



**International Journal of Research  
in  
Pharmaceutical and Nano Sciences**

Journal homepage: [www.ijrpns.com](http://www.ijrpns.com)

<https://doi.org/10.36673/IJRPNS.2021.v10.i03.A20>



**WOUND HEALING ACTIVITY OF AN AQUEOUS EXTRACT OF THE *GANODERMA LUCIDUM***

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**ABSTRACT**

The medicinal mushroom *Ganoderma lucidum* is famous due of its health-promoting qualities. The benefits of *Ganoderma lucidum* extract on cancer, hypertension, hypercholesterolemia and hepatitis have been documented by several researches.  $\beta$ -Glucans are a kind of medicine that belongs to the class of biological response modifiers. They have a wide range of biological functions that help people stay healthy. Dermatology, particularly wound care, is a specialty. The goal of this study was to see how  $\beta$ -Glucans affected the healing effectiveness of an aqueous lyophilized extract of *Ganoderma lucidum* from on a cutaneous excision lesion in rats. With a reference povidone-iodine ointment, the healing effectiveness was compared. The *Ganoderma lucidum* + $\beta$ -Glucans extract significantly increased wound contraction, indicating improved healing activity. The findings show that  $\beta$ -Glucans greatly improved *Ganoderma lucidum's* wound-healing ability.

**KEYWORDS**

$\beta$ -Glucans, *Ganoderma lucidum* and Wound healing activity.

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**INTRODUCTION**

Wound healing on the skin is a complicated and varied biological process aims to restore damaged tissues. Inflammatory cells, vascular cells, epidermal cells, extra cellular matrix (ECM), proteolytic enzymes and inhibitors are all required to work together in this dynamic system. A

multitude of things might obstruct the natural healing process at any point along its route<sup>1</sup>. Wound healing is aided by a variety of natural and botanical products that include bioactive components such as alkaloids, glycosides, flavonoids and triterpenes. These substances generally have an effect on one or more stages of the healing process. Mushrooms are a type of macro-fungus that have been used as food and medicine for thousands of years all over the world<sup>2</sup>. The mushroom *Ganoderma lucidum* is one of the most well-known, with a long history in many countries<sup>3</sup>.

It grows as a parasite or saprotroph at the base and stumps of deciduous trees. Because of its immunomodulatory and adaptogenic properties, as well as for the treatment of chronic bronchitis, it has been used as a home remedy in Asian countries for over 2000 years<sup>4,5</sup>. However, it is now widely accepted as a dietary supplement in Western countries<sup>6</sup>. Polysaccharides, adenosine, alkaloids, coumarin, ergosterols, ganoderic acids, lactones, mannitol, organic germanium, triterpenoids and uncommon minerals are all reported to be biosynthesized by *Ganoderma lucidum*<sup>7</sup>. *Ganoderma lucidum*'s bioactive components aid in the improvement of blood circulation, the elimination of weariness, the enhancement of energy, the strengthening of the immune system and the removal of toxins.

Cancers, immunological diseases, heart disease, infections and wounds have all been found to benefit from its various pharmacological actions<sup>8-12</sup>. The biological response modifiers family of medicines includes  $\beta$ -glucans, which are glucose polymers produced from a variety of sources including yeast, grain and fungus. It is an anti-infective, anti-tumor and immunomodulatory drug that has been discovered to enhance immunological functioning. Dermatology, particularly wound care, is a promising use for  $\beta$ -Glucans<sup>13</sup>. The wound healing process includes homeostasis, re-epithelization, granulation, tissue formation and extracellular matrix remodelling<sup>14</sup>. As a consequence, a multi-modal treatment technique may help the wound heal quicker. As a result, the

goal of this investigation is to determine if  $\beta$ -Glucans can improve the wound healing effectiveness of *Ganoderma lucidum* aqueous lyophilized extract on experimental rat cutaneous wounds.

## MATERIAL AND METHODS

### Mushroom Extract Preparation

Powdered *Ganoderma lucidum* was soaked in nanopure water (1:5, w/v) at room temperature ( $25\pm 1^\circ\text{C}$ ) to make the aqueous extract. The supernatant was decanted after 24 hours and the residue was steeped in new nanopure water. For a full extraction, the operation was done four times. The supernatants were combined, filtered with muslin cloth and centrifuged at  $4^\circ\text{C}$  for 5000g. After centrifugation, the supernatants were lyophilized and the *Ganoderma lucidum* aqueous extract lyophilized powder was kept at  $4^\circ\text{C}$  in an airtight dark plastic container until further usage.

### Animals

For 14 days, the animals were acclimatised to the laboratory setting. The animals were kept in a controlled setting ( $25\pm 1^\circ\text{C}$  and a 12-hour light/dark cycle) in the Institute's animal home. The therapy was carried out with the approval of the animal ethics committee of King Khalid University, as well as the National Institute of Health's standards for the care and use of laboratory animals in the United States (NIH Publication No. 85-23, revised 1996).

### Excision Wound Model

The animals were kept under mild ether anesthesia throughout the surgical procedures. According to Nagappa and Binu (2001) a 500mm<sup>2</sup> imprint was made<sup>15</sup>. The skin of the impressed region was meticulously peeled to its greatest thickness, resulting in a 500mm<sup>2</sup> wound. To achieve hemostasis, a normal saline solution was utilized. The wound was treated topically with ointment base, nitrofurazone ointment and extracts in ointment form until it healed entirely. The physical features of wound healing were recorded, including wound closure (contraction), epithelization and scarring. The animals were kept under mild ether anaesthesia during the surgical procedures. Wound

closure (contraction), epithelization and scarring were all observed as physical features of wound healing. Wound contraction was studied by tracing the raw wound area on transparent paper on days 0, 8 and 16 until full epithelization occurred. The wound area was planimetrically assessed using mm 2 scale graph paper.

#### **Analytical Statistics**

Each group's data is given as the mean standard error of the mean of six animals. Graph Pad Prism 5.0 software was used to determine the statistical significance of the experimental and control data using one-way analysis of variance and Dunnett's post hoc tests. Statistical significance was defined as a value of ( $p < 0.05$ ).

## **RESULTS AND DISCUSSION**

### **Wound-healing potential**

A significant increase in wound-healing activity was observed in rats treated with  $\beta$ -Glucans and *Ganoderma lucidum* aqueous extract. Visual inspection of this combination group showed no evidence of bleeding, exudates, pus, or inflammation at any time and all wounds healed without incident. The wounds treated with extract and the combination were found to contract much faster. A significant increase in wound contraction at the eighth and sixteenth days after wounding, respectively was observed in extract-treated wounds compared with the controls ( $p < 0.05$ ).

### **Discussion**

*Ganoderma lucidum* has long been used to prevent and treat a variety of human diseases. Polysaccharides, triterpenoids, nucleosides, sterols, alkaloids and uncommon minerals are among the bioactive compounds extracted and discovered from *Ganoderma lucidum*<sup>5,6</sup>. The impact of  $\beta$ -Glucans on the wound-healing effectiveness of *Ganoderma lucidum* in experimental cutaneous wounds in rats was investigated in this work. The nucleosides adenosine, adenine and uracil were discovered in abundance in the aqueous lyophilized extract of *Ganoderma lucidum*. Nucleosides are known to have a role in the control and modulation of a variety of physiological processes in the body, with

purinergic and/or pyrimidine receptors being involved. These bases are claimed to promote cellular proliferation and immunological response, affect fatty acid metabolism, which contributes to iron absorption in the gut and promote gastrointestinal tract healing after injury, in addition to being precursors in nucleic acid synthesis<sup>16</sup>. Interferon<sup>17</sup> and other cytokines, all of which have a role in accelerated wound healing.

Wound healing is an integration of dynamic interaction processes involving cells, the ECM and their receptors and soluble mediators, rather than a simple linear process in which growth hormones drive cell proliferation. Collagen is a key component of connective tissue and its synthesis, accumulation and maturation are all controlled in the healing process. Hydroxyproline is a component of the ECM that is a fundamental element of collagen structure. According to a recent study, topical administration of *Ganoderma lucidum* aqueous lyophilized extract resulted in substantial wound healing activity, as measured by increases in hydroxyproline, hexosamine, and total protein levels. By creating electrostatic and ionic connections, increased ground components such hexosamine aid in the stability of collagen molecules<sup>18</sup>.

The wound healing activity of *Ganoderma lucidum* +  $\beta$ -Glucans resulted in significant ( $p < 0.001$ ) wound healing activity. The treated wounds showed notable dryness of wound edges, tissue regeneration and decreased wound area when compared to controls, demonstrating the combination's healing capability. Increased wound contraction in extract-treated rats might be due to increased fibroblast activity. Wound contraction is mediated by granulation tissue's specialised myofibroblasts. The pro-healing action of *Ganoderma lucidum* is indicated by a higher degree of re-epithelialization in extract-treated wounds.

**Table No.1: Effect of Topical Application of Aqueous Lyophilized Extract of *Ganoderma lucidum* + $\beta$ -Glucans on Wound Area Contraction (mm<sup>2</sup>) in Experimental Rats**

S.No	Treatments	Remaining of original excision wound area (mm <sup>2</sup> )			
		Day 0	Day 8	Day 16	Epithelisation time (d)
1	Control	484.00 ± 14.80	311.00 ± 14.97	151.40 ± 8.10	23.30 ± 1.34
2	Nitrofurazone	480.30 ± 11.33	219.80 ± 14.55**	11.40 ± 0.48**	16.50 ± 0.51*
3	<i>Ganoderma lucidum</i>	488.00 ± 11.57	224.50 ± 10.96**	74.00 ± 0.84**	30.10 ± 0.63*
4	<i>Ganoderma lucidum</i> + $\beta$ -Glucans	479.30 ± 13.49	176.90 ± 13.59**	20.80 ± 3.14**	5.09 ± 0.89*

Values are expressed as mean ± SEM for five observations. \* p<0.01, \*\*p<0.001 versus control

## CONCLUSION

Finally, the findings of this investigation show that biological response modifier  $\beta$ -Glucans significantly enhanced the wound healing activity of *Ganoderma lucidum* aqueous extracts. The outcomes of this study emphasize the *Ganoderma lucidum*'s historic use for wound healing.

## ACKNOWLEDGEMENT

The authors are grateful to Deanship of Scientific Research, King Khalid University's for sponsoring this study through the Large Research Group Project under grant number RGP 2/186/42.

## CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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