# Chemical Peels

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Peels, whether mechanical, enzymatic, laser, or chemical, stimulate regeneration. Chemical peels are traditionally used for medical indications such as acne, keratoses, scars, and hyperpigmentation. As fruit acids (AHAs), they are now widely used in anti-ageing treatments.

Chemical peels contain substances that are not only derived from chemical synthesis, but are often of natural origin or contained in plant extracts (herbal peels). The term "chemical" refers to the fact that the peeling effect is based on chemical processes.
Acids alter the structure of a protein environment by breaking hydrogen bonds and destroying the secondary structure of proteins ("denaturing" them). This applies to both the stratum corneum and active areas of the epidermis and below.
Denaturation is followed by irritation, which progresses to coagulation necrosis as it penetrates further. The same thing happens, incidentally, when basic media are applied – such as caustic soda (after a short time) or sodium carbonate (soda; after a longer time). While acids destroy the corresponding layer structure without directly removing it, bases (alkalis) dissolve the individual components – this is easy to understand from the immediate slippery feeling on the skin.

**Acid strengths**

Not every acid has the same effect at comparable molar concentrations. Equal molar concentration means that a solution contains the same number of acid molecules. This means that at the same percentage concentration, lactic acid (alpha hydroxy acid [AHA]; M = 90.08 g/mol) contains about three times as many acid molecules as 2-hydroxy-5-octanoylbenzoylbenzoic acid (beta hydroxy acid [BHA]; M = 264.32).
To be effective as an acid, it depends on how effectively the hydrogen atoms (H) of acids react with water ($H_2O$) to form hydronium or oxonium ions ($H_3O^+$). This is called the dissociation of an acid. Example: acetic acid:

$$CH_3COOH + H_2O \leftrightarrow CH_3COO^- + H_3O^+$$

Long-chain acids, such as palmitic acid with a molar mass of M = 256.43, have no effect simply because they are not soluble in water.
The hydronium concentration determines the acid strength and pH of an acid. The lower the pH, the more aggressive the acid.

Whether an acid peel is effective on the surface or deeper down depends on the molecular structure of the acid. The BHA mentioned above is a salicylic acid derivative that contains a large lipophilic residue, which makes it less aggressive than the underlying salicylic acid, whose molar mass (M = 138.12) is only about half that of BHA. Trichloroacetic acid is stronger than salicylic acid, with a higher molar mass (M = 163.39) but a highly polar structure due to the chlorine atoms. It is used in medical medication when the peel goes beyond the removal of the stratum corneum.
Glycolic acid and mandelic acid also belong to the AHA acids. The latter is related to pyruvic acid, an alpha-keto acid [AKA]; both have an aromatic residue. In addition to AHA acids, polyhydroxy acids [PHA] are also used, which have a milder effect in percentage terms due to their high molar mass. Typical examples are lactobionic acid and D-gluconic acid, which is present in the solid state as gluconic acid δ-lactone (GDL). GDL is also used in food as an acidifier (E 575) and baking powder component.

**Vitamin A acid**

At first glance, it seems obvious to classify vitamin A acid (retinoic acid; INN: tretinoin) in the acid peel category. However, this is not the case. With a molecular weight (M = 300.43), it is actually higher than palmitic acid, but its unsaturated isoprene structure allows it to penetrate the skin much more effectively. Vitamin A acid has a biochemical effect by interfering with physiological control loops and stimulating a strong regenerative effect, during which the uppermost layers of skin are shed. Vitamin A (retinol), its esters and vitamin A aldehyde (retinal) have similar but weaker effects. They are all metabolised into retinoic acid, which also has a comedolytic effect, among other things. Direct treatment with retinoic acid is prohibited in cosmetics.

**Phenolic compounds**

While acid peels work their way "deeper" from the skin's surface through the stratum corneum

and the biochemical effect of retinoic acid takes place after it has penetrated the horny layer, the third type of chemical peel is based on the tissue toxicity of the compounds used, which ultimately results in the rejection of the affected skin layers.
Phenolic compounds dominate in this area. Even today, toxic phenol (hydroxybenzene) is still used in medical treatment. Polyphenols such as hydroquinone (1.4-dihydroxybenzene) and resorcinol (1.3-dihydroxybenzene) are frequently used. Hydroquinone is prohibited in cosmetics and resorcinol is subject to restrictions on its use as a component in hair dyes. Phenolic compounds have an antimicrobial effect. They are therefore also used to treat acne.
It should be noted that salicylic acid (2-hydroxybenzoic acid) and 2-hydroxy-5-octanoylbenzoic acid also contain a phenolic hydroxy group. However, they are toxicologically harmless due to the adjacent acid group.
A compound frequently used in combination with phenol is croton oil. In addition to triglycerides with high proportions of oleic acid, croton oil contains highly complex terpenes that trigger inflammation, have an epidermolytic effect and increase cell proliferation – including in existing tumours.[1]

**Peeling depth**

The aims of chemical peels are to remove pigment disorders, age spots, keratoses, scars, and wrinkles that are cosmetically disturbing. But they are also used to treat dermatological conditions such as acne. This raises the question of the depth of the peel, because on the one hand you want to achieve high effectiveness at the target site, but on the other hand you want to cause as little collateral damage as possible. The depth of a peel (superficial, medium, deep) depends on whether the effect is achieved by acids (AHA, BHA, PHA, AKA), biochemically (retinoic acid) or through tissue toxicity (phenols, croton oil). In addition, the molar and percentage concentration of the active ingredients and the duration of exposure also play a role. This means that even substances that initially appear to be "mild" can reach deeper skin layers at high doses and with prolonged exposure, leading to unintended side effects. The classification in Table 1 provides a rough guide.

Table 1: Classification of peel depth[2] (simplified)

| **Peeling depth** | **Active ingredients and concentrations (examples)** |
|---|---|
| Superficial: The effect takes place in the epidermis without going beyond the basal layer. | 30-50% glycolic acid<br>10-30% mandelic acid<br>30% salicylic acid<br>50% pyruvic acid |
| Medium: The entire epidermis and the papillary layer (stratum papillare) are affected. | > 30% salicylic acid<br>70% glycolic acid<br>30-50% trichloroacetic acid |
| Deep: The epidermis and dermis (stratum papillare and stratum reticulare) are penetrated. | > 50% trichloroacetic acid<br>50-55% phenol |

While superficial chemical peels are performed more frequently, for example every few weeks, trichloroacetic acid is typically applied at intervals of one to several years. The extent to which this is cosmetically or medically indicated is another matter. Frequent use of fruit acid peels stresses the skin and, over time, makes it sensitive and parchment-like.
Chemical peels are characterised by severe redness and skin peeling, are sometimes painful and leave the skin in an unattractive condition. This distinguishes them from superficial mechanical and enzymatic peels.
Pre- and post-treatment care should be carried out as for aesthetic procedures.[3]

**Combinations**

Mixtures are often used, particularly in medicine. They may offer advantages in specific cases, but as the following list shows, they are sometimes dependent on the individual, the

[1] https://de.wikipedia.org/wiki/Crotonöl
[2] T. Soleymani, J. Lanoue, Z. Rahman, A Practical Approach to Chemical Peels, J Clin Aesthet Dermatol. 11 (8), 21-28 (2018)
[3] H. Lautenschläger, Synergieeffekte: Vor- und Nachsorge bei ästhetischen Eingriffen, Beauty Forum 2024 (9), 94-96

time, and the trend. Direct comparisons are naturally rare.

- Baker-Gordon formula[4]: Phenol + 2.1% croton oil
- Brody's combination[5]: Dry ice (solid $CO_2$) + 35% trichloroacetic acid
- Coleman's combination[5]: 70% glycolic acid + 35% trichloroacetic acid
- Jessner's[6]: 14% resorcinol, 14% lactic acid (85%), 14% salicylic acid and ethanol
- Jessner-modified[7]: 17% lactic acid, 17% salicylic acid, 8% citric acid in ethanol
- Hetter's[4]: Phenol + ≤1.6% croton oil
- Monheit's combination[7] : Jessner + 35% trichloroacetic acid

In some cases, superficial treatments (AHA acids) are carried out using peels whose pH is adjusted to a higher value by adding buffer substances.

**Side effects**

Similar to hydrochloric acid accidents, acids can cause chemical burns that penetrate deep into the tissue if used carelessly (too high a concentration, prolonged exposure).
After-effects include:

- Infections, including viral infections (warts), especially with superficial peels, partly because the microbiome is completely destroyed.
- Medium and deep peels can cause permanent scarring.
- Pigmentation disorders and sensitivity to light
- Acne and rosacea
- Semolina-like cysts
- Accelerated skin-ageing

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[4] C.G. Wambier et al., Advanced chemical peels: Phenol-croton oil peel, J. of the American Academy of Dermatology 81 (2), 327-336 (2019)
[5] M. I. Rendon et al., Evidence and Considerations in the Application of Chemical Peels in Skin Disorders and Aesthetic Resurfacing, J Clin Aesthetic Dermatol 3, 32-43 (2010)
[6] A. A. O'Connor et al., Chemical peels: A review of current practice, Australasian J. of Dermatology 59 (3), 171-181 (2018)
[7] M. Landau, Chemical peels, Clinics in Dermatology 26 (2), 200-208 (2008)