

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/burns



Assessing effect of three herbal medicines in second and third degree burns in rats and comparison with silver sulfadiazine ointment



Mohammad Reza Akhoondinasab^{a,*}, Ali Khodarahmi^b, Motahhare Akhoondinasab^c, Mohsen Saberi^d, Maryam Iranpour^e

^a Faculty of Plastic and Reconstructive Surgery, Burn Research Centre, Iran University of Medical Sciences, Tehran, Iran

^b Burn Research Centre, Iran University of Medical Sciences, Tehran, Iran

^c Faculty of Pharmacy, Tehran University of Medical Sciences, Tehran, Iran

^d Medicine, Quran and Hadith Research Center and Department of Community Medicine, Faculty of Medicine,

Baqiyatallah University of Medical Sciences, Tehran, Iran

^e Kerman University of Medical Sciences, Kerman, Iran

ARTICLE INFO

Article history: Accepted 2 April 2014

Keywords: Herbal medicines Burn ointment Animal model Silver sulfadiazine

ABSTRACT

Introduction: Assessing effect of three herbal medicines on healing of deep second and third degree burns in rats and their comparison with silver sulfadiazine group.

Methods and materials: 40 rats were randomly assigned to one of the four groups, each group 10 rats. A deep second degree burn and a third degree burn were induced on the lower back and upper back of each rat under standard burning procedure, respectively. The burns were daily dressed with Robacin in group 1, silver sulfadiazine in group 2, aloe vera extract in group 3, and Rimojen in group 4. Responses to the treatment were assessed by digital photography during the treatment until day 32. Histological parameters (PMN, epithelialization, fibrosis, and angiogenesis) were assessed after the scar biopsy at the end of the research.

Results: On the basis of the taken photos, the wound had better healing in Robacin group. Also, speed of healing was better in aloe vera group than silver sulfadiazine and Rimojen groups. In terms of wound surface area maximal improvement was observed at the same time in the second and third degree burn wounds in Robacin group, in the second degree wound of aloe vera and Rimojen groups, and in the third degree wound of aloe vera and silver sulfadiazine groups. In pathological respects, epithelialization was more evident in both wounds of aloe vera group and third degree burn of Robacin group. In both wounds of Robacin group (second and third degree), the extend of angiogenesis and fibrosis was significantly less than other groups; but, inflammation was at a less level in third degree of silver, second degree of Rimogen and aloe vera, and third degree of aloe vera groups. *Conclusion:* In histological survey, minimal rate of angiogenesis and fibrosis was seen in Robacin group, which indicated less wound scar in this group. Healing speed of the burn

© 2014 Elsevier Ltd and ISBI. All rights reserved.

* Corresponding author. Tel.: +98 2122142592.
E-mail addresses: akhoondinasab@yahoo.com, meibody@gmail.com (M.R. Akhoondinasab).
http://dx.doi.org/10.1016/j.burns.2014.04.001
0305-4179/© 2014 Elsevier Ltd and ISBI. All rights reserved.

wound was also higher in Robacin group.

1. Introduction

Major burn is a particularly severe form of trauma characterized by a hypermetabolic state. A logical therapeutic approach for promoting recovery after burn would therefore be necessary to block the immediate triggering of the inflammatory cascades that result in prolonged metabolic imbalances. The second component of therapy would be to enhance wound healing [1].

Wound healing is widely discussed in the medical literature. Numerous works have been carried out to develop more sophisticated dressing that expedites the healing process and diminishes the bacterial burden in wounds. Traditional forms of medicine, especially the herbal products deployed for centuries in Africa and Asia, are under scientific investigation for their attributes in the wound treatment. Avicenna, the Persian physician and scholar (980-1037 AD), recommended medicinal plants for dressing wound in his famous book: Canon of Medicine [2]. Red Ginseng root extracts have also been used clinically as topical treatments for atopic suppurative dermatitis, wounds, and skin inflammation [3]. Kiwifruit which was originated more than 700 years ago in China was later introduced in New Zealand and California, where the first major planting occurred in 1960. Some clinical effects of kiwifruit ingredients such as ascorbic acid (as a scavenger), antibacterial agents, and actinidin (a potent protein-dissolving enzyme) have been reported in the literature [4].

Burn wound healing is one of the major indications of aloe vera gel use in many countries [5,9]. Clinical data on the treatment of psoriasis and lichen ruber planus have confirmed long-lasting ameliorative effects of BAC-3 (existing with high concentration in di-rhamnolipid) when compared to conventional therapy using corticosteroids [6].

Herbal products seem to possess moderate efficacy with no or less toxicity and are less expensive than synthetic drugs [7].

Spathodea campanulata Beauv. (Bignoniaceae) which is widely distributed throughout Africa and particularly found in Cameroon and Senegal is used in traditional herbal medicine for the treatment of ulcers, filaria, gonorrhea, diarrhea, and fever. S. campanulata was also known in Cameroon traditional medicine to have a healing activity in burn wounds [8].

Combudoron is composed of extracts from arnica and stinging nettleis and used for the treatment of partial thickness burns and insect bites in Europe. Nettle root extracts contain at least 18 phenolic compounds and 8 lignans [10]. Burn healing is still a challenge in modern medicine and there are a few drugs which could accelerate this process. As an alternative, plants have rich sources for investigations [11].

Traditionally, fresh leaves or decoction of *Chromolaenaodor* ata have been long used throughout Vietnam as well as other tropical countries for the treatment of leech bite, soft tissue wounds, burn wounds, skin infection, and dento-alveolitis [12].

Combudoron also seems to have positive effects on healing grade 2 laser induced burns which deserve further investigation [13].

Swift eschar separation with a resulting wound-bed that appeared pink and viable suggests that kiwifruit may help in the management of patients with deep burns [14].

These data provided the motivation for designing an animal study for further randomized evaluation of some public herbal medicine used for burn wound in Iran; if the results of the study are encouraging, then a clinical trial can be done. In this study, two herbal medicines named Robacin and Rimojen and also extract of aloe vera leaves were compared with silver sulfadiazine (a synthetic burn ointment) for treating the induced second and third degree burn in rats. Robacin is a mixture of several herbal components including *Rosa damacena*, *Calendula officinlis*, and beeswax. Rimojen also is a mixture of thymus serpyllum, macrophyllum, and platonychium. Both of them have been used as a traditional burn ointment by conventional therapists and have reported good results; but, there are no scientific data to support their outcomes.

2. Materials and methods

In a randomized clinical trial, 40 Wistar-albino male rats (average weight: 300-350 g, average age: 3-4 months old) were randomly divided into 4 equal groups (1: topical Robacin treated group, 2: topical silver sulfadiazine treated group, 3: topical aloe vera group, and 4: topical Rimojen group). Robacin is composed of several herbal components including: Rosa damacena, Calendula officinlis, and beeswax. Rimojen also is a mixture of thymus serpyllum, macrophyllum and platonychium. One of the animals in silver sulfadiazine group and one in Robacin group died on the 8th day, thus 38 rats were remaining. All rats were sheltered in standard environment (temperature: 20-25 °C; humidity: 65-75%) under the supervision of a veterinarian. During the experimentation, the rats were fed with usual rat chow and tap water and each rat was kept in a separate cage. All the rats were handled according to the ethical principles for animal experiments of the international council for animal protection. All the experimental procedures were confirmed by the research ethics committee of the university. The rats were anesthetized with inhalational anesthesia using xylazine (10 mg/kg) and ketamine hydrochloride injection (50-100 mg/kg intramuscularly) was used to increase the depth of anesthesia. The skin on the dorsum was



Fig. 1 – Third degree burn over the upper back and second degree burn over the lower back in the 2nd session (on the 4th day).



Fig. 2 - Burn wounds in the 4th session (on the 16th day).

shaved using an electrical clipper. A deep, second degree burn wound was induced by a hot plate (diameter: $4 \text{ cm} \times 2 \text{ cm}$) warmed 5 min within boiling water and placed for 10 s on the skin with an equal pressure over the lower back and a third degree burn with 30 s of pressure was made over the upper back. Then the surface of wounds was covered with the corresponding ointment and no dressing was applied. In aloe vera group, the burn wound was covered with mucilaginous gel by compressing the cut fresh leaf. In Robacin group, before applying the ointment, the surface of the wound was treated with alcohol camphor. These ointments were used on a daily basis. For assessing wound healing, digital photography was taken every 4 days under general anesthesia. The photographs were then assessed by Image j software and percentage of healing was calculated. Histologic parameters (PMN, epithelialization, fibrosis, and angiogenesis) were assessed on biopsy specimens of the wound at the end of the study. Every specimen was taken under general anesthesia by resection of the healed area and surrounding normal skin. Histological criteria were defined as following: for fibrosis (collagen bundles): normal bundle: 2, disorganized/edematous: 1, amorphous: 0, for PMN/X-40 field: 0-10: 2, 11-40: 1, >40: 0, and for angiogenesis, 3 degrees of mild, moderate and severe. Epithelialization was expressed as positive and negative (Figs. 1 and 2).



Chart 1 - Healing comparison of second degree burn.



Chart 2 - Healing comparison of third degree burn.

3. Results

This work was an experimental study using laboratory rats (male Sprague-Dawley), which aimed to investigate the healing properties of two mixtures of herbal ointment and also extract of aloe vera leaf. One of the animals in silver sulfadiazine group and one in Robacin group died on the 8th day and were removed from the study. According to the rule that t-test analysis is not convenient for comparing more than 2 groups, we used ANOVA and post hoc test for our 4 groups.

Differences of wound healing surface area for second degree burn were significantly inferior in Rimojen group; but, speed of healing was significantly better in Robacin group. In Robacin group, healing rate was better in the first two weeks after the burn and its slope of healing was gradually becoming similar to that of aloe vera and silver sulfadiazine groups near the end of the study (Charts 1 and 2). But, for the third degree burn, the difference was not as significant as the second degree burn, although the speed of wound contraction was higher in Robacin group (Tables 1 and 2). Pathological assessments of the specimens encompassed fibrosis, angiogenesis, inflammation, and epithelialization. In both wounds of Robacin group (grades 2 and 3), the extend of angiogenesis and fibrosis was significantly less than that of other groups; but, inflammation was less in grade 3 of silver sulfadiazine and aloe vera groups and in grade 2 of Rimogen and aloe vera groups. Epithelialization was more evident in both third degree burn wounds of aloe vera and Robacin groups (Table 3). In second degree wounds, except in the 2nd, 8th, and 11th sessions, there was significant difference between the groups (p < 0.005) and the best results belonged to Robacin and aloe vera groups. However, results of Rimojen group were inferior to those of others. In third degree wounds, except in the 2nd, 4th, and 11th sessions, there was a significant difference between the groups (p < 0.005) and again Robacin and aloe vera acted better. None of the rats developed any allergic reaction or erosion of the surrounding intact skin.

4. Discussion

Burns are among the most common and devastating forms of trauma. They are physical and chemical phenomena and

Table 1 – Healing comparison of second degree burn. Descriptive analysis of second and third degree burn.						
	Ν	Mean	Std. deviation			
Percent of healing in the 2nd phase based on b	urn area of the first pha	ase				
Rimojen, grade 2	10	-6.94	24.76			
Aloe vera, grade 2	10	4.84	15.46			
Robacin grade 2	10	9.52	23.30			
Silver, grade 2	10	10.43	9.80			
Percent of healing in the 3rd phase based on by	urn area of the first pha	se				
Rimojen, grade 2	10	-0.33	22.17			
Aloe vera, grade 2	10	18.92	13.57			
Robacin, grade 2	10	40.53	29.54			
Silver, grade 2	10	20.01	19.47			
Percent of healing in the 4th phase based on by	urn area of the first pha	se				
Rimojen, grade 2	10	6.93	27.24			
Aloe vera, grade 2	10	45.87	11.29			
Robacin, grade 2	10	61.87	22.37			
Silver, grade 2	10	50.52	6.78			
-	40	41.30	27.67			
Percent of healing in the 5th phase based on h	irn area of the first pha	SP				
Rimoien, grade 2	10	8.34	19.78			
Aloe vera, grade 2	10	67.03	22.98			
Robacin, grade 2	10	72.69	20.71			
Silver, grade 2	10	55.84	15.02			
	40	50.98	31.97			
Descent of backing in the 6th phase based on by	um area of the first pho					
Percent of healing in the out phase based on bo		10.20	22 50			
Aloo yora, grade 2	10	76.66	23.30			
Robacin grade 2	10	82.98	17.75			
Silver grade 2	10	62.96	12.03			
	10	02.91	12.07			
Percent of healing in the 7th phase based on bu	urn area of the first pha	se				
Rimojen, grade 2	10	34.39	20.26			
Aloe vera, grade 2	10	88.61	10.65			
Silver grade 2	10	80.05 70.15	14.52			
Silver, grade 2	10	70.15	14.52			
Percent of healing in the 8th phase based on bu	urn area of the first pha	se				
Rimojen, grade 2	10	58.33	19.02			
Aloe vera, grade 2	9	94.31	8.87			
Robacin, grade 2	10	93.88	10.67			
Silver, grade 2	10	82.34	13.95			
Percent of healing in the 9th phase based on bu	urn area of the first pha	se				
Rimojen, grade 2	10	78.91	12.91			
Aloe vera, grade 2	9	96.80	7.70			
Robacin, grade 2	9	97.70	5.66			
Silver, grade 2	10	93.48	6.21			
Percent of healing in the 10th phase based on b	ourn area of the first ph	ase				
Rimojen, grade 2	5	92.79	5.05			
Aloe vera, grade 2	5	99.49	1.14			
Robacin, grade 2	6	100.00	00			
Silver, grade 2	10	96.62	4.42			
Percent of healing in the 11th phase based on h	ourn area of the first ph	ase				
Rimojen, grade 2						
Aloe vera, grade 2	2	99.77	.32			
Robacin, grade 2	1	100.00				
Silver, grade 2	10	99.31	1.54			

cause many morbidities and mortalities in the world. The final goal of all of the current burn treatments is to accelerate skin healing and prevent wound infection [2,7,10]. When skin is damaged, pathogens have a direct route to infiltrate the body, potentially resulting in infection. Cutaneous wound repair consists of orderly progression of events that establish the integrity of the damaged tissue. The sequence of events that repairs the damage is categorized into three overlapping phases: inflammation, proliferation, and tissue remodeling. The normal healing process can be impeded at any step along its path by a variety of factors that can contribute to impaired healing. Impaired wound healing may be a consequence of pathologic states associated with diabetes, immune disorders, ischemia, and venous stasis and injuries such as burn,

Table 2 – Healing compariso	on in third degree burn.		
	N	Mean	Std. deviation
Percent of healing in the 2nd pha	ase based on burn area of the first pl	nase	
Rimojen, grade 3	10	-9.27	25.10
Aloe vera, grade 3	10	9.23	11.44
Robacin, grade 3	10	1.89	9.84
Silver, grade 3	10	3.16	11.37
Total	40	1.25	16.54
Percent of healing in the 3rd pha	se based on burn area of the first ph	ase	
Rimojen, grade 3	10	-6.75	30.95
Aloe vera, grade 3	10	13.01	15.74
Robacin, grade 3	10	18.34	12.14
Silver, grade 3	10	9.07	20.72
		0.12	20.72
Percent of healing in the 4th pha	se based on burn area of the first ph	ase	04.44
Rimojen, grade 3	10	20.68	31.41
Robacin grade 3	10	23.92	10.15
Silver grade 3	10	18 98	19.00
Total	40	24.85	20.20
		21100	20120
Percent of healing in the 5th pha	se based on burn area of the first ph	ase 42.50	25.24
Aleo yero grade 2	10	43.59	25.24
Robacin grade 3	10	51.52	23.35
Silver grade 3	10	34.06	13 66
Total	40	46.08	22.92
Percent of healing in the 6th pha	se based on burn area of the first ph	ase co 71	24.28
Aleo yero grade 2	10	60.12	24.38
Robacin grade 3	10	70.83	16.81
Silver, grade 3	10	52.12	17.48
Total	40	63.20	20.92
Percent of healing in the 7th pha	se based on hurn area of the first nh	250	
Rimoien grade 3	9	77 39	8 01
Aloe vera, grade 3	10	81.41	19.20
Robacin, grade 3	10	81.93	12.04
Silver, grade 3	10	53.78	12.88
Total	39	73.53	17.76
Percent of healing in the 8th pha	se based on burn area of the first ph	ase	
Rimojen, grade 3	9	87.55	7.01
Aloe vera, grade 3	9	91.03	14.50
Robacin, grade 3	10	86.16	12.41
Silver, grade 3	10	74.80	9.97
Total	38	84.65	12.51
Percent of healing in the 9th pha	se based on burn area of the first ph	ase	
Rimojen, grade 3	8	91.71	7.51
Aloe vera, grade 3	9	94.60	8.60
Robacin, grade 3	10	92.04	12.62
Silver, grade 3	10	81.42	9.07
Total	37	89.72	10.73
Percent of healing in the 10th ph	ase based on burn area of the first p	hase	
Rimojen, grade 3	6	94.37	5.94
Aloe vera, grade 3	8	96.77	6.35
Robacin, grade 3	9	96.45	7.50
Silver, grade 3	10	90.36	7.76
Iotal	33	94.31	/.28
Percent of healing in the 11th ph	ase based on burn area of the first p	hase	
Rimojen, grade 3	0		
Aloe vera, grade 3	7	99.29	1.37
Kobacin, grade 3	6	99.48	./6
Total	23	98.66	1 99

Table 3 – Histopathologic wound healing scale.							
Score	Epithelialization	Inflammation	Fibrosis	Angiogenesis			
1	Focal	Minimal	Minimal	Minimal			
2	Thin, complete surface	Mild	Mild	Mild			
3	Thick, complete surface	Evident	Evident	Severe			

frostbite, and gunshot wounds [7]. The final step of the proliferative phase is epithelialization, which involves migration, proliferation, and differentiation of epithelial cells from the wound edges to resurface the defect. In open full thickness burn wounds, epithelialization is delayed until a bed of granulation tissue is established to allow for the migration of epithelial cells [6].

Studies have demonstrated that burn infection is the main cause of mortality in patients with extensive burns. Therefore, many researchers have tried to achieve appropriate treatment methods to reduce the risk of wound infections and shorten the period of treatment in the patients with burn wounds. Some of these treatments involve using topical antimicrobial agents, which effectively reduce mortality rate of burns. One of these antimicrobial topical ointment is 1% silver sulfadiazine, with advantages such as easy and convenient use, not causing pain during consumption, yielding low toxicity and sensitivity, and having antibacterial effect, which have made it known as the gold standard among anti-microbial topical drugs for the patients with burns and turned it to the main consumed drug in the treatment of burn wounds around the world [2]. Topical antibacterial agents and disinfectants are good in protecting against infection; but, the occurrence of allergic reactions and skin irritations to these agents reduces rate of skin regeneration and increases recovery time [7].

Because thermal injury disrupts the protective barrier function of skin, dressing is needed to protect against the environmental flora and evaporative heat loss and accentuate the healing period. The ultimate burn dressing wound be inexpensive and comfortable; it would not only allow the burn to heal rapidly, but also clean the wound and debride fragments of separated eschar and devitalized tissue and have an antibacterial activity. A wide variety of substances have been reported to be useful in the treatment of burn wounds [4]. Burn healing is still a challenge in modern medicine and only a few drugs are capable of accelerating this process. As an alternative, plants are rich sources for more investigations [11]. Effect of herbal medicine on burn wound has been noted for many years. Herbal products seem to possess moderate efficacy with no or less toxicity and are less expensive than synthetic ones. Many plants and plant-derived products have been shown to possess potent wound-healing activities [7]. Eupolin ointment, a formulation prepared from the aqueous extract of leaves of C. odorata (formerly, Eupatorium odoratum), has been licensed for clinical use in Vietnam [12].

In the present study, two of traditional herbal ointments and also aloe vera extract were compared with silver sulfadiazine as the standard treatment for burn wound in rats. The actual mechanism of improved healing was unclear; however, the probable mechanism could be providing the necessary material for healing, increasing blood flow to the burned area, decreasing inflammatory response, decreasing rate of infection, etc. A significant reduction was observed in wound surface area in the rats treated with Robacin dressing in comparison with traditional silver sulfadiazine cream. Also, healing time in grade 2 wound of aloe vera group was significantly shorter than silver sulfadiazine group. This effect was more obvious in the second degree burn, because, in third degree wound, contraction plays a major role, especially in lax skin of rats. Rat skin wound healing does not perfectly mimic human skin wound healing, because the skin morphology is different (rats are described as looseskinned animals) and "loose" skin allows wound contraction to play a significant role in closing rat skin wounds. Consequently, wound contraction is usually more rapid than epithelialization [6].

Humans have tight skin and this difference makes it difficult to compare them with loose-skinned animals. Although there are inherent drawbacks in using rats for comparison with human skin wound healing, there are also some advantages in the use of rats as a research model, which include the availability of broad knowledge based on rat wound healing gained from years for previous research [6].

Aloe vera (Aloe vera Linn, synonym: aloe vera barbadensis Mill.) is in the family Liliaceae, which is a tropical plant easily grown in hot and dry climates including Thailand. Numerous cosmetics and medicinal products are made from the mucilaginous tissue, called aloe vera gel, which is located in the center of aloe vera leaves. Aloe vera gel has been used for many indications since the Roman era or even long before. Burn wound healing is one of the major indications of aloe vera gel which is used in many countries [5].

A recent review of four clinical trials investigating the effect of aloe vera on burn wounds has found that aloe vera significantly shortens the wound healing time (by approximately eight days) compared to the control. They concluded that it may be an effective treatment for first and second degree burns [9].

Most of the herbal medicines are a mixture of several plants, but none of these traditional ointments have been scientifically investigated. Results of this study could provide the ground for starting human studies. A new burn ointment is hoped to be introduced by using herbal medicines with less adverse effects and shortened period of healing; thus, rate of hypertrophic scar could be reduced.

Conflict of interest

We declare that there is no conflict of interest that could be perceived as prejudicing impartiality of the research reported. Iran University of Medical Sciences has provided necessary fund for the study.

- Jurjus A, Atiyeh BS, Abdallah IM, Jurjus RA, Hayek SN, Abou Jaoude M, et al. Pharmacological modulation of wound healing in experimental burns. Burns 2007;33:892–907.
- [2] Daryabeigi R, Heidari M, Hosseini SA, Omranifar M. Comparison of healing time of the 2 degree burn wounds with two dressing methods of fundermol herbal ointment and 1% silver sulfadiazine cream. Iran J Nurs Midwifery Res 2010;15(3):97–101.
- [3] Kimura Y, Sumiyoshi M, Kawahira K, Sakanaka M. Effects of ginseng saponins isolated from Red Ginseng roots on burn wound healing in mice. Br J Pharmacol 2006;148(6):860–70.
- [4] Mohajeri G, Masoudpour H, Heidarpour M, Khademi E, Ghafghazi F, Adibi S, et al. The effect of dressing with fresh kiwifruit on burn wound healing. Surgery 2010;148(5):963–8.
- [5] Maenthaisong R, Chaiyakunapruk N, Niruntraporn S, Kongkaew C. The efficacy of aloe vera used for burn wound healing: a systematic review. Burn 2007;33:713–8.
- [6] Stipcevic T. Enhanced healing of full-thickness burn wounds using di-rhamnolipid. Burn 2006;32(1):24–32.
- [7] Upadhyay NK, Kumar R, Siddiqui MS, Gupta A. Mechanism of wound-healing activity of *Hippophaerhamnoides* L. leaf extract in experimental burns. In: Evidence-based complementary and alternative medicine. 2011;659705.

- [8] Sy GY, Nongonierma RB, Ngewou PW, Mengata DE, Dieye AM, Cisse A, et al. Healing activity of methanolic extract of the barks of Spathodea campanulata Beauv (Bignoniaceae) in rat experimental burn model. Dakar Med 2005;50(2):77–81.
- [9] Leila C, Margit K, Olena K, Narelle G, Pei-Yun L, Hong-En C, et al. The efficacy of Aloe vera, tea tree oil and saliva as first aid treatment for partial thickness burn injuries. Burn 2008;34:1176–82.
- [10] Chrubasik JE, Roufogalis BD, Wagner H, Chrubasik S. A comprehensive review on the stinging nettle effect and efficacy profiles. Part II: urticae radix. Phytomedicine 2007;14(7–8):568–79.
- [11] Kahkeshani N, Farahanikia B, Mahdaviani P, Abdolghaffari A, Hasanzadeh Gh, Abdollahi M, et al. Antioxidant and burn healing potential of *Galiumodoratum* extracts. Res Pharm Sci 2013;8(Jul–Sep (3)):197–203.
- [12] Thang PT, Patrick S, Teik LS, Yung CS. Anti-oxidant effects of the extracts from the leaves of *Chromolaenaodorata* on human dermal fibroblasts and epidermal keratinocytes against hydrogen peroxide and hypoxanthine–xanthine oxidase induced damage. Burns 2001;27:319–27.
- [13] Huber R, Bross F, Schempp C, Gründemann C. Arnica and stinging nettle for treating burns—a self-experiment. Complement Ther Med 2011;19(Oct (5)):276–80.
- [14] Farhad H, Rad HE, Naghibzadeh B, Nouhi AH, Naghibzadeh G. Actinidiadeliciosa (kiwifruit), a new drug for enzymatic debridement of acute burn wounds. Burn 2010;36:352–5.