

Aloe vera acts as barrier against pollutants

Over the past two decades, skin care has advanced at a rate rivalling that of technology. Just as it used to be enough for cell phones to simply make phone calls, it used to be enough for skin care products to simply cleanse, tone and moisturise. Those days are long gone. As baby boomers started showing the first signs of ageing two decades ago, they demanded more of their skin care products. They insisted on multi-tasking formulas that could reduce their fine lines and wrinkles, firm their sagging skin, and make their dull complexions lustrous again.

Recently, the cosmetics performance bar has been raised even further. Now, it is not enough to simply minimise the signs of ageing. Today's savvy customers want to prevent one of its main causes – skin-degrading pollutants – from taking its toll. Evidence for that trend is provided by the flood of mass market and natural anti-pollution skin care products hitting the shelves in recent years. Unfortunately, in the rush to incorporate the latest new fad ingredients into their formulas, many manufacturers have overlooked one of the simplest and most effective anti-pollution agents available: *Aloe vera*.

Aloe vera has been known since antiquity as an effective burn and wound healer and a soothing moisturiser – properties that have been verified by modern scientific investigation. However, recent research has revealed that *Aloe* also deserves a place in pollution-fighting skin care products because it acts as an effective barrier to pollutants, reduces the oxidative stress created by pollution-generated free radicals, activates the body's detoxification system, and restores immune suppression caused by UVB rays. Best of all, *Aloe* works both topically and internally, making it ideal for both cosmetics and dietary supplements positioned for their anti-pollution and detoxifying benefits.

Barrier effect

Remarkable in design, the skin forms an almost impermeable barrier between the inside of the body and the outside world. That barrier keeps unwanted guests, such



as pathogens, out, while locking necessary nutrients, such as water, in. Unfortunately, sometimes marauding molecules penetrate the barrier. In fact, according to researcher Lowell A. Goldsmith, the skin is “a target organ for pollution and allows the penetration of exogenous agents into the body.”¹

Surprisingly, the skin often surpasses inhalation or ingestion as a route of toxin exposure. A study of crude oil refinery workers, for example, found that 75% of their daily dose of the toxin pyrene was absorbed through the skin.² Likewise, greater quantities of chloroform – a probable carcinogen formed when chlorine reacts with organic matter – are absorbed through the skin during showering than from drinking chlorinated water.^{3,4}

As the largest organ in the body, and the one with the most direct contact with the environment, the skin may be the first place to show signs of damage from indoor and outdoor air pollution. In other words, it acts as the body's “canary in a coalmine”.

Role of pollutants

What exactly do pollutants do to the skin? First, they can aggravate existing skin problems, including atopic dermatitis, psoriasis, and scaly skin, as discovered by researchers who found that these diseases are more severe in urban populations.⁵

Second, they can increase the incidence of skin diseases. A 14-year study in Athens, Greece, for example, found that for every additional unit (mg/m^3) of carbon monoxide in the air, the number of diseases of the skin and subcutaneous tissue increased by up to 3.3%.⁶ And third, pollutants such as volatile organic compounds (VOCs) can cause skin rashes.

But a more far-reaching problem is that pollutants generate free radicals, those unstable molecules that have been implicated in the ageing process, including the ageing of the skin. While our bodies are equipped to neutralise a certain amount of these rogue molecules, sometimes our antioxidant reserves are depleted faster than they can be replenished. For example, a 1997 study found that in highly polluted cities such as Mexico City and Los Angeles, ground-level ozone depleted the antioxidant vitamin E from the outermost layer of the skin at a rate of 25% every two hours, most likely because the vitamin E was working hard to neutralise the pollution-generated free radicals and then became spent.

Without the protection of vitamin E, skin becomes more vulnerable to free radicals, which attack and degrade collagen and elastin, the skin's supporting structures.

Collagen and elastin are not the free radicals' only victims, however. Another study, this time conducted by L'Oréal, found that air pollutants such as ozone and nitric oxide increase the oxidation of sebum, the skin's built-in moisturiser. According to the company, that affects the smoothness and brightness of the skin, but even more distressing, it compromises the skin's natural defences and may enhance irritation and allergic reactions.⁷

There is one last skin problem caused by air pollution, albeit indirectly. Because pollutants such as chlorofluorocarbons have eaten a hole in the ozone layer, people are exposed to higher levels of UVB rays than they were in the past, which puts them at greater danger for skin cancer. For every percentage decrease in ozone, there is a two percentage increase in UVB radiation, and a predicted two percentage increase in skin cancer.⁸

Modern uses of *Aloe vera*

So how can consumers deal with these affronts to their skin that are being waged daily by pollution? By using topical and internal products featuring *Aloe vera*. What is remarkable about *Aloe vera* is that it works in so many different ways to fight the effects of pollutants.

A barrier to pollutants

One of the skin's main purposes is to protect us from pathogens and toxins by acting as a barrier to the outside world. Applied topically, *Aloe* gel reinforces that barrier. How? The mucopolysaccharides contained within *Aloe vera* form chemical bonds with water, giving the gel that characteristic thick, sticky consistency. By creating a gelatinous shield over the skin, *Aloe* gel helps keep pollutants out and water in. Incidentally, that is also what makes it such a good moisturiser.

Neutralises oxidative stress

The skin is constantly being hit with reactive free radical molecules created both by pollution and UVB rays. Free radicals, which can degrade the skin's supporting structures, are considered one of the causative effects of premature skin ageing. *Aloe vera* neutralises this oxidative stress in three distinct ways, thereby supporting a youthful appearance.

First, *Aloe* naturally contains a variety of antioxidants – including vitamins, phenolic compounds and peroxidases – that directly quench free radicals on the skin and in the body. In fact, a recent investigation of the antioxidant potential of an *Aloe vera* extract found it exhibited a radical scavenging activity of 72%, compared with only 65% for alpha-tocopherol.⁹

Second, in addition to containing its own stores of antioxidants, *Aloe vera* gel may also activate the body's endogenous antioxidant enzyme systems. Research in mice has shown internal administration of the gel elevates liver levels of three out of five cellular antioxidant enzyme families: the glutathione family, the superoxide dismutase family, and the catalase family.¹⁰

Third, *Aloe* has the unique and remarkable ability to increase the absorption of vitamins E and C. A crossover study in normal human subjects found that taking *Aloe vera* gel in combination with vitamin E increased plasma levels of the vitamin by 369% compared to controls, while taking it with vitamin C increased plasma levels by 304% compared to controls.¹¹ Considering that ground-level ozone rapidly depletes vitamin E from the outermost layer of the skin, any substance that can increase E's absorption is a must for urban dwellers.

Activates Phase II metabolism

Another way that *Aloe vera* gel protects the skin is that it activates Phase II metabolism, which is responsible for inactivating, detoxifying, and eliminating pollutants, including free radicals. That is a crucial function, because whether or not a toxin ultimately causes harm is largely determined by how well the body is able to detoxify it. The same mouse study that found *Aloe vera* gel elevates liver levels of cellular antioxidant enzymes, additionally discovered it induces two important Phase II detoxifying enzymes: glutathione-S-transferase and DT-diaphorase.¹²

Restores immune suppression caused by UVB rays

When UVB rays hit the skin, they not only create free radicals but also suppress immunity. In fact, chronic UVB-induced suppression of T-cell mediated immunity is a proposed mechanism behind the development of skin cancer. Unfortunately, due to the release of ozone-depleting pollutants into the atmosphere, the ozone layer does not absorb as much UVB radiation as it used to. Therefore people are more at risk of skin cancer today than they were just a few decades ago.

One of the most interesting discoveries about *Aloe vera* gel is that it can restore the immune suppression caused by UVB rays. Or, more specifically, an intermediate molecular weight polysaccharide fraction from *Aloe* gel, called Modified *Aloe* Polysaccharide (MAP) can. An impressive *in vivo* study used the contact hypersensitivity (CHS) test to measure the degree of immune suppression in mice that were first exposed to UVB radiation, then treated either with MAP or water, and then challenged with dinitrofluorobenzene (DNFB), a highly toxic liquid. MAP completely restored the immune suppression induced by UVB exposure compared to controls, making it a perfect addition to sunscreens and after-sun lotions.

So now that you are convinced you should be formulating your anti-pollution skin care products with *Aloe vera*, you should beware: not all *Aloe vera* is alike.

Variation among preparations

Unfortunately, the composition and efficacy of commercial *Aloe* preparations varies wildly. The most obvious variable is the manufacturing method employed. The composition of *Aloe* gel produced through the "fillet method," for example, wherein the rind containing the laxative anthraquinones is separated from the pulp and mucilage layer mechanically, differs considerably from *Aloe* produced through

the "whole leaf method," wherein the entire leaf is ground, and the rind particles and anthraquinones are removed through filtration. Other variables that may affect the composition of the gel include whether or not it was exposed to heat, UV light or enzymes during processing, all of which can degrade the active polysaccharide constituents.

Another, more malevolent, factor that can affect *Aloe* efficacy is purposeful adulteration, which is regrettably widespread. It is not uncommon for *Aloe* to be spiked with maltodextrin, for example, to make it look like the material has higher levels of *Aloe* polysaccharides than it actually does. One way for manufacturers to be assured of consistent *Aloe* gel quality is to look for the seal of the International *Aloe* Science Council (IASC), which was created in 1981 to establish standards for content and purity of *Aloe* materials. Aloecorp, one of the largest producers of *Aloe* products, has been one of the major supports of the IASC.

One final variable that can affect the efficacy of *Aloe* is the type of extract used. For many indications, native *Aloe* gel has proven itself efficacious. However, when it comes to immunomodulatory activity, the intermediate molecular weight polysaccharides (MAP) clearly outperform the gel. For example, MAP stimulates the release of TNF- α (a cytokine that activates the immune system) in cultured mouse peritoneal macrophages, while native *Aloe* gel does not.¹³ It also provides about half the protection from UVB-induced immune suppression that MAP does.

As it turns out, there is a "sweet spot" of polysaccharide molecular weight – between 5 and 400 kDa – for modulating immunity. Research has shown that for all immune parameters measured, the MAP fraction falling in that "sweet spot" was responsible for virtually all of *Aloe*'s immunomodulating activity, with higher and lower molecular weight fractions either having no effect or displaying marginal activity.¹⁴ Aloecorp offers a standardised *Aloe vera*, called ACTIV α loe, which concentrates the polysaccharides that fall into the active molecular weight range, as well as Certified Plus *Aloe vera*, in both gel and whole leaf form.

Aloe vera in combination

Clearly, with so many diverse anti-pollution roles – reinforcing the skin's barrier function, neutralising pollution-induced oxidative stress, activating the body's detoxification systems, and protecting against skin cancer – *Aloe vera* should be one of the top ingredient choices for manufacturers formulating skin care cosmetics and dietary supplements that

protect against and detoxify pollutants. *Aloe* is undoubtedly strong enough to stand on its own in such product areas. However, forward-thinking manufacturers may want to consider pairing *Aloe vera* with fruits and vegetables that have documented anti-pollution benefits to create value-added cosmeceutical drinks, capsules, or topical products.

In general, fruits and vegetables work against toxins in two of the four ways that *Aloe* does: they neutralise pollution-induced oxidative stress, and they activate the body's detoxification systems. Interestingly, it tends to be fruits that work the first way and vegetables that work the second.

Fruits that neutralise pollution-induced oxidative stress

When nutrition scientists at the USDA analysed the antioxidant content of over 100 fruits, vegetables, nuts, and spices, berries won 6 out of the top 11 spots on the agency's list of the 20 most antioxidant-rich foods.¹⁵ In the lead were wild blueberries, claiming the number two spot. Regular blueberries won fifth place, followed by cranberries in sixth, blackberries in eighth, raspberries in tenth, and strawberries in eleventh. No doubt about it, berries are packed with pollution-fighting antioxidants – specifically anthocyanins, protective pigments that give berries their blue and purple colours. One anthocyanin, called cyanidin 3-O-β-D-glucoside (C3G), is documented to be over 40 times as powerful as vitamin E at neutralising the oxidative stress caused by ultraviolet light,¹⁶ so it may help protect against skin cancer.

Like berries, Concord grapes are also rich in anthocyanins, as evidenced by their deep purple skins. An *in vitro* study found that in healthy human cells exposed to the carcinogen benzo[a]pyrene, treatment with an anthocyanin-rich extract from Concord grapes suppressed free radicals generated by the toxin.¹⁷ But grapes do not have to be of the Concord variety to protect against oxidative damage. Tests by the USDA have found that consumption of both regular grapes and kiwis boosts plasma antioxidant capacity in human subjects.¹⁸

Vegetables that activate the body's detoxification systems

A number of vegetables have a special ability: they can induce Phase II detoxification enzymes – including both glutathione S-transferase and quinone reductase – that help to inactivate, detoxify, and eliminate xenobiotics (foreign chemicals) such as pollutants from the body.

The most famous and well-studied Phase II-inducing vegetables belong to the cruciferous family. These include broccoli, Brussels sprouts, cabbage, kale,

cauliflower, bok choy, collards, turnips, radishes, arugula, and watercress. Crucifers are loaded with glucosinolates, which are transformed into isothiocyanates in the body. Isothiocyanates, of which sulforaphane is the most famous, are well-documented to upregulate Phase II detoxification.¹⁹⁻²⁵

While less famous than their cruciferous cousins, a number of other vegetables also induce Phase II detoxification, including green beans, carrots, celery, asparagus, and spinach.²⁶

For manufacturers interested in combining antioxidant fruits and detoxifying vegetables with *Aloe vera*, Aloecorp has developed a processing technology, called Qmatrix, which enables the company to blend farm-fresh, bioactive *Aloe vera* with almost any fruit or vegetable puree and then dry the combination into a homogenous matrix. This technology opens up the possibility for a multitude of cosmeceuticals, from a detoxifying *Aloe* and vegetable juice, to an after-sun lotion with *Aloe* and kiwi, to an *Aloe* berry salt scrub. The possibilities with this age-old anti-pollution agent are endless. PC

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