ORAL AND TOPICAL USE OF SOY MAY PROVIDE SKIN BENEFITS

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Introduction

Traditional Chinese medicine professes that topical soy provides skin care benefits.¹ There are reportedly anecdotal accounts from scientists that Asian workers in soybean factories who handled soy regularly had hands that were especially smooth and even-toned and that women workers in the tofu industry had beautiful skin. While these types of observations may not stand up to modern day scientific scrutiny, cosmetics companies have certainly embraced soy.

Within the past 10 years, the cosmetic industry (worldwide sales are reportedly $170 billion dollars a year, almost 25% of which occurs in the United States) has tapped the soybean and its components for use in a wide range of products – from shampoos and conditioners to creams aimed at evening skin tone and reducing blotchiness. While most cosmetic interest in soy involves topical application and is thus unrelated to dietary considerations, there is emerging interest in the effects of soy product ingestion on skin health – adopting the “beauty from within” concept.

Skin aging is influenced by genetic, environmental and hormonal factors. Intrinsic aging is that which occurs normally with the passage of time whereas extrinsic aging refers to skin damage from solar exposure (photoaging). Intrinsic aging is characterized by smooth, pale, finely wrinkled skin and dryness.² Photoaging is characterized by severe wrinkling and pigmentary changes such as solar lentigo (small, sharply circumscribed, pigmented flat, distinct, colored areas of the skin surrounded by normal-appearing skin) and mottled pigmentation.³

With respect to the soy-cosmetic connection it is especially intriguing that there are multiple components in the soybean that appear to beneficially affect various aspects of skin health as discussed below.

Topical Application

In 2001, Paine et al.⁴ showed in vitro that soybean protease inhibitors and soymilk when added to keratinocytes (the predominant cell type in the epidermis) in culture and in vivo when applied topically to microswine resulted in depigmentation and prevented ultraviolet (UV)-induced pigmentation. These results concur with the findings of a clinical study in which significant skin lightening was found in patients with hypermelanosis (excessive pigmentation of the skin) after a 3 wk treatment with a soybean extract containing soybean trypsin inhibitor (STI).⁵ A second study by this research group also found a beneficial effect of a soy extract when topically applied to Asian women with solar lentigines.⁶ The two main soybean protease inhibitors, the Kunitz inhibitor (soybean trypsin inhibitor) and the Bowman Birk chymotrypsin and trypsin inhibitor (BBI) comprise as much as 6% of the total soybean protein.⁷

Recently, a placebo-controlled trial that included 65 women with moderate facial photodamage evaluated the effects of a soy moisturizer containing nondenaturated STI and BBI.⁸ At the end of the 12-week study period, results showed the soy moisturizer had significantly improved mottled pigmentation, blotchiness, dullness, fine lines, overall texture, overall skin tone, and overall appearance. Furthermore, a
test of commercial anti-wrinkle products showed that topical application of a soy lotion was found to beneficially affect the epidermis of hairless mice. However, the chemical composition of the lotion was not described. The combination of soy (no description provided) and jasmine was also shown to produce improvements in skin health when applied for three months to women aged 45 to 65. This study is noteworthy because it was the first to use multiphotonic tomography to evaluate in vivo the effects of cosmetics on skin structures.

Research suggests a combination of soy molecules is likely to be more efficacious than any individual one. In addition to the protease inhibitors, both soybean phytosterols and isoflavones are being investigated for cosmetic applications. For example, when soybean phytosterols were applied to the skin of volunteers and methyl nicotinate-induced erythema (redness of the skin caused by hyperemia of the capillaries) was monitored using reflectance spectrophotometry, three days after tape stripping, the sites treated with the formulation containing phytosterols showed an appreciable recovery of barrier function compared to those treated with a vehicle control without soy phytosterols.

Interest in isoflavones is not surprising given that they bind to estrogen receptors – which are present in the skin – and that estrogen therapy is thought to improve a number of skin parameters including skin elasticity, water-holding capacity, pigmentation and vascularity. Skin appendages, such as hair follicles, are also influenced by estrogens. Importantly, isoflavones preferentially bind to and transactivate estrogen receptor-β in comparison to estrogen receptor-a, and it is the former that is the predominant receptor in the skin. However, isoflavones may also affect skin independent of estrogen receptor binding. To this point, pretreatment of human skin with the soybean isoflavone genistein inhibited UV-induced epidermal growth factor receptor tyrosine kinase activity and favorably affected several other signal transduction pathways in a manner suggesting this isoflavone may prevent photoaging. Further, in a placebo-controlled in vivo study, topical application of a soy isoflavone emulsion significantly enhanced the number of dermal papillae after two weeks, which is important considering that flattening of the dermal-epidermal junction is the most important reproducible change in aging skin, indicating that topical soy can “rejuvenate the structure of mature skin.”

Genistein also prevents UV light-induced oxidative DNA damage in vitro and when applied to rodents, which suggests it could have a role in preventing photocarcinogenesis. This isoflavone also protects against damage caused by UV-B irradiation when applied to human reconstituted skin. Equol, the bacterially-derived metabolite of daidzein, which is receiving considerable attention for its potential health properties, also protects against UV induced skin damage. Interestingly, the chemopreventive effects of soy are not limited to isoflavones as topical application of non-denatured but not heat-denatured soymilk once a day, 5 days a week, inhibited UV-B light induced skin tumors in hairless mice. Topical applications of STI and the BBI also inhibited the tumor formation, but not as effectively as non-denatured soymilk.

These findings in animals concur with those of a Brazilian study, in which postmenopausal women were treated topically with either estradiol and isoflavones for 24 weeks. Facial skin biopsies were performed on each patient before and after the treatment. Both treatments resulted in improvements in histomorphometrical parameters; although the effect of estrogen was greater than that of isoflavones. Research has shown that isoflavones are absorbed from the skin and Huang et al. proposed that topical delivery may serve as a potent route for soy isoflavones against photoaging and photodamage. In fact, Minghetti et al. suggested that topical administration could lead to circulating isoflavone levels sufficient to have systemic effects.

Benefits of isoflavones were also noted in a study in which Bifidobacterium-fermented soymilk (BE) extract containing genistein and daidzein topically applied to the skin of hairless mice for six weeks significantly restored changes in the elasticity and viscoelasticity of mouse skin, increased hyaluronic acid content and increased hydration and thickening of the skin. Hyaluronic acid is a major component of skin where it is involved in tissue repair. Topical application of a gel formula containing 10% BE to the human forearm for three months also improved skin elasticity.
Finally, soybean protease inhibitors and soymilk have been shown to slow the growth rate of hair in mice and in men when topically applied to the face and to the legs. And genistein was shown to decrease hair growth by 60 to 80% when hair follicles isolated from scalp biopsies were treated in culture. Topical treatments with 17β-estradiol have also been shown to inhibit hair growth in mice, while an estrogen receptor antagonist initiated hair growth in this system. Since protease inhibitors don't interact with estrogen receptors, soymilk appears to contain at least two different molecules working through different mechanisms to inhibit hair growth.

**Oral Administration**

It has been reported that wrinkling in Asians is not noticeable until the age of 50 and that even then its degree is not as marked as in the Caucasian population. Although many factors such as pigmentation and lifestyle certainly play a role in photoaging, it is conceivable that nutrition has a major effect as well.

One of the first studies to evaluate the effects of oral ingestion of a soy product on skin health involved 80 postmenopausal women who were given for six months a placebo or two tablets containing soy extract, fish protein polysaccharides, extracts from white tea, grape seed and tomato, vitamins C and E as well as zinc and chamomile extract for six months. Compared to the placebo, clinical grading showed that the active group had improved significantly in several parameters including reduced periocular and perioral wrinkles, mottled pigmentation, laxity and sagging and under eye dark circles. Photo evaluation also showed that the active group had significantly greater overall facial improvements after 3 and 6 months of treatment. The obvious limitation to this study design is that it prohibits drawing conclusions about the specific contribution of any individual component of the active treatment.

In a second (pilot) study, two groups of 20 healthy postmenopausal women were each instructed to consume their usual diet with or without 20 g/d of an isoflavone-rich soy protein. There were statistically significant improvements in facial-skin wrinkling, discoloration and overall appearance in the supplement group. The results, while intriguing, should be considered preliminary because although there was a control group, the benefits seen in the soy group could have simply resulted from a general improvement in nutrition, possibly because of a higher protein intake in the active group.

In a third study, a skin punch was performed in the gluteal region of 30 postmenopausal women before and immediately after the end of treatment with 100 mg/d of an isoflavones-rich, concentrated soy extract for six months. Treatment resulted in a 9.5% increase in the thickness of the epidermis in 23 patients. In addition, the papillary index was reduced in 21 (70%) women. The amount of collagen in the dermis was increased in 25 women (86.2%); in 22 (75.8%) and 21 (70%) women the number of elastic fibers and dermal blood vessels significantly increased, respectively. Although the results are encouraging, as in the previous study, the lack of a true control group limits the implications of the findings.

Interestingly, a fourth study involved premenopausal Japanese women, and found that over a 3 month period, use of supplements that provided 40 mg/d isoflavones led to a statistically significant decrease (p<0.05) in fine wrinkles whereas no change occurred in the placebo group. There was also an increase in skin elasticity in the isoflavone group at week 8 (but not at week 12) whereas again, no change occurred in the placebo group. The authors of this study concluded that isoflavones improve skin health; however, the study included only 26 subjects. Also, all subjects consumed soy products containing isoflavones as part of their usual diet although this design limitation would actually make finding statistically significant benefits more, not less, difficult.

Finally, in mature, ovariectomized rats, genistein in aglycone form (without a sugar attached to the isoflavone) was recently shown to improve skin (wound) healing and tensile strength. In this study, genistein was subcutaneously injected; however, it
is noteworthy because although both raloxifene and estradiol were also efficacious, genistein exerted a greater effect than both of these treatments. Selective estrogen receptor modulators (mixed estrogen agonists/antagonists) such as raloxifene and isoflavones are receiving attention for their potential role in skin health. 47

Summary and Conclusions

Cosmetic industry use of soy and soy extracts in topically applied products appears to have scientific support. The impact of dietary soy on skin health in humans has been investigated to a very limited extent but the preliminary results provide justification for continued research in this area. Molecules found in relatively high concentrations in the soybean are under investigation for their cosmetic applications even beyond those discussed in this article (isoflavones, phytosterols and protease inhibitors) such as saponins, omega-6 and omega-3 fatty acids and vitamin E. 50 Isoflavone and phytosterol absorption from oral ingestion readily occurs although skin concentration data for these compounds is lacking. Research also indicates that even large proteins, 54 such as the BBI, 55 can be absorbed relatively intact in sufficient amounts to potentially exert physiological effects. Thus, there is certainly the potential for the dietary use of soy products to improve skin health. Whether that potential is realized will be determined by future research.


