Original Article

The influence of PH on skin's surface

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Abstract

The pH of skin is very decisive in the life of humans because it helps in enhancing infections that are related to antimicrobials. So far, the skin of humans considered is the main outdoor for several bacterial infections. The acidic Nature (pH) of the skin performs an integral physiologically part in the body and it has been identified as a regulatory component in the stratum corneum's homeostasis and skin barrier permeability. Surveys were done later illustrated that aggregation, skin barrier function& lipid production, epidermal differentiation& desquamation are basically impacted by the pH itself. Multiple epidermal pH figures have also been observed and tested in this study, all within the acidic condition however varying from pH 4.0 to 7.0, and depending on this pH, the 'natural' skin surface pH is expected to be 4.7 to 5.75 or 6. In addition, various studies are available in the latest days that focused primarily on alterations inside the pH of the stratum corneum's deeper layers including the effect of various physiological and pathological variables. Whenever the skin barrier is compromised, pH rises, resulting in a variety of ailments, including dermatitis, irritating contact dermatitis, ichthyosis, acne, and dry and ageing skin. In the current review, we will summarise many autogenous factors and exogenic factors such as skin moisture, sweat, sebum (produced by sebaceous glands), anatomic site, genetic susceptibility, age, detergents, so-called skin health maintenance products, wounds occlusive dressing could bother the pH of the skin. With that, we collected several publications in this review and explored the importance of pH surface and the key factors that influence skin's pH-related skin illness. We'll also go over how to determine the pH of the surface of the skin and also how it would affect skin and wounds.

Keywords: corneocyte, epidermal differentiation, lipid production, stratum corneum's homeostasis, wounds.

INTRODUCTION

The epidermis (an exterior layer), dermal (a fiber layer), and hypodermis (a subterranean texture of fat) make up the bulk of the integumentary, which occupies approximately 23 sq. ft and is 0.075-0.15 mm thick.[1]. It serves as a body's first line of protection against Ultraviolent (UV) radiation, microbial infection, and chemical irritants [2].

Several questions and ambiguities concerning the possible involvement of skin pH still exist today. When it comes to the pH of the skin's surface, there are three primary concepts to consider: the acidic mantle of the skin related to the secretion of sebaceous/sweat glands, the degradation product of filaggrin protein, and the presence of natural moisturizing factors (NMFs) [3]-[6]. Skin wetness can affect the acidic character of human skin. pH of the top layer of the skin ranges from 4.2 to 6.1, which is normally acidic. [7]-[8]. Ever since Heinrich Schade and Alfred Marchionini coined the term "acid mantle" in 1928, in which skin pH has been an important factor studied for over a century. The term acid mantle is made up of a thin sticky mixture of perspiration and sebum that covers the outer layer of the stratum corneum (SC) [9].

Because they govern the existence of resident skin microorganisms and are associated with physiological processes like lipids barrier formation and SC homeostasis, the pH of the acidic interface, as well as the related pH differential just on stratum corneum (SC) are fundamental to skincare. [10],[11]. It is created throughout the skin and has already been connected to various important biological processes in the skin, including desquamation and antimicrobial defence. Several essential SC enzymes are pH-dependent [12]-[14].

Also, there is evidence suggesting skin pH might influence large macro properties of the Stratum corneum, with one remarkable being the modification of the skin permeability barrier function by changes in skin pH [15]-[16]. Knowing how pH changes impact SC transport characteristics is important because SC transport qualities are tightly tied to the cellular mechanics of the SC components and can also help to gain molecular details of the relationship between skin pH and macroscopic properties such as hydration and transport properties [17]-[18].

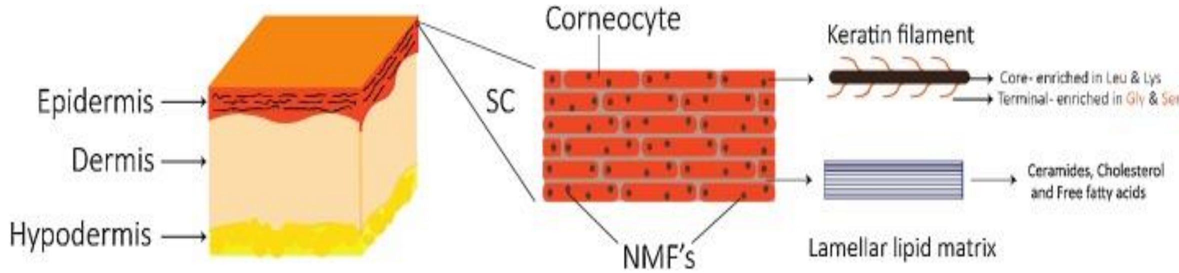
COMPOSITION OF SKIN

The Stratum Corneum (SC):

The majority of the organism's body is coated with fifteen to thirty layers of SC. The top stratum is composed of 3–5 layers and is gradually desquamated. The strata compactum appears thicker and has characteristics which are more similar to the surrounding epidermis. The epidermal barrier activity is propelled by the light coating of SC [19]. Hundreds of species of commensal organisms, including bacteria, fungi, viruses, and mites, known as the microbiota, constitute the microbiome barrier on the skin's surface [20-21]. There are several communication channels and interactions between keratinocytes, immune cells, and microorganisms that maintain skin barrier permeability and homeostasis in both healthy and stressed settings, such as wounds and bacteria. Regular Stratum Corneum is mainly comprised of around 70% protein & 15% H2O, which varies from the constitution of a keratinocyte inside a living epidermis [22]. Between both the stratum granulosum and strata compactum, there is a significant reduction in H_2O content, due to this. This development continues, albeit at a slower rate, all the way up to the stratum disjuncture [23]. The amount and the kind of substances which bind the SC together, which include amino acids, peptides, Natural Moisturising factors, and phosphatides, dictate its moisture levels. Since it is more in terms of polarity than that of the lipid molecules domain, the innermost compartments of corneocytes are indeed the primary site of water binding. [24].

The SC has a complicated architecture consisting of nucleus empty corneocyte cells enveloped in a cornified membrane [25,26]. Corneocyte cells are packed with keratin protein, which accounts for 85 percent of the SC's dry weight, and are embedded in a multilamellar lipid stack. These are required for the maintenance of the stratum corneum(sc), but they also contribute to the total skin ph. [19,27-29].

Fig1. A small layout of the skin



The natural moisturizing factor (NMF)

In drying circumstances, the natural moisturizing factor (NMF) plays a critical function in preserving molecular mobility in SC components [30-31]. The NMF is composed of small polar molecules such as CH_4N_2O, C3H6O3, free amino acids, and salts containing two monovalent and divalent cations [32-33]. Several of those NMF compounds are also regularly utilized as 'humectants' in skincare products. In dehydrated circumstances, the NMF components can replenish water, retaining fluidity in the SC lipid and protein molecular components [30].

Multiple studies have been carried out on urocanic acid from histidine, aminotransferase from aspartic acid, & pyrrolidone carboxylic acid discovered that such compounds are being created from amino in the mucus layer zone thought to be free of enzyme system since it contains only dead tissue [34-37]. The SC is currently regarded to be physiologically inactive however biologically active [38]. An examination of the amino acid content of the stratum corneum revealed that the NMF components were breakdown products of the filaggrin protein's proteolysis [39]. A corneocyte layer is present above the granular layer and is very rich in filaggrin histidine protein [40]. It progressively degrades, having a 1/2 lifespan of twenty hours [41]. Table 1 shows the general makeup of NMF.

Table 1: chemical composition of skin's natural moisturizing factor.

Components	Percentage
Free amino acid	40.0%
Pyrrolidone carboxylic acid	12.0%
Urocanic acid	3%
Lactates	12.0%
Ammonia, calcium, magnesium	1.5%
urea	7.0%
Citrate, phosphate	0.5%
Sugars, inorganic acids, Other unidentified materials	8.5%

INSTRUMENTATIONS AND MEASUREMENT OF SKIN pH

In chemistry, pH analysis is widely calculated to investigate overall acid-base balancing in aqueous media.

There are many techniques for determining the ph value of skin that are similar to those seen in analytical methods for evaluating PH of the aqueous medium. The first research examining skin pH involved "colorimetric" techniques, which used indications that changed colour on changing pH. This technique seems complex since it requires the gathering of an indicator from the skin surface [9,42-43]. Numerous indicators needed the broad portion of skin for the usage and after being collected in a tube, were measured by the colorimetric method. To simplify this a method was introduced known as the "foil colorimetric method" in which adsorbing sheets are used. But the analysis of the evidence seemed arbitrary, and even not reliable [44]. Another alternative, known as the buffer capacity method, has been evaluated in which we must inject diluted NaOH straight to the skin. After that, neutralize the skin surface and use an indicator to calculate the buffer capacity [45].

As a result, the method was progressively phased out in favour of a new method known as the "potentiometric method" [42]. Currently, this approach is without a doubt the most extensively used method for determining the Ph of the skin. It requires the use of many electrodes [46]. It controls the pH of the deeper epidermal layers and detects electrical impulses using an electrode [47]. Several electrodes were developed, but the glass electrode technique with H-ion selectivity seemed to have good sensitivity and reliability [48]. The electrode is frequently planar in form and was designed to satisfy the specific necessity of measuring skin pH. a lot of research is there in the literature which reveals Practical recommendations for assessing skin's pH by using a "planar glass electrode technique". Schirren was the first to employ a glass electrode method with a flat or planar detecting surface to test the pH of the skin. It comprises both active and standard electrodes, which are sometimes known as "combined" or "single glass rod electrodes. Today's planar transistors generate a modest electrical voltage, which is recorded and shown as the pH value. [49]."

Presently, four methods of glass planar electrode equipment are available i.e.

- skin pH meter 1140

- Skin pH meter 900 or 905,
- Russell pH Ltd
- pH metre (Radiometer, Copenhagen, Den mark) [50].

C. Ehlers demonstrates the difference of 2 pH meters, the pH meter 'pH900' by Courage & Khazaka and the pH meter '1140' by Mettler to reveal the overall change in skin's pH evaluated somewhat on forearms. The original pH meter (pH900) seemed to have a pointing electrode as well as a three-second stabilization period. The forthcoming pH meter (pH 1140) utilized globular electrodes and does not have a predetermined stabilization time. pH parameters were measured both on the forearm at 5 different locations, ranging from the elbows to the wrist area and three pH measurements were performed. He noticed that with a greater range of fluctuation the pH meter (900 or 905) has a greater measurement range as compared to the pH1140.

Furthermore, Researchers also urged that the PH meter should be allowed to settle for measuring the pH value. [51].

The tewl measurement technique is often used to analyse overall water barrier properties of skin both in normal and pathological conditions, to evaluate the efficiency of treatment modalities on damaged skin & to execute anticipated irritancy tests. This technique might be tested in vivo using 3 disparate methods. H.lambers et al. measured the skin pH in volunteers' volar forearms with the tewameter TM210 (courage+khazaka) and reported an estimated value of 5.12, although after 24hrs he observed that without any specific product application, The value falls to a typical mean of less than 5 [52]. The most recent study sought to ascertain the link between skin pH & TEWL, as well as their relationships with AD symptoms. Youth ages 4 to 12 were measured using the HI 99181 & Tewameter TM 300 in 2 lesional & 2 nonlesional regions. The TWEL levels and pH were found to be greater on lesional skin surfaces whereas negatively on the non-lesional surfaces. Greater pH levels were linked to illness and itching [53].

The current clinical study introduces a method called “forearm-controlled application technique (FCAT)” to assess the cleaner’s mildness on the skin's pH using 2 original cleansing bars that are similar in form but differ in pH against a balanced pH surfactants bars and 2 body wash articulations that are similar in Optimum pH of 4.7 & 6.7. According to the findings of this study, skin pH bar & fluids with lesser pH compositions are harsher on the skin than those with balancedpPH parameters.[54].

During recent periods, pH transistor technology was applied to create a novel method of monitoring pH. An "ion-sensitive field-effect semiconductor" is used in this procedure. [55]. This looks to be ideal for determining the total pH of semisolid or very fluid substances when a glass pH sensor would be ineffective. It could even detect the pH of a tiny region or less than a drop. Other complicated methods of detecting skin pH with certain challenges are not yet widely employed, such as the use of microelectrodes-sensitive fluorochromes, electron spin microscopy, and so on [12, 56-57].

According to, M Finnegan's most recent publication from 2022, A substantial correlation between a sensor color response and the PH of the skin's surface was shown in a study employing wearable bio diagnostic sensor nodes This is being researched utilizing merely a basic wearable colourimetric sensor integrated detector section comprising "encapsulated BCG (bromocresol green) pH indicator pigment during an enclosed chamber immediately above the skin(palm)." He tested this on five men and five women with approximately the same skin types. The biosensor patches change color, when basic mobile nitrogen(N) molecules, including NH3, are released from the skin's surface. Ultimately, it was revealed that men produced a larger color reaction than women for similar skin surface PH. They also investigate the effect of inter-person variation on sensor gig and highlight the problems associated with this method in ED sensors. They may alter the skin occlusion and trigger the sweat response by wearing calorimetric sensor platforms, and they may be utilized to accurately assess certain aspects of the skin’s volatile emission [58].

THE ROLE OF OPTIMUM PH ON THE SKIN’S SURFACE

“pH is defined as a negative logarithm (10 base) of the proportion of free hydronium ions and is used to compute the acidity–alkalinity ratio on a scale of 0 to 14” [59]”. The pH in the human body is controlled by acid-base homeostasis ranging from 1 to 8, depending on the organ and function enzymes lose their capacity to operate when they are outside of the permitted range. Many studies have demonstrated that skin acidification is essential for maintaining healthy skin and defending the body against exogenous factors [60].

Proper regulation of these processes is required to keep the skin smooth, prevent infections, and make the skin less prone to inflammation [61].

The Natural skin surface pH in most body parts is estimated to be in the range of 4.1-5.8 with slight variations in between the face, and extremities [62-63]. The pH values on the chin were discovered to be the highest-ranking at 5.6. The much more acidic regions range from 4.4 to 4.6, including, the nose, neck, laugh line, and face, as well as the sinciput and upper medial canthus [64]. There are certain exceptions: in some physiological gaps (axillae, groyne, toe interdigital, and anus), pH levels range from 6.1 to 7.4 [61]. These PH values which are listed above have been obtained with potentiometric and glass electrode methods. Most of the writers were believe that the true skin pH is closer to 6, as the measurement technique only considers water-soluble components [65]. Recognizing the centrality of pH in pathophysiology and illness, it is critical for every human tissue to endure acid/alkaline aggressiveness (maintain a certain pH) or to get a buffer system [66]. Despite the fact that reliable evidence suggests a certain co-dependence in both activities, evidence suggesting a degree of co-dependence in both activities, human skin's buffering capability has been examined separately from the skin's pH preservations operations. [67]. Existing evidence suggests that the importance of free amino acids in the epidermis to the formation and preservation of the Skin has not yet been fully understood as Free amino acids are critical components of the skin's neutralizing ability [67].

Aside from all these facts age and ethnicity are common observations that affect the PH of the skin[4].on the other hand, the skin pH of infants is higher, ranging from 6.5-7.38, and it approaches the physiological norm within 4 weeks[68]. The feeble alkaline skin becomes acidulous within its quest to develop an acid mantle, which intensifies the SC's functional maturity. [69-70]. During this time, new-born skin is extremely vulnerable to injury and generally stays so until the end of the fifth decade of life [71]. Gender disparities, while commonly documented, are not typically seen as substantial [72]. According to Ehlers et al., women's skin surface pH is slightly lower than men's, with an average pH of 5.54 for females & 5.80 for males [73]. Another research, on the other contrary, showed pH values below 5.0 in men on the anatomical areas like sinciput, facia, neck, antebrachium., and hand, but in women, the pH was always higher and primarily on the forehead [74]. It was also shown that when postmenopausal women were compared to premenopausal women, their PH increased from 4.7 to 5.0 [69-70].

Racial disparities in skin pH are also important as it was observed that darkly pigmented skin had a lower pH (4.6 vs. 5.0) and better SC consistency and barrier effectiveness than pale skin as Serine protease activity was reduced in the profound melanin group and continued to rise in a faintly pigmented cluster. [75].

The surface of the skin is acidic, but when it goes deeper into the skin, it becomes more neutral (around 7-7.4) [76]. Acidified microdomains have also been identified all across the Stratum Corneum, demonstrating that pH gradients are sophisticated. [77]. The existence of such acidic microdomains was detected by fluorescence lifetime imaging in the stratum granulosum–stratum corneum contact and in the lower SC interstices [76-77]. Such gradients, as well as acidic microdomains, provide the acidification, which is necessary for both lipid synthesis and barrier homeostasis modulating the activities of PH-dependent enzymes. [78-79].

AN ASPECT THAT AFFECTS SKIN PH

Although skin PH modulation is vital to the physiological defence system, but there are additional intrinsic & extrinsic parameters that affect skin PH, such as aging, cleansers, topical treatments, and so on. Multiple elements have already been investigated in order to explain the challenges in correlating skin's surface PH.

Endogenous factors

There are some endogenous(physiological) factors that affect the PH of the skin surface:

Age

Increased age is connected with skin pH levels that fluctuate on a regular basis. This adds to the difficulty of establishing comparisons between various age factors. Wilhelm et. used a flat glass electrode linked to a skin pH meter to assess skin pH in 14 young individuals and 15 older persons. He reported that pH at the sinciput & ankle was significantly much greater in the older group and there were no substantial changes in any other anatomic region [80]. further Fluhr et al. assessed skin surface pH on the antebrachium of forty-four adults aged between 21 to 44 yrs and 44 children aged 1–6 years using a skin pH meter and no significant changes are found [81]. The pH of neonates becomes less acidic even than those of adults and also the skin's pH across the most anatomical region remains steady between 18 to 60 years aged people [82].

Gender

Experiments in current decades disclosed that women have much higher skin pH balance than men [83].

Ethnic

On occasion, skin pH was seen to change depending on ethnic and genetic provenance. However, objective approaches have only been used to explore ethnic disparities in the skin. Persons with dark skin have a lower pH than people with white skin [84]. Quantitative statistical approaches have still yet to verify whether dark skin Indians have a slight difference in their skin's pH as compared to Europeans [85]. According to previous research, various differences in skin ph have been detected based on ethnic and genetic origin. People with darker complexions have weaker pH than those who have light complexions, but the majority of the time there have been no differences occur between these groups [86].

Sebum

The volume of the sebum secreted by the skin seems to have a minor impact on the pH which is being analysed. However, there is a scientifically notable -ve relationship between both sebaceous glands & skin's pH inside the skin's zone (i.e. U and T zone with and without acne), but this connection is insufficient to analyse the effects of sebum production on the skin's pH[87]. A high sebum content on the sinciput generally seemed in a patient having acne, which might falsely alter the pH test. Skin hydration also seems to have an impact on the skin's PH. [82].

Sweating

Early investigation has demonstrated that sweaty PH modulates with sweating rate. It predominantly contains NaCl, fatty acids, CH_4N_2O, and $C_3H_6O_3$. It mainly contains salt like chloride, lactate, fatty acid & so on. Sweat contains lactate, which helps acidify the human tissue. Relative levels of azane, 2-oxopropronic aid, & lactic acid reduce as the number of eccrine sweats rises, as a result, the pH of the skin becomes increased. [79,88-89].

Except there are a lot of other factors like circadian rhythms, and skin temperature which affects the pH in a moderate amount.

Extensive factor

Extrinsic factors that have a substantial impact on the observed skin surface pH are many and must be understood before creating experimental techniques for this subject.

Skin cleansing

The pH increases from 10.5 to 11.0 after cleansing the skin using alkaline cleaners. the Use of cleansing detergent having the same pH value as skin, along with normal water, induces an elevation in the skin's pH, but only for a shorter period [90-91]. It is hypothesized that such transitory skin pH alterations are restricted to the stratum corneum's outermost levels, which were tested using the tape-stripping method [42].

Cosmetic products

There are a lot of so-called products for skin health maintenance the pH of the skin drops following the use of cosmetic items, may mitigate the effect of cleansing with normal water [52].

Occlusive dressings

When skin is occluded, its pH rises; however, when the occlusive dressings are removed, the pH environment returns to an acidic state. The usage of these dressings leads to a lesser-term impact on the pH value of the skin surface [92-93].

Except for this, there are some experimental factors like electrolyte-liquid level, contamination of the electrode, PH meter calibration, excess water on measuring electrode, excessively dry electrode, etc. which affect the pH of the skin [42].

MICROORGANISMS AND THEIR SKIN DISEASES

Underneath the acidic mantle and lipids barriers, the different layers of the epidermis have fairly static and regulated physiological pH values; nevertheless, when the defensive barrier is broken or the natural pH level of the epidermis is disturbed, the risk of several skin problems increases. A number of studies have found a connection between the surface of the skin pH and disorders such as atopic dermatitis, acne, dryness, ichthyosis, and others.

Atopic dermatitis (eczema)

A persistent inflammatory skin condition characterised by a red, itch rash. The inclusion of significant numbers of Staphylococcus on the skin of eczema patients has been reported to worsen the illness [94]. Although a pH of 7.0 to 7.5 is optimum for S. aureus development, the bacteria may reproduce at neutral pH of 9.0. The alkalinity of the skin's exterior fluctuates between 4.5 and 6.0, which is insufficient to totally eliminate germs. The genesis of atopic dermatitis is influenced by genes and environmental variables, including enhanced S. aureus colonisation [95]. Substances with just an acid pH have been proven in clinical testing to be therapeutically effective in the upkeep treatment of eczema skin problems, and acid topical skin-care treatments have been proved to be curative for eczema erysipelas and dermatitis in several investigations. Four weeks of frequent application to the skin of kids with dermatitis of a sun lotion with an acid citrate buffer system and a pH of 5 considerably reduced the alkaline neutralisation time in treated areas compared to untreated skin [96]. Pre-treatment with a directly analogous acidified hand lotion demonstrated a significant preventative impact on sodium lauryl Chloride pH rises and skin irritations in adult patients [97].

Seborrheic dermatitis

Dermatitis is a skin disease that primarily affects the head. It causes crusty patches, irritated skin, & chronic hair. Dermatitis can also impact greasy parts of the body, like the cheekbones, side of the face, temples, and breasts. The fungus pittosporum plasmodium is more common in the flakes scale of those who have seborrheic dermatitis. Schwartz and colleagues have found that the medicine ketoconazole improves seborrheic dermatitis. They studied the literature and discovered that P. ovule is the causative agent of this illness, however, the method by which P. Ovale produces inflammation and desquamation is unclear [98,99].

Irritant Contact dermatitis

In people who don’t have an atopic background, the pH of the surface of the skin could also be used to forecast the chance of aggravating skin irritation. Wilhelm and Four months ago evaluated a range of skin variables in 10 healthy subjects during irritation using 1 percentage sodium lauryl. The researchers noted important correlations among surface pH and the deeper stratum corneum layers exposed after four tape stripping, however just not among trans epidermal loss of moisture, sebum concentration, or horny layer renewal rate [100]. The Francomano group confirmed these findings, discovering that individuals with skin types who've been actually susceptible to itchy skin had higher pH values in the cheeks than human volunteers [101]. In new-born, changes in epidermal pH have a pathophysiological effect. Although the surface has been proven to provide an enhanced foundation pH of 6.6 in some settings, nitrogen actions stimulate faces enzyme including such protease and trypsin, producing irritation and destruction of the cell membrane [102].

Diaper dermatitis

Baby eczema is an irritant dermatitis due to skin drying, erosion, extended contact with urine & faeces, residual diaper detergents, and topical therapies. According to a previous study, its pH value ranges between 5.3 and 5.5. Diapering is prevalent in new-borns, and it is associated with higher wetness and epidermal pH value. Ronald & co-workers [103] studied 1601 babies in their study. The results demonstrate that diapered skin has roughly twice the Plus of undiapered skin. Wearing a diaper epidermis does have a pH 6 to undiapered skin (pH 5.3), which would be related to the pH of the acid mantle. Skin moisture can compromise skin health by raising irritant permeability, and frictional coefficient, and promoting microbial growth [104]. Elevated pH levels have been shown to increase faecal activity. Elevated pH can increase the activity of faecal protease, which can degrade the extracellular matrix of the skin and finally destroy tissues [105].

Acne Vulgaris

The proliferation of the resident flora is aided by an acidic pH. When the pH rises, the local flora alters [106]. Propionibacterium acnes grows best in a pH range of 6.0– 6.5; however, when the pH drops below 5.5, its growth slows drastically [107].

The number of face inflammatory lesions was compared between those who used a traditional alkaline soap and those who used an acidic syndet bar in a study of acne-prone patients. The number of inflammatory lesions increased in the alkaline soap group and decreased in the acidic s yndet group by the fourth week of application [108].

The mean pH value in the healthy control group was within the normal range, according to Prakash et al, who assessed face skin pH in acne sufferers and in aged and sex-matched healthy skin. The pH of comedones and the normal skin surface, according to Holland and Cunliffe are identical. The function of the epidermal barrier in acne sufferers has received little attention. Acne vulgaris, on the other hand, may be linked to a loss in water barrier function, which contributes to cosmogenesis and inflammation, according to current research. Despite the fact that all clinical studies support the use of superficial peels (such as beta hydroxy acid, glycolic acid (pH 1.2), and others in the treatment of mild-moderate acne, polyhydroxy acids and gluconolactone are used in acne treatment cannot be regulated. (107).

Candida Infections

Skin pH is known to be one of the factors that promote candida infection, which diabetics are more likely to have. The blastospore form of Candida albicans is related to acidic pH, while the mycelial form is associated with alkaline pH [109,110]. Clinical investigations have demonstrated the pathogenicity of Candida albicans mycelial form. Diabetes patients' skin pH was much higher than that of normal control skin, according to Gil Yosopo vitch and colleagues. Furthermore, diabetics with candidiasis had higher skin pH levels than diabetics without the infection. This suggests that skin pH and candida infection may be linked [111-113].

Tinea pedis Mean skin pH values from the foot region of patients with and without tinea pedis were compared in one study. In tinea patients, the pH of the skin on their feet was much higher. There may be more links between skin pH and tinea pedis, uremic, pityriasis Versicolor, erythrasma, pyoderma, and miliaria rubra [75]. More research is needed to see if variations in skin surface pH can help us understand these illnesses' path mechanisms.

THE IMPACT OF PH ON WOUND HEALING

pH impacts matrix metalloproteinase activity, fibroblast activity, keratinocyte proliferation, microbial proliferation, biofilm formation, and immune responses in both acute and chronic wounds [114]. To recover from skin damage or associated infection, a successive series of healing is suggested which may require distinct pH conditions. pH imbalances can cause significant persistent sores.

MMPs (matrix metalloproteinases) are a group of over 20 proteases which can break down extracellular entities, and aids in the clearance of broken tissues right after the formation of the new issue. Excessive protease levels, on the other hand, can stymie wound healing by damaging endothelial cells and damaging the epidermal-dermal interface, resulting in the destruction of freshly generated tissues [114-115]. In chronic wounds, inhibition of MMPs is done by metalloproteinases which are commonly present in fewer amounts. The concentration of MMPs & TIMPs must be equal for optimal healing.

TIMP is found to be very important to heal a wound properly. The activity of four proteases is crucial in wound healing which is usually dependent on acidity or basicity. Because chronic wounds are likely to place in a basic medium, elevated MMP may contribute to wounds that do not improve in time, still many proteases are not activated for pH below 5, decrease in pH around sites of the affected area may be a great option to heal wounds. reduction in pH value of the surrounding may assist to elevate the rate of wound healing. Lönnqvist et al. observed that when human keratinocytes were taken in a medium having pH around 6, it was found a lower tendency to populate the region and none of the wounds was able to undergo re-epithelialization at pH above 5. according to Lönnqvist et al. [116]. Therefore, it is necessary to make the pH of the wound above this pH value to improve re-epithelialization. Various processes of healing necessitate distinct pH conditions. An acidic environment may promote fibroblast proliferation. Re-epithelialization was found to be more appropriate in neutral and basic surroundings with a pH range of 7.20 to 8.35 [117-118]. An acid milieu helps to establish the protective acid mantle and normal skin barrier, which helps to avoid the formation of chronic wounds by suppressing excessive levels of MMPs.

SKIN PH PROVENANCE

When it came to the origins of skin PH, the early theories suggested that the hydro-lipid film (acidic mantle) was the result of molecules from a superficial layer.

Significant research has been performed to explain the provenance of protons (h+) on the skin surface, implying an interrelation of cellular and metabolic activities which are essential for both the acidification and regulation of the skin's PH. Phospholipid-to-free-fatty-acid conversion, Na+/H+ antiporter type 1 (NHE1), the filaggrin urocanic acid route, melanin persistence/extrusion, and cholesterol sulfate ionization and hydrolysis appear to be the most major sources of protons. Given the significance of pH inside the biological body, it is reasonable to expect that many activities choose to create H+ ions in addition to keeping pH within tissue-specific limitations. Different ion channels, receptors, and transducers have gotten a lot of interest since their role in pH regulation is being studied thoroughly [119].

Skincare/skin health protection

There are significant anatomical variations between infant as well as adolescent skins. Since newborn skin is underdeveloped and does not have a functional skin barrier. Because they have sensitive skin that's also easily injured, appropriate and necessary steps must be taken to protect them. According to several studies, new-borns should not wash their skin for further than five min because it may enhance moisture and reduce friction. Moreover, detergents and cleaners should be ignored during the first few days of a baby's existence as every effort to improve the skin's PH increase the number of microbes as well as the TEWL [120]. Detergent alternatives with skin-like pH values, including such believed that the only true descriptors and sodium lauryl sulphate, are gentler than soap. They have no impact on either pH or bacteria, but decay fast and can cause skin dryness [121].

Y.C. Jung and collaborators claimed that lowering skin pH can be handled in grownup skincare by enhancing hydration, that now the presence of low skin Ph-induced increased sebum excretion rate, and also that the combined effects might slow skin ageing by decreasing wrinkle length and depth. Furthermore, liquid compositions are more effective than oil-in-water compositions because of their longer beneficial properties. However, just a few research have looked into the influence of skincare on ageing skin with high pH levels. When contrasted to rinsing with water, bathing delicate skin with a moderate acid emulsion (pH 5.5) caused relatively minor harm to SC function (pH 7.0). Furthermore, α- hydroxy acid proves to be beneficial in reducing dryness & enhancing barrier function. [122]. The use of a mixture of glucosides and -lipoic acid on sunburn and time-of-life skin enhanced the appearance of the skin's tone, discolouration, & development of wrinkles. As per the research, skin pH rises with ageing, resulting in poorer SC functioning & decreased buffering proportions. External acidity of the skin surface can reverse the adverse effects of a time of life rise in skin pH. As a result, beauty product solutions for mature skin must be designed to balance the age-related rise in skin surface pH in order to improve SC functioning [122].

S. H. Youn et al. discovered that increasing skin pH to 5.5 to 6 for ladies' skin conditions and lowering skin pH to roughly 5.5 in men acne sufferers helped to treat T-zone acne [123]. Also, Saba et al. proposed that the pH of hand soap, detergent, or cleansers be from the region of 4.5–6.5, which corresponds to the acid layer of the skin. Artificial dishwashers, or syndets, are also less stinging and preferred [124]. It really is suggested that when selecting skin cleaning agents, numerous parameters such as formulations, ingredients, skin tolerability, pH, and infection prevention and control challenges be addressed. Dermatology treatments with pH levels higher than 7 can impair the skin barrier. The elderly, in particular, should utilize treatments with such a pH of 4 to 7 because elderly skin is rougher, more prone to breaking, and recovers less gradually from alkali damage [125].

CONCLUSION

More study is undoubtedly required to learn more about the complex link between pH-dependent events and skin pH. As previously said, one of the most important elements determining physiological function in the skin is pH value. The stratum corneum pH has historically been connected with antimicrobial defence, but a new study shows that it also modulates skin barrier function and desquamation. Because of the favourable environment for bacteria formation, there are various skin illnesses with impaired barrier function and aberrant pH levels that were previously unknown. There is enough measurable data to establish the general importance of an acidic skin layer, as well as the impacts of cosmetic product pH on skin pH. It might be extremely useful in identifying and treating wounds and other cutaneous problems. Further skin surface pH measurements were and continue to be important in determining the health of healthy and disordered skin.

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