restraint stress developed depression in rats as evidenced by decreased body weight and increased blood glucose level. Then depression may cause renal damage as evidenced by increased serum urea level, which was further directly supported by moderate changes in kidney architecture observed by histological examination. These changes may be due to increased production of free radicals.

Furthermore, lower level of fasting blood glucose and increased body weight of the depressed mushroom supplemented group of this study suggested the anti-depressant effect of mushroom in this group of animals. Again, abnormal histological changes found in depressed mushroom supplemented group rats were less than those of depressed rats. It provides a direct evidence of renoprotective effect of the Oyster mushroom extract on kidney, might be due to its free radical scavenging activity.

**Conclusion**

From this study it can be concluded that Oyster mushroom (Pleurotus florida) can prevent...
oxidative damage of kidney tissues and thereby can maintain its normal histological architecture, may be due to its inhibition of generating and scavenging free radicals. But the active component of mushroom, which is responsible for this effect is not known.

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