Article

Effect of Oyster Mushroom on Kidney in Stress Induced Depressed Rats

Nasim Jahan[1], 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.

J Bangladesh Soc Physiol. 2017, June; 12(1): 33-40
For Authors Affiliation, see end of text.

http://www.banglajol.info/index.php/JBSP

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 arthritis[1,2].

It has been stated that stress as an emotional factor is associated with anxiety, depression and

Received 10 Feb 2017; Accepted 21 May 2017

cognitivedysfunction[3].Recently, oxidative stress has been proposed as a contributing factor in the pathogenesis of depression[4].Again, significantly lower plasma concentrations of several key antioxidants (vitamin- E,zinc and coenzyme Q),as wellas lower antioxidant enzyme activity, have been reported in major depression[5].Depression is aneuropsychiatric illness that has been estimated to be third among the global burden of diseases[6].

Some researchers observed significant reduction of bodyweight after 2hr immobilization stress in rats[7]. Again, depressed rats showed reduced motor activity, reduced appetite and increased sleep[8].

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)[9].In a longitudinal study (5days 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 injuryduring follow-up[10].

However,the traditional antidepressantsdrugs are available but have some side effects such as, relapse, delayed onset of action, sexual dysfunction, weight gain, cardiovascular and gastrointestinal complications etc[11].

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[12].Some other researchers found that feeding of 5% oyster mushroom powder reduced body weight significantly in hyper-cholesterolemic rats. Again serum bilirubin, creatinine and blood urea nitrogen (BUN) levels weredecreased in both hypercholesterolemic and mushroom fed hypercholesterolemic rats, but those were nonsignificant[13].

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[14].Again,resveratrol found in grapes or other polyphenols decreased kidney damage by ischaemia-reperfusion[15].

However, some researchersobserved hepatoprotective[16], antidepressant[17] and hypoglyceamic[18] effects of Oyster mushroom in ratsinour country. In addition, mushrooms have antihypertensive[19],andlipid lowering effect[20]and it also plays a role in the development and function of the central nervous system[21]. 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 180g (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 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 extract[22] (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 estimated[23]in the laboratory of Department of Physiology, SSMC. Moreover, to detect kidney function, serum urea level was measured[24] 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 extract[22]

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)ofblood 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**)**

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

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,GroupIb=depressed control,GroupII =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**)**

Parameter	Group Ia (n=10)	GroupIb (n=9)	GroupII (n=10)
Fasting blood glucose (mmol/L)	5.23 ± 0.65	8.10 ± 0.64 *	5.04 ± 0.69 •
Serum urea (mmol/L)	13.4+ 2.8	30.9 + 5.34	9.1+ 0.99

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, GroupII = depressed mushroom supplemented

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

Histological features	Group Ia n(%)	GroupIb n(%)	GroupII n(%)
Normal	10 (100%)	2 (22%)	9 (90%)
Abnormal	0 (0%)	7 (77.8%)	1 (10%)

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

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

Groups	Observation	Findings
Ia(n=10) (Baseline control group)	Architecture of - glomerulus,- renal tubules Orientation of -lining epithelium	Normal histological findings Glomerulus consists of capillaries lined by fenestrated endothelium Glomerular tuft is supported by mesangial cells
Ib(n=9) (Depressed control group)	Enlarged, hypercellular glomeruli, Proliferation of endothelial and mesangial cells,interstitial edema, Infiltration by leucocytes, Presence of tubular necrosis, Loss of lining epithelium of tubules	Moderate histological changes
Group II (n=10) Depressed mushroom supplemented	Restoration of normal architecture of glomerulus and renal tubules.Glomeruli become normal in size. Interstitial edema ubsides, Decreased proliferation of endothelial and mesangial cell, less or absence of tubular necrosis, less or absence of lymphocytic infiltration .-	Normal histological findings in 9 rats but presence of glomerular and tubular necrosis in 1 rat. minimal degenerative changes of endothelial and mesangialcells, interstitialedema infiltration of lymphocytes and sclerotic changes were found in one rat.

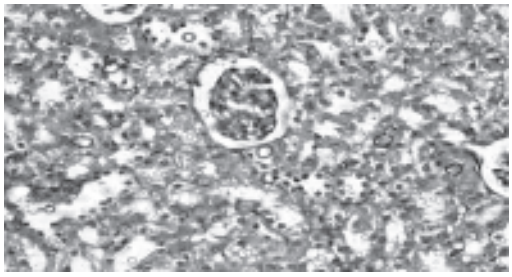

Figure 1: Normal architecture of kidney tissue of baseline control rats (X 100).

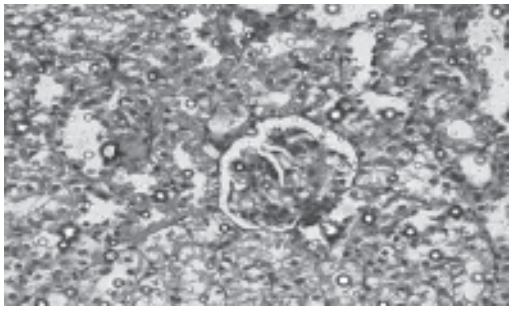

Figure 2: Enlarged hypercellular glomeruli, proliferation ofendothelial and mesangial cells of depressed control rats (X 400).

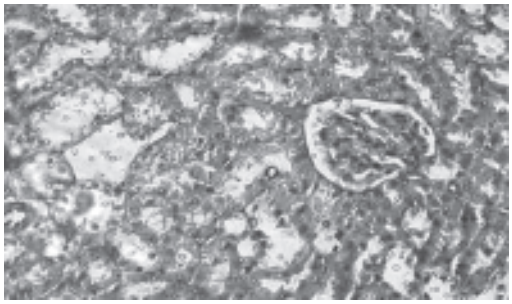

Figure 3: Interstitial edema and infiltration by leucocytes of depressed control rats (x400)

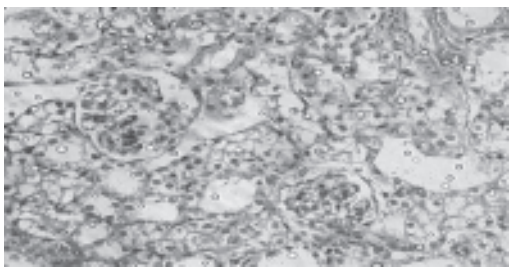

Figure 4: Normal histological findings of kidney tissue of depressed mushroomsupplemented rats(x100)

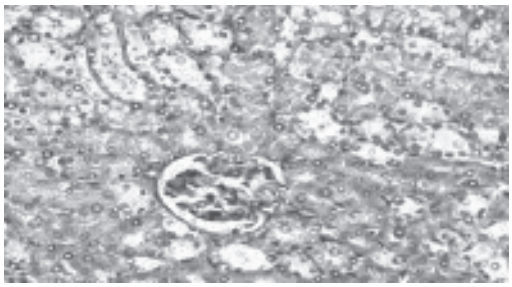

Figure 5: Normal histological findings of kidney tissue of depressed mushroomsupplemented rats(x100)

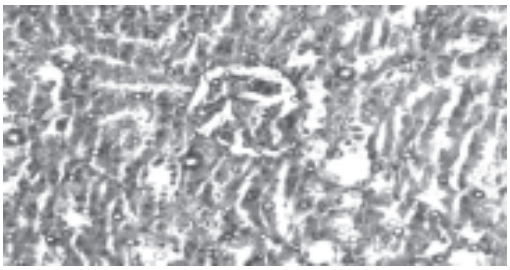

Figure 6: Presence of minimal degenerative changes of endothelial and mesangial cells in 1 rat of depressed mushroom supplemented group (x400)

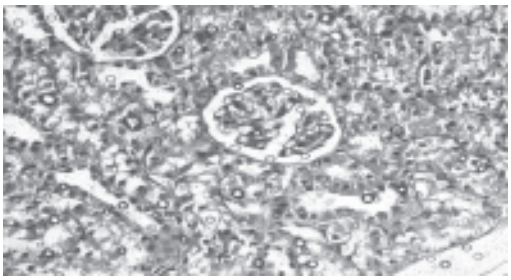

Figure 7: Presence of interstitial edema, infiltration of lymphocytes and sclerotic changes in 1 rat of depressed mushroom supplemented group (x400)

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[25] but they used tulsi as supplementation.

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,mushroomhasalso blood glucose reducing effect[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[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[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[12].

It has been postulated that in restraint stress suppression of weight gain may be due to depression and anorexia[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[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[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[12].

Moreover, polyphenols, active components of mushroom may have cytoprotective action on the glomerular mesangial cells[29].

Again, B-glucan of mushroom improves mood state[30] and have anti-depression activity[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[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.

Acknowledgement

Authors of this study are thankful to Professor Dr**.**Sheikh Nazrul Islam, Institute of Nutrition and Food Science, University of Dhaka for the cooperation he provided**.**

Authors' Affiliations

1. *Nasim Jahan, Professor and Head, Department of Physiology, Enam Medical College, Savar, Dhaka, Bangladesh. Email : prof.dr.nasimjahan @gmail.com
2. Sharmin Akhter, M.PhIl (Physiology), Sir Salimullah Medical College, Dhaka, Bangladesh
3. Nahid Sultana, Associate Professor, Department of Community Medicine, Dhaka National Medical College, Dhaka, Bangladesh. E-mail: dr_nahid sultana@yahoo.com

**for correspondence*

References

1. Engs RC. What stress is and health problem it can cause[Internet]. 1987. Available from: http://www.indiana.edu/engs/hints/Stress1.htm
2. The American Institute of Stress. What is stress? [Internet]. Available from:http://www.stress.org/what-is-stress/
3. SelyeH.The evolution of the stress concept. Am. Sci. 1973; 61(6): 692-699.
4. Ng F, Berk M, Dean O, Bush A.I. Oxidative stress in psychiatric disorders: evidence base and therapeuticimplications. Int. J. Neuropsycho-pharmacol 2008; 11(6): 851-876.
5. Maes, M.; Galecki, P.; Chang, Y.S.; Berk M. A review on the oxidative and nitrosative stress (OandNS) pathways in major deprssions and their contribution to the (neuro) degenerative processes in that illness.Prog. neuropsychopharmacol. Biol. Psychiatry 2011; 35*(3):*676-692.
6. WHO. The global burden of disease [Internet]. 2004 update.Available from: http://www.who.int/healthinfo/global_buden_disease/2004_report_update/en/
7. Jayatissa, MN., Bisgaard, C.F., West, M.J.,Wiborg, O. The number of granule cells in rat hippocampus is reduced after chronic mild stress and reestablished after chronic escitalopram treatment. Neuropharmacology 2008; 54:530-541
8. NasirN, Khan AA. Effects of stress induced acute depression and antidepressant drugs on CA3 region of hippocampus of albino rats. Current Neurobiology 2011: 2(1), pp. 31-34
9. Necib Y, Bahi A, Zerizer S, Abdennour C, Boulakoud MS. Effect of virgin olive oil (*Olea Europea.L*) on kidney function impairment and oxidative stress induced by mercuric chloride in rats. American journal of Biochemistry and Biotechnology 2013; 9(4): 415-422.
10. Kop WJ, Seliger JC, Katz R, Odden MC, Fried LF, Rifkin DE, Sarnak MJ, Gottdiener JS. Longitudinal association of depressive symptoms with rapid kidney function decline and adverse clinical renal disease outcomes. Clin J Am Soc Nephrol 2011; 6: 834-844.
11. Rosenzweig-Lipson S, Beyer CE, Hughes ZA, Khawaja X, Rajarao SJ, Malberg JE, Rahman Z, Ring RH, Schechter LE. Differentiating antidepressants of the future: efficacy and safety. Pharmacol Ther 2007: 113: 134-153.
12. Zhong WD, He HC, Ou RB, Bi XC, Dai QS, Han ZD, Liang YX, Ye YK, Qin WJ, Li Z, Zeng GH, Zhu G. Protective effect of ganoderan on renal damage in rats with chronic glomerulonephritis. Clin Invest Med 2008; 31(4): E212-217.
13. AlamN, AminR, Khan A, Ara I, Shim MJ, Lee MW, LeeUY, Lee TS. Comparative effects of Oyster mushroom on lipid profile, liver and kidney function in hypercholesteromic rats. Mycobiology 2009; 37(1): 37-42.
14. Pietta, P., Simonetti, P., Gordona, C., Brusamolino, A., Morazzoni, P., Bombardelli, E, 1998. Relationship between rate and extent of cathechin absorption and plasma antioxidant status. Biochem. Mol.Biol.Int.46, 895-903
15. RodrigoR, Bosco C. Oxidative stress and protective effects of polyphenols: comparative studies in human and rodent kidney. A review. Comp Biochem Physiol C Toxicol Pharmacol 2006; 142(3-4): 317-27.

16. Sumy AK, Jahan N, Sultana Nayma. Study on the hepatoprotective effect of oyster mushroom (Pleurotus Florida) against paracetamol induced liver damage in Wistor Albino Rats. J BangladeshSocPhysiol.2010 December; 5(2): 46-52

17. Sharmin A, Jahan N and Sultana N Effect of oyster mushroom (pleurotus Florida) on stress induced depression on Wistor Albino rats [M Phil thesis]. [Dhaka]: SirSalimullahMedicalCollege; 2014.80p.

18. Akter F, Jahan N, Sultana N. Effect of Peanut (Arachis Hypogaea L.) on fasting blood glucose and Hb_{A1C}in alloxan induced diabetic male rats. JBSP 2014; 9(2): 48-53.

19. Chang R. Functional properties of edible mushroom. Nutr Rev 1996; 54: 91-93.

20. Fukushima M, Nakano Y, Morii Y, Ohashi T, Fujiwara Y and Sonoyama K. 2000 Hepatic receptor mRNA in rats is increased by dietary mushroom (agaricus bisoporus) fiber and sugar beet fiber. J Nutr. 130:2151-2156

21. Hashimoto M, Shinozuka K, Gamoh S. The hypotensive effect of docosahaxaenoic acid is associated with the enhanced release of ATP from the caudal artery of aged rats. J Nutr 1999a; 129: 70-76.

22. Jayakumar T, RameshE, GeraldineP.Antioxidant activity of the oyster mushroom Pleurotus osteratus, on CCL_4 induced liver injury in rats. Food and Chemical Toxicology 2006; 44: 1989-1996

23. Rahimi P, KabiriN, AsgeryS and Setorki m. antidiabetic effects of walnut oil on alloxan induced diabetic rats. AJPP 2011; 5(24): 2655-2661

24. Fawcett, JK and Scott, JE, J Cin. Path. 1960; vol.13: 156-159

25. Siraji D[3], Islam N, Begum N[3], Ferdousi S[4] Effect of ocimum Sanctum Linn (tulsi) on body weight and some biochemical parameters in restraint stressed albino rats. J Bangladesh Soc Physiol. 2008; Dec(3):29-34

26. Shimizu N, Oomura Y, Kai Y. Stress induced anorexia in rats mediated by serotonergic mechanisms in the hypothalamus. PhysioloBehav 1989; 46: 835-841.

27. Hall JE. Textbook of medical physiology. 12th edn. Elsevier India Pvt Limited:2011. p868-883

28. Jeyanthi Tand Subramanium P, Nephroprotective effect of Withania Somnifera: A dose dependent study. Renal failure 2009: 31 (9): 814-821

39. Kitamura M, Ishikawa Y. Oxidant-induced apoptosis of glomerular cells: intracellular signaling and its intervention by bioflavonoid. Kidney Int.1999; 56: 1223-1229.

30. TalbottS, Talbott J**.** Effect of beta 1, 3/1, 6 glucal on upper respiratory tract infection symptoms and mood state in marathon athletes**.** J Sports Sci Med 2009; 8 **:** 509**-** 515

31. Bovek P, Ozdin L, Kuniak L. Effect of Oyster mushroom and isolated ²-glucan on lipid peroxidation and on the activities ofantioxidative enzymes in rats fed the cholesterol diet. The Journal of Nutritional Biochemistry 1997; 8: 469-471.

32. Fu HY, Shieh DE, Ho CT. Antioxidant and free radical scavenging activities of edible mushrooms. J Food Lipids 2002; 9: 35-43.