



Effect of *Ganoderma lucidum* (Reishi) on Hematological Parameters in Wistar Rats

Hammad Ahmed and Muhammad Aslam*

Department of Pharmacology, Faculty of Pharmacy, Ziauddin University, Karachi, Pakistan

*Corresponding e-mail: pharmacologist1@yahoo.com

ABSTRACT

Ganoderma lucidum (Reishi), has been used in Traditional Chinese Medicine (TCM) for 5000 years or more. In China and Japan *Ganoderma lucidum* has been used in folk medicine, commonly in the treatment of neurasthenia, insomnia, hepatopathy, nephritis, gastric ulcers, asthma, and hypertension. In this study we have evaluated the effect of *Ganoderma lucidum* on hematological parameters in Wistar rats. The extract was given orally by gavage at the dose of 150 mg/kg and 300 mg/kg body weight. The result of our study shows extremely significant increase in the hemoglobin level, platelet count and leukocyte count more specifically at a dose of 150 mg/kg of *Ganoderma lucidum* extract when compare with normal control group. However, at a dose of 300 mg/kg of GLE, significant increase in hemoglobin level and extremely significant increase in leukocyte count were observed. Whereas, insignificant result was observed at both the doses of GLE in case of hematocrit level, MCV, MCHC, MCH and RBC count.

Keywords: *Ganoderma lucidum*, Anemia, Hemoglobin, Platelets, Leukocytes, Thrombocytopenia

INTRODUCTION

Anemia is the most familiar blood disorder which may be due to decrease in the amount of hemoglobin or reduction of red blood cells in the body. Malnutrition, loss of blood on daily basis and over use of alcohol are the well-known causes of anemia. However, some medications and different surgical procedures can also lead to anemia [1]. Symptoms of anemia such as fatigue, inability to work due to weakness, and lack of concentration is due to less oxygen delivery to various tissues [2,3]. Iron deficiency is the most common type of anemia which is due to deficiency of iron [1]. Various studies reported that thrombocytopenia is associated with iron deficiency anemia and this may be due to bone marrow dysfunction, aplastic anemia, Evan's syndrome, etc. [4]. Many standard treatments are available to cope up with these disorders such as platelet transfusion in case of thrombocytopenia [5], use of erythropoietin and iron supplements in iron deficiency anemias, but these treatments have some common adverse reactions [1].

Mushrooms had been one of the major sources of many medicinal products. There are around 10,000 varieties of mushrooms, out of which 2000 have nonpoisonous effects and around 300 of them have shown important medicinal effects [6]. Studies show that mushroom extracts are advantageous for the human body, as they have shown several pharmacological activities such as anti-bacterial, anti-inflammatory, anti-viral and anti-hyperglycemic activity [7].

Ganoderma lucidum (Reishi), has been used in Traditional Chinese Medicine (TCM) for 5000 years or more [8,9]. In China and Japan, *Ganoderma lucidum* has been used in folk medicine, commonly in the treatment of neurasthenia, insomnia, hepatopathy, nephritis, gastric ulcers, asthma, and hypertension. *Ganoderma lucidum* has been cultivated over 4000 years as a longevity-enhancing, tonic [10]. Studies show that fruit bodies of *Ganoderma lucidum* and ginseng (*C. A. Meyer Paxax ginseng*), are the most necessary medicinal products in the world [11,12]. Different varieties of *Ganoderma lucidum* are preferred in different regions. For example, in Japan red variety is favored while black variety is preferred in South China [13]. *Ganoderma lucidum* is widely used and distributed throughout the world as therapeutic mushroom. There are more than 250 species of *Ganoderma lucidum* around the world [14].

MATERIALS AND METHODS

Collection of Mushroom

Ganoderma lucidum extract composed of cracked spores and fruiting bodies, branded ReishiMax Glp®, was procured from Pharmanex Inc. (United States of America).

Animals

Healthy adult rats (Wistar strain) bearing weight of 150-200 g were purchased from the animal house of Dow University of Health Sciences, Pakistan. Polypropylene cages were used for keeping the animals under controlled conditions at a room temperature of (25°C-30°C) with light-dark cycle of 12/12 hour. Standard diet and water ad libitum were given to the rats. Handling of the animals were done according to the requirements mentioned in "Guidelines for care and use of laboratory animals 8th edition" [15]. Prior approval from the ethical review committee of Ziauddin University was taken before conducting this research.

Animal Grouping

Male rats were divided into four groups (six animals per group):

Group I: Normal control group, given distilled water (10 ml/kg) orally for 40 days.

Group II: Treated group, given extract (150 mg/kg) for 40 days.

Group III: Treated group, given extract (300 mg/kg) for 40 days.

Biochemical Tests

Sample collection: On 40th day of the study rats were anaesthetized using chloroform. By cardiac puncture, 2 ml of blood was collected and taken in EDTA tubes for hematological study.

Hematological parameters: For the estimation of hematological parameters Mindray (BC-3000 plus) auto hematology analyzer was used to analyze the samples of blood. RBC count, WBC count, platelet count, hematocrit, hemoglobin (Hb), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and mean cell volume (MCV) were assessed.

Statistical Analysis

One-way ANOVA following Tukey's test was used for analyzing the data. Data were expressed as mean \pm standard error of mean (SEM). A statistical level of 0.05 or less was accepted as significant.

RESULTS

The result of our study shows extremely significant increase in the hemoglobin level, platelet count and leukocyte count more specifically at a dose of 150 mg/kg of *Ganoderma lucidum* extract when compare with normal control group. However, at a dose of 300 mg/kg of GLE, significant increase in hemoglobin level and extremely significant increase in leukocyte count were observed. Whereas, insignificant result was observed at both the doses of GLE in case of hematocrit level, MCV, MCHC, MCH and RBC count (Figures 1-8).

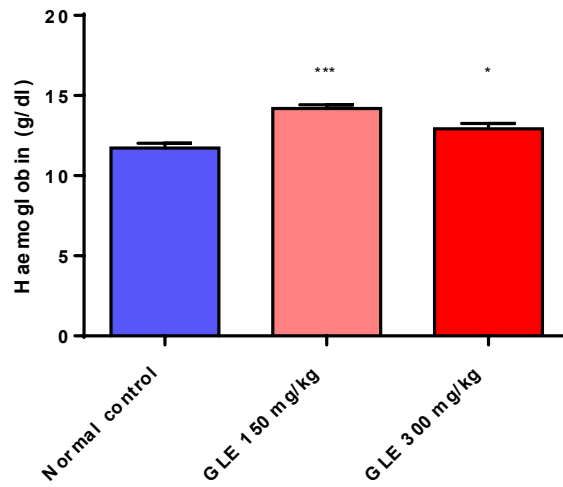


Figure 1 Effect of *Ganoderma lucidum* on hemoglobin level in male rats All values are expressed as mean \pm SEM, n=6 (Number of animals in each group), ***P<0.001 (Extremely significant difference), **P<0.01 (Very significant difference), *P<0.05 (Significant difference)

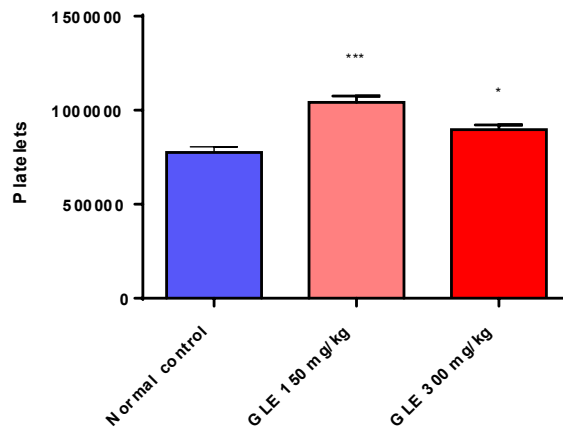


Figure 2 Effect of *Ganoderma lucidum* on platelets in male rats All values are expressed as mean \pm SEM, n=6 (Number of animals in each group), ***P<0.001 (Extremely significant difference), **P<0.01 (Very significant difference), *P<0.05 (Significant difference)

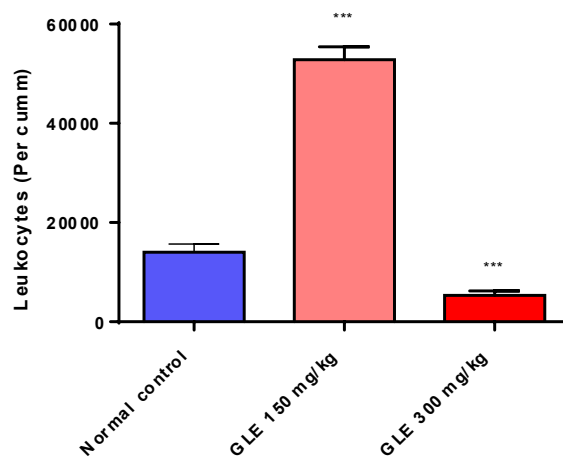


Figure 3 Effect of *Ganoderma lucidum* on Leukocytes in male rats. All values are expressed as mean \pm SEM, n=6 (Number of animals in each group), ***P<0.001 (Extremely significant difference), **P<0.01 (Very significant difference), *P<0.05 (Significant difference)

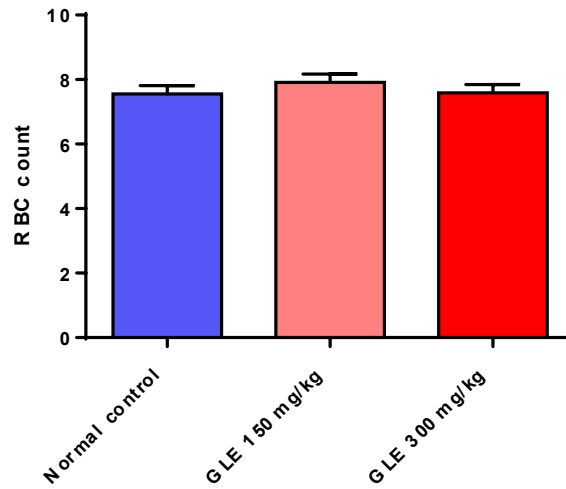


Figure 4 Effect of *Ganoderma lucidum* on RBC count in male rats. All values are expressed as mean ± SEM, n=6 (Number of animals in each group), ***P<0.001 (Extremely significant difference), **P<0.01 (Very significant difference), *P<0.05 (Significant difference)

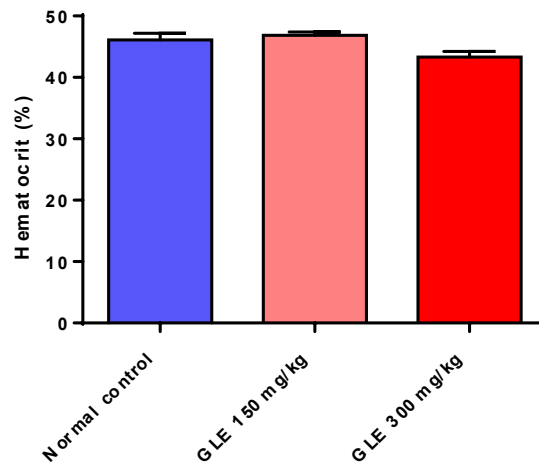


Figure 5 Effect of *Ganoderma lucidum* on hematocrit level in male rats. All values are expressed as mean ± SEM, n=6 (Number of animals in each group), ***P<0.001 (Extremely significant difference), **P<0.01 (Very significant difference), *P<0.05 (Significant difference)

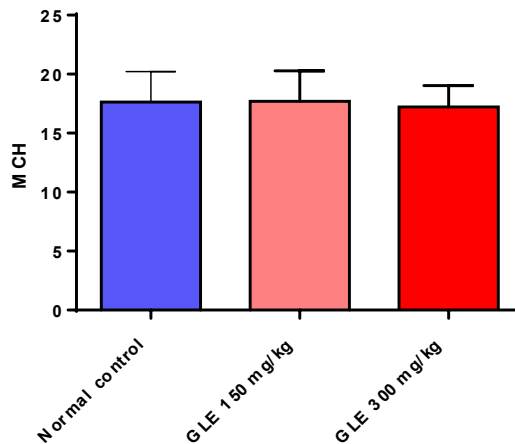


Figure 6 Effect of *Ganoderma lucidum* on MCH level in male rats. All values are expressed as mean ± SEM, n=6 (Number of animals in each group), ***P<0.001 (Extremely significant difference), **P<0.01 (Very significant difference), *P<0.05 (Significant difference)

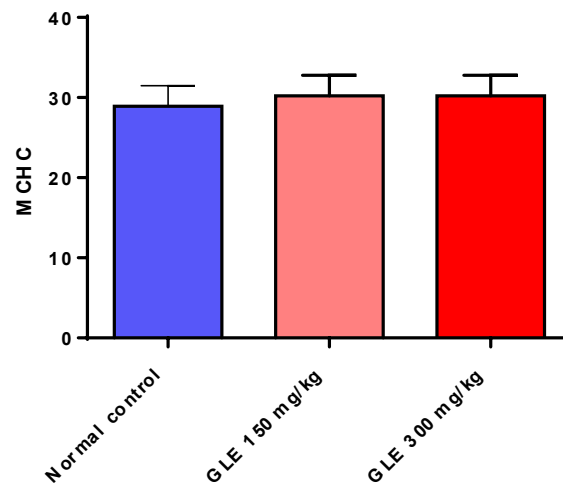


Figure 7 Effect of *Ganoderma lucidum* on MCHC level in male rats. All values are expressed as mean \pm SEM, n=6 (Number of animals in each group), ***P<0.001 (Extremely significant difference), **P<0.01 (Very significant difference), *P<0.05 (Significant difference)

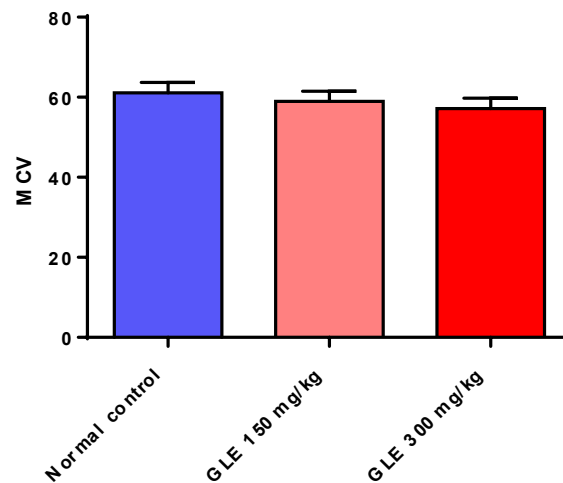


Figure 8 Effect of *Ganoderma lucidum* on MCV level in male rats. All values are expressed as mean \pm SEM, n=6 (Number of animals in each group), ***P<0.001 (Extremely significant difference), **P<0.01 (Very significant difference), *P<0.05 (Significant difference)

DISCUSSION

The results of our study show significant effect of *Ganoderma lucidum* extract on hematological parameters in rats. In this study the increase in the hemoglobin level in the GLE groups may be due to strong anti-oxidant effect of *Ganoderma lucidum* which prevent the destruction of RBC's from free radical formation [16-18]. This hematopoietic effect of *Ganoderma lucidum* may be due to the antioxidant properties of its constituents. *Ganoderma lucidum* can increase the activity of anti-oxidant enzymes in mice if triterpenes of *Ganoderma lucidum* are to be administered to mice. However, at a dose of 150 mg/kg, GLE has shown an increase in the platelet count and this enhancement of platelet may be due to the presence of tannins, a phytochemical compound found in the *Ganoderma lucidum* which acts as an important hemostatic agent causing arrest of bleeding by increasing the platelet plug formation [19]. Due to this reason *Ganoderma lucidum* can be used as an important medicinal mushroom in the treatment of thrombocytopenia. There was an insignificant increase or decrease in the hematocrit, MCH, MCHC, MCV and RBC count in both 150 mg/kg and 300 g/kg GLE groups. Whereas, there is a dose dependent decline in some hematological parameters such as hemoglobin, hematocrit, platelet, RBC count and leukocytes count. With increase in the dose of drug i.e., at a dose of 300 mg/kg there is a decrease in the above-mentioned parameters. This shows that selective

effect of *Ganoderma lucidum* has been observed at specific doses on hematological parameters in rats. There is an extremely significant increase in the leukocyte count in both GLE groups and this effect is due to the presence of polysaccharides [20]. However, this increase in leukocyte count shows that this extract has immunomodulatory effect which can boost up the immune system of rodents by increasing the production of WBC [21].

CONCLUSION

In this study *Ganoderma lucidum* has shown extremely significant effect on hematological parameters specifically in case of hemoglobin level, leukocyte count and platelet count. It is, therefore, concluded that *Ganoderma lucidum* can be used as an important medicinal mushroom in the treatment of anemia, thrombocytopenia, and blood clotting disorders.

DECLARATIONS

Conflict of Interest

The authors and planners have disclosed no potential conflicts of interest, financial or otherwise.

REFERENCES

- [1] Aslam, Muhammad, and Syed Zohaib Hussain. "The effect of hydro-alcoholic extract of *Cydonia oblonga* Miller (Quince) on blood cells and liver enzymes in New Zealand white rabbits." *Inventi Rapid: Ethnopharmacology*, Vol. 3, 2013, pp. 1-4.
- [2] McCann, Joyce C., and Bruce N. Ames. "An overview of evidence for a causal relation between iron deficiency during development and deficits in cognitive or behavioral function." *The American Journal of Clinical Nutrition*, Vol. 85, No. 4, 2007, pp. 931-45.
- [3] Beard, John L., and James R. Connor. "Iron status and neural functioning." *Annual Review of Nutrition*, Vol. 23, No. 1, 2003, pp. 41-58.
- [4] Morris, Van K., et al. "Severe thrombocytopenia with iron deficiency anemia." *Pediatric Hematology and Oncology*, Vol. 27, No. 5, 2010, pp. 413-19.
- [5] Lieberman, Lani, et al. "Platelet transfusions for critically ill patients with thrombocytopenia." *Blood*, Vol. 123, No. 8, 2014, pp. 1146-51.
- [6] Morris, Humberto J., et al. "The use of mushrooms in the Development of functional foods, drugs, and nutraceutical." *Wild Plants, Mushrooms and Nuts: Functional Food Properties and Applications*, Vol. 5, 2017, pp. 123-59.
- [7] De Silva, Dilani D., et al. "Medicinal mushrooms in supportive cancer therapies: an approach to anti-cancer effects and putative mechanisms of action." *Fungal Diversity*, Vol. 55, No. 1, 2012, pp. 1-35.
- [8] Bishop, Karen S., et al. "From 2000 years of *Ganoderma lucidum* to recent developments in nutraceuticals." *Phytochemistry*, Vol. 114, 2015, pp. 56-65.
- [9] Batra, Priya, Anil Kumar Sharma, and Robinka Khajuria. "Probing Lingzhi or Reishi medicinal mushroom *Ganoderma lucidum* (higher Basidiomycetes): a bitter mushroom with amazing health benefits." *International Journal of Medicinal Mushrooms*, Vol. 15, No. 2, 2013.
- [10] Okamoto, Hidehumi, and Takashi Mizuno. "IV. Cultivation of reishi (*Ganoderma lucidum*) Black reishi (*Ganoderma lucidum*, Black)." *Food Reviews International*, Vol. 13, No. 3, 1997, pp. 370-73.
- [11] Chen, ZuQin, et al. "Research progress on *Ganoderma lucidum* intensive processing in China." *Journal of Food Safety and Quality*, Vol. 7, No. 2, 2016, pp. 639-44.
- [12] Baeg, In-Ho, and Seung-Ho So. "The world ginseng market and the ginseng (Korea)." *Journal of Ginseng Research*, Vol. 37, No. 1, 2013, p. 1.
- [13] Zhou, Xuan-Wei, et al. "Species Clarification of the Widely Cultivated *Ganoderma* in China Based on rDNA and FIP Gene Sequence Analysis." *International Journal of Agriculture & Biology*, Vol. 18, No. 5, 2016.
- [14] Mohanta, Yugal Kishore, et al. "Green synthesis and antimicrobial activity of silver nanoparticles using wild

- medicinal mushroom *Ganoderma applanatum* (Pers.) Pat. from Similipal Biosphere Reserve, Odisha, India.” *IET Nanobiotechnology*, Vol. 10, No. 4, 2016, pp. 184-89.
- [15] National Research Council, Division on Earth and Life Studies, Institute for Laboratory Animal Research, Committee for the Update of the Guide for the Care and Use of Laboratory Animals. *Guide for the Care and Use of Laboratory Animals: Eighth Edition*. National Academies Press, 2011.
- [16] Nwinuka, Nwibani M., Michael O. Monanu, and Barine I. Nwiloh. “Effects of aqueous extract of *Mangifera indica* L.(mango) stem bark on haematological parameters of normal albino rats.” *Pakistan Journal of Nutrition*, Vol. 7, No. 5, 2008, pp. 663-66.
- [17] Wong, Kar-Lok, et al. “Antioxidant activity of *Ganoderma lucidum* in acute ethanol-induced heart toxicity.” *Phytotherapy Research*, Vol. 18, No. 12, 2004, pp. 1024-26.
- [18] Halliwell, Barry. “Antioxidants in human health and disease.” *Annual Review of Nutrition*, Vol. 16, No. 1, 1996, pp. 33-50.
- [19] Tanko, Y., et al. “Haemostatic effect of aqueous extract of mushroom (*Ganoderma lucidum*).” *European Journal of Experimental Biology*, Vol. 2, No. 6, 2012, pp. 2015-18.
- [20] Shi, Min, Zhenya Zhang, and Yingnan Yang. “Antioxidant and immunoregulatory activity of *Ganoderma lucidum* polysaccharide (GLP).” *Carbohydrate Polymers*, Vol. 95, No. 1, 2013, pp. 200-06.
- [21] John, Ogbe Raphael, Adenkola Adeshina Yahaya, and Anefu Emmanuel. “Aqueous ethanolic extract of *Mangifera indica* stem bark effect on the biochemical and haematological parameters of albino rats.” *Archives of Applied Science Research*, Vol. 4, No. 4, 2012, pp. 1618-22.