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Documentation of Wound Healing Plants in Lagos-Nigeria: Inhibition of Lipid Peroxidation as *In-vivo* Prognostic Biomarkers of Activity

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ABSTRACT

Ethnobotanical study of wound healing plants in the central part of Lagos, Nigeria recorded 23 species of plants, belonging to 18 plant families. The plants are used as first aids, in the washing of sores, extraction of pus, as well as on infected wounds. Taxonomic distribution shows bark (36.7%), root (27.2%), leaves (9.1%), juice (22.5%) and rhizome (4.5%). Ethanol extracts of wound healing medicinal plants most commonly mentioned in the survey [Ageratum conyzoides Linn. (Asteraceae), Anthocleista nobilis G. Don (Loganiaceae), Cocos nucifera Linn. (Palmae), Croton lobatus Linn. (Euphorbiaceae), Entandrophragma utile (Dawe & Sprague) Sprague (Meliaceae), Nauclea latifolia Sm. (Rubiaceae), Parquetina nigrescens (Afzel.) Bullock (Asclepiadaceae), Petiveria alliacea L. (Phytolaccaceae), Treculia africana Decne (Moraceae), Uvaria chamae P. Beauv. (Annonaceae) and Vernonia amygdalina Del. (Asteraceae)] were investigated for free radical scavenging activities and also lipid peroxidation. Total phenol and flavonoid contents were determined spectrophotometrically as gallic acid and rutin equivalents respectively. Flavonoid content correlated positively with activity. Flavonoids reduce lipid peroxidation by preventing or slowing the onset of cell necrosis and also by improving vascularity. Hence, any extract that inhibits lipid peroxidation will increase the viability of collagen fibrils by increasing the strength of collagen fibres, circulation, prevent cell damage and hasten the process of wound healing by inhibition of lipid peroxidation as prognostic biomarkers.

Keywords: Wound healing plants, Ethnobotany, Lipid peroxidation, Prognostic biomarkers.

INTRODUCTION

Wound healing or wound repair, is the body's natural process of regenerating dermal and epidermal tissue. When an individual is wounded, a set of complex biochemical events takes place in a closely orchestrated cascade that results in the contraction and closure of the wound and restoration of a functional barrier [1, 2].

Molecular oxygen plays a central role in the pathogenesis and therapy of chronic wounds. Wound sites are rich in free radicals [2]. The presence of these radicals will result in oxidative stress leading to lipid peroxidation, DNA breakage and enzyme inactivation including free radical scavenger enzymes, thereby causing cytotoxicity and delayed wound healing. Therefore, elimination of reactive oxygen species (ROS) could be an important strategy in healing of chronic wounds [3], as these antioxidants hasten the process of wound healing by destroying the free

radicals [4]. A combination of grape seed proanthocyanidin extract and resveratrol facilitates a key element supporting wound angiogenesis. Strategies to manipulate the redox environment in the wound are likely to be of outstanding significance in wound healing [5]. Agents that demonstrate significant antioxidant activity may, therefore, preserve viable tissue and facilitate wound healing.

Ascorbic acid has antioxidant activity. Many studies have emphasized the importance of ascorbic acid in wound healing. Ascorbic acid is concentrated in healing wounds and its circulating levels are acutely diminished following skin injury. Also, ascorbic acid is essential for the growth and maintenance of connective tissue. It is a cofactor for several hydroxylating enzymes in the body, including prolyl hydroxylase and lysyl hydroxylase, enzymes that hydroxylate prolyl and lysyl residues, respectively, in the pro-collagen polypeptide to form hydroxyproline and hydroxylysine. Hydroxyproline is essential for maximum stability of the triple helix and, consequently, for secretion of pro-collagen from the cell. Hydroxylysine, on the other hand, participates in cross-link formation and serves as a site for covalent attachment of galactosyl or glucosyl-galactosyl residues during collagen biosynthesis. Ascorbic acid also stimulates collagen synthesis by stimulating lipid peroxidation leading to increased transcription of the collagen genes [5].

Lagos is a huge metropolis which originated on islands separated by creeks. The city is the economic and financial capital of Nigeria. Intensive research in wound healing has not yielded, economic and efficacious pro-healing agents that could alleviate the long hospitalization of patients following surgery and wound infliction. An ethnobotanical study was carried out among women herb sellers who live in the central part of Lagos, Nigeria. Verbal information on the medicinal plants was obtained through unstructured questionnaire administered by interview in the local language spoken by the herb sellers in the study area. The local name, parts of plants used, mode of preparation and administration were recorded and literature searches carried out for the evaluation on the current status of investigations on these plants. Specimens were purchased in order to collaborate economically with their time and to gain their confidence.

Ethanol extracts of these documented wound healing medicinal plants *Ageratum conyzoides Anthocleista nobilis*, *Cocos nucifera*, *Croton lobatus*, *Entandrophragma utile*, *Nauclea latifolia*, *Parquetina nigrescens*, *Petiveria alliacea*, *Treculia africana*, *Uvaria chamae* and *Vernonia amygdalina* were investigated for free radical scavenging activities and also lipid peroxidation. Free radical scavenging activity was evaluated using 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radicals and inhibition of lipid peroxidation was accessed with thiobarbituric acid (TBA) method in a poly unsaturated fatty acid (PUFA) model of *Scomber japonicum* fish homogenate calculated as MDA equivalent/gm of tissue. Total phenol and flavonoid contents were determined spectrophotometrically as gallic acid and rutin equivalents respectively. The present investigation is focused on the establishment of wound healing activity of the documented plants.

MATERIALS AND METHODS

Interviews with traditional herb sellers and collection of samples: A total of thirty six herb sellers (ages between 38 to 62 years) were interviewed in Agege, Mushin-Olosha and Oyingbo open herbal markets in Lagos Nigeria using unstructured questionnaires (March 2008 to June 2009).

The herb sellers that consented were asked to give their knowledge on herbs that have been used successfully to for wound healing both external and internal wounds. The ethnobotanical data (local name, mode of preparation, medicinal uses) were collected through interviews and discussions using a more qualitative conversational technique in their local language as earlier reported by Muanya and Odukoya, 2008 [6]. Our discussions allowed descriptive responses on the plant prescribed, such as part of the plant used, detailed information about mode of preparation (i.e., decoction, paste, powder and juice), form of usage either fresh or dried and mixtures of other plants used as ingredients. The conversations were built on trust with the common goal to improve the health situation in the country and to preserve and increase the knowledge on medicinal plants. We bought the medicinal specimens in order to gain their confidence and to cooperate economically with them as earlier reported by Marcia *et al*., 2005[7] and used by Sofidiya *et al*., 2007[8]. The plants were identified at the Department of Pharmacognosy, Faculty of Pharmacy, University of Lagos through literature [9, 10] and using local names. Further confirmation of identity was carried out with assistance of Mr. Wale Ekundayo at the Forestry Research Institute of Nigeria (FRIN) herbarium Ibadan. Museum specimens are kept in our laboratory.

Table 1: Medicinal plants identified from ethno botanical survey with part used and mode of preparation and administration

S/N	LOCAL NAME	BOTANICAL NAME	FAMILY	PART USED	METHOD OF PREPARATION AND ADMINISTRATION
1	Epo igi jebo	**Entandrophragma utile* (Dawe & Sprague)	Meliaceae	Bark	The plant is boiled with water and the decoction is used to wash the wound
2	Epo Aganwo	*Khaya ivorensis* A.Chev	Meliaceae	Bark	The plant is boiled with water and the decoction is drank for internal ulcer
3	Epo Sapo	**Anthocleista nobilis* G. Don	Loganiaceae	Bark	The plant is boiled with water and the decoction is drank for internal ulcer Cooked with other herbs. Hot infusion aids to heal wound from inside.
4	Egbo Inabiri	*Plumbago zeylanic*a Linn.	Plumbaginaceae	Root	The plant is boiled with water and the decoction is drank for internal ulcer
5	Epo Eruju Egbo Eruju	**Uvaria chamae* P. Beauv.	Annonaceae	Bark Root	Boil the plants together with water. The decoction is then taken to treat wounds that refuse to heal. Cooked with other herbs. Helps to heal it from inside
6	Epo Asofeyeje	*Rauwolfia vomitoria* Afzel	Apocynaceae		Boil the plants together with water. The decoction is then taken to treat wounds that refuse to heal.
7	Egbo Ewuro- jije	**Vernonia amygdalina* Del.	Asteraceae	Root Leaves	The plant is boiled with water and the decoction is drank for internal ulcer Squeezed juice or cooked in water in addition with other herbs. Used to aid the healing of wounds from inside.
8	Eru	*Croton lobatus* Linn.	Euphorbiaceae	Fruit	Boil the plants together with water. The decoction is then taken to treat wounds that refuse to heal.
9	Egbo Agbon	*Cocos nucifera* Linn.	(Palmae)	Stem	The plants are boiled with water and the decoction is drank for internal ulcer
10	Egbo Ogbo	**Parquetina nigrescens* Afzel Bullock	Periplocaceae	Root Leaves and stem	Boil the plants together with water. The decoction is then taken to treat wounds that refuse to heal. Treatment of ulcers Wash it only put water and be drinking it.
11	Epo Iyeye	*Spondias mombin* Linn.	Anacardiaceae	Bark	Boil the plants together with water. The decoction is then taken to treat wounds that refuse to heal.
12	Ata ile	*Zingiber officinalis* Roscoe	Zingiberaceae	Rhizome	Boil the plants together with water. The decoction is then taken to treat wounds that refuse to heal.
13	Irawo Ile	*Euphorbia hirta*	Euphorbiaceae		Squeezed and the juice is applied on fresh wounds.
14	Asunwon Oyinbo	*Senna alata* Linn.	Caesalpinaceae		Cooked with other herbs .The hot infusion is drunk. This aids to heal the wound from inside
15	Ewe botuje funfun	*Jatropha curcas* Linn.	Euphorbiaceae		Squeezed then the juice is used in addition to other herbs. It is used in the treatment of internal ulcers.
	Ewe botuje pupa	*Jatropha gossypifolia* Linn.	Euphorbiaceae		
16	Tinupogbe	ND		Root/stem	Squeezed with the juice of the leaves of botuje (*Jatropha curcas*) soaked in water. It is used in the treatment of internal ulcers. Treatment of ulcers Boil with water and drink preferably together with other herbs.
17	Egbo Karanjagban	*Triclisia subcordata* Oliv.	Mernispermiaceae	Root	Cooked with other herbs. Used to treat internal wounds
18	Egbo Ito	*Millettia thonningii* (Schum. et Thonn.) Bak	Fabaceae	Root	Cooked with other herbs. Use treat internal wounds
19	Egbo Ifon	*Treculia africana* Decne	Moraceae	Root	Cooked with other herbs. Helps to heal wound from inside
20	Ewe Effinrin	*Occimum gratissimum* Linn.	Lamiaceae	Leaves	The juice is used. The juice is applied on fresh wounds.
21	Epo Awogba	*Petiveria alliaceae* Linn.	Phytolaccaceae	Bark	Treatment of ulcers Boil with water and drink. effective when combined
22	Egbo Eruju	*Uvaria chamae* P. Beauv.	Annonaceae	Stem	Treatment of ulcers Boil with water and drink. More effective when combined.
23	Egbo Egbesi	*Nauclea latifolia* S.M.	Rubiaceae	Root/stem	Treatment of wounds Wash the plant part and boil with water. The juice gotten is used to bath the affected part.

**Frequently mentioned plants; ND=NOT DONE*

Determination of qualitative antioxidant activity

DPPH radical-scavenging activity

The stable 1, 1-diphenyl-2-picryl hydrazyl radical (DPPH) was used for a rapid determination of qualitative antioxidant activity by its free radical-scavenging activity of the extracts. Different concentrations of each extracts were added, at an equal volume, to ethanolic solution of DPPH (100 µM). After 15 min at room temperature, the absorbance was recorded at 517 nm. The experiment was repeated three times with Vitamin C used as standard control.

$$\% \text{ Antioxidant Capacity} = \frac{\text{Absorbance of Standard-Absorbance of Sample}}{\text{Absorbance of Standard}} \times 100\%$$

Determination of total phenol content: Total phenol contents in the extract were determined by the modified Folin-Ciocalteu method of Wolfe *et al*., 2003 [11] as used by Sofidiya *et al*., 2008[12] and Odukoya *et al*., 2009 [13]. An aliquot of the extract was mixed with 5 ml Folin-Ciocalteu reagent (previously diluted with water 1:10 v/v) and 4 ml (75 g/l) of sodium carbonate. The mixture was allowed to stand for 30min at room temperature and the absorbance was measured at 760nm spectrophotometrically. The final results were expressed as Gallic Acid Equivalents (GAE).

***Determination of Total flavonoid*:** Total flavonoids were estimated using the method of Ordonez *et al*., 2006 [14]. To 0.5 ml of sample, 0.5 ml of 2% $AlCl_3$ ethanol solution was added. The absorption was measured at 420nm after 1hr 10minutes, at room temperature. Total flavonoid contents were calculated as rutin from a calibration curve.

Lipid peroxidation*:* Antioxidant efficacy of the extracts towards lipid peroxidation in raw and cooked fish homogenate of *Scomber japonicum* Houttuyn (Scombridae) obtained from the local market was measured by thiobarbituric acid reactivity method. Thiobarbituric acid (TBA) reactivity in the homogenate was determined by following a modified method of Luotola and Luotola (1985)[15] as used by Muanya and Odukoya (2008) [6] and expressed as MDA equivalent/mg of tissue using vitamin C as reference standard.

Table 2: Antioxidant capacity, total phenol and flavonoid content of plant extracts

Plant Material		Antioxidant Capacity (%)	Total Phenol Content (mg/ml)	Flavonoid Content (mg/ml)
Botanical name	Plant Code Used			
Ageratum conyzoides leaf juice	ACL	97.3212±0.2319	389.3376±0.1446	84.2977±0.0076
Anthocleista nobilis	ANB	30.4481±0.0081	134.7623±0.0347	17.4083±0.1181
Cocos nucifera	CNB	45.9471±0.0353	142.4448±0.0086	21.9272±0.1007
Croton lobatus	CLF	46.0034±0.0001	129.5894±0.5711	6.9483±0.0329
Entandrophragma utile	EUB	50.0478±0.5437	202.0067±0.0082	23.9541±0.2201
Milletia thonningii	MT	35.9024±0.3904	161.5901±0.3234	26.5572±0.0093
Nauclea latifolia	NLR	19.1762±0.4973	32.1973±0.1176	0.2477±0.0021
Ocimum gratissimum leaf juice	OGL	74.9744±0.0289	218.3255±1.6729	51.9572±0.0033
Parquetina nigrescens	PNL	69.4892±0.0198	143.8849±0.0916	42.7736±0.0547
Petiveria alliacea	PAB	54.4984±0.0174	21.0096±0.0000	3.8116±0.1192
Rauwolvia vomitoria Leaves	RVL	59.1242±0.2091	31.5229±0.1883	0.7553±0.0064
Rauwolvia vomitoria Root	RVR	42.2442±0.1892	17.4487±0.1161	0.3779±0.0400
Treculia africana	TAR	42.9045±0.1333	9.4428±0.4520	0.8003±0.0001
Triclisia subcordata	TSR	45.9483±0.0852	89.5723±0.0045	5.9571±0.1103
Uvaria chamae	UC	75.2448±0.2446	286.0092±0.1007	12.7062±0.0054
Vernonia amygdalina leaf juice	VAL	71.4451±1.2049	227.9473±0.0146	67.0074±0.1103
Vernonia amygdalina root	VAR	28.1694±0.0671	215.4906±0.6667	28.8723±0.0063

RESULTS

Ethnobotanical survey

Survey results are presented in **Table1**. These herbs have been used successfully locally in the treatment of both internal and external ulcers. In this survey thirty six herb sellers were interviewed and twenty-two (23) plants were mentioned. The plants mentioned are listed in **Table1** with their local name, part used and route of administration. The most frequently mentioned plants in the three markets were *Ageratum conyzoides*, *Anthocleista nobilis*, *Cocos nucifera*, *Croton lobatus*, *Entandrophragma utile*, *Nauclea latifolia*, *Parquetina nigrescens*, *Petiveria alliacea*, *Treculia africana*, *Uvaria chamae* and *Vernonia amygdalina*.

DPPH AND LIPID PEROXIDATION ASSAY

The order of activity had *Ageratum conyzoides* as highest and *Milletia thonningii* had lowest as indicated in **Table 2**. All these extracts also tested positive to phenol and flavonoid. Quantitative antioxidant activity correlated positively with both phenol (R^2=0.388) and flavonoid (R^2=0.461) content.

It was observed that as the concentration increases the amount of TBARS value decreases (**Table 3&4**) indicating low levels of MDA and a reduction in lipid peroxides both in the raw and cooked fish homogenate.

Table 3: TBARS values (mean of 3 readings ± SEM) with raw fish homogenate in plant extracts

Plant Code Used	TBARS (MDA/mg) of tissue at different concentration (mg/ml)				
	80.0	40.0	20.0	10.0	1.0
ACL	12.5721±0.4471	1.6572±0.0895	98.7786±0.5694	149.3241±0.0902	253.1756±0.1376
ANB	65.0627±0.0002	8.2984±0.9320	90.8837±0.3489	146.4955±.0.0489	211.5893±0.0883
CNB	13.3483±0.7364	9.7256±0.0845	28.4472±0.6657	47.4459±0.3349	114.5628±0.3209
CLF	26.4873±0.0089	5.0790±0.6921	68.5892±0.1896	91.9906±0.0937	126.8837±0.0449
EUB	43.5601±0.0043	9.6412±0.0321	54.4321±0.0069	53.6743±0.0654	179.1638±0.0008
MT	12.2149±0.0421	3.9098±0.0067	178.8862±0.2286	203.2876±0.0183	271.5763±0.0038
NLR	18.3386±0.1005	9.5620±0.0189	41.9042±0.0667	82.6554±0.0062	89.9473±0.1106
OGL	29.2489±0.0082	2.9387±0.0627	65.7734±0.0558	83.3351±0.0571	91.0284±0.0487
PNL	32.9735±0.4478	4.5709±0.0097	73.6703±0.0889	86.0956±0.0000	88.7362±0.5572
PAB	61.5847±0.0673	1.2098±0.1446	83.7832±0.3722	85.4582±0.0034	131.6115±0.0764
RVL	22.9234±0.1118	3.7451±0.1862	68.9804±0.0377	78.4977±0.1104	81.3648±0.5481
RVR	43.9567±0.0726	0.3675±0.0558	97.4671±0.0448	132.8745±0.0017	169.8394±0.0072
TAR	91.6541±0.2118	141.7804±0.0035	152.2567±0.0020	168.3300±0.0392	193.5813±0.0002
TSR	87.8690±0.0532	152.9482±0.0892	109.8765±0.0279	214.6423±0.0078	243.1038±0.0034
UC	18.5790±0.0322	27.8654±0.0044	52.4256±0.0115	61.1578±0.0591	92.8473±0.0068
VAL	11.9876±0.0067	39.5923±0.2271	41.7789±0.4467	69.5903±0.3428	101.0098±0.0085
VAR	48.3455±0.0653	63.9257±0.5432	74.0954±0.0262	187.5428±0.0672	269.2840±0.0049

ND=NOT DONE

Table 4: TBARS values (mean of 3 readings ± SEM) with cooked fish homogenate in plant extracts

Plant Code Used	TBARS (MDA/mg) of tissue at different concentration (mg/ml)				
	80.0	40.0	20.0	10.0	1.0
ACL	9.6611±0.0089	36.8948±0.0158	67.8977±0.0772	94.4905±0.0371	161.2290±0.0554
ANB	59.4397±0.1036	77.2674±0.1471	92.3763±0.0019	104.2291±0.0772	208.3376±0.0042
CNB	41.5509±0.0478	69.0228±0.0038	83.4960±0.0053	127.3499±0.0096	181.4455±0.0328
CLF	24.7322±0.0011	41.4876±0.0916	59.1186±0.0077	79.7568±0.0903	92.3341±0.0056
EUB	39.0951±0.0561	46.5672±0.0447	48.4762±0.0023	57.29374±0.0044	130.775I±0.0001
MT	87.3896±0.0008	109.0063±0.2812	142.9487±0.0524	200.6978±0.0021	263.0094±0.1092
NLR	15.5590±1.0052	26.7629±0.0916	30.6981±0.0471	77.9388±0.0047	85.6824±0.0463
OGL	10.0964±0.0287	50.9049±0.2256	44.3976±0.0334	61.5489±0.0066	72.3468±0.0047
PNL	20.1320±0.0472	27.6987±0.0093	51.5097±0.0227	50.2987±0.0081	92.2272±0.0663
PAB	54.2908±0.0918	48.3980±0.0008	56.8176±0.0068	57.1266±0.0016	109.8816±0.0005
RVL	19.6851±0.0074	36.4788±0.0000	61.6874±0.0481	53.127I±0.0028	49.6673±0.0118
RVR	13.0836±0.0127	19.0918±0.0167	28.0198±0.1817	47.3773±0.0712	114.8786±0.0559
TAR	43.7629±0.0361	69.0298±0.0589	129.2098±0.0031	141.8776±0.0944	176. 3430±0.0372
TSR	37.1289±0.0745	79.7421±0.0045	91.3990±0.0246	124.3I88±0.1105	191.8011±0.0118
UC	14.3976±0.0246	12.1987±0.2067	39.5877±0.0049	42.0811±0.0003	68.7742±0.0096
VAL	12.1073±0.0085	30.3984±0.0015	37.7539±0.0007	46.3876±0.1110	98.5567±0.0004
VAR	32.4471±0.0067	41.6098±0.0218	59.9087±0.1167	164.4441±0.0261	201.3333±0.1062

ND=NOT DONE

DISCUSSION

Interviewing traditional healers for accurate information about herbal recipes, their component herbs, and their medicinal and other uses constitutes an important activity in ethnopharmacological field investigation [16]. Specimens were purchased in order to collaborate economically with their time and to gain their confidence. The knowledge and experience of a traditional healer is considered valuable as it comes from thousands of years of trial and error and forms the basis of modern medicine and therapeutics. A survey of medicinal plants used in wound healing was carried out in Mushin, Oyingbo and Agege as the major herbal markets in Lagos metropolis. These

plants are used as first aids, in the washing of wounds, extraction of pus, as well as on infected wounds. Taxonomic distribution shows bark (36.7%), root (27.2%), leaves (9.1%), juice (22.5%) and rhizome (4.5%). Methods of preparation varies and they are species specific viz: plant parts applied as a paste, juice extracted from the fresh plant parts, powder made from fresh or dried plant parts, some fresh plant parts, and decoction. The most frequently used preparations are decoctions and powdered plant material.

A rapid, simple and inexpensive method to measure antioxidant capacity involves the use of the free radical, 2, 2-Diphenyl-1- picrylhydrazyl (DPPH). DPPH is widely used to test the ability of compounds to act as free radical scavengers or hydrogen donors, and to evaluate antioxidant activity. The qualititative analysis of the ethanolic extracts of the twenty two plants obtained from the market survey was carried out using the DPPH method. The odd electron in the DPPH free radical gives a strong absorption maximum at 517 nm and is purple in colour. The colour turned from purple to yellow as the molar absorptivity of the DPPH radical at 517 nm reduces from 9660 to 1640 when the odd electron of DPPH radical becomes paired with hydrogen from a free radical scavenging antioxidant to form the reduced DPPH-H. The resulting decolorization is stoichiometric with respect to number of electrons captured. Therefore extracts with no colour changes with DPPH were not subjected to further quantitative assessment with UV spectrophotometer. High absorbance was an indication of degree of activity. Quantitative antioxidant activity correlated positively with both phenol (R^2=0.388) and flavonoid (R^2=0.461) content. The free radical scavenging activity exhibited by the plants is therefore associated with the presence of polyphenols and flavonoids. Flavonoids are the most common widely distributed group of plant phenolics and they are free radical scavengers and super antioxidant. The biological functions flavonoids include protection against allergies, inflammation platelet aggregation and ulcers. The presence of polyphenols and flavonoids in *these extracts* accounts for its use in healing of wounds. Polyphenols have astringent properties that hasten the healing of wounds and the inflamed mucous membrane [17].

It was observed that as the concentration increases the amount of TBARS value decreases i.e. low levels of MDA and a reduction in lipid peroxides both in the raw and cooked fish homogenate. The values for the cooked homogenate were higher than those of the raw homogenate. Cooking helps the fish fat to get into the medium and solubilise thereby, making available more fats for peroxidation, more access to the radical and thus better activity. These results showed that there are more ROS being destroyed with increasing concentrations of extract (**Table 4**).
Lipid peroxidation is considered responsible for the impairment of endothelial cells, keratinocyte capillary permeability, fibroblast and collagen metabolism. Therefore, it can be seen that the increased lipid peroxidation might be one of the factors causing the defect in vascular endothelial growth factor (VEGF) expression and finally producing the impairment in the wound-healing process [18].

Flavonoids are known to reduce lipid peroxidation not only by preventing or slowing the onset of cell necrosis but also by improving vascularity. Hence, any drug that inhibits lipid peroxidation is believed to increase the viability of collagen fibrils by increasing the strength of collagen fibres, increasing the circulation, preventing the cell damage and by promoting the DNA synthesis [19].

Thus, any extract that inhibits lipid peroxidation will increase the viability of collagen fibrils by increasing the strength of collagen fibres, circulation, prevent cell damage and hasten the process of wound healing by inhibition of lipid peroxidation as prognostic biomarkers. The plants documented may serve as possible sources of new wound healing molecules.

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