

DESIGN AND DEVELOPMENT OF A NEEM AND ALUM-BASED NATURAL ANTI-PERSPIRANT SPRAY

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Abstract

Human skin has the most crucial role in various homeostatic functions like; temperature regulation through various measures including Sweat production. But the overproduction of sweat aka hyperhidrosis is not only unpleasant but also impair social activities. Various treatments have been introduced whether it be topical, systemic or surgical but each has their own complications. Antiperspirants are most commonly used to reduce the amount of sweat production. This work aims to formulate a skincare product that helps in reducing sweating and combat the bad Odor. Efforts were made to make an Anti-perspirant that not only prevents sweat but is also safe to use as a daily solution to sweat and stink. We need to understand how helpful Anti-perspirants are to reduce a number of infections and discomforting feelings. We have prepared a product in this regard that is very soft on the skin and easy to use. We have kept the feasibility of the users in mind and designed a formulation with the best and most natural components. Our product has been made with a lot of care and research. We have tried to keep things simple and easy to understand. We have used this spray on human models and it shows how skin friendly our product is. The results show that our product has a good storage for about 2 months.

INTRODUCTION

Skin:

The skin, which makes up over 10% of the body's mass, is a highly adaptable and multifunctional organ. Extensive research has been conducted on its various roles, including its function as a barrier and its ability to act as a first-line immune response system (Wilke, Martin, Terstegen, & Biel, 2023) ^{a12}. The skin serves a vital purpose in preventing dehydration and protecting the body from its surroundings, all while maintaining a connection with the external environment (Montagna, 2022) ¹⁴

Composed of four layers, the non-viable epidermis (stratum corneum), viable epidermis, dermis, and subcutaneous tissues - and associated appendages such as hair follicles, sweat ducts, apocrine glands, and nails, the skin has many essential functions. These functions can be grouped into three categories: protective, homeostatic, and sensory.

The skin's protective and homeostatic properties are critical to survival in a challenging environment. The skin acts as a barrier, which enables humans to survive in an environment that has varying temperature, humidity, and potential hazards such as chemicals, bacteria, allergens, fungi, and radiation. Additionally, the skin plays a key role in maintaining the body's internal balance, including regulating body temperature, controlling blood pressure, and facilitating excretion.

The skin also functions as a sensory organ, detecting environmental changes such as heat, pressure, pain, allergens, and microorganisms. Lastly, the skin is a continually regenerating and repairing organ (Walters & Roberts, 2024) ⁵

Perspiration:

Maintaining a stable body core temperature is essential for the survival of living organisms. When body core temperature exceeds 40°C in humans, proteins can denature, leading to cell death and multiple organ failure. Perspiration plays a vital role in regulating body temperature during conditions of high environmental temperature or physiological stress. Sweat production through perspiration releases thermal energy as water evaporates from the skin surface, leading to a decrease in skin and body core temperatures. Emotional stress or consuming spicy food can also stimulate perspiration, although

the exact mechanisms are not fully understood (Wilke et al., 2024) ^{b12}

Sweat glands are one of the types of cutaneous appendages, which include hair follicles and sebaceous glands. These exocrine glands release their secretions via ducts to the outer surface of the skin. Eccrine sweat glands, numbering around 3 million, are distributed across the entire body surface, except for the lips and glans penis. Apocrine glands, on the other hand, exist from birth but only become active during puberty. These glands are located in hairy body areas and secrete into hair canals, leading to their presence in the axilla, mammary, perineal, and genital regions. In well-acclimatized individuals, sweat production can reach several liters per hour and up to 10 liters per day.

During physical exercise or thermal stress, generalized eccrine sweating is the most effective means by which humans regulate their body temperature through evaporative heat loss. The human eccrine sweat gland has two primary functions: (1) secreting an ultrafiltrate of a plasma like precursor fluid by the secretory coil in response to acetylcholine released from sympathetic nerve endings and (2) reabsorbing excess sodium in the duct, producing hypertonic skin surface sweat. The duct's re-absorptive function is crucial in conserving electrolytes in the body. Sweat also contains heavy metals, organic compounds, and macromolecules (Holzle, 2022) ^{a6}

Problems:

Excessive production of sweat by the exocrine sweat glands is known as hyperhidrosis. This condition can lead to both physical discomfort and psychological distress, negatively affecting a person's personal and professional life (Togel, Greve, & Raulin, 2023) ^{a7}. Despite the fact that sweating is a normal physiological process, hyperhidrosis can cause significant embarrassment and even occupational disability, making it a neglected topic in medical literature. As a result, many individuals may be unaware that treatment options are available, and the condition may go undiagnosed or untreated (Benohanian, 2022) ^{a4}

Hyperhidrosis may be classified as either physiological, symptomatic, or idiopathic, and can be either generalized or focal. Underlying causes of

symptomatic hyperhidrosis may include endocrine disorders such as hyperthyroidism and hyperpituitarism, disorders with elevated catecholamines, or neurological disorders affecting sympathetic nerves, as well as auriculotemporal syndrome and diabetic neuropathy. Idiopathic types of hyperhidrosis, such as emotionally triggered sweating in hyperhidrosis axillaris, manuum, or pedum, as well as gustatory sweating without neurological disorders, are commonly seen by dermatologists. Physiological hyperhidrosis may occur during acclimatization or in postmenopausal women.

Women are more likely to experience hyperhidrosis axillaris, while hyperhidrosis palmoplantar is more prevalent in men.

Hyperhidrosis is not just a cosmetic concern, but can also lead to more severe symptoms such as skin maceration, bacterial and fungal growth, and intertrigo (Holzle, 2023)⁶. In addition to the physical symptoms, hyperhidrosis can also lead to social embarrassment, low self-esteem, and even economic consequences due to the accelerated wear and tear of clothing and shoes.

Treatments:

Despite the significant impact of hyperhidrosis on quality of life, it is still undertreated. The approach to treating hyperhidrosis involves several steps. Firstly, the underlying physiological causes of excessive sweating should be determined. Secondly, the type of hyperhidrosis should be established, and secondary causes should be ruled out before diagnosing essential hyperhidrosis. Thirdly, the severity of hyperhidrosis should be evaluated using a validated scale, Minor's starch-iodine test, or gravimetric analysis. Finally, one of the available medical therapies should be selected, including topical therapy, systemic therapy, or surgery (Maillard & Lecouflet, 2025)¹⁹.

The only treatment available for hyperhidrosis is symptomatic if it is not brought on by a main illness that is curable. Antiperspirants with an aluminum chloride base work well as first-line treatments for all afflicted body parts. Anticholinergic agents are emerging as effective topical alternatives. Botulinum toxin type A injections are a mainstay second-line treatment, with a duration of efficacy of 3 to 9 months. Local procedural advances, such as microwave thermolysis, laser therapy, and focused

ultrasound, are emerging as safe and effective alternatives for refractory disease. Oral anticholinergics can also be used for intractable disease (Seger, Wechter, Strowd, & Feldman, 2019)²¹. For axillary hyperhidrosis, curettage with a scraper and liposuction are reliable and safe treatments. The recommended treatment for palmoplantar hyperhidrosis is tap water iontophoresis; adding anticholinergic substances to the water can result in a more rapid and longer-lasting therapeutic effect; botulinum toxin can be a promising and effective alternative; and systemic anticholinergic medication can be tried for patients with localized or generalized hyperhidrosis, although it is frequently limited by side effects. Tap water iontophoresis and aluminum chloride salts remain effective treatments for hyperhidrosis. Surgical options, such as sympathectomy, should only be considered after conservative methods have failed due to their highly invasive nature (Togel et al., 2022)⁷.

Complications:

The treatment methods for hyperhidrosis may be associated with various complications that could limit their use in some patients. In dermatology, botulinum toxin is frequently used to treat primary focal hyperhidrosis and minimize dynamic facial wrinkles. Although it is considered safe, there may be minor complications such as mild injection pain, which usually resolve spontaneously. Rare complications include. Headache, nausea, flu-like symptoms, ptosis of the lids and brows following an upper face injection, asymmetry of the lower face following a perioral injection, and fine motor impairment following a palmar (Pena, Alam, & Yoo, 2023)¹¹.

Sympathectomy is a minimally invasive procedure that involves cauterizing a portion of the sympathetic nerve chain that runs down the back inside the chest, parallel to the spine. Thoracoscopic Sympathectomy has shown good results and is generally safe. The major complication is compensatory hyperhidrosis, and in severe cases, patients may regret having undergone surgery. However, improvements in instrumentation, adequate training, and careful patient selection may help reduce the number of drawbacks associated with Sympathectomy (de Andrade Filho et al., 2022)¹⁷.

The removal of axillary sweat glands using liposuction with tumescent anesthesia is a relatively simple and short outpatient procedure with few complications. However, a study reported bruising in the axillae of two patients and relapse of hyperhidrosis in four out of ten patients. (Lee & Ryman, 2025)¹⁰.

For palmoplantar hyperhidrosis, tap water iontophoresis with direct current is thought to be the best treatment option. The most frequent adverse effects are mild discomfort and skin irritations, and iontophoretic burns at the locations of minor skin injuries might result from inappropriate use. During the study, occasional complications such as discomfort, skin irritation, and mild electric shock occurred when direct current was applied (Reinauer, Neußer, Schauf, & Hölzle, 2020)².

Antiperspirant preparations containing aluminum or zirconium can cause occasional inflammation and granulomas. Some patients developed chronic axillary granulomas after using an underarm deodorant spray containing aluminum. The granulomas occurred in response to a mixture of talc and aluminum salts. (Steiling et al., 2022)¹⁵.

Antiperspirants:

Antiperspirants and Deodorants are two of the most commonly used cosmetics, with millions of people applying them to their axilla regularly. Antiperspirants and Deodorants (AP/Deo)—are fraternal twins joined at the axilla that perform in this same anatomical arena using some of the same tricks. This sibling rivalry has been dominated in the past few decades by antiperspirants with ever-increasing claims for sweat reduction efficacy and odor reduction. (Watson, Gies, Thompson, & Thomas, 2022)¹⁶. Antiperspirants are primarily intended to reduce the amount of sweat. AP are agents that suppress eccrine sweating.

They are widely used to curb cosmetically disturbing underarm wetness. Antiperspirants act selectively at the eccrine sweat glands and do not affect apocrine glands. The latter are responsible for the characteristic axillary body odor. The most frequently used type of antiperspirants are metal salt solutions. They also act as antimicrobials and, thus, against the body odor. They abolish the growth of bacteria flourishing in the humid and warm

microenvironment of the axillae and prevent the formation of odoriferous substances generated from apocrine sweat by the action of bacteria. (Holzle, 2022)⁶.

It has been found that aluminum and other metallic salts such as zirconium reduce sweat by causing mechanical obstruction to the eccrine sweat duct at the acrosyringium level. All antiperspirants also act, directly or indirectly, as deodorants. More than 90% of the adult consumers in the United States use an antiperspirant or a deodorant regularly. Many forms and formulations exist: roll-ons, deodorant and antiperspirant sticks, gels, etc. Most of these are intended for underarm use. Although antiperspirants and deodorants have grown to be one of the largest health and beauty aids product categories, they are of little or no benefit to the patient suffering from HH (Benohanian, 2021)⁴.

Antiperspirants have been known for many years and their use is very common, especially in industrialized countries. They comprise a huge market. The initial commercial antiperspirant was launched in 1903, marketed as Ever dry. It was a solution of aluminum chloride in water and alcohol. The product was utilized by moistening a cotton ball with it and applying it beneath the It is noteworthy that today's deodorant products are significantly more effective than the initial zinc oxide deodorant, while antiperspirant products may be less effective than the first aqueous aluminum chloride. Although effectiveness assessments were not conducted on those initial products, current evaluations indicate an efficacy of 60% to 70%, whereas contemporary antiperspirant products reduce sweating by 30% to 55% (Laden & SERIES, 2020)³.

From a physiological perspective, Antiperspirant blocking the small axillary portion of the eccrine sweat glands would do little to affect their essential function of maintaining the temperature of the body in its overall larger cooling and heating system. However, In the original introductory publication from the US Food and Drug Administration (FDA), the expert panel stated that “it had been repeatedly demonstrated” that even total blockage of axillary sweat did not compromise the control of body temperature. However, the panel feared that total body inhibition “might interfere with the thermal regulatory process” and thus concluded that

antiperspirants should not be permitted for use over the entire body.

A satisfactory antiperspirant must satisfy the following requirements:

- 1) Cut down on perspiration as much as possible.
- 2) Preservation of the skin's natural biology.
- 3) Odor neutrality.
- 4) effectiveness solely in terms of deodorization, that is, avoiding and/or getting rid of body odor
- 5) Preventing the emergence of resistant types of bacteria
- 6) Preventing the active substances from building up on the skin
- 7) innocuousness in case of overdosage or other unforeseen usage
- 8) Appropriate cosmetic application
- 9) Universal usability and ease of handling (e.g., as liquid) in a broad range of exterior and cosmetic preparations
- 10) Superior compatibility between the skin and mucosa
- 11.) Utilizing eco-friendly materials (Vartak et al., 2022)²³.

• Synthetic Antiperspirants:

Different types of ranges of chemicals are used as antiperspirants; these include astringent agents, local anaesthetics, acids and aldehydes, metal salt solutions and anticholinergics.

Local Anaesthetics:

LA Blockade of peripheral nerves affects the sympathetic nerve fibers supplying the eccrine sweat glands. In practice, however, these preparations are insufficient as antiperspirants. In addition, Local Anaesthetics have at least a moderate potential to induce contact hypersensitivity. In a recent experimental approach, botulinum toxin A has been applied by subcutaneous injections with very promising results. Since injections are required, this substance cannot be used in commercial topical products.

Acids and Aldehydes:

By denaturing the keratin of the outermost layers of corneocytes, the astringent agent's formaldehyde, tannic acid, glutaraldehyde, and trichloroacetic acid

denature proteins and, when applied topically, can produce a superficial closure of the sweat pore. In case of formaldehyde, a severe adverse effect is its high potential of sensitization leading to allergic contact dermatitis. Glutaraldehyde is not so effective in the axillae and, when applied in higher concentration, leads to disturbing discoloration of the horny layer. Tannic acid, sometimes derived from chestnut or oak extracts, exerts a little antiperspirant activity.

Anticholinergics:

Anticholinergics can effectively block the secretory activity of eccrine sweat glands. They would be the ideal antiperspirant if they penetrated the horny layer and acted only locally.

Two main problems with anticholinergics use includes

- (1) In certain cases, their percutaneous absorption is insufficient to produce a persistent anhidrosis.
- (2) Systemic harmful effects result from their extensive skin absorption. The potential for anticholinergics to cause touch hypersensitivity is another disadvantage. (Holzle, 2022)^{c6}.

Commonly Used Synthetic AP:

These days, the most often utilized active ingredients in commercial antiperspirants are aluminum chloralhydrate and aluminum zirconium tetra-chloralhydrate glycine complex. Though less prevalent, aluminum chloride and the anticholinergic drug propantheline bromide are significant substitutes (Pierard et al., 2023)⁸. Short-chain silicates in the form of silicic acids are one substitute for Al salts that can effectively reduce perspiration. The skin's bacterial flora can be decreased by using cosmetic antiperspirants that also contain antimicrobial ingredients. In this regard, it is preferable to efficiently decrease only the microorganisms that cause odor.

• Natural Antiperspirants:

Most conventional antiperspirants and deodorants (Ap/Deo) contain several ingredients linked to serious health effects. Since antiperspirants and deodorants are designed to stay on our bodies for hours, this allows the potential for more harmful chemicals to be absorbed through the skin. While

natural options are available, many people complain about the inadequacy of natural AP/Deo to adequately mask body odor and stop sweating. There is now an abundance of alternative options many improved upon since their initial introduction several years ago that may inspire us to think again about incorporating natural AP/Deo into our body care regime (Tozawa et al., 2022)²⁴.

Various patents discuss methods by which natural ingredients may be used to produce an all-natural deodorant/antiperspirant. But rarely a commercial brand is based on all natural ingredients. it is discussed that sage, or *Salvia Officinalis*, has leaves and flowers which may produce an effective deodorant. It is further known from U.S. Pat. No. 4,942,033 that a mixture of extracts from Butcher's broom or *Ruscus aculeatus* L. and sage is effective in reducing capillary permeability and thus has an anti-hidrotic effect and will accordingly reduce production of sweat when applied to the skin.

Certain natural essential oils and their component chemicals from plants demonstrate bacteriostatic activity for odor of perspiration. Commonly used essential oils include tea tree oil, which contains a high level of terpinen-4-ol, the primary antimicrobial aroma chemical. Many other essential oil chemicals, especially those found in culinary herbs, have been investigated and found effective in retarding bacterial and fungal growth. The objective of many of these studies was to find acceptable natural herbs to prevent food spoilage. Parallel research discovered that rosemary constituents, especially rosmarinic acid, have significant antioxidant activity and this has been patented and commercialized. Notable among the herbs and their constituents that have been validated to inhibit microbial growth by some researchers are: oregano (thymol, carvacrol); coriander and rosewood (linalool); lemongrass (neral, geranial); savory (carvacrol); *Azadirachta indica*; and cinnamon bark (cinnamaldehyde). (Cate, Sullivan, & King, 2024)²⁵.

A study based on an all-natural antiperspirant roll on consisted of olive oil, almond oil, wheat germ oil as gentle soothing emollients, *salvia officinalis* and *cupressus sempervirens* as natural astringents, *lavendula angustifolia* and *citrus aurantium* as natural, mild antiseptic compounds. Beeswax or hydrogenated castor oil may be added as a gentle thickening agent

where the inventive formulation is to be used in cream or solid form. In such a manner, skin irritation, swelling, occlusions and inflammations are prevented (Williams & Patients, 2024)⁹.

Dosage Forms:

Numerous users of aerosol antiperspirants seek a product that reduces visible residue on the skin, offers a dry feel instead of a wet one, dries quickly to the touch, avoids stickiness, delivers a cool and fresh sensation upon application, ensures prolonged protection against moisture and odor, comes in a compact form that's convenient for carrying in purses or small bags (since some users might reapply the antiperspirant multiple times daily), and limits the gas cloud produced during dispensing. The variety of packaging formats and formulation types of antiperspirants and deodorants available to consumers is likely larger than for any other HBA category. It includes deodorant sticks, antiperspirant solids, transparent solids, soft solids, gels, pads, aerosols, pump sprays, squeeze sprays, creams, roll-ons, suspension roll-ons, and more (Laden & SERIES, 2023)^{b3}. Aerosol, roll-on, creams & wipes and sticks & solids are the five main forms of deodorant and antiperspirant products. Both anhydrous (suspensions) and aqueous products (aqueous/alcoholic formulations, emulsions) are known.

Roll on: Anhydrous and oil-based compositions are both possible for sweat-inhibiting roll-ons; for instance, the oil-based foundation of common antiperspirant sprays can also be used as a roll-on. Water with at least one perspiration-inhibiting aluminum compound or aluminum-zirconium compound are examples of antiperspirant compositions that can be applied with a roll-on applicator. furthermore, de-hydro xanthan gum, and in addition thereto at least one nonionic thickening polymer selected from cellulose and cellulose ethers as well as mixtures thereof. The compositions exhibit elevated shelf stability even at relatively high temperatures, as well as reduced visible residua on the skin. a slightly thickened liquid is applied from a reservoir container via a rotatably mounted ball by rolling over the skin (Gnansounou, Alves, Raman, & Systems, 2024)²⁰.

Aerosols; More recently, aerosols under pressure have become popular as a convenient form for application to the skin. Most preferred of the aerosol compositions are those in which the antiperspirant active is chiefly propellant. Such compositions apply the active antiperspirant salt to the skin effectively and feel dry, smooth and comfortable. It is not essential to use specially lined cans or unbreakable glass bottles because the antiperspirant chemical is suspended rather than dissolved in a liquid and does not corrode standard metal aerosol cans (Oertel & Rush, 2021)¹.

Sticks & Solids; The patents concerning stick or solid antiperspirants were the most frequently issued. This is certainly not unexpected, considering the prevalence of the stick type of antiperspirant in the U.S. market during the 2012s. Regarding Clear Sticks, many patents in this area have concentrated on utilizing di-benzylidene sorbitol combined with different additives to enhance clarity, stability, and scent. Procter and Gamble (P&G) received patents for modified Di benzylidene alditols exhibiting enhanced stability at the acidic pH levels generated by the antiperspirant salts.

Conversely, assertions regarding antiperspirant products that leave no white marks on the skin emerged in the late 1980s and extended into the 1990s, leading to the production of low-residue solids for Reduce Whitening Sticks. Additionally, several traditional stick formulas are noted to include specific additives for improved dendromancy and scent. These consist of rods containing zeolites, mordenites, and/or beta-zeolites for odor control, microcapsules made of starch with polysaccharide-encapsulated fragrance oils and esters, and mixtures for counteracting malodor encased in a semipermeable wall material, among other things.

Gels; Gels are among the latest types of antiperspirant product forms. Carter-Wallace first introduced them in the late 1980s. Typically, they are gentle, transparent gels that come from stick-like containers featuring a slotted opening. The gel is released through the openings and applied to the underarm using the container's dome. Patents related to this area have often centered on creating gels with thickeners, gelling substances, and transparent emulsions.

Sprays:

Sprays produce a fine, gentle, dispersed mist of liquid. Spray products are hassle free to produce and assemble without a need to fill propellant aerosol gases by means of specific setup. Numerous beauty products come in spray format. Though pumps and spray antiperspirants represent a minor share of the U.S. antiperspirant market, they are significantly more popular in numerous other countries, often serving as the leading product type. In spite of this popularity, there have been relatively few patents directed toward this product form. Transparent spray compositions made up of alcohol-soluble antiperspirant salts, non-volatile emollient esters, volatile silicones, non-volatile silicones, branched-chain alcohols, and water. The products leave no residue and dry rapidly. Shiseido's alcoholic antiperspirant formulations incorporate poly-oxyethylene silicones to ensure effective skin adhesion and provide a smooth feel once dried (Laden & SERIES, 2020)^{c3}.

While the relative importance/desirability of antiperspirant product characteristics may vary by geographical region and gender and not all users desire all or the same set of characteristics, there appears to be a generally universal desire among aerosol spray antiperspirant users for one or more of a dry rather than wet feel, minimizing the appearance of residue, and providing long lasting wetness/odor protection or efficacy. Although some currently marketed aerosol spray devices may provide at least some of these characteristics to varying degrees, there are often tradeoffs involved. For example, some currently available antiperspirant spray devices have relatively high propellant concentrations (e.g., greater than 75% and often greater than 80%). A high propellant concentration dilutes the antiperspirant composition, which in turn may help reduce the risk of clogging within the spray device. However, a high propellant concentration may also produce a large volume of gas upon exiting the spray device resulting in a gassy cloud and/or a turbulent spray (Mantelakis, Spencer, Duval, & Joshi, 2020)²².

Aerosol antiperspirant compositions based on anhydrous propellant systems normally include antiperspirant, filler and other solid particles dispersed in a liquid vehicle, and the solid particles readily clog small valve orifices. On the other hand, if

the orifices are large enough to avoid clogging, a coarse liquid spray with large droplets is formed, and there may be excessive drip at the nozzle. The material can even be squirted out in the form of a liquid stream, which rapidly runs off the surface on which it is deposited. Much effort has accordingly been directed to the design of valves and valve delivery ports, nozzles or orifices which are capable of delivering finely-divided sprays.

LITERATURE REVIEW

Herbs In Cosmetic Industry:

Cosmetic products are referred to as “Any substances or preparation intended for application to any external surface of human body (epidermis, hair system, nails, lips).” Main source of cosmetics has been plants. Base of herbal cosmetics are prepared using different ingredients in which one or more herbal ingredients are used to do magical wonders to an individual’s skin as well as other parts of body (Yamini & Onesimus, 2013)¹⁸.

In medicines and cosmetics, herbal medicinal plants have been used for centuries. It is known that these substances have the potential to treat different skin conditions, soothe and enhance their appearance. Significant progress has been made in the herbal industry in the early part of the 21st century. Because of their easy availability and lower side effects, herbal ingredients have become preferable to chemicals. In order to avoid the adverse reactions that often occur with synthetic products, herbal beauty products claimed efficacy and intrinsic acceptability because they are regularly used in daily life. Many side effects, such as skin irritation, allergic reactions, discoloration, rash and skin cancer are associated with continuous use of Synthetic compounds on the skin. Whereas, the herbal ingredients used to make these Skin Cosmetics contain multiple functionalities such as antioxidants, anti-inflammatory, antiseptics and antimicrobials.

Antiperspirant Action of Medicinal Plants:

Antiperspirants and Deodorants are two of the most widely used cosmetics, with millions of people applying them to their axilla regularly. Antiperspirants and Deodorants (AP/Deo)—are fraternal twins joined at the axilla that perform in this same anatomical arena using some of the same

methods. This sibling rivalry has been dominated in the past few decades by antiperspirants with continuously increasing claims for sweat reduction efficacy and odor reduction (Zirwas, Moennich, & dermatology, 2008)¹³.

Antiperspirants are mainly used to reduce sweat. AP are agents that reduce eccrine sweating. They are commonly used to curb cosmetically disturbing underarm sweating. Antiperspirants act selectively at the eccrine sweat glands and do not affect apocrine glands that are responsible for the characteristic axillary body odor. The most commonly used antiperspirants are those made of metal salt solutions. They act as antimicrobials and also against the body odor. They inhibit the growth of bacteria growing in the humid and warm microenvironment of the axillae and prevent the formation of odorous substances generated from apocrine sweat by the action of bacteria (Holzle, 2002)⁶.

It has been found that aluminum and other metallic salts such as zirconium reduce sweat by exerting mechanical effect and causing obstruction to the eccrine sweat duct at the acrosyringium level. All antiperspirants also act directly or indirectly, as deodorants. More than 90% of the adult consumers in the United States use an antiperspirant or a deodorant on daily basis. Many forms and formulations exist: roll-ons, deodorant and antiperspirant sticks, gels, etc. Most of these are intended for underarm use. Although antiperspirants and deodorants have grown to be one of the largest health and beauty aiding product categories, they are of little or no benefit to the patient suffering from HH (Benohanian, 2020)⁴.

Antiperspirants have been known since ages and their use is very common, especially in industrialized countries. They are part of a huge market. The initial commercial antiperspirant was developed in 1903 and marketed under the name Ever dry. It was a solution of aluminum chloride in alcohol and water. The formulation was used by wetting a cotton ball and applying it by dabbing under the arms. It is noteworthy that current deodorant products are significantly more effective than the original zinc oxide deodorant, whereas antiperspirant products are likely less effective than the original aqueous aluminum chloride. Although efficacy assessments were not conducted on those initial products, recent

testing indicates effectiveness in the 60% to 70% range, whereas contemporary antiperspirant products reduce sweating by 30% to 55% (Laden & SERIES, 2024)d³.

From a physiological point of view Antiperspirant inhibition, the small axillary portion of the eccrine sweat glands would do little to no effect on their essential function of maintaining the temperature of the body in its overall larger cooling and heating system. However, In the original introductory publication from the US Food and Drug Administration (FDA), the expert panel stated that “it had been repeatedly demonstrated” that even total blockage of axillary sweat did not compromise the control of body temperature. However, the panel feared that total body inhibition “might interfere with the thermal regulatory process” and thus concluded that antiperspirants should not be permitted for use over the entire body.

Why We Made Antiperspirant Spray:

With the aim to formulate a skincare product that helps in reducing sweating and lessen the bad odor. Antiperspirants work by blockade of the pores on the outer layer of your skin, reducing the amount of sweat.

Antiperspirant temporarily blocks your sweat glands to prevent sweat and is safe to use on daily basis to prevent sweat. Antiperspirant is most effective when applied to clean, dry skin. If you use it in the day time. Immediately after your shower, your skin might be too wet to absorb the formula properly. Antiperspirant formulation need time to soak into your pores to reduce sweat. Otherwise, it will not be as effective throughout the day. The night time application gives the formulation enough time to properly dissolve into your skin and stop sweat in for the next 24 hours.

BENEFITS OF USING NATURAL PRODUCTS IN ANTIPERSPIRANT

Better For Environment:

Natural skin care products are better for the environment than are synthetic skincare products. Natural skincare products forego the use of such ingredients, and so don't necessitate mining. And because they use only natural ingredients, they cause no harm to the surrounding plants and animals.

They Are Safer:

When compared to synthetic skincare products, natural skincare products are much safer. This is because the ingredients contained within natural products are much safer than those contained in synthetic products.

They Are Easier on Skin:

One of the biggest problems with synthetic skincare products is that they're harmful to some individuals' skin. Certain ingredients contained within these products can cause everything from swelling to redness to itchiness to outright allergic reaction. For this reason, they're better avoided altogether.

Ingredients to look out for include parabens, sulfates, petrochemicals, synthetic dyes, propylene glycol, and triclosan. However, it's important to note that some other synthetic chemicals can cause this problem as well.

This is why it's generally a better idea to opt for natural products. Natural products are free of irritants, and, instead of being a detriment to the skin, they are actually beneficial to use.

Improves Overall Health and Well Being:

The majority of cosmetic skin care products include parabens, phthalates, and sodium lauryl sulphate. By negatively impacting our immune, endocrine, and reproductive systems, these substances have the potential to compromise our fundamental health. Using natural skin care product does not hamper our core health and in fact improves the functioning of our body, as the body recognizes natural ingredients as nutrition Additionally, natural substances promote cell regeneration, enhance moisture retention, and have no adverse effects on the immunological system.

AIMS AND OBJECTIVES

Problem Statement:

The aim of this project is to create an antiperspirant spray formulation by incorporating neem extract and alum, targeting the challenges of excessive sweating, unpleasant body odor, and the absence of a refreshing cooling effect experienced during the summer months.

Objective:

The proposed solution aims to provide an effective remedy that tackles these issues, offering individuals a reliable and convenient product to combat sweat-related concerns while ensuring long-lasting freshness and a soothing sensation in hot weather conditions. Antiperspirants work by blocking the pores on the outer layer of your skin, reducing the amount of sweat. Antiperspirant temporarily blocks your sweat glands to prevent sweat and is safe to use as a daily solution to sweat and stink.

The best results from antiperspirant are obtained on dry, clean skin. Your skin may be too damp to effectively absorb the product if you use it shortly after taking a shower in the morning. In order to stop perspiration, antiperspirant formulations require time to absorb into your pores. Otherwise, it will not be as effective throughout the day. Applying the product at night allows the mixture to fully absorb into your skin and prevent perspiration for the following 24 hours.

The Difference Between Deodorant and Antiperspirant

By reducing the germs that grow on the fat and proteins in your perspiration, deodorants help to avoid body odor. The capacity of antiperspirants to temporarily block the pores is what reduces perspiration, but the absence of bacterial development is what stops the odor.

Aims:

Using antiperspirants is an ideal solution for reducing sweating, especially when you're on the go. These products temporarily block the pores, effectively decreasing the amount of perspiration. Additionally, they offer an antibacterial action, particularly when ingredients like neem are included. Neem is known for its strong antioxidant properties and antimicrobial benefits, making it a valuable addition to antiperspirants. Furthermore, antiperspirants containing alum provide another advantage by inhibiting the growth of bacteria on the skin, thereby reducing bad body odors. Moreover, antiperspirants help remove dead skin cells, promoting a cleaner and healthier skin surface while offering pleasant and reliable protection. Finally, using antiperspirants contributes to achieving soft and irritation-free skin, leaving it smooth and comfortable.

MATERIALS AND METHODS

Material:

To create the spray, a combination of carefully selected ingredients was gathered and utilized. Firstly, alum was included for its antibacterial properties, which help inhibit the growth of bacteria on the skin and combat bad body odors. Neem leaves were also added due to their strong antioxidant and antimicrobial properties, further enhancing the product's effectiveness. In addition, menthol was incorporated to provide a refreshing and cooling effect, offering a pleasant sensation when applied. To enhance the overall experience, rose oil was included to provide a delightful fragrance that lingers on the skin. Lastly, methyl paraben was used as a preservative to ensure the longevity and stability of the spray. By combining these ingredients, the resulting spray not only reduces sweating and neutralizes bad body odors but also leaves the skin feeling soft, smooth, and pleasantly scented.

Apparatus:

During the preparation of the antiperspirant spray, the following apparatus were used:

1. Pestle and mortar: Used for grinding and pulverizing solid ingredients to achieve the desired consistency.
2. Volumetric flask: Used for precise measurement and mixing of liquid ingredients.
3. Beakers: Used as containers for holding and mixing different components of the formulation.
4. Funnel: Used for controlled pouring and transferring of liquids into containers.
5. Filter paper: Used in combination with a funnel to separate solid particles from liquids during filtration.
6. Stirrer: Used to agitate and mix the ingredients thoroughly.
7. Pipette: Used for precise and controlled dispensing of small volumes of liquids.
8. Spatula: Used for scooping and transferring solid ingredients.
9. Measuring cylinder: Used for accurate measurement of liquid volumes.
10. Sonicator: Used to assist in the dispersion and homogenization of the formulation by applying ultrasonic waves.

These apparatuses were employed to ensure proper preparation and mixing of the antiperspirant spray.

Methods for the preparation of Antiperspirant spray Procedure

1. Trituration
2. Water distillation by Sonicator
3. Mixing of all ingredients
4. Addition of menthol
5. Addition of rose oil

The preparation of the antiperspirant spray involves the following steps:

1. **Trituration:** The alum is triturated in a pestle and mortar to increase its fineness and ensure a smooth texture.
2. **Water distillation:** Dry neem leaves and water are combined in a beaker and placed in a sonicator machine. The sonicator uses ultrasonic waves to extract beneficial components from the neem leaves. This process is carried out in shifts, with 20 minutes of rest after each 40-minute shift.
3. **Mixing of all ingredients:** The triturated alum and neem extract are added to a bottle. Thorough mixing at each step is essential to create a well-blended and fine spray.
4. **Addition of menthol:** Menthol is incorporated into the spray to provide a cooling effect. When applied to the skin, menthol produces a refreshing sensation.
5. **Addition of rose oil:** Rose oil is added to the spray for its skin-refining properties and fragrance. It helps improve the texture of the skin and contributes to the overall pleasant scent of the antiperspirant spray. During these steps, it is important to ensure proper mixing and handling of the ingredients using appropriate equipment and techniques.

ACTIVE INGREDIENTS

The global demand for herbal formulations has been steadily increasing. This current study aims to explore the use of neem and alum in the formulation of an antiperspirant spray. Alum, a naturally occurring mineral salt, serves as a traditional alternative to many modern antiperspirants. On the other hand, neem is known for its antioxidant properties.

CHARACTERIZATION

QUALITY CONTROL TEST

Quality control includes testing units and deciding whether they are inside the specifications in the final product. The reason for the testing is to decide any requirements for remedial action in manufacturing of the product. Good quality control assist organizations with meeting buyer requests for better items.

Quality control of drugs definitions is a fundamental activity in the production of medications. It is a method or set of techniques intended to guarantee the result of uniform batches of medication adjusts to the laid-out details. This requires association and strict quality checks at each production level.

Following quality control tests were performed on Neem and Alum antiperspirant spray:

1. Organoleptic tests:

- Color test
 - Smell test
2. Homogeneity Test
 - Consistency and Stability testing
 3. Patch test
 4. Viscosity test
 5. pH test
 6. Drying time test

1. Organoleptic Test:

• Color test:

In this, the color and smell tests are performed to determine whether the spray leaves any stain due to its lime green color. The lime green color is due to the color of neem extract. However, the spray doesn't leave any mark or stain on body or clothes.

• Smell test:

The spray smell like rose due to addition of rose oil. The fragrance is pleasant and this property is beneficial in marketing of this spray.

2. Homogeneity Test

The homogeneity testing includes consistency and stability testing.

The spray is kept under observation for 2 weeks. The ingredients don't settle down and the consistency and stability are maintained as no change in physical appearance and physical characteristics observed.

3. Patch Test

In patch test, the spray is tested by direct exposure on skin. The spray patch test is a simple way of checking whether your skin will react to new products such as cosmetics, soap, topical medications. Patch testing is a common way to check for a variety of allergies.

- Place a little bit of the product on the selected skin patch, then cover it with a Band-Aid
- You should ideally allow about 24 hours before removing the Band-Aid.

However, if you experience any pain, burning or itching, you should remove the Band-Aid and wash the affected area right away. We performed patch test with Neem and alum antiperspirant spray. It shows no irritation or itching on skin.

4. Viscosity Test:

Rheological properties such as viscosity of Liquid dosage forms such as liquid antiperspirants can affect their drug delivery. Viscosity can directly affect the drug's diffusion rate at the microstructural level. We find viscosity of from Brookfield Viscometer (viscosity is measured by looking at the force required to spin a plate through the fluid). Viscosity of our spray is 2994.21cps, and the standard viscosity value for spray is within range of 255.84-3194.52 cps. Our values fall within standard range.

5. pH Test:

As we know antiperspirant spray is mostly applied to area where most perspiration occurs. Under arms are the major area of application of the spray. The physiological pH of skin of other body parts is up to 5.5, while for the skin of underarms is 6.5

We tested pH by using litmus paper at room temperature. The litmus paper is dipped into the liquid and the result is matched with the standard pH chart.

By performing above test, pH obtained was 6 (range 4.5-6.5).

6. Drying Time Test:

The drying time test is carried out by observing the time preparation takes to dry. The test determines the time when the preparation is fully dried when applied on skin. The drying time observed is 20 seconds it

takes longer time because no alcohol is added during preparation.

PUBLIC SURVEY ON ANTI PERSPIRANT

Storage And Packaging

Here are some tips for storing the natural deodorant or antiperspirant spray:

1. Store in a cool, dry place: It is crucial to store your antiperspirant spray in a cool and dry environment. Excessive heat and humidity can affect the consistency and effectiveness of the product.
2. Avoid direct sunlight: Direct exposure to sunlight can cause the ingredients in the spray to degrade and lose their potency. Store the product away from windows or other sources of direct sunlight.
3. Keep away from moisture: Moisture can lead to the growth of bacteria or mold in the product. Make sure the cap is tightly sealed after each use and avoid storing the spray in a bathroom or other humid areas.
4. Check the expiration date: Natural deodorants and antiperspirant sprays have a shelf life. Check the expiration date on the product and discard it if it has expired to ensure optimal performance and safety.
5. Follow any specific storage instructions: Some natural deodorants or antiperspirant sprays may have specific storage requirements. Read the product label or manufacturer's instructions for any specific instructions regarding storage temperature or conditions.

By following these tips, you can help maintain the quality and effectiveness of your natural deodorant or antiperspirant spray for an extended period.

1. **Cool and Dry Environment:** To prolong the life of your antiperspirant spray, it is recommended to store it in a cool and dry area of your bedroom. This helps maintain its consistency and effectiveness. As an extra tip, you can even place the spray in the refrigerator and take it out 15 minutes before applying for a refreshing experience.
2. **Away from the Sun:** Just like any other cosmetic product, prolonged exposure to sunlight and heat can degrade the spray and make it stickier. Therefore, it is important to store it away from direct sunlight or any other heat source. If you need to carry your deodorant with you, ensure that your bag is kept in a cool spot or under shade to protect it from excessive heat.

By following these storage tips, you can extend the lifespan and maintain the quality of your antiperspirant spray.

However, packaging plays a crucial role in ensuring the proper preservation and effectiveness of drugs in the clinical and pharmaceutical industries. It is important that the packaging used for medications maintains the integrity of the product, preventing external contaminants from entering the container and ensuring that the chemicals in the packaging do not compromise the safety and efficacy of the medication.

The ideal packaging should possess the following qualities:

Protection from natural hazards: The packaging should effectively shield the medication from environmental factors such as light, temperature, moisture, particles, or microorganisms.

This helps maintain the stability and potency of the drug.

Protection from environmental changes: The packaging should safeguard the drug substance from environmental factors like vibration, shock, abrasion, or puncture. This ensures that the medication remains intact and undamaged throughout its shelf life.

Minimal product loss or addition: The packaging should not contribute to any loss or contamination of the medication. It should be designed to securely contain the product without leakage or evaporation.

Appealing appearance: The packaging should have an aesthetically pleasing appearance, conveying professionalism and quality. This can instill confidence in the consumer/patient about the product's authenticity and reliability.

User-friendly design: The packaging should be convenient and easy to use for the patient. It should be designed with features that facilitate proper and accurate dosing, administration, and storage.

By adhering to these packaging considerations, pharmaceutical companies can ensure the safety, efficacy, and overall quality of their medications, while also providing a positive user experience for patients.

We have opted for plastic spray bottles for our preparation, and here are the characteristics that influenced our choice:

Aesthetic and Smooth: Plastic spray bottles have a visually appealing appearance and a smooth texture both inside and outside. This enhances the overall presentation of the product.

Consistent and Welding-Free: Plastic spray bottles are manufactured using advanced techniques that ensure consistency in their shape and structure. They are typically constructed as a single piece, eliminating the need for welding or joining parts together.

Lightweight yet Strong: Plastic spray bottles are lightweight, which makes them easy to handle and convenient for transportation. Despite their lightness, they exhibit great strength and durability, providing adequate protection for the contents.

Resistance to Influences: Plastic spray bottles offer resistance to various factors that could potentially affect the product. They are resistant to impact, ensuring that the bottles can withstand normal handling, filling, transportation, stacking, and dumping conditions without compromising their integrity.

Corrosion Resistance and Non-Toxic: Plastic spray bottles are designed to be corrosion resistant, protecting the contents from potential interactions with the bottle material. Additionally, they are made from non-toxic materials, ensuring that the integrity and safety of the product are maintained.

Convenient Transportation: Plastic spray bottles are designed for easy and convenient transportation. They are lightweight, which reduces shipping costs, and their durability ensures that they can withstand the rigors of transportation without damage.

Long Service Life: Under normal conditions of filling, transportation, stacking, and dumping, plastic spray bottles have a shelf life of approximately 1.5 years. This demonstrates their ability to maintain the quality of the product throughout its intended lifespan.

By utilizing plastic spray bottles with these characteristics, we can ensure a visually appealing, durable, and convenient packaging solution for our antiperspirant spray product.

RESULT

Our carefully formulated antiperspirant spray contains key components that provide various benefits:

- **Neem Extract (25%):** Neem is known for its antiseptic properties, making it an effective ingredient for reducing the risk of infections and maintaining hygiene.
- **Alum Solution (25%):** Alum is utilized for its astringent properties and is commonly used in antiperspirants to help reduce sweating.
- **Menthol Crystals (5%):** Menthol provides a refreshing and cooling effect when applied to the skin, enhancing the overall sensation of freshness.
- **Rose Extract (Fragrance):** We have added a small amount of rose extract to provide a pleasant fragrance, as it is widely accepted and appealing to many individuals.
- **Methyl Paraben (0.9%):** Methyl paraben is included as a preservative to maintain the integrity and shelf life of the product, ensuring its effectiveness over time.

The combination of these ingredients in our formulation aims to offer effective antiperspirant properties, a sense of freshness, a cooling effect, and a pleasant fragrance. We have taken into consideration the acceptance and appeal of natural components to provide a product that meets the expectations of our users.

DISCUSSION

Antiperspirant sprays play a significant role in maintaining personal hygiene and reducing the risk of infections and discomfort. Our carefully formulated product is designed to be gentle on the skin while effectively reducing sweating and providing antiseptic properties.

By utilizing natural components, we ensure that our antiperspirant spray is safe for use and minimizes the potential for adverse reactions. The formulation has been developed with the user's convenience and feasibility in mind, aiming to provide an easy and hassle-free application.

Regular use of our antiperspirant spray can help in controlling excessive sweating, preventing the growth of bacteria that can cause infections and unpleasant odors. By keeping the skin dry, our product contributes to a more comfortable and confident experience throughout the day.

We understand the importance of maintaining good personal hygiene, and our antiperspirant spray is

designed to support individuals in their daily care routine. With the use of high-quality and natural ingredients, we aim to deliver a product that not only effectively reduces sweating but also promotes overall skin health.

Choose our antiperspirant spray for its softness, ease of use, and the benefits it provides in reducing infections and discomfort, allowing you to feel fresh and confident in your daily activities.

CONCLUSION

Our product has been meticulously developed, taking into account extensive care and research. We have strived to create a formulation that is simple to use and comprehend, ensuring a seamless experience for our customers.

The primary purpose of our antiperspirant spray is to effectively reduce sweat and combat unpleasant odors. Through rigorous testing on human models, we have demonstrated that our product is gentle and compatible with various skin types.

The results of our studies have indicated that our antiperspirant spray is skin-friendly and does not cause any adverse reactions or discomfort when applied.

Furthermore, we have ensured that our product maintains its quality and effectiveness over time.

Based on our evaluations, the spray exhibits good storage stability for approximately 2 months, allowing users to enjoy its benefits consistently.

Future Prospects:

The identified aims and objectives for the development of an antiperspirant spray containing neem extract and alum pave the way for promising future prospects. With continuous research and development, the following possibilities emerge:

1. **Enhanced Formulation:** Further refinement of the formulation can be explored to optimize its efficacy in reducing sweating, combating body odor, and providing a cooling sensation. This can involve studying the synergistic effects of neem extract and alum with other natural ingredients to enhance their antibacterial and antimicrobial properties.
2. **Extended Product Line:** The success of this antiperspirant spray formulation can lead to the expansion of the product line. Additional variants

could be introduced to cater to specific needs, such as sensitive skin formulations or scented options to provide a personalized experience for consumers.

3. **Market Expansion:** As the formulation aligns with the increasing consumer demand for natural and eco-friendly personal care products, the future prospects include capturing a larger market share. The formulation's unique combination of neem extract and alum, along with its efficacy in reducing sweating and odor, can position it as a preferred choice in the antiperspirant market.
4. **Research on Skin Health Benefits:** The future prospects also involve exploring the potential skin health benefits of the formulation. The inclusion of neem extract and alum may offer additional advantages such as exfoliation, promoting smooth and irritation-free skin, and potentially addressing other skin concerns, opening avenues for further research and product development.
5. **Sustainability and Environmental Considerations:** The formulation's natural ingredients provide an opportunity to align with sustainable practices. Future prospects include exploring eco-friendly packaging options, sourcing sustainable ingredients, and promoting the product's environmental benefits to appeal to environmentally conscious consumers. In conclusion, the future prospects for the antiperspirant spray containing neem extract and alum encompass product refinement, market expansion, research on skin health benefits, and sustainability considerations, making it a promising solution with potential for growth and success in the personal care industry.

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Author Contributions

OM and FI planned the experiments, HN and KR and RR evaluated the findings, OM, FI and KR made the write up and AN statistically analyzed the data and made illustrations

Conflict of Interest

There is no conflict of interest of any authors

Data Availability

The corresponding author will provide the data described in this study upon reasonable request

Ethics Approval

Not relevant to this paper.

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