

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Evaluation of Angiogenesis Potency of *Portulaca quadrifida* Extract Using Chick Embryo Wound Model.

R Thirumalaikumaran*, Nivedithaa VR, Nivetha Bakthavatchalam, D Raja Vidhya, M Rithicka, and D Chamundeeswari.

Department Of Pharmacognosy, College Of Pharmacy, Sri Ramachandra Medical College and Research Institute, Chennai-600 116.

ABSTRACT

Portulacaquadrifida Linn. is a plant reported for use in the Ayurvedic and Siddha system of medicine for treating various diseases. The study presented was an attempt to screen the hydro alcohol extracts of the leaves for wound healing potency using chick embryo wound model developed as part of the study. As evident from the experimental data the aqueous extract showed good dose-dependent healing potency. The hydroalcohol extract at 500 µg concentration showed increased wound contraction by 50% compared to the negative control model in the chick embryo chorioallantoic membrane excision wound model. The results were statistically significant when compared to the control groups ($p < 0.05$). The extract was also found to have better angiogenic properties from neovascularization studies. The chick embryo wound model has been reported to be a reliable model and could be used as an alternative to animal models for preliminary screening of compounds with wound healing potency.

Keywords: Angiogenesis, *Portulacaquadrifida*, Chick embryo, Chorioallantoic membrane, Wound healing.

<https://doi.org/10.33887/rjpbcs/2019.10.6.11>

*Corresponding author

INTRODUCTION

The general repair response of the body immediately after the disruption of skin integrity is Wound healing. It has five interconnected and overlapping phases; haemostasis and inflammation, neovascularization, granulation, re-epithelization and remodelling^[1]. In chronic wounds with a prevalence of 4 per 1000 population^[2] the treatment is sometimes problematic. Because of their low availability, high cost, and various detrimental side effects^[3] wound healing drugs currently in use are not affordable and effective. Therefore, medicinal plant derived drugs is under great demand due to a common belief that they are safe, reliable, clinically effective, low cost, globally competitive and better tolerated by patients^[4]. Since ancient times, based on empirical observations without any scientific knowledge for the treatment of wounds, cuts, and burns^[5] human beings have been using many plant resources. Tannins, triterpenoids and alkaloids have been found to affect one or more phases of wound healing process^[6,3] which are biologically active compounds found in plants. These species include various clinically important constituents including alkaloids, flavonoids, triterpenoids, glycosides, tannins, amino acids and saponins^[7]. Our earlier studies report phytochemical composition of *Portulacaquadrifida*^[8]. Furthermore, other *Portulaca* species have been used for the neurological disorders and wound healing activity^[9,10]. In spite of its rich phytochemical composition and wide traditional use against various ailments the plant has not been studied for its wound healing activity.

METHODOLOGY

Plant Material

Portulacaquadrifida leaves were collected from Chennai district, Tamil Nadu, India in the month of February 2014. The plant material was identified and authenticated by botanist, Dr. P. Jayaraman at Plant Anatomy Research Center (PARC), Chennai. The plant materials were shade dried in open air and ground to a coarse powder.

Preparation Of Plant Extracts

Fifty grams of the powder was extracted with water: ethanol (1:1) and was filtered through eight layers of muslin cloth. The procedures were repeated twice with 250 ml of ethanol and water each. The pooled extracts were concentrated by evaporation. The residue was stored in stock vials for further use^[11].

Embryo Collection

Fertilized white shell eggs were purchased from Tamilnadu Veterinary and Animal Science University, Madhavaram Milk Colony, Chennai. The outer surface of the embryos was cleaned with 75% ethanol and incubated at 37°C throughout the study.

Preparation Of Saturated Filter Disk for Wound Assay

Whatman No. 1 filter paper was purchased from Millipore. Small disks were generated using a standard 5 mm hole puncher, sterilized by autoclaving and stored for further use. The pre-sterilized filter disks were saturated with different concentrations of the crude extract, from 100-500 µg/ml, and the control solutions. Diclofenac sodium (50 µg/ml) in 4% ethanol and sterile saline were used as positive and negative controls respectively^[12].

Wound Assay

All dissection tools used in the assay were sterilized using 75% ethanol before use. The embryos were incubated for 11 days to allow good maturation of the chorioallantoic membrane. On day 12 of incubation the outer shell was wiped with 75% ethanol to sterilize the surface. Under aseptic conditions a tiny hole was made carefully in the egg shell with a needle and a small window of the shell was cracked open exposing the opaque inner shell membrane (Figure 1). About 0.5-1 ml sterile saline was added to the inner shell membrane to make it translucent. This layer was then peeled to visualize the CAM layer. The CAM layer was pulled gently by using sterile forceps and an excision wound of approximately 3 mm diameter was created in the CAM layer by using a small dissecting scissor. The drug saturated discs were then placed on the CAM of the embryos labelled with

the corresponding concentrations and controls. The window on the egg shell was covered with para film and the eggs were returned to the incubator. Measurements of wound closure were made on alternative days up to day 5 of observation post wounding.

The wound closure was measured as wound contraction percentage (WC %) by using the formula^[13].

$$WC \% = \frac{\text{Initial wound size} - \text{Specific day wound size}}{\text{Initial wound size}} \times 100$$

Angiogenesis Assay

The vascular network forms well in the developing embryo by 7 days of incubation. On day 8 of incubation the outer shell was wiped with 75% ethanol to sterilize the surface. Under aseptic conditions, a tiny hole was made carefully in the egg shell with a needle and a small window of the shell was cracked open. The CAM layer was exposed as above. The drug saturated disks were then placed carefully on the CAM vasculature of the embryos labeled with the corresponding concentrations and controls and the egg shell window closed with parafilm before incubation. Morphometric evaluation of the blood vessels on the CAM was done on alternative days of observation in terms of number of new vessels and thickness. The results were photographed on each observation and recorded (Figure 2).

Statistical Analysis

The collected data were analyzed with SPSS 16.0 version. The values are presented as mean with Standard Deviation. To find the significance with positive controls, One-Sample Wilcoxon Signed Rank Test was used. In the above statistical tool the probability value $p < 0.05$ was considered as significant level.

RESULTS

The results showed that % wound closure was dose-dependent with the maximum being at 500 µg/mL concentration. At 500 µg/ml concentration the hydroalcoholic extracts showed 57% wound contraction compared to the positive control which showed 78.61 % and the negative control which showed no significant wound closure (Table 1).

Table 1

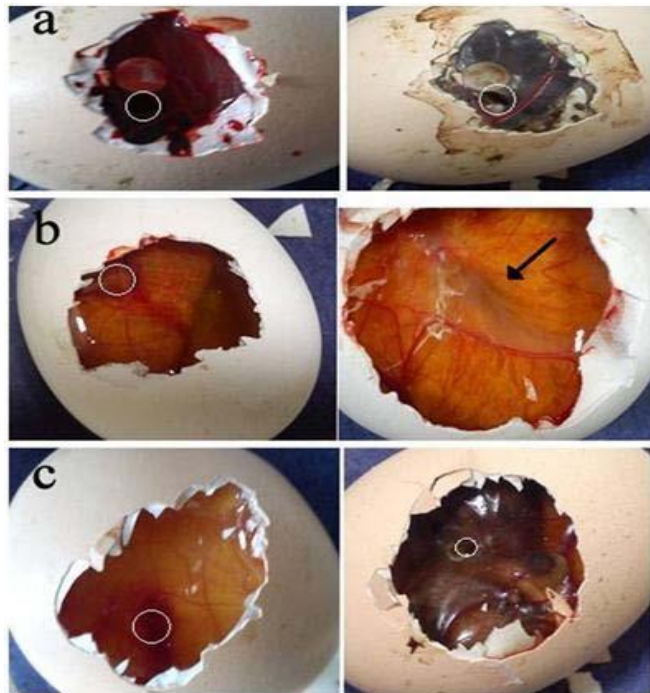
Treatment	ID (mm)	% WC
Positive control (Diclofenac Sodium 50 µg/ml)	0.49± 0.02	78.61
Negative Control (Saline)	3.0± 0.009	0.0
Hydro alcoholic extract		
100 µg/ml	2.71± 0.08	9.46
200 µg/ml	2.62 ± 0.04	10.31
300 µg/ml	2.29 ± 0.20	22.32
400 µg/ml	2.0 ± 0.12	37.51
500 µg/ml	1.29 ± 0.15	57.02

(ID –Internal diameter in mm, WC-wound contraction in percentage)

ID Values presented are mean with standard deviation where n=6; $p < 0.05$ was considered statistically significant compared to the control group.

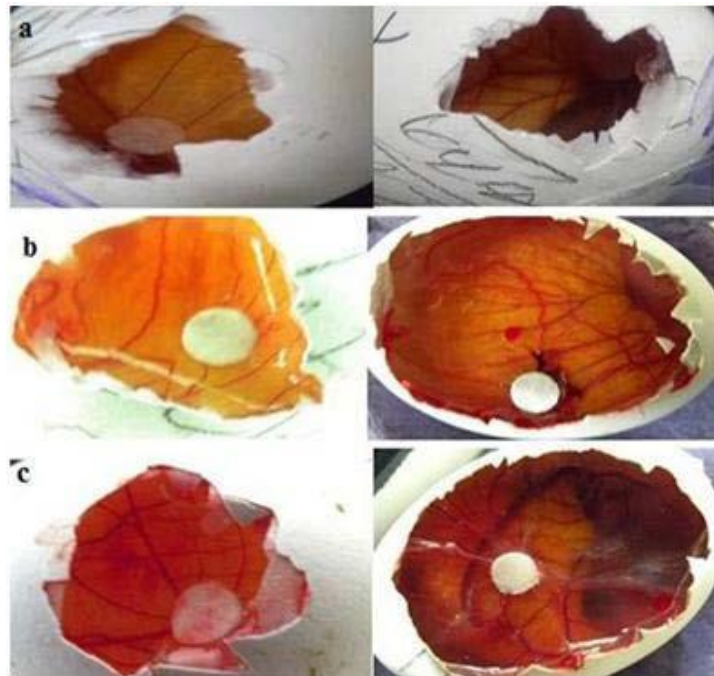
Angiogenesis was morphometrically analyzed and tabulated by counting the number of blood vessels in various treatments. The extract promoted an increase in the number of blood vessels compared to saline control. The hydroalcoholic extract was more angiogenic in terms of increase in number and thickness of blood vessels than the aqueous extract (Figures 3).

Figure 1



Treatment of the established wound model
 (a) Negative control (saline),
 (b) Positive control (Diclofenac sodium-50 µg/ml) and
 (c) Treatment with the Hydroalcoholic extract (500 µg/ml).

Figure 2



Neovascularization observed on the CAM layer of the treated models.
 (a) Positive control (Diclofenac sodium-50 µg/ml)
 (b) Negative control (saline) and
 (c) Hydroalcoholic extract treatment (500 µg/ml)

DISCUSSION

Through the results, we found that the potency of the drug for wound healing increases with increasing concentrations, both in the form of angiogenesis and wound contraction which was comparable with positive control Diclofenac sodium (50µg/ml). The presence of phenolic compounds, saponins, steroids, tannins and flavanoids was observed through preliminary phytochemical screening with the hydroalcoholic extract. Flavanoids have proved that they possess anti-inflammatory activity. Inflammation is the first phase of wound repair mechanism has to be immediately controlled when the actual healing begins. Since the extract has the anti-inflammatory activity, it may accelerate the healing process. The compounds like terpenoids, tannins, saponins, steroids have proved antimicrobial activity which eliminates the heavy microbial load at the wound site and avoid prolonged inflammation. Vascular endothelial growth will be unregulated by the compounds like Phenolic and tannins which enhances the angiogenesis and wound contraction^[14,15].

CONCLUSION

The established alternative to the *in-vivo* animal wound models for screening of wound healing herbal extracts is found to be chick embryo wound model. The wound healing potency for the extracts may be based on the wound contraction and angiogenic traits. The hydro alcoholic extract of the *Portulacaquadrifida* was found to possess excellent wound healing potency which was dose-dependent. The healing potency of the plant was evident from the phytoconstituents. Further molecular mechanism behind the activity could be determined using the established model with the knowledge of the target protein or other factors involved in the complex healing pathway.

ACKNOWLEDGEMENT

The authors are thankful to the Chancellor, Sri Ramachandra University for the facilities and support.

REFERENCES

- [1] Suguna L, Singh S, Sivakumar P, Sampath P, Chandrakasan G. Influence of *Terminalia chebula* on dermal wound healing in rats. *Phytotherapy Research*, 16(3) 2002. 227-231.
- [2] Sasidharan S, Nilawaty R, Xavier R, Latha LY, Amala R. Wound healing potential of *Elaeisguineensis* Jacq leaves in an infected albino rat model. *Molecules*, 15(5) 2010 3186-3199.
- [3] Kumar B, Vijayakumar M, Govindarajan R, Pushpangadan P. Ethnopharmacological approaches to wound healing—exploring medicinal plants of India. *Journal of Ethnopharmacology*, 114(2) 2007 103-113.
- [4] Balekar N, Katkam NG, Nakpheng T, Jehtae K, Srichana T. Evaluation of the wound healing potential of *Wedeliatrilobata* (L.) leaves. *Journal of Ethnopharmacology*, 141(3) 2012 817-824
- [5] Wang J.-p, Ruan J.-l, Cai Y.-l, Luo Q, Xu H.-x, Wu Y.-x. *In vitro* and *in vivo* evaluation of the wound healing properties of *Siegesbeckiapubescens*. *Journal of Ethnopharmacology*, 134(3) 2011 1033-1038.
- [6] Nayak B, Pereira LMP. *Catharanthus roseus* flower extract has wound-healing activity in Sprague Dawley rats. *BMC Complementary and Alternative Medicine*, 6(1) 2006 41.
- [7] 7.Syed Kamil Mulla and Paramjyothi Swamy, Preliminary Pharmacognostical And Phytochemical Evaluation of *Portulacaquadrifida* Linn. *International Journal of PharmTech Research* 2(3), 2010 1699-1702.
- [8] Mulla SK and Swamy P, Preliminary pharmacognostical and phytochemical evaluation of *Portulacaquadrifida* Linn. *International Journal of Pharmtech Research*, 2(3):1699-1702, (2010).
- [9] 9.Syed Kamil M, Liyakha T Ahmed MD and Paramjyothi, Neuropharmacological Effects of Ethanol Extract of *Portulacaquadrifida* Linn. In Mice, *International Journal of PharmTech* 2(2), 2010 1386-1390.
- [10] 10.A.N Rashed, F.U Afifi, A.M Disi, Simple evaluation of the wound healing activity of a crude extract of *Portulaca oleracea* L. (growing in Jordan) in *Mus musculus* JVI-1, *Journal of Ethnopharmacology*, 88 (2-3) 2003 131-136.
- [11] 11. Lalitha Vaidyanathan, Devi Thanikachalam, Lokeshwari T S Sivaswamy, Evaluation of Wound Healing Potency of *Cassia auriculata* Flower Extracts Using Chick Embryo Wound Model, *International Journal of Pharmaceutical Sciences Review and Research*, 27(2), 2014 222-227.
- [12] 12. Chris S, David M, Dwayne GS, Angiogenesis assay in the chick CAM, *Methods in Molecular Biology*, 294 2005 123-136.
- [13] 13. Narendra N, Gaurav P, Lokesh D, Naveen K, Wound healing activity of latex of *Calotropis gigantea*,



- International Journal of Pharmacy and Pharmaceutical Sciences*, 1(1) 2009 34-35.
- [14] 14. Kun L, Yunpeng D, Houli Z, Shouyu W, Zhen Z, Tannin extracts from immature fruits of *Terminalia chebula* Fructus Retz. Promote cutaneous wound healing in rats, *BMC Complementary and Alternative Medicine*, 11 2011 86.
- [15] 15. Serafini M, Peluso I, Raquzzini A, Flavonoids as anti-inflammatory agents, *Proceedings of the Nutrition Society*, 69(3) 2010 273-278.