

Probiotics and Disease: A Comprehensive Summary—Part 6, Skin Health

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Abstract

This article series provides a literature review of the disease-specific probiotic strains associated with dermatological disorders and conditions that have been studied in published clinical trials in humans and animals. This is not an exhaustive review. The table design allows for quick access to supportive data and will be helpful as a guide for both researchers and clinicians. The goal of the probiotics and disease series is to provide clinically useful tools. The first article (part 1) focused on mental health and neurological conditions, and the second article (part 2) explored cultured and fermented foods that are commonly available in the United States. The third article (part 3) explored the relationship between bacterial strains and 2 of the most prevalent diseases we have in modern society:

cardiometabolic disease and fatigue syndromes. The fourth article (part 4) elucidated the role of the microbiome in infectious diseases, and the fifth article (part 5) examined respiratory conditions and conditions of the ears, nose, and throat. This sixth article (part 6) article explores the relationship between the microbiome and skin disorders. Future articles will review conditions related to autoimmunity and dermatological conditions; the influence of the microbiome on cancer development and prognosis, gastrointestinal and genitourinary diseases associated with dysbiosis conditions; followed by an article focused on probiotic supplements. This literature review is specific to disease condition, probiotic classification, and individual strain.

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The purpose of this summary is to provide nutritionists and other medical practitioners with a reference guide for recommending health-promoting commercially produced cultured and fermented food products to patients. Research was conducted via grocery store trips, company Web site reviews, personal communication with food company personnel, and PubMed and EBSCO Research Premier searches. The lists contained herein are not exhaustive; however, they represent items that are commonly accessible to US consumers.

There is considerable research on the gut microbiome and role of probiotics; however, this research has not been clearly connected with clinical practice. The authors undertook a review of current literature to explore which specific probiotics and probiotic strains have been utilized in clinical and laboratory studies. To make this clinically valuable, product names of probiotics and fermented foods have been included. Finished products vary between manufacturers; thus, the researchers included brand listing to provide transparency and to facilitate a functional probiotics guide for clinicians. Exclusions of products meeting our criteria do not imply that these products are not effective—we simply were not aware of them.

Methodology

This literature review originated from a group project that was part of the requirements for a course in the doctoral program in functional and clinical nutrition at Maryland University of Integrative Health (Laurel, MD, USA). The student researchers had approximately 2 months to review the literature and synthesize the paper. The authors agreed on format, templates, and execution. Each author researched and wrote sections reviewing probiotics in relation to various health conditions with literature searches conducted in PubMed, Biomed Central, EBSCO

Research Premier, PLoS One, Cochrane reviews, and topic-specific open-source journals.

The review of specific probiotic products in the professional marketplace and specific probiotics products was performed using Internet searches, primarily Shop Google, in addition to topic-specific databases to search for specific probiotic species including the strains listed in the research. Novel strains were cross-referenced to determine whether the strain was available only for research purposes. If a probiotic combination was used in the research, formulas that closely matched the combination were included. Formulas that contain all or most of the specific probiotics and strains were also included. The food survey focused on bacterial strains in food and includes foods that are commercially produced and commonly available in the refrigerated sections of grocery stores in the United States. Information was gleaned from commercial Web sites and by visiting grocery stores (primarily in California).

Introduction: Skin Health

Although it may not be intuitive, evidence supporting the interaction between the intestinal microbiome and skin health is growing. As researchers have explored these

interactions, conditions related to atopy have received attention, with several studies emerging on the therapeutic use of probiotics for eczema and reactive skin. Much of this exploration has been with pregnant women and newborns to improve outcomes for infants who are at higher risk for developing eczema or hypersensitivity reactions.

Additional studies exploring the anti-inflammatory, anti-infectious, photoprotective, and reparative effects of various probiotic strains on skin health are delving deeper into the theories and mechanisms of action.¹⁻⁴ Through these efforts, investigators are exposing many unique interactions between probiotics and the mediators of skin health. With some strains, we see an association with improved barrier function and balance of helper T cells (Th and Th₂).⁵ There is also evidence supporting microbial modulation of dendritic cells, regulatory T cells (Treg), toll-like receptors, and genes for immune mediators such as forkhead box P3 (FOXP3).⁶ This chart reports the outcomes from 28 studies on the topic. The underlying premise is that the probiotic supplementation alters the intestinal microbiome in a way that improves skin permeability and barrier function, while modulating the immune response.

Table 1. Skin

Skin Health	Strains	Overview	Professional and Commercial Products	Foods
Eczema				
Shin et al ⁶ (2016) Murine model	Combination of: <i>B bifidum</i> BF3, <i>B breve</i> BR3, <i>L acidophilus</i> LA1, <i>L plantarum</i> LP3, <i>L rhamnosus</i> LR5, <i>L lactis</i> SL6, <i>S thermophilus</i> ST3	Oral administration of this blend at a dose of 10 ⁹ CFU/mL was associated with a significant reduction in atopic dermatitis measured by itching, erythema/hemorrhage, scaling/dryness, edema, and excoriation/erosion.	Not commercially available.	None
Marlow et al ⁷ (2015)	<i>L rhamnosus</i> , <i>B animalis lactis</i>	Modifies expression of toll-like receptors to reduce genetic predisposition to atopic dermatitis.	<i>L rhamnosus</i>: Common in multistrain options. <i>B animalis subsp lactis</i>: HLC Maintenance (Pharmax)	Almond yogurt Nondairy yogurt Amande cultured almond milk Trader Joe's cultured coconut milk Nancy's organic cultured soy Nancy's organic yogurts Activia Green Valley Organics lactose-free kefir Nancy's Organic low-fat plain kefir Redwood Hill Farm goat milk kefir Kevita Kombucha Masterbrew Kevita Kombucha sparkling probiotic drink
Wang & Wang ⁸ (2015)	<i>L paracasei</i> GMNL-133 (LP), <i>L fermentum</i> GM090 (LF) Combination of and the novel LP + LF	Children were given 2 × 10 ⁹ CFU of both LP and LF, daily, 4 × 10 ⁹ CFU of the combination or placebo. After 3 mo, the children in the probiotics groups showed a significant reduction in atopic dermatitis severity compared to placebo. The effect was more significant in children <12 y old.	Not commercially available.	None

Table 1. (continued)

Skin Health	Strains	Overview	Professional and Commercial Products	Foods
Yeom et al ⁹ (2015) Murine model	<i>L casei</i> subsp <i>rhamnosus</i> (LCR35)	Mice that had been topically treat with TMA showed dose dependent reduced inflammation at 2.5 × 10 ⁷ and 2.5 × 10 ⁸ CFU kg ⁻¹ body weight of saline suspension of LCR35, given orally each day for 15 d, 30 min before TMA application.	Not commercially available.	None
Allen et al ¹⁰ (2014) RCT	Combination of: <i>L salivarius</i> , <i>L paracasei</i> , <i>B animalis</i> subsp <i>lactis</i> , <i>B bifidum</i>	Administration to pregnant women at 36 wk gestation through to delivery resulted in reduced sensitivity to food allergens when children are 2 y old.	<i>B animalis</i> subsp <i>lactis</i>: HLC Maintenance (Pharmax) <i>L salivarius</i>, <i>L paracasei</i>, <i>B bifidum</i>: Nexabiotic (Bioprospers Labs) Primal Defense (Garden of Life) LactoPrime Plus (Klaire Labs) Probiotic 10 (Now Foods) Ultimate Flora Critical Colon (Renew Life) iFlora Multi-Probiotic Formula (Sedona Labs) ProBiota 12 (Seeking Health)	Amande cultured almond milk Trader Joe's cultured coconut milk Nancy's Organic yogurts Wallaby Yogurt Company organic Greek whole milk plain yogurt Green Valley organics lactose-free kefir
Kim et al ¹¹ (2012) Murine model	<i>L rhamnosus</i> (LCR35)	Oral administration of LCR35 1 × 10 ⁹ CFU/600 ll/mouse, daily from 1 wk before sensitization and through the duration of the study, suppressed development of atopic dermatitis.	Not commercially available.	None
Wickens et al ¹² (2008) RCT Wickens et al ¹³ (2012) RCT Wickens et al ⁵ (2013) RCT	<i>L rhamnosus</i> (HN001)	Administration to pregnant women from 35 wk and postpartum while breastfeeding or until 6 mo, and to the infants from approximately 6 d postpartum to 2 y, significantly reduced risk of developing eczema by age 2 y. Administration of 6 × 10 ⁹ CFU to pregnant women at 35 wk gestation through to 6 mo postpartum for breastfeeding women and all infants until age 2 y, resulted in reduced risk of eczema and rhinoconjunctivitis. In a follow-up to the previous study, the decreased risk of eczema was still present at age 6 y.	<i>L rhamnosus</i>: Widely available in nutritional supplements.	Almond Dream nondairy yogurt Amande Cultured almond milk Trader Joe's cultured coconut milk Nancy's Organic cultured soy Nancy's Organic yogurts Green Valley organics lactose-free kefir Nancy's Organic low-fat plain kefir Redwood Hill Farm goat milk kefir Kevita Kombucha Masterbrew Kevita Kombucha sparkling probiotic drink
Weise et al ¹⁴ (2011) Murine model	<i>E coli</i> Nissle 1917 (EcN)	10 ⁷ CFU/d and 10 ⁸ CFU/d were added to electrolyte solution given to mice with allergen-induced dermatitis. Improvement in dermatitis followed a dose-dependent pattern, with only the 10 ⁸ dose reaching significance.	<i>E coli</i> Nissle 1917: Mutaflor (Tribute Pharmaceuticals)	None
Dotterud et al ¹⁵ (2010)	<i>L acidophilus</i> LA5, <i>B animalis</i> subsp <i>lactis</i> BB12	Administration to pregnant women at 36 wk gestation through to 3 mo postpartum for breastfeeding women resulted in reduced incidence of atopic dermatitis at age 2 y.	<i>B animalis</i> subsp <i>lactis</i>: HLC Maintenance (Pharmax)	None

Table 1. (continued)

Skin Health	Strains	Overview	Professional and Commercial Products	Foods
Kim et al ¹⁶ (2010) RCT	Combination of: <i>B bifidum</i> , <i>B lactis</i> , <i>L acidophilus</i>	Administration to pregnant women at 8 wk before expected delivery through to 3 mo postpartum and to the infants from 4 to 6 mo resulted in reduced incidence of eczema at age 1 y.	Combination of: <i>B bifidum</i> , <i>B lactis</i> , <i>L acidophilus</i> : HMF Capsules (Seroyal) Probioplus DDS (UAS Laboratories) Enzyme Probiotic Complex (American Health) Probiotic Blend (Daily Essentials) Mega Probiotic-ND (Food Science)	Almond Dream nondairy yogurt Amande cultured almond milk Kite Hill almond milk yogurt Coconut Grove organic cultured coconut milk Trader Joe's cultured coconut milk Nancy's Organic cultured soy Stonyfield Organic O'Soy soy yogurt Dahlicious Cow's milk lassi Nancy's Organic yogurts Wallaby Yogurt Company organic Greek whole milk plain yogurt Redwood Hill Farm goat milk yogurt Bellwether Farms sheep's milk yogurt Green Valley Organics lactose-free kefir Redwood Hill farm goat milk kefir
Chernyshov ¹⁷ (2009) RCT	Combination of: <i>L rhamnosus</i> R0011 (95%), <i>L helveticus</i> R0052 (5%)	Children with atopic dermatitis received 1 capsule with 2 billion live cultures for 30 d used less topical corticosteroid than children receiving the maltodextrin placebo.	<i>L rhamnosus</i> R0011 , <i>L helveticus</i> R0052 : Lacidofil	None
Hacini-Rachinel et al ¹⁸ (2009) Murine model	<i>L casei</i> DN114 001	Oral administration to MHC-class II deficient mice of 200 μL of <i>L casei</i> DN-114 001 (10 ⁸ CFU/mL) can reduce DTH responses mediated by Ag-specific CD4 ⁺ or CD8 ⁺ T cells.	Not available.	None
Niers et al ¹⁹ (2009) RCT	Combination of: <i>B bifidum</i> , <i>B lactis</i>	Administration to pregnant women during the last 6 wk of pregnancy and to the infants for the first 12 mo significantly reduced development of eczema in high-risk infants (those who develop eczema within the first 3 mo).	<i>B bifidum</i> , <i>B lactis</i> : Ecologic Panda HMF Capsules (Seroyal) Probioplus DDS (UAS Laboratories) Enzyme Probiotic Complex (American Health) Probiotic Blend (Daily Essentials) Mega Probiotic-ND (Food Science)	Almond Dream nondairy yogurt Amande cultured almond milk Trader Joe's cultured coconut milk Nancy's organic cultured soy Nancy's organic yogurts Redwood Hill Farm goat milk yogurt Green Valley Organics lactose-free kefir Redwood Hill Farm goat milk kefir
Tanaka et al ²⁰ (2009) Murine mode	<i>L rhamnosus</i> (LPR)	Oral administration of LPR in drinking water at 5 × 10 ⁸ CFU/mL to pregnant mice 1 wk before delivery and then to the mice pups until 12 wk after birth was associated with decreased risk of developing atopic dermatitis.	Not commercially available.	None
West et al ²¹ (2009) RCT	<i>L paracasei</i> ssp <i>paracasei</i> strain F19	Administration to infants from 4 to 13 mo, significantly reduced development of eczema in infants at age 13 mo.	<i>L paracasei</i> ssp <i>paracasei</i> strain F19 : Gene-filus F19 (Sifra Farmaceutici)	None
Abrahamsson et al ²² (2007) RCT	<i>L reuteri</i>	Administration to pregnant women from 4 wk before delivery and to the infants from birth to 12 mo, resulted in reduced IgE-mediated eczema at age 2 y.	<i>L reuteri</i> : Ultimate Probiotic Formula (Lee Swanson Signature Line) Mega Flora Plus (Mega Food) Probiotics Ultra (Syontix)	None

Table 1. (continued)

Skin Health	Strains	Overview	Professional and Commercial Products	Foods
Kukkonen et al ²³ (2007) RCT	<i>L rhamnosus</i> GG, <i>L rhamnosus</i> LC705, <i>B breve</i> BB99, <i>P freudenreichii</i> ssp <i>shermanii</i> JS	Administration to pregnant women from 2 to 4 wk before delivery and to the infants from birth to 6 mo, resulted in reduced IgE-mediated eczema at 2 y.	<i>L rhamnosus</i> GG: Walgreens Probiotic <i>Lactobacillus</i> GG Advanced Multi-Billion Dophilus (Solgar) ProSynbiotic (Standard Process) TruBiotics (Bayer)	None
Psoriasis				
Groeger et al ¹ (2013)	<i>B infantis</i> 35624	Plasma CRP and TNF- α inflammatory markers were significantly decreased in participants with psoriasis after 8 wk taking <i>B infantis</i> 35624.	<i>B infantis</i> 35624: Align Probiotic Digestive Care (Proctor & Gamble)	None
Acne				
Al-Ghazzewi & Tester ²⁴ (2010) In vitro	<i>L casei</i> ssp <i>casei</i> <i>L acidophilus</i> <i>L plantarum</i> <i>L gasseri</i> <i>L lactis</i> ssp <i>lactis</i>	In the presence of a prebiotic (Konjac glucomannan hydrolysate), the probiotics inhibited the growth of <i>P acnes</i> .	<i>Lactobacillus plantarum</i>: Jarrow Formulas Ideal Bowel Support (10 Billion Organisms V-Capsules) Probiotic Supplement (GoodBelly) Probiotic GX (Nature's Bounty) Probiata Digestion Support and Critical Care (Kyolic) Probiotic Balance (Sundown Naturals) Heart Healthy Probiotic Solutions (Dr Sinatra) Digestive Health Probiotic (Nature Made)	King's Asian gourmet kimchi Seoul Kimchi (Lucky Foods) PureLiving pickled beets Wildbrine pickled beets Wildbrine pickled ginger Bubbies sauerkraut Farmhouse Culture sauerkraut PureLiving sauerkraut Wildbrine sauerkraut Wildbrine fermented juice Kimchi live shots green and Spanish olives in glass jars Wildbrine salsa Almond Dream nondairy yogurt Amande cultured almond milk Kite Hill almond milk yogurt Coconut Grove organic cultured coconut milk Trader Joe's cultured coconut milk Nancy's Organic cultured soy Stonyfield Organic O'Soy soy yogurt Dahlicious cow's milk lassi Nancy's Organic yogurts Wallaby Yogurt Company organic Greek whole milk plain yogurt Redwood Hill Farm goat milk yogurt Dahlicious cow's milk lassi Bellwether Farms sheep's milk yogurt Dahlicious cow's milk lassi Green Valley Organics lactose-free kefir Dahlicious cow's milk lassi Redwood Hill Farm goat milk kefir
Mastitis (Lactational)				
Vazquez-Fresno et al ⁴ (2014)	<i>L salivarius</i>	Lactating women with mastitis ingested <i>L salivarius</i> within a 21-d period, resulting in significant reduction in staphylococcal and streptococcal bacteria along with resolution of or significant reduction in pain.	<i>L salivarius</i>: Widely available in nutritional supplements.	None

Table 1. (continued)

Skin Health	Strains	Overview	Professional and Commercial Products	Foods
Arroyo et al ²⁵ (2010)	<i>L fermentum</i>	Administration of each strain resulted in reduced bacterial counts and resolution of or significant reduction in clinical symptoms after 21 d. <i>L salivarius</i> was associated with greatest reduction in bacterial counts—especially in <i>S aureus</i> .	<i>L fermentum</i>: Reg'Activ Immune & Vitality (Essential Formulas) Nexabiotic (Bioprospan Labs) Propolis Plus (Essential Formulas)	None
Jiménez et al ²⁶ (2008) RCT	Combination of: <i>L salivarius</i> , <i>L gasseri</i>	Women with mastitis that did not improve with antibiotic therapy were given this supplement for 30 d. After 15 d, all clinical symptoms of mastitis had resolved and there was a significant reduction in <i>Staphylococcal</i> bacterial counts.	Combination of: <i>L salivarius</i>, <i>L gasseri</i> Ultimate Probiotic Formula (Lee Swanson Signature Line) Ultimate Flora Critical Colon iFlora Multi-Probiotic Formula	None
Reactive Skin				
Gueniche et al ²⁷ (2014)	<i>L paracasei</i> NCC 2461	After supplementation for 57 d, participants demonstrated decreased skin reactivity to a capsaicin challenge and improved skin barrier integrity.	Not commercially available.	None
Cutaneous Wounds				
Shahsafi ² (2017) Murine model	<i>B subtilis</i>	10 ¹⁰ CFU/mL added to Eucerin ointment and applied, topically, to cutaneous wounds resulted in significantly enhanced wound healing as compared to control, according to histological examination of the wound area.	<i>B subtilis</i>: BioSpora (Klaire Labs) SBO Probiotic (Dr. Axe) Primal Defense (Garden of Life) Adult Probiotic (Smarty Pants) Digestive Daily Balance (Blessed Herbs) Probiotic optimized formula (Totnes Health) Gastrointestinal Support (Prescript-Assist) Royal Flora (Beyond Probiotics) Advanced Multi-strain formula (Bio-Kult) Ultra-biotics (Steele Spirit)	None
Ultraviolet Radiation Damage				
Sugimoto et al ³ (2012) Murine model	<i>B breve</i> strain Yakult (BBY) 12272	Oral administration of BBY cells were associated with reduced damage to elastic function. Also, BBY-fermented milk included in the diet had a similar effect.	Not commercially available.	<i>B breve</i> found in Yakult
Bouilly-Gauthier et al ²⁸ (2010)	<i>L johnsonii</i> (LA1)	Oral supplementation with 5×CFU with 7.2 mg carotenoids, daily before UVR exposure in 3 clinical trials for 6, 6, and 3-4 wk, respectively, were associated with reduced inflammation and preserved density of skin Langerhans cells.	<i>L johnsonii</i> (LA1): BioAmicus Johnsonii	None

Abbreviations: CFU, colony-forming units; CRP, c-reactive protein; DTH, delay-type hypersensitivity; IgE, immunoglobulin E; LF, *L fermentum* GM090; LP, *L paracasei* GMNL-133; LRP, *L rhamnosus*; RCT, randomized controlled trial; TMA, trimellitic anhydride; TNF- α , tumor necrosis factor alpha; UVR, ultraviolet radiation.

Research Overview: Skin Health

Atopic conditions are associated with immunoglobulin E-mediated immune responses, and probiotic related improvements to these conditions generally have multiple targets.¹⁴ Recently, researchers have explored other avenues of immunity. Marlowe et al⁷ explored the role of probiotic supplements in modulating genetic expression of toll-like receptors (TLRs) to decrease eczema in children. Marlow et al⁷ describe a mechanism by which *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp *lactis* HNO19 modify the genetic expression of single nucleotide polymorphisms of TLR genes. In their research, *L rhamnosus* had the more significant effect by modulating 20 variants of TLR genes, whereas *B animalis* subsp *lactis* HNO19 modified only 2. The result was a decreased risk in children developing eczema. In their murine model of atopic dermatitis, Shin et al⁶ also saw an increase in the presence of FOXP3 in the skin cells of the mice treated with a combination of *Bifidobacterium bifidum* CBT BF3, *Bifidobacterium breve* CBT BR3, *Lactobacillus acidophilus* CBT LA1, *Lactobacillus plantarum* CBT LP3, *L rhamnosus* CBT LR5, *Lactococcus lactis* CBT SL6, and *Streptococcus thermophilus* CBT ST3. Along with increased FOXP3 levels, there was also an increase in FOXP3⁺, cluster of differentiation CD4⁺, and T lymphocytes (T cells), which were associated with a shift away from the T_h2 inflammatory mediators and toward the T_h1 cytokines associated with reduced inflammation.⁶

Generally, the research suggests that probiotic supplementation before birth and continued supplementation during infants first 12 to 24 months of life are also correlated with decreased risks of developing atopic conditions,^{13,15,16,19,29} but other research demonstrates that the quality of the evidence is low.³⁰ This is likely due to the outcomes with use of different probiotic supplements, as well as differences between exclusively prenatal versus pre- and postnatal supplementation protocols.⁵ *Lactobacillus* strains are the primary species implicated in these reduced risk outcomes. Wickens et al⁵ found benefit with administration of 6×10^9 colony-forming units (CFU) of *L rhamnosus* (HN001) for the mother beginning at 35 weeks gestation and continuing to 6 months postpartum in breastfeeding women. The same dose was simultaneously given to the infants from birth through to 2 years of age.⁵ Through modifying genetic expression and inflammatory markers and by competing with other bacterial strains in the intestinal microbiome, probiotics have repeatedly shown efficacy with eczema.

Beyond eczema, additional research in probiotics and dermatological pathologies has examined conditions such as acne and mastitis, which have evidence to suggest they may be caused by infection with pathogenic bacteria (*Propionibacterium acnes* in acne and *Staphylococcus aureus* in mastitis).^{4,24} Probiotic supplementation for these conditions emphasizes reducing inflammation and

controlling colonization by pathological bacteria. For both conditions, researchers compared probiotics with antibiotic options. One trial on mastitis used a subject pool, which had been unsuccessful with antibiotic therapy prior to starting the probiotics.²⁶ In the treatment group, the combination of *Lactobacillus salivarius* and *Lactobacillus gasseri* at dosages of 10 billion CFU resolved clinical symptoms after 15 days of supplementation.²⁶ In a subsequent paper, women with mastitis were given either *Lactobacillus fermentum* CECT716 or *L salivarius* CECT5713 at dosages of 1 billion CFU, or standard antibiotic therapy for 3 weeks. Women taking both probiotics had mastitis that resolved more quickly and with less recurrence than women taking the antibiotic. Both of these papers demonstrate the benefit of specific probiotic supplementation for mastitis.²⁵ Exploring these unique traits of the individual strains will increase options for developing more targeted supplementation depending on the type of infection or the individual's genetic predispositions. In acne, there are 2 clinical studies showing promise. One used 3 billion CFU per day *L rhamnosus* SP1 for 12 weeks and demonstrated significant 32% improvement in acne and 65% increases IGF-1 and FOX-1 gene expression over a placebo group.³¹ The other study divided women into 3 groups to receive either probiotic, minocycline, or probiotic plus minocycline in acne treatment. At 12 weeks, the group who received probiotics and minocycline demonstrated the most benefit. Two women receiving minocycline alone developed vaginal yeast infections and stopped treatment.³²

As compared with the plethora of research on conditions such as eczema, there are relatively few studies exploring other dermatological conditions such as psoriasis, ultraviolet radiation (UVR) damage, burns, wounds, and reactive skin conditions. However, the results are promising. For those studies that used combination probiotics, it would be beneficial for follow-up research to look more closely at the unique effect versus synergistic effects of the probiotics.

Many of the wound healing and protective effects that are involved with eczema, psoriasis, and mastitis are also implicated in the photoprotective and reparative effects of probiotics on skin. *Bacillus subtilis*, a soil-based organism, was associated with improved wound healing when applied topically in a murine model of cutaneous wounds.² Similarly, Bouilly-Gauthier et al²⁸ and Sugimoto et al³ examined the effect of *Lactobacillus johnsonii* (LA1) and *B breve* strain Yakult (BBY) 12272 on damage to the epidermis from UVR exposure. The earlier clinical trials by Bouilly-Gauthier et al²⁸ demonstrated that the combined effects of carotenoid supplementation along with LA1 were associated with some protection from the inflammation and increased pigmentation effects associated with UVR. Following that study, Sugimoto et al³ used a model of hairless mice to explore the skin protective effects of probiotics naturally occurring in

Yakult milk. The results showed a reduction in damage to elastase and reduced levels of interleukin 1 beta in the mice given the BBY when compared to controls.³ The researchers noted that the benefit was also present in those mice that consumed the BBY through consumption of the cultured milk. Although it has not received a lot of research attention, the potential for protective effects against UVR damage could have tremendous potential and warrants further research.

Nutritional Supplements Overview

Professional and commercial dietary supplements containing probiotics are widely available.³³ In 2002, it was estimated that more than 100 companies in the United States marketed probiotic supplements and nearly 2 million adults consume them regularly.³⁴ In 2012, probiotic or prebiotic use was the third most commonly used nonvitamin, nonmineral dietary supplement and global sales were projected to reach to \$42 billion by the end of 2016.³⁵ Using probiotics for general health versus targeting a specific health concern is more complex as the properties of probiotic species are strain specific. Unfortunately, research models lack consistency in naming therapeutic strains, and specific strains are often not listed on supplement labels. This challenge prevents the practitioner from distinguishing the researched strain from the supplemental product and is a limitation of these tables. If the researched strain was not readily available on

the label or marketing material, the brand, potentially containing the strain, was not included in the table.

The Joint Food and Agriculture Organization of the United Nations/World Health Organization Expert Consultation on Evaluation of Health and Nutritional Properties of Probiotics developed guidelines for evaluating probiotics in food. A combination of phenotypic and genotypic tests must be performed to determine the strain; however, regulations on species identification is not in place and supplement companies are not required to list this information on labels. During this multiseried review, it was identified that 30 species were specifically isolated for research purposes and were unavailable and another 56 strains were not commercially available. Due to the wide variety of formulations on the market, lack of knowledge, and poor labeling, it is difficult for practitioners and consumers to determine which brand contains specific strains researched to address a particular health concern.

This table is designed to be a resource to see what is available “at-a-glance.” The brands were chosen by searching the probiotic strain and/ or strain species in Google, several supplement companies, Probiotics Advisor,³⁷ and the Clinical Guide to Probiotic Products.³⁸ Based on the results and to determine what was commercially available, the search was refined using Google Shopping. In some instances, the supplement company was called to determine if the formula contained a specific species.

Table 2. Dermatological Health

Health Concern	Professional and Commercial Products	Strains
Acne	iFlora Multi-Probiotic Formula (Sedona Labs)	<i>L acidophilus</i> , <i>L plantarum</i> , <i>L gasseri</i> , <i>L casei</i> ssp <i>casei</i>
Acne	Not available	<i>L lactis</i> ssp <i>lactis</i>
Acne	PRO-15 (Hyberbiotics)	<i>L acidophilus</i> , <i>L plantarum</i> , <i>L gasseri</i> , <i>L casei</i> ssp <i>casei</i>
Acne	Ultimate Flora Critical Colon (Renew Life)	<i>L acidophilus</i> , <i>L plantarum</i> , <i>L gasseri</i> , <i>L casei</i> ssp <i>casei</i>
Cutaneous Wounds	Bio-Spora (Klaire Labs)	<i>B subtilis</i>
Cutaneous Wounds	SBO Probiotic (Dr Axe)	<i>B subtilis</i>
Cutaneous Wounds	Primal Defense (Garden of Life)	<i>B subtilis</i>
Cutaneous Wounds	Adult Probiotic (Smarty Pants)	<i>B subtilis</i>
Cutaneous Wounds	Digestive Daily Balance (Blessed Herbs)	<i>B subtilis</i>
Cutaneous Wounds	Probiotic Optimized Formula (Totnes Health)	<i>B subtilis</i>
Cutaneous Wounds	Gastrointestinal Support (Prescript Assist)	<i>B subtilis</i>
Cutaneous Wounds	Royal Flora (Beyond Probiotics)	<i>B subtilis</i>
Cutaneous Wounds	Advanced Multi-Strain Formula (Bio-Kult)	<i>B subtilis</i>
Cutaneous Wounds	Ultrabiotics (Steele Spirit)	<i>B subtilis</i>
Eczema	Ecologic (Panda)	<i>B bifidum</i> , <i>B lactis</i>
Eczema	Not available	<i>B bifidum</i> CBT BF3, <i>B breve</i> CBT BR3, <i>L acidophilus</i> CBT LA1, <i>L plantarum</i> CBT LP3, <i>L rhamnosus</i> CBT LR5, <i>L lactis</i> CBT SL6, <i>S thermophiles</i> CBT ST3 combined
Eczema	HLC Maintenance (Pharmax)	<i>B animalis</i> subsp <i>lactis</i>
Eczema	Enzyme Probiotic Complex (American Health)	<i>B bifidum</i> , <i>B lactis</i> , <i>L acidophilus</i> combined
Eczema	Gene-filus F19 (Siffra Farmaceutici)	<i>L paracasei</i> ssp <i>paracasei</i> strain F19

Table 2. (continued)

Health Concern	Professional and Commercial Products	Strains
Eczema	HLC Maintenance (Pharmax)	<i>B animalis</i> subsp <i>lactis</i>
Eczema	HLC Maintenance (Pharmax)	<i>B animalis</i> subsp <i>lactis</i>
Eczema	HMF Capsules (Seroyal)	<i>B bifidum</i> , <i>B lactis</i> , <i>L acidophilus</i> combined
Eczema	LactoPrime (Klaire Labs)	<i>L salivarius</i> , <i>L paracasei</i> , <i>B bifidum</i> combined
Eczema	iFlora Multi-Probiotic Formula (Sedona Labs)	<i>L salivarius</i> , <i>L paracasei</i> , <i>B bifidum</i> combined
Eczema	Mega Flora Plus (Mega Food)	<i>L reuteri</i>
Eczema	Mega Probiotic-ND (Food Science)	<i>B bifidum</i> , <i>B lactis</i> , <i>L acidophilus</i> combined
Eczema	Nexabiotic (Bioprospers Labs)	<i>L salivarius</i> , <i>L paracasei</i> , <i>B bifidum</i> combined
Eczema	Primal Defense (Garden of Life)	<i>L salivarius</i> , <i>L paracasei</i> , <i>B bifidum</i> combined
Eczema	Probioplus DDS (UAS Laboratories)	<i>B bifidum</i> , <i>B lactis</i> , <i>L</i> combined
Eczema	ProBiota 12 (Seeking Health)	<i>L salivarius</i> , <i>L paracasei</i> , <i>B bifidum</i> combined
Eczema	Probiotic 10 (Now Foods)	<i>L salivarius</i> , <i>L paracasei</i> , <i>B bifidum</i> combined
Eczema	Probiotic Blend (Daily Essentials)	<i>B bifidum</i> , <i>B lactis</i> , <i>L acidophilus</i> combined
Eczema	Probiotics Ultra (Syontix)	<i>L reuteri</i>
Eczema	ProSynbiotic (Standard Process)	<i>L acidophilus</i> LA5, <i>B animalis</i> subsp <i>lactis</i> BB12
Eczema	TruBiotics (Bayer)	<i>L acidophilus</i> LA5, <i>B animalis</i> subsp <i>lactis</i> BB12
Eczema	Ultimate Flora Critical Colon (Renew Life)	<i>L salivarius</i> , <i>L paracasei</i> , <i>B bifidum</i> combined
Eczema	Ultimate Probiotic Formula (Lee Swanson Signature Line)	<i>L reuteri</i>
Eczema	Widely available	<i>L rhamnosus</i>
Eczema	Widely available in commercial supplements	<i>L rhamnosus</i>
Eczema	Widely available in nutritional supplements	<i>L rhamnosus</i>
Eczema	Mutaflor (Tribute Pharmaceuticals)	<i>E coli</i> Nissle 1917 (EcN)
Mastitis (Lactational)	Ultimate Flora Critical Colon (Renew Life)	<i>L salivarius</i> , <i>L gasseri</i> combined
Mastitis (Lactational)	iFlora Multi-Probiotic Formula	<i>L salivarius</i> , <i>L gasseri</i> combined
Mastitis (Lactational)	Nexabiotic (Bioprospers Labs)	<i>L fermentum</i>
Mastitis (Lactational)	PRO-15 (Hyberbiotics)	<i>L salivarius</i> , <i>L gasseri</i> combined
Mastitis (Lactational)	Propolis Plus (Essential Formulas)	<i>L fermentum</i>
Mastitis (Lactational)	Reg'Activ Immune & Vitality (Essential Formulas)	<i>L fermentum</i>
Mastitis (Lactational)	Ultimate Probiotic Formula (Lee Swanson Signature Line)	<i>L salivarius</i> , <i>L gasseri</i> combined
Mastitis (Lactational)	Widely available in nutritional supplements	<i>L salivarius</i>
Psoriasis	Align Probiotic Digestive Care (Proctor & Gamble)	<i>B infantis</i> 35624
Reactive Skin	Not available	<i>L paracasei</i> NCC 2461
Ultraviolet Radiation Damage	Not available	<i>B breve</i> strain Yakult (BBY) 12272
Ultraviolet Radiation Damage	BioAmicus Johnsonii	<i>L johnsonii</i> (LA1)

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