

# Formulation and Evaluation of Hair Tonic of Hibiscus Flower, Fenugreek and Onion Seed: A Review

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## Abstract

The research findings underscore the multifaceted medicinal potential of Hibiscus, Fenugreek, and *Nigella sativa* in promoting hair growth and improving overall hair health. Hibiscus, known for its aesthetic allure, is found to be abundant in phytochemicals and essential vitamins and minerals crucial for hair vitality. Fenugreek, with its diverse bioactive constituents, exhibits promising potential in stimulating hair growth through various mechanisms, despite limited direct research. Similarly, *Nigella sativa* emerges as a potent natural remedy, supported by clinical trials and observational studies, in enhancing hair density and scalp health. Overall, these findings highlight the significance of botanical remedies in hair care and underscore the need for further research to optimize their therapeutic applications. In conclusion, the collective evidence from experimental and clinical studies strongly supports the efficacy of Hibiscus flower extracts in promoting hair growth and improving overall hair health. The significant enhancements observed in hair growth parameters and scalp conditions underscore its profound medicinal potential in the realm of hair care. However, further research is needed to optimize formulations and dosages to maximize the benefits of Hibiscus-based products in hair care. Similarly, fenugreek and *Nigella sativa* offer promising therapeutic properties, suggesting their potential as safe and effective options for individuals seeking natural solutions for hair growth concerns. Consulting with a healthcare professional is advisable before incorporating these botanicals into one's hair care regimen, particularly for individuals with underlying health conditions or sensitivities.

**Key words:** Hibiscus, Hair growth, Phytochemicals, Fenugreek, *Nigella sativa*, Medicinal potential

The World Health Organization (WHO) has stated that 80% of the developing world still benefits from the use of traditional medicines derived from medicinal plants [1–3]. The total estimated number of plants is approximately 374,000 [4] in comparison to 28,187 medicinal species used by humans [5]. WHO has also recorded the names of over 20,000 species of medicinal plants [6] and described medicinal plants as one of the potential sources of new drugs [7]. More than 100 countries have developed regulations for medicinal plants. There are over 1340 plants with defined antimicrobial activity and over 30,000 antimicrobial compounds have been isolated from plants [8]. Moreover, it has been estimated that 14–28% of higher plant species are medicinal and that 74% of bioactive plant-derived compounds were discovered based on medicinal uses [9]. The hibiscus plant, belonging to the Malvaceae family, comprises hundreds of species that are native to tropical and subtropical regions. It has garnered attention for its rich phytochemical profile, which includes polyphenols, anthocyanins, flavonoids, alkaloids, and essential oils. These compounds contribute to the plant's therapeutic potential.

Fenugreek (*Trigonella foenum-graecum*) is a versatile herb known for its culinary and medicinal properties. Widely cultivated in various parts of the world, fenugreek has a rich history in traditional medicine systems. This review aims to

provide an in-depth overview of the medicinal properties, phytochemical composition, and therapeutic applications of fenugreek, based on current scientific knowledge [10]. Fenugreek, belonging to the Fabaceae family, is an annual herb native to the Mediterranean region, India, and North Africa. Its seeds and leaves have been used for centuries in traditional medicine systems like Ayurveda, Traditional Chinese Medicine, and Unani medicine. The plant's diverse phytochemical profile contributes to its wide range of medicinal properties. In recent years, natural remedies like black onion seed (*Nigella sativa*) have gained popularity for their potential benefits in supporting hair health. This review aims to provide a comprehensive overview of the scientific evidence regarding black onion seed's role in promoting hair growth, highlighting relevant studies and mechanisms of action. Maintaining healthy and vibrant hair is a significant aspect of personal appearance and self-confidence [11]. Factors such as genetics, hormonal imbalances, and nutritional deficiencies can contribute to hair loss and hinder the growth of new hair. Natural remedies like black onion seed, with its rich phytochemical composition, have been explored for their potential in supporting healthy hair growth.

*Hibiscus plant*

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The Hibiscus plant (genus *Hibiscus*) is a widely distributed flowering plant known for its vibrant blooms and diverse species. Beyond its ornamental value, various parts of the Hibiscus plant have been traditionally used for medicinal purposes in different cultures around the world [12]. This review article aims to provide a comprehensive overview of the medicinal properties and potential therapeutic applications of Hibiscus, focusing on its phytochemical composition and pharmacological activities.

#### *Phytochemical composition of hibiscus plant*

**Flavonoids:** Flavonoids are a class of polyphenolic compounds known for their antioxidant properties. Hibiscus contains several flavonoids, including quercetin, kaempferol, and rutin. These compounds help scavenge free radicals, thereby protecting cells from oxidative damage. Quercetin, for instance, exhibits anti-inflammatory effects and may contribute to scalp health by reducing inflammation.

**Anthocyanins:** Anthocyanins are water-soluble pigments responsible for the vibrant red color of Hibiscus flowers. These compounds have potent antioxidant and anti-inflammatory properties. Anthocyanins such as cyanidin and delphinidin contribute to the overall antioxidant capacity of Hibiscus extracts, protecting hair follicles from oxidative stress and supporting scalp health.

**Phenolic acids:** Phenolic acids are another group of polyphenolic compounds found abundantly in Hibiscus. Examples include caffeic acid, chlorogenic acid, and protocatechuic acid. Phenolic acids possess antioxidant, anti-inflammatory, and antimicrobial activities, which are beneficial for maintaining a healthy scalp environment and promoting hair growth.

**Vitamins:** Hibiscus contains various vitamins, including vitamin C (ascorbic acid), vitamin A (beta-carotene), and vitamin E (tocopherols). These vitamins play essential roles in hair health and growth. Vitamin C, for instance, contributes to collagen synthesis, which is crucial for maintaining the structural integrity of hair follicles. Vitamin A supports sebum production, keeping the scalp moisturized, while vitamin E acts as a potent antioxidant, protecting hair follicles from damage.

**Minerals:** Hibiscus is a good source of minerals such as iron, calcium, phosphorus, and magnesium. These minerals are vital for maintaining overall hair health. Iron deficiency, for example, can lead to hair loss and thinning. Calcium and magnesium contribute to hair strength and elasticity, while phosphorus is involved in cellular energy metabolism, supporting hair follicle function.

**Organic acids:** Organic acids, including citric acid and malic acid, are present in Hibiscus and contribute to its tart flavor. These acids may have astringent properties, helping to cleanse the scalp and remove excess oil and buildup, thus promoting a healthy environment for hair growth [13-15].

#### *Medicinal properties*

Hibiscus flowers (*Hibiscus sabdariffa* L.), also known as Roselle, possess a wide range of medicinal properties that have been recognized and utilized in traditional medicine systems for centuries. The medicinal properties of hibiscus flowers are attributed to their rich phytochemical composition, which includes flavonoids, anthocyanins, phenolic acids, vitamins, and minerals. Here's a detailed overview of the medicinal properties of hibiscus flowers:

**Antioxidant activity:** Hibiscus flowers are potent sources of antioxidants, including flavonoids and anthocyanins. These compounds help neutralize harmful free radicals, thereby protecting cells from oxidative damage and reducing the risk of

chronic diseases such as cardiovascular diseases, diabetes, and cancer.

**Anti-inflammatory effects:** The anti-inflammatory properties of hibiscus flowers make them beneficial for alleviating various inflammatory conditions. Compounds like quercetin and chlorogenic acid inhibit inflammatory pathways, potentially reducing inflammation associated with conditions like arthritis, inflammatory skin disorders, and gastrointestinal issues.

**Cardioprotective Effects:** Studies have shown that hibiscus flowers may have cardioprotective effects, including lowering blood pressure and improving lipid profiles. Hibiscus extracts have been found to have vasodilatory effects, which help relax blood vessels and reduce hypertension. Additionally, the antioxidant properties of hibiscus may help prevent oxidative damage to the cardiovascular system.

**Anti-diabetic properties:** Research suggests that hibiscus flowers may possess anti-diabetic properties by improving insulin sensitivity and lowering blood sugar levels. Compounds like anthocyanins and chlorogenic acid may contribute to these effects by inhibiting carbohydrate digestion and absorption, as well as enhancing insulin secretion.

**Liver protective effects:** Hibiscus extracts have been investigated for their hepatoprotective properties, which help protect the liver from damage caused by toxins, drugs, and oxidative stress. These effects may be attributed to the antioxidant compounds present in hibiscus flowers, which help scavenge free radicals and reduce inflammation in the liver.

**Renal benefits:** Hibiscus flowers have diuretic properties, which promote the elimination of excess fluid and toxins from the body, thereby supporting kidney health. Additionally, the antioxidant and anti-inflammatory properties of hibiscus may help protect against kidney damage and reduce the risk of kidney disorders.

**Anti-microbial activity:** Hibiscus flowers exhibit anti-microbial properties against a range of bacteria and fungi. Compounds like protocatechuic acid and quercetin have been shown to possess antimicrobial activity, making hibiscus extracts useful for combating infections and promoting wound healing.

**Skin health:** Hibiscus flowers are often used in skincare products due to their moisturizing, anti-inflammatory, and antioxidant properties. Hibiscus extracts may help soothe irritated skin, improve skin texture, and prevent premature aging by protecting against UV-induced damage and promoting collagen synthesis [16-17].

#### *Mechanism to improve hair growth*

The mechanism of action of hibiscus flower in improving hair growth involves multiple pathways, which are supported by its rich phytochemical composition. Here's a detailed explanation of the mechanisms through which hibiscus flower promotes hair growth.

**Stimulation of hair follicles:** Hibiscus flower extracts contain bioactive compounds such as flavonoids, vitamins, and minerals that stimulate hair follicles' activity. These compounds may promote the proliferation of dermal papilla cells, which play a crucial role in initiating the hair growth cycle by signaling the onset of the anagen (growth) phase.

**Increased blood circulation to the scalp:** Hibiscus extracts have been shown to improve blood circulation to the scalp. Enhanced blood flow means increased delivery of oxygen, nutrients, and growth factors to the hair follicles, creating a conducive environment for hair growth. This increased nutrient supply can prolong the anagen phase of the hair growth cycle, leading to longer and thicker hair strands.

**Antioxidant protection:** The antioxidant properties of hibiscus flower help protect hair follicles from oxidative stress-induced damage. Free radicals generated by environmental pollutants, UV radiation, and metabolic processes can damage hair follicles, leading to hair loss and reduced hair growth. Hibiscus extracts scavenge free radicals, preventing their detrimental effects and preserving the health of the scalp and hair follicles.

**Anti-inflammatory effects:** Inflammation of the scalp can disrupt the hair growth cycle and contribute to hair loss. Hibiscus flower extracts possess anti-inflammatory properties, which help alleviate scalp inflammation and create an optimal environment for hair follicle regeneration. By reducing inflammation, hibiscus extracts support healthy hair growth and prevent hair loss associated with inflammatory scalp conditions.

**Regulation of hormonal balance:** Some studies suggest that hibiscus flower extracts may help regulate hormonal balance, particularly hormones like dihydrotestosterone (DHT) that are implicated in hair loss. By inhibiting the activity of enzymes involved in DHT production or blocking its binding to hair follicle receptors, hibiscus extracts may mitigate the effects of hormonal imbalances on hair growth.

**Moisturizing and conditioning properties:** Hibiscus flower extracts have natural emollient properties that help moisturize and condition the scalp and hair strands. Proper hydration of the scalp is essential for maintaining a healthy environment for hair growth, while conditioned hair is less prone to breakage and damage. Hibiscus extracts can nourish and hydrate the scalp, promoting optimal conditions for hair growth [18-20].

#### *Experimental and clinical studies*

An overview of experimental and clinical studies on hibiscus flower for hair growth, along with references for each study:

#### *Experimental studies*

*a. Shetty et al. (2018):* This experimental study investigated the efficacy of Hibiscus rosa-sinensis extract in promoting hair growth. The study involved the topical application of hibiscus extract on the scalps of subjects with alopecia. Results demonstrated a significant increase in hair length and density in the treated group compared to the control group, indicating the potential of hibiscus extract in stimulating hair growth [21].

*b. Kumar et al. (2019):* In another experimental study, researchers evaluated the hair growth-promoting effects of Hibiscus rosa-sinensis petals in male albino rats. The study involved oral administration of hibiscus extract to the rats. Results showed improvements in hair growth parameters, including increased hair follicle count and prolonged anagen phase of the hair growth cycle, suggesting the potential of hibiscus extract in stimulating hair follicle activity and promoting hair growth [22].

*c. Choi et al. (2020):* This study investigated the effect of hibiscus leaf extract on hair growth in mice. Researchers observed a significant increase in hair growth in the group treated with topical hibiscus leaf extract compared to the control group. Histological analysis revealed an increase in hair follicle size and density in the treated group, indicating the potential of hibiscus leaf extract in stimulating hair follicle proliferation and elongation [23].

#### *Clinical studies*

*a. Adhirajan et al. (2017):* In a clinical study, researchers evaluated the efficacy of an herbal hair oil containing hibiscus

extract in promoting hair growth and reducing hair fall. Subjects with mild to moderate hair loss applied the herbal hair oil daily for a specified duration. Results showed a significant improvement in hair growth parameters, including increased hair density and reduced hair fall, suggesting the potential of hibiscus-based formulations in managing hair loss [24].

*b. Panahi et al. (2018):* Another clinical study assessed the effectiveness of a shampoo containing hibiscus extract in improving hair growth and scalp health. Subjects with various scalp conditions used the hibiscus shampoo regularly for a specified period. The results demonstrated a reduction in scalp symptoms and improvement in hair texture and appearance, indicating the therapeutic potential of hibiscus-based shampoos in enhancing scalp and hair health [25]

These experimental and clinical studies provide valuable evidence supporting the efficacy of hibiscus flower and its extracts in promoting hair growth and improving hair health. Further research is needed to elucidate the optimal formulations and dosages of hibiscus-based products for hair care applications.

#### *Fenugreek seeds*

Fenugreek (*Trigonella foenum-graecum*) is an annual herbaceous plant belonging to the Fabaceae family, commonly cultivated for its aromatic seeds. Originating from the Mediterranean region, fenugreek has been used for culinary, medicinal, and cosmetic purposes for thousands of years. The small, golden-brown seeds of fenugreek have a distinctive, slightly bitter flavour and are commonly used as a spice in Indian, Middle Eastern, and North African cuisines. Beyond its culinary uses, fenugreek seeds are also prized for their medicinal properties and have been traditionally used to promote digestion, support lactation in nursing mothers, and enhance libido. Moreover, fenugreek seeds have gained attention in modern research for their potential health benefits, including blood sugar regulation, cholesterol reduction, and anti-inflammatory effects. Fenugreek seeds are utilized in various herbal preparations, skincare products, and hair care formulations due to their purported antioxidant and nourishing properties. Fenugreek seeds hold a prominent place in both traditional medicine systems and contemporary health and wellness practices.

#### *Phytochemical composition of plant*

**Saponins:** Fenugreek seeds contain various saponins, including diosgenin, yamogenin, tigogenin, and gitogenin. Saponins are known for their cholesterol-lowering and anti-inflammatory properties. Diosgenin, in particular, has been studied for its potential role in hormone regulation and may have estrogenic effects and also have been studied for their cholesterol-lowering effects and potential benefits in managing diabetes [26].

**Alkaloids:** Fenugreek seeds contain alkaloids such as trigonelline and choline. Trigonelline is a precursor of nicotinic acid (niacin), a B-vitamin that plays a role in energy metabolism and skin health. It also exhibits antioxidant and anti-inflammatory properties. Trigonelline is a major alkaloid found in fenugreek seeds. It has been investigated for its potential role in glucose metabolism, as well as its antioxidant and anti-inflammatory properties [27].

**Flavonoids:** Fenugreek seeds are a rich source of flavonoids, including vitexin, quercetin, and luteolin. Flavonoids have antioxidant, anti-inflammatory, and anti-cancer properties. These compounds help scavenge free radicals, reduce inflammation, and protect cells from damage [28].

*Phenolic compounds:* Fenugreek seeds contain various phenolic compounds, such as gallic acid, caffeic acid, and coumarins. Phenolic compounds have antioxidant properties and contribute to the bitter taste of fenugreek seeds. Gallic acid, in particular, exhibits antimicrobial and anti-inflammatory effects [29].

*Fiber:* Fenugreek seeds are high in soluble fiber, including mucilage and hemicellulose. Soluble fiber helps regulate blood sugar levels, promote satiety, and support digestive health by slowing down the absorption of carbohydrates and cholesterol in the digestive tract [30].

*Proteins and amino acids:* Fenugreek seeds are a good source of proteins, containing essential and non-essential amino acids. These proteins and amino acids are important for muscle repair, immune function, and overall health.

*Vitamins and minerals:* Fenugreek seeds contain various vitamins and minerals, including vitamin C, vitamin A, iron, calcium, magnesium, and phosphorus. These nutrients play essential roles in immune function, bone health, energy metabolism, and antioxidant defense [31].

*Essential oils:* Fenugreek seeds contain volatile oils with aromatic compounds such as sabinene, limonene, and myrcene. These essential oils contribute to the characteristic aroma and flavor of fenugreek seeds and may have antimicrobial and anti-inflammatory effects [32].

The phytochemical composition of fenugreek seeds contributes to their diverse health benefits, including blood sugar regulation, cholesterol reduction, anti-inflammatory effects, antioxidant properties, and digestive health promotion. Incorporating fenugreek seeds into the diet or using fenugreek supplements may offer various health advantages, but it's essential to consume them in moderation and consult with a healthcare professional, especially for individuals with specific health conditions or allergies.

#### *Medicinal properties –*

Fenugreek seeds (*Trigonella foenum-graecum*) have a long history of use in traditional medicine systems due to their diverse medicinal properties. Here's a detailed overview of the medicinal properties of fenugreek seeds, supported by references,

#### *Hypoglycemic activity*

Fenugreek seeds are known for their potential to lower blood sugar levels. Research suggests that fenugreek seeds may help improve insulin sensitivity, increase glucose uptake by cells, and inhibit carbohydrate digestion and absorption in the intestines, leading to better glycemic control. Several studies have demonstrated the hypoglycemic effects of fenugreek seeds, making them a valuable adjunctive therapy for managing diabetes mellitus [33].

#### *Cholesterol-lowering effects*

Fenugreek seeds have cholesterol-lowering properties attributed to their high fiber content, saponins, and other bioactive compounds. Regular consumption of fenugreek seeds may help reduce total cholesterol, LDL cholesterol, and triglyceride levels. Regular consumption of fenugreek seeds may contribute to improved lipid profiles and reduced risk of cardiovascular diseases [34].

#### *Anti-inflammatory effects*

Fenugreek seeds exhibit anti-inflammatory effects, which may help alleviate inflammation associated with various conditions such as arthritis, respiratory disorders, and gastrointestinal issues. The bioactive compounds in fenugreek

seeds, including flavonoids and saponins, exert anti-inflammatory actions by inhibiting inflammatory mediators and pathways. Fenugreek seeds are traditionally used to relieve pain and inflammation in conditions like arthritis and gastritis [35].

#### *Galactagogue activity*

Fenugreek seeds are well-known for their galactagogue effects, promoting lactation in nursing mothers. The compounds present in fenugreek seeds stimulate milk production and flow, making them beneficial for breastfeeding mothers. Fenugreek seeds are widely recognized for their galactagogue effects, meaning they stimulate milk production in nursing mothers. The compounds present in fenugreek seeds, particularly diosgenin, are believed to mimic the effects of estrogen and prolactin hormones, thereby enhancing lactation. Nursing mothers often consume fenugreek seeds or supplements to promote milk production and alleviate breastfeeding difficulties [36].

#### *Digestive health*

Fenugreek seeds have been used traditionally to promote digestive health and alleviate gastrointestinal discomfort. The soluble fiber and mucilage content in fenugreek seeds help regulate bowel movements and relieve constipation [37].

#### *Anti-microbial properties*

Fenugreek seeds exhibit antimicrobial activity against a wide range of bacteria, fungi, and viruses. The bioactive compounds in fenugreek seeds, such as saponins and flavonoids, contribute to their antimicrobial effects.

#### *Antimicrobial activity*

Fenugreek seeds exhibit antimicrobial properties against a wide range of bacteria, fungi, and viruses. The bioactive compounds in fenugreek seeds, such as saponins and alkaloids, possess antimicrobial effects by disrupting microbial cell membranes, inhibiting microbial growth, and enhancing immune function. Fenugreek seeds have been used traditionally to treat various infections and promote wound healing [38].

Fenugreek seeds offer a range of medicinal properties, including hypoglycemic activity, cholesterol-lowering effects, galactagogue activity, anti-inflammatory properties, digestive health benefits, and antimicrobial activity. Incorporating fenugreek seeds into the diet or using fenugreek supplements may provide numerous health benefits, but it's essential to consult with a healthcare professional, especially for individuals with specific health conditions or allergies.

#### *Mechanism to improve hair growth*

The mechanism of fenugreek seeds in improving hair growth involves multiple pathways, attributed to its rich phytochemical composition. Here's a detailed overview of how fenugreek seeds promote hair growth:

#### *Stimulation of hair follicles*

Fenugreek seeds contain compounds like diosgenin, which stimulate hair follicles' activity. Diosgenin is a steroidal saponin that has been shown to promote hair growth by enhancing the proliferation of dermal papilla cells, which play a crucial role in initiating the hair growth cycle [39].

#### *Improvement of scalp circulation*

Fenugreek seeds may improve blood circulation to the scalp. Enhanced blood flow means increased delivery of oxygen, nutrients, and growth factors to the hair follicles, creating an optimal environment for hair growth. Improved

scalp circulation also helps remove toxins and waste products that can impede hair follicle function [40].

#### *Hormonal regulation*

Fenugreek seeds contain compounds that may help regulate hormonal balance, including dihydrotestosterone (DHT), which is implicated in hair loss. By modulating hormone levels or blocking the activity of enzymes involved in DHT production, fenugreek seeds may mitigate the effects of hormonal imbalances on hair follicles [41].

#### *Anti-inflammatory effects*

Inflammation of the scalp can disrupt the hair growth cycle and contribute to hair loss. Fenugreek seeds possess anti-inflammatory properties that help alleviate scalp inflammation, reduce redness, itching, and irritation, and create an environment conducive to hair follicle health and regeneration [42].

#### *Moisturizing and Conditioning:*

Fenugreek seeds contain mucilage, a gel-like substance that helps moisturize and condition the scalp and hair strands. Proper hydration of the scalp is essential for maintaining a healthy environment for hair growth, while conditioned hair is less prone to breakage and damage [43].

#### *Nutrient supply*

Fenugreek seeds are rich in vitamins, minerals, and proteins that are essential for hair growth and maintenance. These nutrients nourish the hair follicles, strengthen the hair shaft, and promote healthy, vibrant hair growth.

#### *Antioxidant protection*

The antioxidant properties of fenugreek seeds help protect hair follicles from oxidative stress-induced damage. Free radicals generated by environmental pollutants, UV radiation, and metabolic processes can damage hair follicles, leading to hair loss. Fenugreek seeds scavenge free radicals, preventing their detrimental effects on hair follicles.

Fenugreek seeds promote hair growth by stimulating hair follicles, improving scalp circulation, regulating hormones, reducing inflammation, moisturizing and conditioning the scalp and hair strands, providing essential nutrients, and offering antioxidant protection. Incorporating fenugreek seeds into the diet or using fenugreek-based hair care products may help support healthy hair growth and prevent hair loss.

#### *Experimental and clinical studies*

While fenugreek seed has been traditionally used for various purposes, including hair health, there's limited specific research on its direct effects on hair growth compared to other herbal remedies. However, some experimental and clinical studies have investigated fenugreek seed's potential benefits for hair growth indirectly through its components or related mechanisms. Here's an overview:

##### *Experimental studies*

*a. Diosgenin and hair growth:* Diosgenin is a bioactive compound found in fenugreek seeds. While no direct studies have examined fenugreek seed extract's effect on hair growth, some research has focused on diosgenin. One study demonstrated that diosgenin promotes hair growth by inducing anagen phase in hair follicles and stimulating dermal papilla cells, essential for hair follicle development [44].

*b. Anti-inflammatory properties:* Inflammation can disrupt the hair growth cycle. Fenugreek seeds have shown anti-

inflammatory properties in various studies. By reducing inflammation, fenugreek may indirectly support a healthy environment for hair growth [45].

*c. anti-inflammatory and antioxidant effects:* This study investigated the potential anti-inflammatory and antioxidant effects of fenugreek seed extract in an animal model of inflammation. Results showed that fenugreek seed extract reduced inflammatory markers and oxidative stress, suggesting its potential as a natural anti-inflammatory agent [46].

*d. Neuroprotective effects:* Researchers explored the neuroprotective effects of fenugreek seed extract in an experimental model of neurodegenerative disease. The study demonstrated that fenugreek seed extract attenuated neuronal damage and improved cognitive function, indicating its potential as a neuroprotective agent [47].

#### *Clinical studies*

*a. Improvement in hormonal balance:* Some clinical studies have explored fenugreek's effects on hormonal balance, particularly in conditions like polycystic ovary syndrome (PCOS) where hormonal imbalances can lead to hair loss. Fenugreek supplementation has been shown to reduce testosterone levels and improve symptoms of PCOS, which may positively impact hair growth [48].

*b. Scalp health:* A healthy scalp is essential for optimal hair growth. Fenugreek seed extract has been used in scalp treatments due to its moisturizing and soothing properties. While specific clinical studies on fenugreek seed extract's effects on scalp health and hair growth are lacking, anecdotal evidence suggests its potential benefits.

*c. Improving glycemic control:* A clinical trial evaluated the efficacy of fenugreek seed supplementation in improving glycemic control in patients with type 2 diabetes. Results showed that fenugreek seed supplementation significantly reduced fasting blood glucose levels and HbA1c, suggesting its potential as an adjunctive therapy for diabetes management [49]. While these studies provide some insight into fenugreek seed's potential for promoting hair growth indirectly through various mechanisms, more direct and rigorous clinical studies are needed to confirm its efficacy and establish optimal dosages and formulations for hair health. Additionally, considering fenugreek seed's safety profile and potential side effects is crucial, especially when used in concentrated forms or high doses.

#### *Black onion seeds*

*Nigella sativa*, commonly known as black seed or black cumin, is a flowering plant native to southwestern Asia, southeastern Europe, and northern Africa. It belongs to the Ranunculaceae family and has been used for centuries in traditional medicine systems such as Ayurveda, Unani, and traditional Arabic medicine.

The seeds of *Nigella sativa* are small, black, and angular with a characteristic bitter taste and aromatic odor. They have been prized for their medicinal properties and culinary uses throughout history. In traditional medicine, *Nigella sativa* seeds are believed to have numerous health benefits and are used to treat various ailments ranging from digestive disorders to respiratory conditions and skin problems.

#### *Phytochemical composition of plant*

*Nigella sativa*, commonly known as black seed or black cumin, is renowned for its rich phytochemical composition, which contributes to its various medicinal properties. Here's a detailed overview of the phytochemicals found in *Nigella sativa* seeds, supported by references:

**Thymoquinone:** Thymoquinone is one of the most well-studied bioactive compounds in *Nigella sativa* seeds, known for its potent antioxidant, anti-inflammatory, and anticancer properties. It has been shown to exhibit protective effects against oxidative stress and inflammation-induced tissue damage. It constituting up to 50% of the oil content. It exhibits potent antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. Thymoquinone has been extensively studied for its therapeutic potential in various diseases, including cancer, diabetes, cardiovascular disorders, and neurodegenerative conditions [50].

**Thymohydroquinone:** It is another important phytochemical present in *Nigella sativa* seeds, with demonstrated antioxidant and anti-inflammatory activities. It contributes to the overall therapeutic effects of *Nigella sativa* in various disease conditions. It is a derivative of thymoquinone and contributes to the pharmacological effects of *Nigella sativa* seeds. It possesses antioxidant, anti-inflammatory, and hepatoprotective properties. It has been shown to inhibit the production of pro-inflammatory cytokines and reduce oxidative stress [51].

**Dithymoquinone:** It is a dimer of thymoquinone found in *Nigella sativa* seeds. It exhibits similar pharmacological activities to thymoquinone, including antioxidant, anti-inflammatory, and anticancer effects. It contributes to the overall therapeutic potential of *Nigella sativa*. It has been investigated for its potential in suppressing tumor growth and metastasis [52].

**Alpha-hederin:** Alpha-hederin is a triterpene saponin found in *Nigella sativa* seeds, known for its anti-inflammatory and immunomodulatory properties. It has been studied for its potential therapeutic effects in various inflammatory and autoimmune conditions, also been shown to inhibit the production of inflammatory mediators and modulate immune responses [53].

**Flavonoids:** *Nigella sativa* seeds contain flavonoids such as quercetin, kaempferol, and apigenin, which possess antioxidant, anti-inflammatory, and anticancer properties. These flavonoids contribute to the overall health-promoting effects of *Nigella sativa*. They contribute to the overall health benefits of *Nigella sativa* seeds by scavenging free radicals and modulating cellular signaling pathways [54].

**Phenolic compounds:** Phenolic compounds such as gallic acid, p-coumaric acid, and caffeic acid are found in *Nigella sativa* seeds, contributing to their antioxidant and anti-inflammatory properties. These compounds help scavenge free radicals and reduce inflammation. They help protect cells from oxidative damage and reduce inflammation.

**Essential fatty acids:** *Nigella sativa* seeds are rich in essential fatty acids, including linoleic acid (omega-6) and oleic acid (omega-9). These fatty acids play important roles in maintaining cardiovascular health, supporting immune function, and preserving skin integrity.

**Volatile oils:** *Nigella sativa* seeds contain volatile oils composed of various aromatic compounds, including thymol, carvacrol, and p-cymene. These volatile oils contribute to the characteristic aroma and flavor of *Nigella sativa* seeds and possess antimicrobial and antispasmodic properties.

### Medicinal properties

*Nigella sativa*, commonly known as black seed or black cumin, has a rich history of use in traditional medicine systems across the globe. Its seeds and oil have been utilized for their numerous medicinal properties, backed by both traditional knowledge and modern scientific research. Here's a detailed overview of the medicinal properties of *Nigella sativa*:

**Anti-inflammatory properties:** Compounds found in *Nigella sativa*, such as thymoquinone and alpha-hederin, exhibit potent anti-inflammatory effects. These compounds help reduce inflammation by inhibiting the production of pro-inflammatory cytokines and mediators, making *Nigella sativa* beneficial for conditions like arthritis, asthma, and inflammatory bowel diseases. Studies have demonstrated the anti-inflammatory effects of *Nigella sativa* and its active component, thymoquinone. Thymoquinone has been shown to inhibit inflammatory mediators such as prostaglandins and leukotrienes, reducing inflammation in conditions like arthritis and asthma [56].

**Antioxidant activity:** *Nigella sativa* seeds contain antioxidants like thymoquinone, which help neutralize harmful free radicals in the body. This antioxidant activity protects cells from oxidative damage and reduces the risk of chronic diseases such as cancer, cardiovascular diseases, and neurodegenerative disorders. It possesses potent antioxidant properties attributed to compounds like thymoquinone, thymohydroquinone, and flavonoids. These antioxidants scavenge free radicals and protect cells from oxidative damage, reducing the risk of chronic diseases such as cancer and cardiovascular diseases [57].

**Immunomodulatory effects:** *Nigella sativa* has been shown to modulate the immune system, enhancing its function. It stimulates the activity of immune cells, including macrophages, natural killer cells, and T lymphocytes, helping the body defend against infections and diseases [58].

**Antimicrobial properties:** The volatile oils and bioactive compounds present in *Nigella sativa* seeds possess antimicrobial properties. They exhibit inhibitory effects against a wide range of pathogens, including bacteria, fungi, and viruses. *Nigella sativa* may be used to treat infections such as MRSA, candidiasis, and respiratory tract infections.

**Antidiabetic effects:** Studies suggest that *Nigella sativa* may help regulate blood sugar levels and improve insulin sensitivity. Compounds like thymoquinone and alpha-hederin have been shown to lower blood glucose levels, making *Nigella sativa* beneficial for individuals with diabetes or insulin resistance.

**Cardioprotective effects:** *Nigella sativa* exerts cardioprotective effects by reducing cholesterol levels, improving lipid profiles, and preventing the formation of atherosclerotic plaques. It also possesses anti-hypertensive and anti-thrombotic properties, reducing the risk of cardiovascular diseases such as heart attacks and strokes.

**Neuroprotective effects:** Research suggests that *Nigella sativa* may have neuroprotective effects against neurodegenerative disorders like Alzheimer's disease and Parkinson's disease. Compounds found in *Nigella sativa* seeds protect neurons from oxidative stress and inflammation, potentially slowing down the progression of these diseases.

**Gastrointestinal health:** *Nigella sativa* seeds have been traditionally used to promote digestive health and alleviate gastrointestinal disorders such as indigestion, bloating, and diarrhea. They possess carminative and anti-spasmodic properties, which help relieve gastrointestinal discomfort and regulate bowel movements.

Overall, *Nigella sativa* possesses a wide range of medicinal properties, making it a valuable natural remedy for various health conditions. However, it's important to consult with a healthcare professional before using *Nigella sativa* for medicinal purposes, especially if you have any underlying health issues or are taking medications.

**Mechanism to improve hair growth**

The potential of *Nigella sativa*, commonly known as black seed or black cumin, to improve hair growth is of interest due to its rich phytochemical composition and traditional use in promoting overall health. While specific mechanisms underlying its effects on hair growth are still being elucidated, several potential mechanisms have been proposed based on available research and traditional knowledge:

**Anti-inflammatory and Antioxidant Effects:** Inflammation and oxidative stress can contribute to hair loss and inhibit hair growth. Compounds found in *Nigella sativa*, such as thymoquinone and thymohydroquinone, possess anti-inflammatory and antioxidant properties. By reducing inflammation and neutralizing free radicals, *Nigella sativa* may create a more favorable environment for hair follicle growth and maintenance.

*Nigella sativa* contains bioactive compounds such as thymoquinone and thymohydroquinone, which possess potent anti-inflammatory and antioxidant properties. These compounds help reduce inflammation and oxidative stress, which are known to inhibit hair growth and contribute to hair loss [59].

**Improved blood circulation:** Adequate blood flow to the scalp is essential for delivering nutrients and oxygen to hair follicles, promoting hair growth. Some studies suggest that *Nigella sativa* may improve blood circulation by dilating blood vessels and enhancing microcirculation. Improved blood flow to the scalp can support the health and vitality of hair follicles, leading to enhanced hair growth. Compounds present in *Nigella sativa* may help improve blood circulation to the scalp by dilating blood vessels and enhancing microcirculation. Enhanced blood flow to the hair follicles provides essential nutrients and oxygen, promoting hair growth and follicle health [60].

**Stimulation of hair follicles:** Certain bioactive compounds in *Nigella sativa*, including thymoquinone and alpha-hederin, may directly stimulate hair follicles and promote hair growth. These compounds may interact with signaling pathways involved in hair follicle development and cycling, leading to increased hair growth rate and thickness [61].

**Hormonal regulation:** Hormonal imbalances, such as elevated levels of dihydrotestosterone (DHT), can contribute to hair loss and thinning. Some research suggests that *Nigella sativa* may help regulate hormone levels, including DHT, through its phytoestrogenic and anti-androgenic properties. By balancing hormone levels, *Nigella sativa* may mitigate the effects of hormonal hair loss. It may help regulate hormone levels, including dihydrotestosterone (DHT), through its phytoestrogenic and anti-androgenic properties. By balancing hormone levels, *Nigella sativa* may mitigate the effects of hormonal hair loss and promote healthy hair growth [62].

**Nutrient supply:** *Nigella sativa* seeds contain essential nutrients such as vitamins, minerals, and fatty acids, which are important for hair health and growth. These nutrients play vital roles in supporting the structure and function of hair follicles, promoting hair growth, and preventing hair loss. Incorporating *Nigella sativa* into the diet or using its oil topically may provide essential nutrients necessary for optimal hair growth [63].

**Anti-microbial effects:** Scalp health is crucial for maintaining healthy hair growth. *Nigella sativa* possesses antimicrobial properties that may help combat scalp infections and conditions like dandruff, which can impede hair growth. By maintaining a healthy scalp environment, *Nigella sativa* may indirectly support hair growth.

While these mechanisms suggest the potential of *Nigella sativa* to improve hair growth, further research, including clinical studies, is needed to confirm its efficacy and elucidate the specific pathways involved. Additionally, individual responses to *Nigella sativa* may vary, and it's essential to consult with a healthcare professional before using it for hair growth purposes.

#### *Experimental and clinical studies*

Experimental and clinical studies investigating the effects of *Nigella sativa* on hair growth have provided valuable insights into its potential as a natural remedy for hair loss and promoting hair growth. Here's a detailed overview of both experimental and clinical studies on the hair growth effects of *Nigella sativa*:

#### *Experimental studies*

##### *a. Animal studies*

Animal studies have demonstrated the potential of *Nigella sativa* and its active components to promote hair growth. For example, a study on mice found that topical application of *Nigella sativa* oil significantly increased hair growth compared to control groups. This effect was attributed to the antioxidant and anti-inflammatory properties of *Nigella sativa* [64].

A study conducted on mice investigated the effect of *Nigella sativa* oil on hair growth. The results demonstrated that topical application of *Nigella sativa* oil significantly increased hair growth compared to control groups. Histological analysis revealed that *Nigella sativa* oil promoted the induction of anagen phase hair follicles and increased hair follicle density, indicating its potential to stimulate hair growth [65].

##### *b. In Vitro studies*

In vitro studies have explored the mechanisms underlying the hair growth-promoting effects of *Nigella sativa*. These studies have revealed that compounds such as thymoquinone and alpha-hederin found in *Nigella sativa* may stimulate hair follicle proliferation and elongation, leading to increased hair growth [66].

#### *Clinical studies*

##### *a. Human trials*

Several clinical trials have investigated the efficacy of *Nigella sativa* in promoting hair growth in humans. A randomized controlled trial involving participants with hair loss found that topical application of *Nigella sativa* oil resulted in a significant improvement in hair density and thickness compared to a placebo group. The study concluded that *Nigella sativa* oil could be an effective natural remedy for hair loss [67].

A randomized controlled trial investigated the efficacy of *Nigella sativa* oil in promoting hair growth in individuals with alopecia. The study included participants with mild to moderate alopecia who applied either *Nigella sativa* oil or placebo to their scalps for a specified duration. Results showed that participants in the *Nigella sativa* oil group experienced a significant improvement in hair density and thickness compared to the placebo group, indicating its potential as a therapeutic agent for hair loss [68].

##### *b. Observational studies*

Observational studies have also supported the hair growth-promoting effects of *Nigella sativa*. A study involving individuals with alopecia found that regular consumption of *Nigella sativa* seeds led to improvements in hair growth, thickness, and overall scalp health. These findings suggest that

*Nigella sativa* may be beneficial for individuals experiencing hair loss [69].

These experimental and clinical studies provide scientific evidence supporting the potential of *Nigella sativa* for promoting hair growth and treating hair loss. However, further research, including larger clinical trials and mechanistic studies, is needed to fully understand its efficacy and mechanisms of action in the context of hair growth.

The results demonstrate the multifaceted medicinal potential of the Hibiscus plant, Fenugreek, and *Nigella sativa* in promoting hair growth and improving overall hair health. Hibiscus, renowned for its aesthetic appeal, proves to be rich in phytochemicals and essential vitamins and minerals crucial for hair vitality. Fenugreek, with its diverse bioactive constituents, shows promising potential in enhancing hair growth through various mechanisms, despite limited direct research. Similarly, *Nigella sativa* emerges as a potent natural remedy, supported by clinical trials and observational studies, in promoting hair density and scalp health. Overall, these findings underscore the significance of botanical remedies in hair care and highlight the need for further research to optimize their therapeutic applications.

## CONCLUSION

In conclusion, the collective evidence from experimental and clinical studies strongly supports the efficacy of Hibiscus flower extracts in promoting hair growth and improving overall hair health. The significant enhancements observed in hair growth parameters and scalp conditions upon the application of Hibiscus-based formulations underscore its profound medicinal potential in the realm of hair care. With its rich phytochemical composition and diverse pharmacological activities, the Hibiscus plant emerges as a versatile botanical that holds promise in both traditional and modern therapeutic applications. However, further research is needed to optimize formulations and dosages to maximize the benefits of Hibiscus-based products in hair care. Similarly, fenugreek demonstrates multifaceted therapeutic properties beyond its potential in managing diabetes and other health conditions. Its rich

phytochemical profile offers a wide range of benefits, including anti-inflammatory, antioxidant, and neuroprotective effects, making it a valuable botanical treasure with centuries of traditional use and modern scientific evidence supporting its efficacy. Likewise, *Nigella sativa* emerges as a promising natural remedy for promoting hair growth and treating hair loss, thanks to its diverse medicinal properties and rich phytochemical composition. While additional research is required to elucidate its specific mechanisms of action and optimize therapeutic use, existing evidence suggests its potential as a safe and effective option for individuals seeking natural solutions for hair growth concerns. As always, consulting with a healthcare professional is advisable before incorporating these botanicals into one's hair care regimen, particularly for individuals with underlying health conditions or sensitivities.

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*Special thanks to the authors of the research articles and clinical trials cited in this narrative review, whose work has provided valuable insights into the mechanisms underlying the hair growth-promoting effects of these natural remedies. Their commitment to advancing scientific knowledge in the field of herbal medicine is commendable and serves as an inspiration to us all.*

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