Original Research Article

SPINACH: A GREEN BOOST FOR HEALTHY HAIR-EXPLORING ITS NUTRIENTS AND BENEFITS FOR HAIR CARE

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Abstract

The significance of maintaining healthy hair and preventing hair loss in the context of individual health and beauty. It stresses spinach, a leafy green food, as a beneficial natural resource for fostering hair development and resolving hair loss. Due to their critical functions in preserving the health of hair, spinach is particularly abundant in vital nutrients like folate, iron, vitamin A, and vitamin C. Folate, found abundantly in spinach, is noted for its ability to support cell division and tissue growth, which in turn encourages hair follicle regeneration. Iron is described as vital for oxygen transportation to the hair follicles, ensuring their ongoing health and vibrancy. Vitamin A is mentioned for its role in sebum production, a natural hair conditioner that enhances moisture and strength. The summary closes by highlighting the advantages of including spinach in one's diet to acquire these crucial nutrients, which can lead to stronger, healthier hair and possibly help prevent hair loss. In conclusion, spinach is emphasized as a helpful dietary option for anyone wishing to naturally improve their hair care regimen and boost robust hair growth**.**

1.Introduction

Spinacia oleracea is a species of edible flowering plant in the Amaranthaceae family. S. oleracea, previously believed to belong to the Chenopodiaceae family, was transferred to the Amaranthaceae family in the order Caryophyllales in 2003. Both "Paalak" and "Spinach" are terms used to describe it. The region's native habitats include Central and South Western Asia. The reason it's grown is for its succulent leaves. For the duration of the winter, Indians eat most of this cuisine [(1)]. Vitamins A, C, E, K, B6, B2, Magnesium, Manganese, Folate, Betaine, Calcium, Potassium, Folic Acid, Copper, Protein, Phosphorus, Zinc, Niacin, Selenium, and Omega-3 Fatty Acids are all present in significant amounts. Varieties of spinach are good foods for obese persons and diabetes since they contain less fat. The anti-oxidants polyphenols, flavonoids, and carotenoids, which have been shown to have anti-inflammatory in nature anti-mutagenic, anti-neoplastic, and chemopreventive characteristics, are also prevalent in spinach [(2)]. The pharmacological effects of Spinacia oleracea include anti-oxidant, anti-proliferative, anti-inflammatory, antihistaminic, CNS depressant, protection against gamma radiation, and hepatoprotective effects. It has been claimed that this plant produces a variety of secondary metabolites, including flavonoids, carotenoids, and phenolic chemicals [(3)]. Spinach leaves are cooling, emollient, wholesome, antipyretic, diuretic, maturant, laxative, digestible,

anthelmintic, useful in urinary concretion, inflammation of the lungs and the bowels, sore throat, pain in joints, thirst, lumbago, cold and sneezing, sore eye, ringworm scabies, leucoderma, scalding urine, arrest vomiting, biliousness, flatulence. And have been applied to the management of febrile illnesses [(4)]. Beta-carotene, lutein, and zeaxanthin are three carotenoids present in spinach that are similar to antioxidants found in carrots, kale, and broccoli [(5)]. Additionally, spinach contains flavonoids, a type of potent antioxidant that prevents disease by thwarting the body's exposure to free radicals [(6)].

Humans have hair, which plays a crucial part in their daily life. Since the dawn of humanity, it has impacted both sexes and all races to varying degrees, making it a universal issue. In the fields of cosmetics and primary healthcare, hair loss is a prevalent and growing issue. As long as humans have existed, it has impacted both sexes and all races to varying degrees, making it a worldwide issue [(7)]. Since hair loss is a dermatologic condition, researchers are still looking for natural items that can encourage hair growth [(8)]. Hair loss, dandruff, hirsutism, and alopecia are common patient complaints that significantly increase physical and psychological stress [(9)]. Natural goods are sold and utilized as hair tonics, hair growth promoters, hair conditioners, hair cleansing agents, antidandruff agents, as well as for the treatment of alopecia and lice infestations (often in the form of herbal formulations [(10)]. Spinach is an essential dietary component for preventing hair loss due to its rich concentration of vital vitamins and nutrients, including folate, iron, vitamin A, and vitamin C. These nutrients are indispensable for promoting hair growth. Spinach, in particular, boasts a high iron content, which plays a pivotal role in maintaining the health of your hair [(11)].

2.Hair

Hair is a vital component of the human body. Numerous problems, including hair loss, unmanageable hair, a lack of hair volume, conditioning, immature graying, dandruff, thinning hair, dullness, etc., can be brought on by it. Hair can come in a variety of shapes, lengths, diameters, textures, and colors. In addition to being circular, triangular, uneven, or flattened, the cross-sectional structure of the hair also determines how it curls. All mammals have hair. Its main job is to regulate body temperature. It also seeks to reduce friction, offer sun protection, and act as a way organ. Hair is a person's finest achievement and is significant to human existence. Hairs were once thought of providing a protective covering for the scalp. No matter to which gender a person belongs, hair also aids in giving pride and confidence. Having black, healthy, lustrous, and high-quality hair has always been someone's desire. Keeping and maintaining them, whether they are long or short, is a priority for everyone [(12)] [(13)].

2.1.Hair structure

Hair consists of two parts:

1. Follicle

The hair follicle is a club-shaped component within the skin. At the top of the follicle, there exists a network of blood vessels that provide essential nutrients for nourishing the hair and promoting its growth, and this area is known as the papilla. The formation of each follicle arises from a dynamic interaction between the epidermal and dermal layers of the skin. A follicle is composed of three distinct segments.

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A. Infundibulum: Extends from the follicle's surface opening to the level of its sebaceous gland entrance.
B. Isthmus: Stretches from the infundibulum to the point where the arrector Pilli muscle inserts.
C. Inferior segment: A tuff of vascularized loose connective tissue termed the dermal papilla invades the base of the bulb. Numerous blood arteries are present in the hair's papilla, which also supplies nutrition for hair growth [(14)].

2. Shaft

The hair shaft is divided into three layers:

A. Medulla: The hair's midpoint. It will be continuous, segmented, broken up, or doubled. It frequently looks like a tube or is packed full of cells. The majority of hairs lack medullas, whereas some have medullas that are broken or fragmented. The centre of the hair shaft is formed by it. Particularly fine hairs frequently lack this layer.

B. Cortex: It is largest part of hair shaft which provides the color to hair i.e. melanin (hair pigment).
C. Cuticle: The hair shaft's cuticle may be its outer, translucent coating. The scales that make up this covering safeguard the inner layers of the hair by overlapping one another. The distal end of the hair is farther from the scalp and the scales project from this end [(15) (16)].

2.2.Hair cycle

The Anagen phase is followed by the Catagen and Telogen phases during the repeated cycle of hair growth [(17)]. The hair is actively developing within the anagen segment, while the catagen segment is marked by the degeneration and resorption of the lower area of the HF. Following this segment, the growth of the HF resumes. This phase is known as the Telogen phase and is where the hair is dormant.
Three important phases make up the hair development cycle on the scalp: anagen, catagen, and telogen. The advancement cycle that has been most frequently seen over the last three to five years is the anagen segment. On a healthy scalp, there are about 100,000 hairs, 90% of which are continually in the anagen stage of hair production. The catagen stage occurs after the conclusion of the growth period, when a follicle starts to become dormant. The telogen stage is a 3–4 month period of dormancy or relaxation. One historical hair sheds when the latent part comes to an end. Then, an HF transitions back to the anagen stage, where a completely new hair starts to grow. Depending on HFs and a character's age, a natural rate of hair growth is approximately 1/2 inch every 30 days. A typical hair growth cycle results in the loss of 50–60 scalp hairs per day, after which new hair follicles start to form. When significantly less new hair begins to grow in, hair loss begins to develop.

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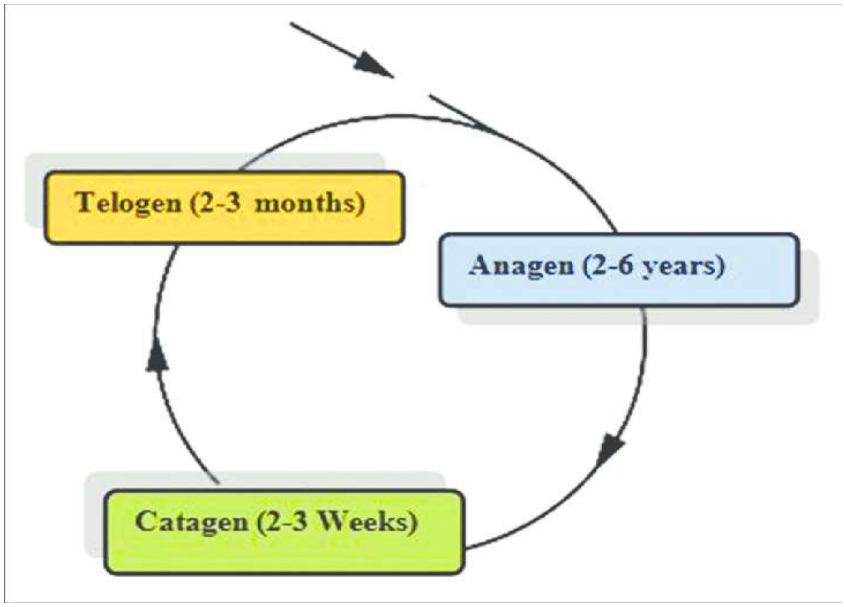

Fig. 1: Hair cycle showing anagen, catagen and telogen [18] [19].

2.3.Hair Problem

Hair Loss

Hair loss and thinning hair are also frequent in women, despite previously being associated with men. Male pattern baldness is becoming more prevalent among men. Stress, medications, shifting hormones, and even menopause can all contribute to female hair loss. Numerous hair styling products (chemicals/excessive heat) can also exacerbate hair loss [20].

Dry hair

Dry hair is a result of too many shampoos. Even though having perfectly clean hair may be a wonderful thing, many people go overboard by washing their hair frequently—sometimes twice or even every day—rinsing away all of the natural oils in the process [21].

Split Ends

Split ends are brought on by frequent hair brushing, perming, overheating, and poor conditioner [22].

Oily hair

Excessive oiliness in hair occurs when the scalp generates an abundance of sebum, a natural oil. This increased oil production happens because the sebaceous glands occasionally become overly active and produce an excessive quantity of oil.

Unruly Hair
When hair experiences a reduction in its natural moisture levels, it can lead to the development of frizz, and this tendency to have frizzy hair can be inherited within families.

Dull Hair
Dull-looking hair can be caused by a variety of factors, including environmental toxins, damage from chemical or heat styling, and others.

Heat Damaged
Too much flat ironing or curling causes harm to the hair [23].

Color Damaged Hair
When dyeing hair, chemicals are used to open the hair shaft, making the hair incredibly porous and vulnerable to breakage.

Gray Hair
For many people, having gray hair is an honor. However, some people would rather get rid of it because gray hair tends to be more fragile and unruly than other types of hair [24].

Dandruff
Little white bits of dead skin that are in someone's hair or have fallen off someone's hair are known as dandruff. *Malassezia restricta*, a fungus, is thought to be the cause, while *Globosa malassezia*, formerly known as Pityrosporum, may be yeast that infects the skin and scalp. It is brought on by not combing one's hair, allergies, stress, taking insufficient showers, etc [25].

3.Spinach
PLANT PROFILE

Regional Name: Mathubucchali(Telugu)
Synonym: Spinacia domestic a Borkh
Common name: Regional name in other language.

- Sanskrit: Chhurika
- English: Spinach
- Hindi: Paalak
- Tamil: Pasali
- Kashmiri: Palakh
- Bangla: Palang [26]

Biological source: Spinacia oleracea Linn, a plant of the Chenopodiaceae family, is known for its fresh or dried leaves, stems, and roots**.**

Distribution: Spinach is widely distributed in temperate regions and the cooler segments of tropical areas. In temperate climates, spinach plays a vital role as a leafy green vegetable that offers versatility in its consumption. It can be enjoyed either in its raw state or as a cooked dish. Young

and tender leaves are ideal for enhancing salads, whereas older leaves, once cooked, are commonly incorporated into soups.

Habitat: Spinach, an annual plant prized for its juicy foliage, has a history of cultivation dating back to ancient times. It originates from Asia and is believed to have been introduced to Europe in the first century, likely via Persia [(27)].

Plant parts used: Leaves, stem, root, and seeds.

Plant morphology

Stem: Standing 30 to 60 cm tall, spherical, smooth, piping, succulent, and occasionally reddish.

Leaves: Alternately, the lower ones have very long petioles, are differently lobed, and have lobes with a sharp triangular shape that are smooth on both sides [(28)].

4.Bioactive compounds presents in spinach

Spinach is a good source of carotenoids (*B*-carotene and lutein), vitamin C, vitamin E, vitamin K, magnesium, and a number of antioxidants such flavonoids. Twelve main flavonoids have been previously identified in spinach [(29)]. The glucuronides, acylated di- and triglycosides of methylated and methylenedioxy derivatives of 6-oxygenated flavonols, which are abundant in spinach, are glycosylated flavonoids [(30)] [(31)].

Flavonoids

Spinach, Spinacia oleracea, is known for having a high flavonoid content. Flavonoids and a decreased risk of coronary heart disease, dementia, and certain malignancies have been linked by epidemiological research [(32)]. Vegetable quality is influenced by a variety of factors, one of which is the amount of flavonoids present [(33)]. Vegetables and other plants have varying levels of flavonoids depending on their genotype, the environment in which they grow their stage of development, how they are handled after harvest, and how they are stored [(34)]. A variety of flavonoids are found in this mixture, including quercetin, myricetin, kaempferol, apigenin, luteolin, patuletin, spinacetin, jaceidin, 4'-glucuronide,5,3',4'-trihydroxy-3-methoxy-6,7-methylenedioxyflavone-4'-glucuronide,5,4'-dihy droxy-3,3'-dimethoxy-6,7-methylenedioxyflavone-4'-glucuronide,5,4'-dihydroxy-3,3'-dimethoxy-6, 7-methylene-dioxin-flavone (C18H14O8), and 3,5,7,3',4'-pentahydroxy-6-methoxyflavone [(35)].

Phenolic Compound

The plant can be used to separate the polyphenols, which include the acids para-coumaric acid, ferulic acid, and ortho-coumaric acid [(36)].

Vitamins

Spinach is well-known for its impressive vitamin content, encompassing substantial quantities of vitamins A, C, E, and K, alongside notable levels of both folic and oxalic acid.

Minerals

Spinach contains a lot of vitamins, but it also has a decent mineral makeup. minerals including phosphorus, manganese, magnesium, calcium, and zinc. Spinach is a unique plant that offers diverse culinary possibilities, whether it's enjoyed fresh in salads and smoothies or used in various cooked preparations such as soups, steaming, or as an ingredient in mixed vegetable dishes. Spinach is primarily composed of water, with a substantial content of up to 91.4%. It contains minimal protein, at just 2.9%, along with 3.6% carbohydrates and 0.4% lipids. The predominant mono- and polyunsaturated fatty acids in its lipid composition include alpha-linolenic acid, oleic acid, and linoleic acid. Additionally, there are trace amounts of saturated fatty acids like capric acid, stearic acid, and myristic acid in spinach. The primary constituents within the lipid composition are mono- and polyunsaturated fatty acids, including alpha-linolenic acid, oleic acid, and linoleic acid. In addition to these, there are minor quantities of saturated fatty acids like capric acid, stearic acid, and myristic acid [(37)]. A 100-g portion of spinach provides enough vitamins, including vitamin K (604%), vitamin A (188%), folate (49%), and vitamin C (47%), to meet or surpass a person's recommended daily allowance [(38)].

Numerous elements, including vitamins A, C, and E, beta-carotene, phylloquinone (K1), and folate, have an impact on the composition of nutrients [(39)]. Folate and tocopherol, as well as minerals including nitrogen, potassium, calcium, magnesium, copper, zinc, and manganese, vary depending on the season in which spinach is grown. The nutritional makeup of spinach is also impacted by cooking. For instance, as spinach is boiled or steam-cooked, the amount of folates drops [(40)].

Phytochemicals, such as carotenoids and phenolic compounds, are non-essential nutrients that can be found in large quantities in spinach and other plants. To quench chloroplast triplet states, stabilize protein-lipid structures, scavenge reactive oxygen species (ROS), and release excess radiant energy that is not required for photosynthesis, carotenoids are pigments that are found in nature and are a component of photosynthetic light- harvesting complexes (photosystem II). Carotenoids and lutein are abundant in spinach [(41)]. This is thought to reduce cataracts and age-related macular degeneration [(42)].A significant number of phenolic chemical metabolites from secondary metabolism is present in spinach [(43)]. Phenolic chemicals have anti-inflammatory, antiviral, antifungal, and antioxidant properties [(44)]. Additionally, 0.8% of spinach is gallic acid.

Based on their chemical composition, polyphenols are divided into four groups: phenolic acid, flavonoids, liganas, and stilbenes [(45)]. Spinach is rich in 17 different flavonoids, including patuletin, spinacetin, spinatoside, jaceidin, and flavone[(46)].The two groups of phenolic 122 acids are hydroxycinnamic acid (including p-coumaric, ferulic, and vanillic acids) and hydroxybenzoic acid[(47)].

Carotenoids

Carotenoids, which are yellow, orange, or red pigments covered in green chlorophyll, may be found in spinach in significant amounts. Despite being susceptible to light oxidation (acting as potent antioxidants), carotenoids have been found to be more stable during heat processing than chlorophylls. Various carotenoids, including lutein 9'- (Z)-neoxanthin, -carotene, and violaxanthin, are present in spinach [(48)]

5.Antioxidant property of spinach

The antioxidant activity in the spinach leaves was extracted with water, and the 20,000 g supernatant was extracted using water: acetone (1:9) solution. The resultant 20,000 g supernatant was purified further using reverse phase HPLC and a C-8 semi-preparative column. The hydrophilic peaks were intense after elution with 0.1 percent TFA. Seven more hydrophobic peaks emerged after elution with acetonitrile in TFA. Each peak was visible at 250 nm, All of the produced fractions showed antioxidant activity when they were tested using three distinct assays. By employing 1H and 13C NMR spectroscopy, four of the hydrophobic fractions were determined to be glucuronic acid derivatives of flavonoids, while the remaining three were determined to be Trans and CIS isomers of pcoumaric acid and the remaining four to be meso-tartarate derivatives of pcoumaric acid. This study is the first to identify the antioxidant components flavonoids and p-coumaric acid derivatives in the aqueous extract of spinach leaves [(49) (50)].

6.Conclusion

In conclusion, consuming spinach regularly is a good way to maintain healthy hair. Antioxidants, including numerous flavonoids and vitamins, including vitamins A, C, E, and K, are abundant in its chemical makeup. These antioxidants are essential for shielding the scalp and hair follicles from oxidative damage, which can result in dullness and hair loss. One can use spinach's antioxidant capabilities to support healthier, stronger, and brighter hair by including it in one's diet. However, it's crucial to keep in mind that general nutrition and a balanced diet are essential components of preserving ideal hair health, and spinach can be a useful component of those variables.

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