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Title

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Journal

Dermatology Online Journal, 21(11)

Authors

Monico, Gabriela
Leo, Micheal
Ma, Brian
et al.

Publication Date

2015

DOI

10.5070/D32111029278

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Review

The use of botanical products and vitamins in sunscreens

Gabriela Monico¹, Michael Leo², Brian Ma³, Ritika S Johal³, Thomas Ma³, Raja K Sivamani⁴

Dermatology Online Journal 21 (11): 1

¹School of Medicine, University of California – Davis, Sacramento, CA

²School of Medicine, University of Wisconsin, Madison, WI

³University of California – Davis, Davis, CA

⁴Department of Dermatology, University of California – Davis, Sacramento, CA

Correspondence:

Raja Sivamani, MD MS CAT
Assistant Professor of Clinical Dermatology
Department of Dermatology
University of California, Davis
3301 C Street, Suite 1400
Sacramento, CA 95816
Phone: 916-703-5145
Email: rksivamani@ucdavis.edu

Abstract

The use of botanical products and vitamins in skin care creams and sunscreens is prevalent. Herein we conduct an evaluation of sunscreens to quantitatively assess how often sunscreens incorporate botanically derived products and vitamins. The most commonly used botanicals products and vitamins are identified and stratified based on the sunscreen sun protection factor (SPF). The overall prevalence for the use of botanical agents and vitamins was 62% and 79%, respectively. Aloe vera and licorice root extracts were the most common botanical agents used in sunscreens. Retinyl palmitate was the most common vitamin derivative utilized in sunscreens. The prices of sunscreens significantly increased when more than one botanical product was added. Botanical products and vitamins are widely utilized in sunscreens and more research is needed to assess how their inclusion may enhance or alter the function of sunscreens.

Introduction

In recent years, the use of natural products and botanical extracts has become more prevalent in skin products and in sunscreens [1]. Sunlight consists of multiple forms of radiation including ultraviolet radiation, visible radiation, and infrared radiation. Ultraviolet radiation can be further categorized into three categories based on wavelength, namely ultraviolet radiation A (320-400 nm), ultraviolet radiation B (280-320 nm), and ultraviolet radiation C (200-280 nm) [2]. It is this ultraviolet radiation that is responsible for generating free radicals and oxidative stress [1,3]. In the skin, damage induced by oxidative stress is counterbalanced by antioxidant properties. However, an imbalance in oxidative stress that exceeds the antioxidant capacity can induce skin related disorders and tissue damage [1]. Although sunscreens now include agents capable of broad-spectrum (UVA and UVB) protection, the use of botanical products is aimed to augment the antioxidant properties of sunscreen. The true efficacy of these ingredients, however, remains uncertain [4].

Whereas the use of natural products is becoming more common, a study of their prevalence in sunscreens has not been performed to date. Herein we examine the prevalence of botanical product use in sunscreens and quantify their frequency of use. We discuss how their prevalence differs between brand name and store brand/generic sunscreens. Currently, some of the most common botanical ingredients used in sunscreens include aloe vera, dipotassium glycyrrhizate (licorice root extract), glycine soja (soybean), and theobroma cacao (cocoa) butter. Sunscreen marketers have also adopted the inclusion of vitamins to augment the antioxidant properties of sunscreens as an alternative strategy [5]. The most predominant vitamins found in sunscreens include retinyl palmitate (Vitamin A), tocopherol (Vitamin E), ascorbic acid (Vitamin C), and ascorbyl palmitate (Vitamin C). Knowledge of the most prevalent botanical products will help to better direct future research to understand their functions given the existing controversy regarding their efficacy.

Additionally, despite the unknown value of botanical ingredients, companies can appeal to consumers by marketing botanical ingredients as novel forms of photoprotection [5]. Botanical ingredients have an unknown protective value and the cost to consumers remains an important consideration in purchasing sunscreen. For this reason, we also assess the economic cost of including botanical products in sunscreen and provide sunscreen purchasers a cost-effective approach in choosing sunscreens.

Methods

The data was collected from five different retail store branches: Walmart, Target, CVS, Rite Aid and Safeway. For each store branch, we visited three locations in California: Sacramento, Woodland, Davis, and Dixon. All sunscreen ingredients were recorded and the number of botanical and vitamin based ingredients were counted for each sunscreen. The sun protection factor (SPF), the price, and the size of the sunscreen bottles were recorded. In the sunscreens that we evaluated, the Sun Protection Factor ranged from 20 to 110. Sunscreens were further subdivided into two categories: brand name and store brand. Store brand sunscreens were manufactured specifically by the store as an alternative to brand name sunscreens. The botanically derived products and vitamin content were recorded for each sunscreen. Additionally for each type of sunscreen, the size and price of the bottle were recorded; these were used to calculate the price per ounce of each sunscreen.

Statistical comparisons were performed with an Analysis of Variance (ANOVA).

Results

Prevalence and Cost of Botanicals and Vitamins in Sunscreens

Botanical ingredients had an overall prevalence of 62% and the use of vitamin/vitamin derivatives had an overall prevalence of 79% in sunscreens (Figure 1). Aloe vera and dipotassium glycyrrhizate are the two most common botanicals in sunscreens with a prevalence of 29.3% and 17.8%, respectively (Table 1). Vitamins had a higher prevalence with 80% of commercial sunscreens containing at least one vitamin. Retinyl palmitate and tocopherol are the two most common vitamins with a prevalence of 58.6% and 40.3%, respectively. Brand name sunscreens are more likely to include at least one botanical ingredient compared to store brands, but both brand name and store brand sunscreens are nearly identical in their inclusion of vitamins. The prevalence of botanicals products and vitamins among brand name and store brand sunscreens was analyzed and then stratified according to SPF (Figure 2A, 2B, 3A, 3B). Upon stratification, SPF 30 sunscreens were more likely to include at least one botanical or vitamin. Furthermore, the inclusion of two botanical ingredients significantly increased the price per ounce of the sunscreens, whereas the addition of one botanical did not increase the price per ounce.

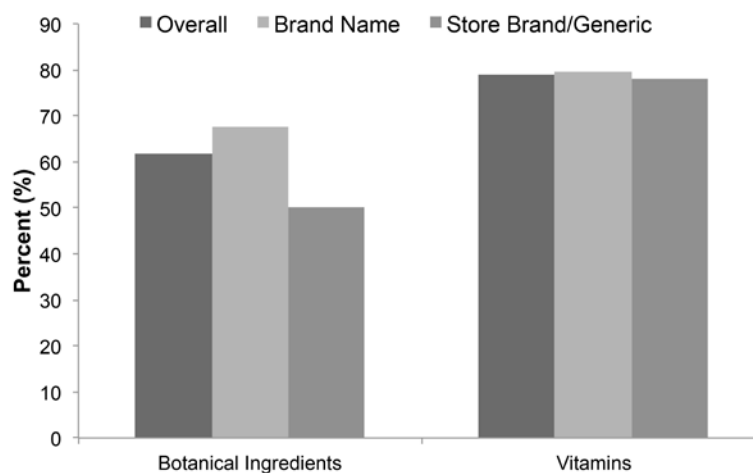
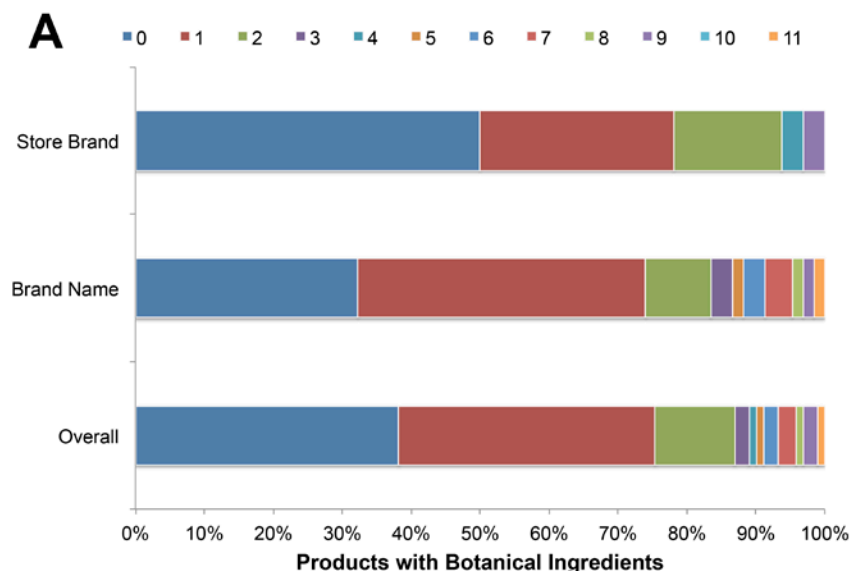


Figure 1. The overall prevalence of at least one botanical ingredient and vitamin in sunscreens

Table 1. Most Commonly Used Botanical Ingredients in Sunscreen Products

Name	Sunscreens Containing Natural Extract (%)
<i>Aloe Vera</i>	29.3
Dipotassium Glycyrrhizate (Licorice Root Extract)	17.8
Glycine Soja (Soybean)	6.3
Theobroma Cacao (Cocoa) Butter	4.7
Carica Papaya (Papaya) Fruit	4.2
Colocasia Antiquorum Root	4.2
Mangifera Indica (Mango) Fruit	4.2
Passiflora Incarnata (Passionflower) Fruit	4.2
<i>Plumeria Acutifolia</i> (Plumeria) Flower	4.2
<i>Psidium Guajava</i> (guava) Fruit	4.2
<i>Camellia Sinensis</i> (Green Tea) Leaf	3.7
<i>Nelumbo Nucifera</i> Flower	3.7
<i>Butyrospermum Parkii</i> (shea butter)	2.6
<i>Chrysanthemum Parthenium</i> (Feverfew)	2.6
<i>Olea Europaea</i> (Extra Virgin Olive) Oil	2.6
<i>Acacia Farnesiana</i> Flower	2.1
<i>Chamomilla Recutita</i> (Chamomile)	2.1
<i>Lavandula Angustifolia</i> (Lavender)	2.1
<i>Rosmarinus Officinalis</i> (Rosemary)	2.1
<i>Simmondsia Chinensis</i> (Jojoba) Oil	2.1
Chamomile	1.6
<i>Cocos Nucifera</i> (coconut oil)	1.6
<i>Euphorbia Cerifera</i> (Candelilla Cera) Wax	1.6
<i>Hippophae Rhamnoides</i> (Seabuckthorn)	1.6
Zea Mays (corn) Oil	1.6



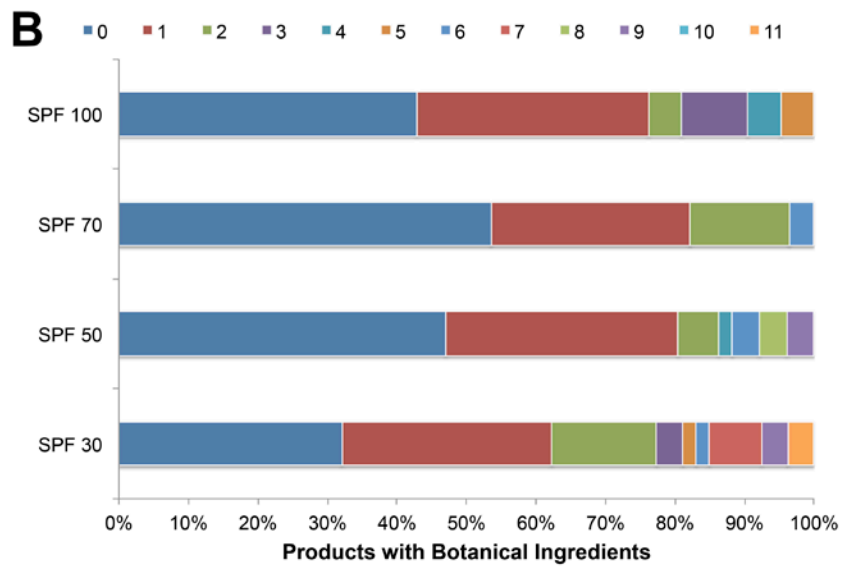


Figure 2. (A) Prevalence of botanical ingredients in all sunscreens. (B) Prevalence of botanical ingredients in sunscreens stratified by SPF

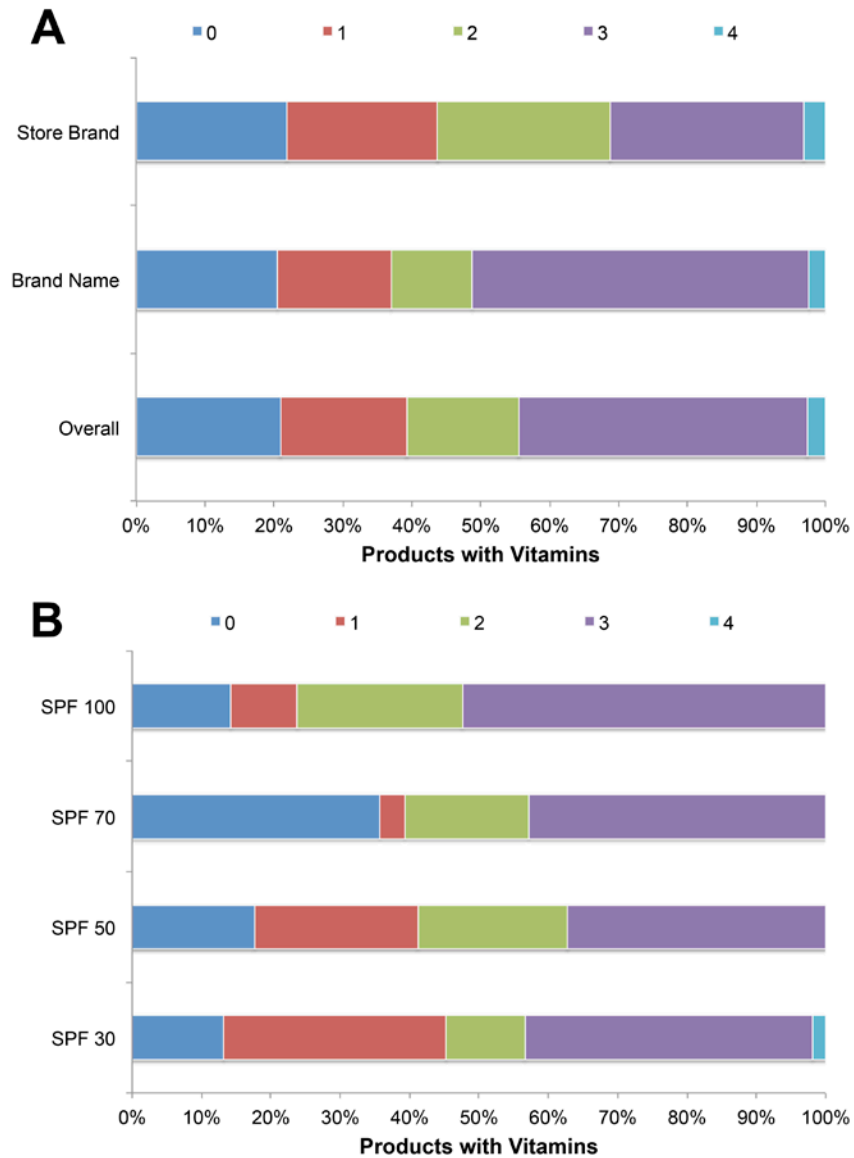


Figure 3. (A) Prevalence of vitamins in all sunscreens. (B) Prevalence of vitamins in sunscreens stratified by SPF

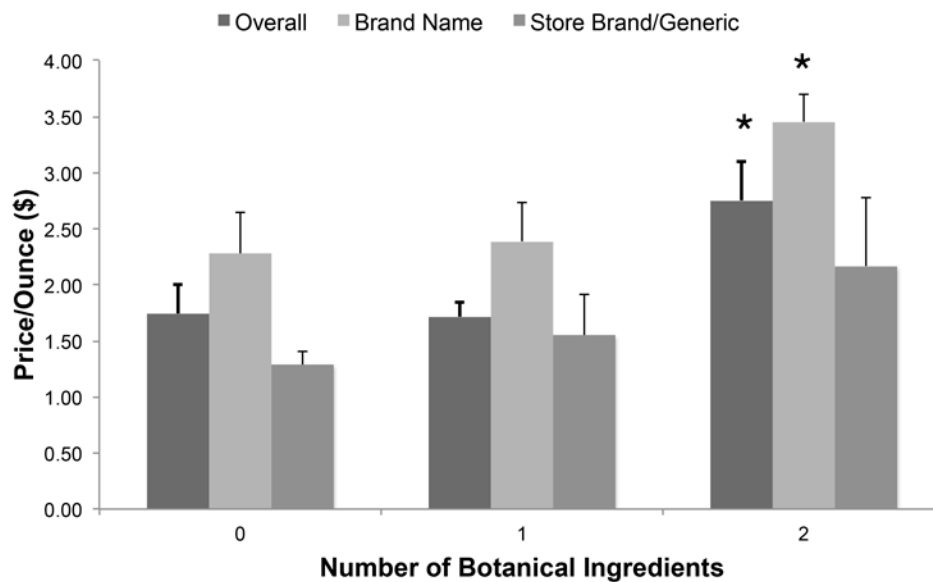


Figure 4. The overall cost of sunscreens with 2 botanical extracts is significantly higher in comparison to sunscreens with only 0 or 1 botanical extract. Brand name sunscreen prices increase by 45% with 2 botanical extracts in comparison to no botanical extracts. However, there was no significant change in the price with 2 botanical extracts for store brand/generic sunscreens. Significance was determined by comparing to the cost of sunscreen with zero botanical extracts (* = $p < 0.05$).

Discussion

The data were collected from local retail stores rather than online stores to more closely mimic how consumers may typically purchase their sunscreens. However, all of our data collection was obtained in Northern California and the prices may vary by state, region, and county as well.

Our results show that extracts from various botanicals and vitamins have been incorporated into sunscreens. Aloe vera was the most popular botanical found in our assessment of sunscreens. Its topical application has been shown to have anti-inflammatory properties against UVB induced erythema in human volunteers and is superior to hydrocortisone 1% gel (but not hydrocortisone 1% cream) [6]. Topical application of aloe vera has also been shown to have tumor chemopreventative properties by decreasing both the number and size of papillomas induced by 7,12-dimethylbenz(a)anthracene in mice [7]. In another study, however, aloe vera cream was not found to be protective against the development of a sunburn [8], nor did it prevent UV-induced edema [9]. Therefore this suggests that the role of aloe vera in sunscreen remains unclear. Interestingly, at different growing stages of plants containing aloe vera, varying amounts of active ingredients are found. This can lead to different degrees of antioxidant potential, adding further complexity to the true efficacy of aloe vera in sunscreens [10].

Glycyrrhizin is the main component of licorice root and was the second most common botanical extract in sunscreens. Pretreatment with glycyrrhizin in vitro prior to UV irradiation significantly protected melanoma cells from radiation damage [11]. Kato, T., et al. found that the inclusion of glycyrrhizin protected keratinocytes from UV irradiation [12]. Protection from UV irradiation among these keratinocytes was measured by determining the viable cell number after a 24 hour incubation period in fresh culture medium. Keratinocytes were exposed to UV irradiation (wavelength 253.7 nm) for 90 seconds. In SKH-1 hairless mice, glycyrrhizin has been shown to be chemopreventative against the development of UVB radiation induced tumors [13]. In vivo studies in humans have not been conducted.

Among the vitamins, retinyl palmitate (RP), a storage form of vitamin A, was the most abundant vitamin found in sunscreens. There remains controversy regarding the association of retinyl palmitate with carcinogenesis; some suggest a positive association [14-17] and others report a negative association [18-20]. Regardless, there is no evidence linking retinyl palmitate to the development of skin cancers in humans. Vitamin E (tocopherol) is also highly prevalent in sunscreens and has shown promising anti-carcinogenic properties [21]. Topical α -tocopherol has been shown to reduce UV-induced edema, inflammation, erythema, and sunburn cell formation [22]. Furthermore, topical formulations combining vitamin E and C (L-ascorbic acid) showed photo-protective effects [21,23]. However, certain studies suggest that topical α -tocopherol and certain esterified forms of it enhance photo-carcinogenic effects [24,25].

An economic evaluation of the annual cost of sunscreen use for the average individual revealed that the inclusion of more than one botanical ingredient created an increase in the price per ounce of a sunscreen. Considering that there has yet to be conclusive

evidence on the benefits of including botanicals in sunscreens, it is difficult to generally recommend the purchase of sunscreen with botanicals, especially since they tend to be more expensive.

In summary, botanicals and vitamins are widely used in sunscreens but their efficacy remains largely unknown and unmeasured. We found that among the botanicals incorporated into sunscreens, aloe vera and glycyrrhizin remain the most widely used. Among vitamins, retinyl palmitate is the most commonly used. Moreover, we found that the addition of botanical products increased the prices in name brand sunscreens. However, it remains largely unknown if the addition of botanical products provides additional sun protective benefit or antioxidant activity. Given this information, it would be useful to develop an antioxidant activity index for sunscreens so that the added efficacy of any included botanicals and/or vitamins can be measured. Several studies have already targeted the specific pathways involved in the photocarcinogenic response among botanicals. However, it remains uncertain how the combination of these responses supplement the antioxidant capacity of sunscreens [3]. The development and application of an antioxidant activity index to sunscreens can help optimize the use of botanicals to generate maximum antioxidant effectiveness. Furthermore, few sunscreen manufacturers state how the extracts were performed since different extraction methodologies can result in different final extraction compositions and functions.

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