



An Approach to Hair Loss and Its Management in Persian Medicine

Narjes Gorji¹, Maryam Naeimi^{2*}, Reihaneh Moeini¹, Zahra Memariani¹,
Fatemeh Kolangi²

¹Traditional Medicine and History of Medical Sciences Research Center, Institute of Health, Babol University of Medical Sciences, Babol, Iran

²Student Research Committee, Babol University of Medical Sciences, Babol, Iran

Received: 21 Jul 2018

Revised: 1 Aug 2018

Accepted: 4 Aug 2018

Abstract

Hair loss is a common problem among more than half of the world's population. The present study aimed to review and assess the etiologies, symptoms and basics of its treatment according to Persian medicine (PM). The main PM books including the Canon of Medicine, Zakhireh Kharazmshahi, Moalejat-e Aghili, Exir-e A'zam, Teb-e Akbari and Makhzan al-adviyah were searched and the related content on hair loss have been extracted. According to PM textbooks, the causes of hair loss can be divided into four categories: skin and hair nutrition disorders (low quality and quantity of nutrients, basal metabolism disorder, circulation of nutrients and skin absorption), skin pore problems (dilation and obstruction), inflammation, and environmental damage. To differentiate the above causes, several symptoms such as hair strand diameters, greasy or dry hair, the scalp condition at the affected area and general symptoms such as weakness and exhaustion were considered. In modern medicine sources, several causes are mentioned to be involved in the process of hair loss including nutritional disorders and anemia, hormonal disorders like thyroid problems, genetics and environmental factors. Applying topical oils of Myrtle, Emblic myrobalan, Myrobalan, Acacia, Oak gall, Lotus, and Violet, as well as the mucilage of marshmallow, common mallow, Psyllium and also labdanum along with nutrition correction and consumption of nutritious foods such as almond, currant and walnut based on the type of hair loss have been recommended. Considering that the causes of hair loss in PM and modern medicine are similar, it seems that therapeutic recommendations of PM provide a suitable ground for future studies.

Keywords: Hair loss; Medicinal plants; Persian medicine

Citation: Gorji N, Naeimi M, Moeini R, Memariani Z, Kolangi F. An Approach to Hair Loss and Its Management in Persian Medicine. Trad Integr Med 2018; 3(3): 127-137.

*Corresponding Author: Maryam Naeimi
Babol University of Medical Sciences, Ganjafrooz Street, Babol, Mazandaran, Iran
Cell: +989155317376
E-mail: naeimima@yahoo.com

Introduction

Hair loss is a multifactorial disease in which the hair of some parts of the head or body begins to fall [1]. The severity of hair loss varies from slight hair loss in the head to severe loss of the whole body hair [2]. The disease has several types, of which common forms include male pattern baldness, female pattern baldness, alopecia, and telogen effluvium [1].

In brief, the natural process of hair growth includes three phases, which are called anagen (growth), catagen (regression), and telogen (resting) phases. In an adult, 80-90% of the head hair is in the anagen phase, which normally lasts from 2-8 years, and the hair grows at this stage. After this time, the hair enters the catagen or the regression phase. This phase, which involves 1 to 2% of the hair, lasts about 2-3 weeks and all hair growth activities stop during this period. After this phase, clubbing hair is formed, then, the telogen or resting phase starts. During this stage, the hair does not have any growth activity and is ready to fall. About 10-20% of the hair is in this phase, and after they fall new hair grows instead (in the anagen phase) [3,4].

Hair loss is a problem that undoubtedly involves the majority of world population. According to researchers, recurrent temporal hair regression in head is seen in 98.6% of men and 64.4% of women. This is despite the facts that over the age of 80, approximately 2/3 of women and 4/3 of men suffer from hair loss in the mid-anterior part of head [5].

Despite the notable advances in the field of skin and hair, the causes of hair loss are still not identified in absolute terms. Recent

research suggests that genetic, hormonal, and environmental factors can be associated with this disease. Although the effect of a specific gene on hair loss has not yet been fully proven, researchers have found that some gene mutations can be associated with hair growth disorders [6,7]. For example, mutation in the APCDD1 gene can lead to alopecia hair loss; or the mutation in the EDARADD gene can be associated with ectodermal dysplasia and cause alopecia [8,9]. Concerning hormonal factors, evidence suggests that some male hormones can reduce hair thickness and reduce the duration of the anagen phase by inhibiting certain metabolic pathways, thereby leading to male pattern hair loss. For example, male hormone derivative dihydrotestosterone hormones, interfere with the Wnt path, and then inhibit the activation of cutaneous papillary cells and ultimately reduce the thickness and increase male pattern hair loss [10-13]. In female pattern hair loss changes in hormonal levels have been studied more widely. Researchers have found that there is a meaningful relationship between female pattern hair loss and contraceptive pills, puberty under the age of 16, fewer childbirths, and menstrual cycles of less than 35 days. As a result, increasing levels of estrogen hormone can also be considered as a predisposing factor for hair loss [14].

Due to different etiologies of hair loss, various treatments have been examined so far. Considering the high prevalence of hair loss and the importance of its impact on the quality of life of individuals, the present study aimed to investigate and analyze the viewpoint of

Persian medicine (PM) scholars as one of the long-standing medical schools to present new treatment proposals.

Methods

This study is an analytical overview of the etiology and treatment methods of hair loss in the perspective of PM. In this study, the main books of PM, including the Canon of Medicine (10th and 11th centuries), *Zakhireh Kharazmshahi* (Treasure of Kharazmshah; 11th and 12th centuries), *Moalejat-e Aghili* (Treatments of Aghili; 18th century), *Teb-e Akbari* (Akbari's Medicine; 18th century), *Exir-e A'zam* (The Great Elixir; 19th century), and *Makhzan al-adviah* (The Storehouse of Medicaments; 18th century) were studied. The chapter of "hair disorder" with keywords including "esghat-e-sha'r" or "tasaghot-e-sha'r" was searched in each book line by line for the content related to hair loss such as causes, complications and methods of treatment; collected data were analyzed via content analysis and then a summary of the results was provided and categorized in Table 1. In the content analysis phase, first the content related to the subject was extracted from the selected texts and after ensuring its validity and reliability, an inductive logical analysis was run. The data were obtained from a complete review of the materials related to the definition, etiology, and general points of hair loss treatment in the main textbooks of PM.

Findings

By reviewing the literature of PM on hair loss subject, this disease can be addressed in several sections:

1-Definition and mechanism of hair loss

In the sources of PM, hair loss is referred to as Esghate-sha'r which refers to the fall of beard, head and eyebrows hair. In PM the creation and growth of hair is believed to occur due to the proper digestibility of consumable food and the production of suitable ingredients in the body, which feeds the scalp and a part of the materials are expelled from the openings of scalp and appear as hair. Thus, when a problem occurs in any stages of intake, digestion, metabolism and the delivery of food to the scalp, the production and growth of the hair becomes difficult [15,16].

2- The reasons for hair loss or lack of hair growth:

In the figure 1, the causes of hair loss are provided in brief.

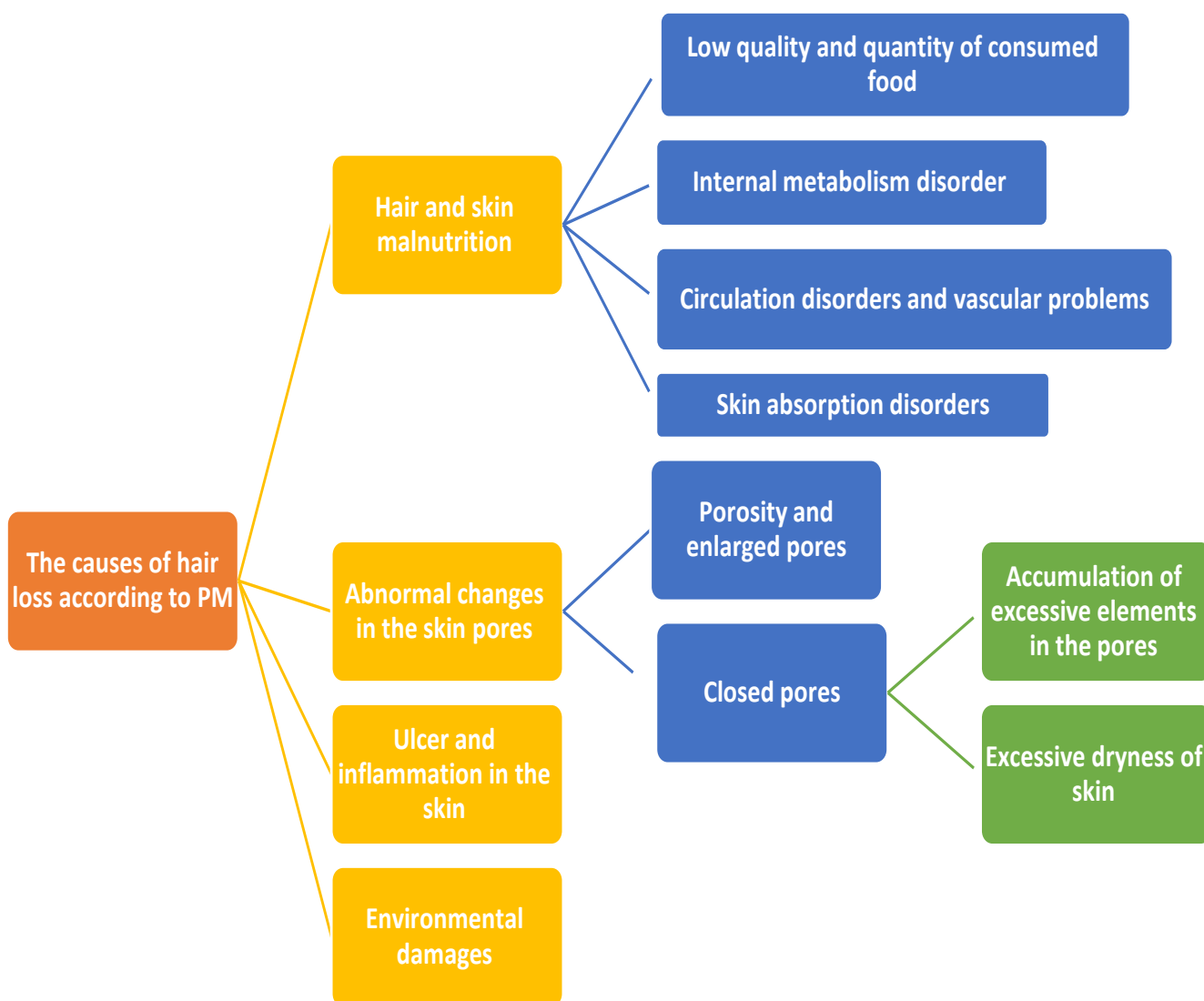


Figure1. The causes of hair loss according to PM

3- The Signs and symptoms of hair loss:

Several symptoms are identified to diagnose the cause of hair loss from the perspective of PM such as: hair diameter, greasy and dry hair, skin symptoms in the affected area, general symptoms such as weakness and feeling tired,

etc. Table 1 shows the various symptoms of hair loss and presumed causes [15-17]

Table 1: Signs and symptoms of hair loss according to PM

NO.	Types of hair loss based on the cause	Symptom				
		Skin	Hair			General symptoms
			Thickness		Symptoms of loss	
1	Open pores	Softness	↓	-	-	-
2	Low food intake and little fluids	Dryness	↓	-	Fast hair loss	Weight loss, The presence of a background disease is the cause of weakness and little food
3	Closed pores due to dryness and density of skin	Thickness and density of skin	↑	-Curly hair -↑Density -Darkness	Separated by pulling	Dry temperament/Mizaj
4	Thick moist and phlegm	Lack of dryness symptoms	↓	-	Fast hair loss	
5	Moisture overcoming the skin	Overhydration of skin	-	-	-	Moisture overcome in the body
6	Intense heat after acute illnesses	--	-	-	-	Wound, leprosy or all kinds of hair loss (such as <i>da al-sa'lab</i> and <i>da al-hayyeh</i>)

4- General Treatment of Hair Loss in PM:

Treatment of hair loss varies according to the type of hair loss and its cause:

4.1. In cases of skin porosity and the enlargement of its pores, which is associated with soft skin and narrow hair, it is advised to wash the head with Emblic myrobalan, Myrobalan, Acacia, oak gall as well as using astringent oils such as Emblic oil and Acacia oil. Labdanum is also used to control the symptoms of this type of hair loss.

4.2. In hair loss caused by malnutrition, it is advised to eat diverse, fresh, delicate and rich foods such as quail, chicken and wheat; and wash the hairs with Alcea, plahtainy, willow leaves, Malva leaves, henna leaves; use lotus and violet oils; and smell flowers and cold odors like violet, lotus, jasmine, apple, and quince.

4.3. For obstructed skin pores, the temperament moisture should become balanced and its dryness should be removed by bathing in lukewarm water and applying chamomile, jasmine and almond oils. The use of Ma al-Jobon or the cheese water (whey) is effective. In addition, the consumption of Acacia and Emblic myrobalan oil, and myrtle leaves are emphasized.

4.4. In narrow skin pores, cleansing the body from causative agents such as phlegm and taking long baths are recommended to reduce body moisture. Rubbing a thick cloth, adding Artemisia Abrotanum and bitter almond oil during bathing is also effective; in this type of hair loss, it is advised to consume spices and dry foods like camel meat, goat and fresh fish with pepper, cinnamon and cumin, and avoiding

foods that generate phlegm.

4.5. Cleansing can be effective for treatment of hair loss caused by excessive moisture in the skin. In various types of ulcers, cleansing and analyzing the material using solvents such as Alcea officinalis and Malva sylvestris and wound cleansing can be effective in treating hair loss.

4.6. In the last type, that is, hair loss caused by diseases involved with excessive heat such as fever, laxative materials such as alcea, malva as well as the other kinds of mucilage, oils and balms, and the suitable Qiruti (topical traditional formulation containing oil and wax) can be effective. In some cases, the treatment of hair loss is basically the treatment of underlying disease, for example, curing the cause of fever [3,15,18].

Discussion

The present study shows that the PM scholars knew hair loss complication as a skin disease very well and had defined its types. Moreover, by examining the symptoms of patients with this disorder, hair loss can be classified based on its different types, cause and symptoms.

From the perspective of PM, one of the important reasons for the emergence and exacerbation of hair loss is blood circulation disorders and inappropriate nutrition of skin and hair root [15,16]. Recent research has shown that nutritional deficiencies, including the lack of essential and non-essential amino acids and various micronutrients, such as iron, zinc and copper deficiency, is a common problem in patients with hair loss regardless of the type of alopecia [19].

According to PM, abnormal pores of the scalp are also another important factor in hair loss [18]. As in allopathic medicine, skin disorders including desquamated skin [20], dysfunction of the sebaceous glands in the production of lipids needed for healthy hair and protecting their physical properties are noted [21].

Also, from the perspective of PM, skin and environmental damages may cause generation and exacerbation of hair loss [15]. According to recent studies, environmental damages including exposure to ultraviolet radiation, saline water, contamination as well as many hair care practices with physical and chemical mechanisms such as combing, drying, hair extension, smoothing and coloring along with nutritional and medical disorders can cause structural damage to hair, fracture, reduced elasticity, and ultimately hair loss [21].

According to PM, one of the important factors in hair loss treatment is identifying the temperament of individuals and pay attention to its importance in the occurrence or exacerbation of hair loss [15]. Temperament (Mizaj) is defined as a quality which is produced from the interaction of different components in the body [22]. PM physicians believed this quality (temperament) determines physical and psychiatric properties and life style such as nutrition could change internal metabolism and temperament [23].

Some recent studies have shown person with different temperament had different protein metabolism [24] and also medicinal plants with hot and cold temperament based on PM had several effects on some metabolic parameters

including body weight gain, food intake, water consumption, urine output, serum glucose and insulin levels in normal rats [25]. Another study has shown significant relationship between Body Mass Index and temperament, based on the knowledge of PM [26]. Although, there are no new published document about the effect of temperament in hair loss, but above mentioned research showed temperament has a significant effect in human metabolism. Nowadays, attention is also paid to genomic structures of individuals to predict the hair growth or hair loss process. This method examines the individual characteristics, because new studies suggest that certain genetic factors affect hair loss and the main cause of the diverse types of hair loss is due to genetic differences [27].

In modern medicine, one of the main methods of androgenic hair loss treatment is taking drugs that inhibit the production of dihydrotestosterone, such as finasteride. Moreover, Minoxidil 2% is also used as topical solutions and foams to treat hair loss even in women [28, 29]. In addition to the two above-mentioned drugs that are widely used, there are other drugs to treat the disease, some of which are only at the laboratory and research stage and have not been yet entered to the market. Among these drugs include inflammatory response regulators. Tofacitinib is an anti-inflammatory drug used in the treatment of rheumatoid arthritis. Researchers have found that some inflammatory response pathways that are similar to those of rheumatoid arthritis can accelerate the process of hair loss, and Tofacitinib can be effective in preventing alopecia by controlling these pathways [30].

In addition to anti-inflammatory drugs, some topical corticosteroids can also be used to treat hair loss. Studies have also shown that injectable triamcinolone and topical diphencyprone are steroids that have influential therapeutic effects on hair loss [17,31].

Attention to the therapeutic recommendations given by PM textbook shows that in some cases, traditional medicines used herbs such as myrtle, Emblic myrobalan and chamomile as topical or systemic therapies [2,15], which are found to have anti-inflammatory effects [32-34], according to new evidence.

Other therapies in modern medicine include spironolactone, prostaglandin, fluridil, ketoconazole, melatonin and estrogen, each having a lot of side effects and complications, so they should be used with caution [35-39]. Due to the different effects of these drugs, researchers have sought to find newer treatments for hair loss in the recent years. Most of these efforts are aimed at finding micronutrients that can increase the growth of hair follicles or reduce their decay. Elements such as sulfur, iron, silica, calcium and iodine play an important role in preventing hair loss [20]. These elements are found in fruits and vegetables, and many other foods. Therefore, the consumption of fresh vegetables, liver, milk, onions, fish, and rice bran which are rich in B-group vitamins, can supply the needed materials for head hair [40]. A remarkable point in PM sources is paying attention to the role of the primary ingredients, i.e. food nutrients in the treatment of diseases; thus, correcting the diet and lifestyle of patient is the first intervention to treat various types of

diseases; even in some cases the proper intake use of food is more emphasized than taking drugs. In hair loss disorders caused by nutritional problems, it is recommended to consume a variety of fresh and rich foods such as quail, chicken and wheat, which is an important point in the health of the hair [9].

In some studies, the impact of high fat in men's diet on accelerating the mechanism of baldness is emphasized. The sebaceous glands adjacent to each hair follicle generate a gamma-alpha reductase. This enzyme plays an important role in converting testosterone into dihydrotestosterone. Then, it causes hair loss with increasing testosterone derivatives in the hair follicles. Reducing fat intake also reduces the activity of these glands, preventing excessive hair loss [41,42].

Persian medical scholars also paid attention to this point and recommended the general cleansing with Ma-al-Juban (whey), avoiding heavy foods, bathing with lukewarm water, and topical application of using reductive oils like chamomile, jasmine and almond [16].

Another hair loss treatment is taking vitamin B supplements and antioxidants. In group B vitamins, the effect of biotin or vitamin B6 is higher than other vitamins [43,44]. In order to prevent hair loss, researchers add biotin and antioxidants to many cosmetic ingredients as supplements. Antioxidants are molecules that can neutralize the harmful effects of free radicals on the body cells, and the most important nutrients that play the role of an antioxidant include vitamin E, vitamin C, beta-carotene, zinc and selenium [45-47].

According to the recent findings on the role of free radicals in damaging body cells and the protective effect of antioxidants, Persian medical scholars used herbs such as Emblic myrobalan, Olibanum, and Pistacia in some cases [2] which have antioxidant properties according to recently found evidence [48-50]. They also emphasized the use of rice, wheat, and the cereals family [9], which are reported as rich sources of group B vitamins and other micronutrients[40].

PM is a medical school founded on temperament/ Mizaj and humors of body that distinguishes it from modern medicine. With this attitude, the type of treatment and even the foods that are recommended to different patients depend on the person and are completely different from other patients. It is believed that if the type of temperament and temperament disorders are not properly diagnosed, the desired result will not be achieved [9]. Today, this issue can be addressed under a new field of science called genomics, which has gained the attention of many scientists in recent years.

Conclusion

Hair is considered as an important element in the appearance, and controlling its loss brings many psychological advantages for individuals. The low effectiveness and high side effects of using medical therapies on the one hand, and the general interest in using complementary therapies on the other hand, supports this fact that employing the ideas of PM can be very helpful for identifying and finding new therapies besides the current modern treatments.

Conflict of interest

None.

Acknowledgments

None.

References

- [1] Vary Jr JC. Selected disorders of skin appendages-acne, alopecia, hyperhidrosis. *Med Clin North Am* 2016;99:1195-1211.
- [2] Biondo S, Goble D, Sinclair R. Women who present with female pattern hair loss tend to underestimate the severity of their hair loss. *Br J Dermatol* 2004;150:750-752.
- [3] Paus R, Cotsarelis G. The biology of hair follicles. *N Engl J Med* 1999;341:491-497.
- [4] Rile N, Liu Z, Gao L, Qi J, Zhao M, Xie Y, Su R, Zhang Y, Wang R, Li J, Xiao H. Expression of Vimentin in hair follicle growth cycle of inner Mongolian Cashmere goats. *BMC genomics* 2018;19:38.
- [5] Sinclair R, Torkamani N, Jones L. Androgenetic alopecia: new insights into the pathogenesis and mechanism of hair loss. *F1000Research* 2015;4:585.
- [6] Duverger O, Morasso MI. To grow or not to grow: hair morphogenesis and human genetic hair disorders. *Semin Cell Dev Biol* 2014;25-26:22-33.
- [7] Blaydon DC, Biancheri P, Di WL, Plagnol V, Cabral RM, Brooke MA. Inflammatory skin and bowel disease linked to ADAM17 deletion. *N Engl J Med* 2011;365:1502-1508.
- [8] Shimomura Y, Agalliu D, Vonica A, Luria V, Wajid M, Baumer A. APCDD1 is a novel Wnt inhibitor mutated in hereditary hypotrichosis simplex. *Nature* 2010;464:1043-1047.
- [9] Bal E, Baala L, Cluzeau C, El Kerch F, Ouldim K, Hadj-Rabia S. Autosomal dominant anhidrotic ectodermal dysplasias at the EDARADD locus. *Hum Mutat* 2007;28:703-709.
- [10] Kishimoto J, Burgeson RE, Morgan BA. Wnt signaling maintains the hair-inducing activity of the dermal papilla. *Genes & development* 2000;14:1181-1185.
- [11] Kitagawa T, Matsuda K-I, Inui S, Takenaka H, Katoh N, Itami S, et al. Keratinocyte growth inhibition through the modification of Wnt signaling by androgen in balding dermal papilla cells. *J Clin Endocrinol Metab* 2009;94:1288-1294.
- [12] Zimmer MP, Ziering C, Zeigler F, Hubka M, Mansbridge JN, Baumgartner M. Hair regrowth following a Wnt- and follistatin containing treatment: safety and efficacy in a first-in-man phase 1 clinical trial. *J Drug Dermatol* 2011;10:1308-1312.
- [13] Heilmann S, Kiefer AK, Fricker N, Drichel D, Hillmer AM, Herold C. Androgenetic alopecia: identification of four genetic risk loci and evidence for the contribution of WNT

- signaling to its etiology. *J Invest Dermatol* 2013;133:1489-1496.
- [14] Su L-H, Chen L-S, Chen H-H. Factors associated with female pattern hair loss and its prevalence in Taiwanese women: a community-based survey. *J Am Acad Dermatol* 2013;69:e69-e77.
- [15] Cheshti MA. *Exir-e Azam (Azam's Elixir)*. Iran University of Medical Science, Institute for Islamic and Complementary Medicine. Tehran 2007.
- [16] Aghili Khorasani MH. *Moalejat-e Aghili*. 2nd ed. Research Institute for Islamic and Complementary Medicine. Tehran 2009 (in Persian).
- [17] Sundberg JP, McElwee KJ, Carroll JM, Oliver RF, Shapiro J, Bissonnette R, McLean DI, Tang L, Lui H. Alopecia areata-like hair loss in C3H/HeJ mice and DEBR rats can be reversed using topical diphenylpyrone. *J Invest Dermatol Symp Proc* 1999;4:239.
- [18] Arzani MA. *Akbari Medicine (Tebbe Akbari)*. Jalal al-Din. Qom 2008.
- [19] Gowda D, Premalatha V, Imtiyaz D. Prevalence of nutritional deficiencies in hair loss among Indian participants: Results of a cross-sectional study. *Int J Trichology* 2017;9:101.
- [20] Rushton D. Nutritional factors and hair loss. *Clin Exp Dermatol* 2002;27:396-404.
- [21] Del Campo R, Zhang Y, Wakeford C. Effect of Miracle Fruit (*Synsepalum dulcificum*) Seed Oil (MFSO®) on the Measurable Improvement of Hair Breakage in Women with Damaged Hair: A Randomized, Double-blind, Placebo-controlled, Eight-month Trial. *J Clin Aesthet Dermatol* 2017;10:39.
- [22] Minae MB, Soltani S, Besharat M, Karimi F, Nazem E. Temperament determination for melatonin: a bridge from Iranian traditional to modern sleep medicine. *Afr J Tradit Complement Altern Med* 2013;10:340-342.
- [23] Moeini R, Memariani Z, Pasalar P, Gorji N. Historical root of precision medicine: an ancient concept concordant with the modern pharmacotherapy. *Daru* 2017;25:7.
- [24] Rezaadoost H, Karimi M, Jafari M. Proteomics of hot-wet and cold-dry temperaments proposed in Iranian traditional medicine: a Network-based Study. *Sci Rep* 2016;6:30133.
- [25] Parvinroo S, Zahediasl S, Sabetkasaei M, Kamalinejad M, Naghibi F. The effects of selected hot and cold temperament herbs based on Iranian traditional medicine on some metabolic parameters in normal rats. *Iran J Pharm Res* 2014;13:177.
- [26] Parvizi MM, Salehi A, Nimrooz M, Hajimonfarednejad M, Amini F, Parvizi Z. The relationship between body mass index and temperament, based on the knowledge of traditional Persian medicine. *Iran J Med Sci* 2016;41:S14.
- [27] Rexbye H, Petersen I, Iachina M, Mortensen J, McGue M, Vaupel JW. Hair loss among elderly men: etiology and impact on perceived age. *J Gerontol A Biol Sci Med Sci* 2005;60:1077-1082.
- [28] Leyden J, Dunlap F, Miller B, Winters P, Lebowhl M, Hecker D. Finasteride in the treatment of men with frontal male pattern hair loss. *J Am Acad Dermatol* 1999;40:930-937.
- [29] Messenger A, Rundegren J. Minoxidil: mechanisms of action on hair growth. *Br J Dermatol* 2004;150:186-194.
- [30] Jabbari A, Sansaricq F, Cerise J, Chen J, Bitterman A, Ulerio G, et al. An Open-Label Pilot Study to Evaluate the Efficacy of Tofacitinib in Moderate to Severe Patch Type Alopecia Areata, Totalis and Universalis. *J Invest Dermatol* 2018;138:1539-1545.
- [31] Porter D, Burton J. A comparison of intralesional triaminolone hexacetonide and triamcinolone acetonide in alopecia areata. *Br J Dermatol* 1971;85:272-273.
- [32] Joshi S, Thatte U. Pharmacological Evaluation of Cytoprotective Potential of *Phyllanthus Emblica* (PE) and *Asparagus Racemosus* (AR) in Preventing Gastric Erosions, Ulcerations and Inflammation induced in Rats. *Natl J Physiol Pharm Pharmacol* 2012;2:18-22.
- [33] Hosseinzadeh H, Khoshdel M, Ghorbani M. Antinociceptive, anti-inflammatory effects and acute toxicity of aqueous and ethanolic extracts of *Myrtus communis* L. aerial parts in mice. *J Acupunct Meridian Stud* 2011;4:242-247.
- [34] Jarrahi M. An experimental study of the effects of *Matricaria chamomilla* extract on cutaneous burn wound healing in albino rats. *Nat Prod Res* 2008;22:422-427.
- [35] Burke B, Cunliffe W. Oral spironolactone therapy for female patients with acne, hirsutism or androgenic alopecia. *Br J Dermatol* 1985;112:124-125.
- [36] Garza LA, Liu Y, Yang Z, Alagesan B, Lawson JA, Norberg SM, et al. Prostaglandin D2 inhibits hair growth and is elevated in bald scalp of men with androgenetic alopecia. *Sci Transl Med* 2012;4:126ra34-ra34.
- [37] Pierard-Franchimont C, De Doncker P, Cauwenbergh G, Pierard G. Ketoconazole shampoo: effect of long-term use in androgenic alopecia. *Dermatology* 1998;196:474-477.
- [38] Fischer T, Burmeister G, Schmidt H, Elsner P. Melatonin increases anagen hair rate in women with androgenetic alopecia or diffuse alopecia: results of a pilot randomized controlled trial. *Br J Dermatol* 2004;150:341-345.
- [39] Georgala S, Katoulis A, Georgala C, Moussatou V, Bozi E, Stavrianeas N. Topical estrogen therapy for androgenetic alopecia in menopausal females. *Dermatology* 2004;208:178-179.
- [40] Marschner H. *Marschner's mineral nutrition of higher plants*: Academic press 2011.
- [41] Foster GD, Wyatt HR, Hill JO, Makris AP, Rosenbaum DL, Brill C. Weight and metabolic outcomes after 2 years on a low-carbohydrate versus low-fat diet: a randomized trial. *Ann Intern Med* 2010;153:147-157.
- [42] Sánchez P, Serrano-Falcón C, Torres J, Serrano S, Ortega E. 5 α -Reductase isozymes and aromatase mRNA levels in plucked hair from young women with female pattern hair loss. *Arch Dermatol Res* 2018;310:77-83.
- [43] Trüeb RM. Serum biotin levels in women complaining of

- hair loss. *Int J Trichology* 2016;8:73.
- [44] Patel DP, Swink SM, Castelo-Soccio L. A review of the use of biotin for hair loss. *Skin Appendage Disord* 2017;3:166-169.
- [45] Haslam IS, Jadkauskaite L, Szabó IL, Staeger S, Hesebeck-Brinckmann J, Jenkins G. Oxidative damage control in a human (mini-) organ: Nrf2 activation protects against oxidative stress-induced hair growth inhibition. *J Invest Dermatol* 2017;137:295-304.
- [46] Jadkauskaite L, Coulombe PA, Schäfer M, Dinkova Kostova AT, Paus R, Haslam IS. Oxidative stress management in the hair follicle: Could targeting NRF2 counter age related hair disorders and beyond. *Bioessays* 2017;39:43-45.
- [47] Çatal T. Efficacy of antioxidant vitamins (vitamin C, vitamin E, beta-carotene) and selenium supplement on D-galactosamine-induced lung injury. *Eur J Biol* 2016;75:11-18.
- [48] Tsai CC, Chou CH, Liu YC, Hsieh CW. Ultrasound assisted extraction of phenolic compounds from *Phyllanthus emblica* L. and evaluation of antioxidant activities. *Int J Cosmet Sci* 2014;36:471-476.
- [49] Afsar V, Reddy YM, Saritha K. Invitro antioxidant activity and anti-inflammatory activity of methanolic leaf extract of *Boswellia serrata*. *Int J LifeSc Bt & Pharm Res* 2012;4:15-23.
- [50] Gardeli C, Vassiliki P, Athanasios M, Kibouris T, Komaitis M. Essential oil composition of *Pistacia lentiscus* L. and *Myrtus communis* L.: Evaluation of antioxidant capacity of methanolic extracts. *Food Chem* 2008;107:1120-1130.