EXECUTIVE SUMMARY

Summary of Scientific Evidence for TrueBroc® Broccoli Seed Extract and Immune Benefits

A healthy and robust immune system is important to all human beings and is relevant regardless of health status or life stage. The clinically-established antioxidant and detoxification actions of sulforaphane delivered from TrueBroc® can provide significant benefits to immune health.

The Immunity Challenge

Our modern environment and style of living compromises our immune defenses in a multitude of ways. Everything from stress (physical and emotional), poo, lack of sleep, exposure to environmental pollution, and the inevitable process of aging, can compromise our immune health. Assaults on our immune system leave us all vulnerable to infections and injurious diets, and less able to rebound easily to achieve and maintain optimum health.

Role of Glucoraphanin and Sulforaphane

There is an abundance of scientifically valid evidence that consumption of the phytochemical glucoraphanin, a key active ingredient found in broccoli and in TrueBroc®, confers a number of benefits associated with strengthening healthy immune function.

One strategy to bolster and reinforce our immune system is to consume glucoraphanin (GR) in a standardized form to ensure that you get the same, efficacious, dose, every day. GR, the active ingredient in TrueBroc®, in the presence of myrosinase, is readily converted to the potent Nrf2 inducer, sulforaphane (SF). While GR and SF are best known as chemopreventive agents, research in recent years has revealed the multifaceted benefits of these compounds, including significant immune health and inflammatory modulation benefits. In the attached document, we discuss several relevant mechanistic pathways by which SF (and its precursor GR) confers these benefits and provide a review of the supportive in vitro and in vivo – animal and human (clinical) studies.

A properly functioning immune system not only recognizes and activates the body to defend against disease-causing germs (pathogens) like bacteria, viruses, parasites, and fungi, but it can also recognize and remove toxins and other harmful chemicals derived from our environment (airborne and ingested), and fight disease-inducing modifications that our body may develop over a lifetime SF supports most of these immune system mechanisms.

Antioxidant Defense and Protection

Sulforaphane’s well-established antioxidant and detoxification properties are especially relevant to immune health. Beyond chemoprevention, SF is best known for its ability to upregulate the production of antioxidants (e.g. glutathione) and related antioxidant enzymes, bolstering the immune system in multiple ways. By increasing glutathione levels, SF increases production and functional activities of immune cells including natural killer cells (NK), T cells and macrophages.

Inadequate intakes of antioxidants resulting from diets lacking in fruits and vegetables and/or depletion of antioxidants by insufficient sleep, stress and environmental pollutants, leads to suboptimal antioxidant status which compromises the human immune system. Studies have
consistently demonstrated that suboptimal antioxidant status, especially ascorbic acid and glutathione, increases vulnerability to infection, damage and injury. Importantly, glutathione has the ability to recycle ascorbic acid, maintaining vitamin C levels prior to and during infection, yet another mechanism by which SF bolsters the immune system by increasing glutathione. Moreover, immune stimulation, such as in the presence of infection, increases antioxidant requirements; inadequate antioxidant status is associated with more severe infections and delayed recovery. SF bolsters immune defenses and enhances the immune response by optimizing antioxidant status and detoxification mechanisms via the Nrf2 pathway. SF further enhances the cellular stress response, inducing production of protective mechanism including the heat shock response.

**Inflammatory Balance**

An integral component of immune protection is the inflammatory response. The ability of SF to modulate inflammatory responses to infection, toxin and allergen exposure and other immunity insults is another important mechanism by which SF supports a healthy immune system. For example, the ability of SF to inhibit the pro-inflammatory NfκB pathway has been the subject of extensive study both in vitro, in animals and clinically in humans with very positive results.

Infection and the inflammatory response to infection in and of themselves are damaging and may compromise the immune system further by increasing oxidative and nitrosative stress, depleting antioxidant status and causing inflammatory damage. By upregulating GSH, antioxidant enzymes, proteins and peptides, SF can attenuate damage and enhance the survival of cells and tissues that have been compromised by infection.

**Up-Regulation of Glutathione**

Glutathione (GSH) is the most ubiquitous and abundant intrinsic antioxidant in the human body. GSH plays a key role in the regulation and maintenance of intracellular redox status, quenching reactive oxygen species directly and recycling other antioxidants, including ascorbic acid (vitamin C), back to their active, reduced forms. GSH participates in multiple detoxification functions, for example, irreversibly binding toxins rendering them inert so that they may be excreted from the body without causing further damage. There is abundant evidence that SF induces the synthesis and recycling of GSH throughout the human body, improving systemic redox and antioxidant status. Additionally, SF has been consistently demonstrated to promote the synthesis of relevant antioxidant and detoxification enzymes, conferring protective benefits that support a healthy and robust immune system.

**Anti-Bacterial**

SF has been shown to modulate gastrointestinal bacterial populations, and glucoraphanin is already being considered as a prebiotic for its role in modifying the balance of the microbiome, areas of active research. Furthermore, there is ample evidence of the direct antibiotic activity of SF. Within the gastrointestinal system, this antibiotic activity may lower bacterial load, for example, of food-borne bacteria, to a level that it is no longer pathogenic to the system, and to Helicobacter pylori, which can cause ulcers and stomach cancer.

**Detoxification**

Over time, exposure to stress, including psychosocial stress, physical stress, inflammation, oxidative damage, environmental toxins, aging, etc. compromise the immune system with negative consequences. SF up-regulates cellular detoxification mechanisms, enzyme, and detoxification protein concentrations, including the neutralization and excretion of cellular and environmental toxins.

Multiple clinical studies have consistently demonstrated positive effects of SF on a variety of respiratory conditions associated with airborne pollution exposure. Strikingly, strong dose-dependent effects of SF on diesel exhaust particle lung injury and on the toxicities of omnipresent air pollutants have been demonstrated in large human clinical trials. These benefits were not exclusive to the lungs, but revealed increased systemic neutralization and excretion of the environmental toxins benzene and acrolein in response to supplementation with GR and/or SF.
Anti-Viral

Effects that have only more recently been appreciated include the direct antiviral activity of SF. Evidence has emerged that SF targets the entry, replication, assembly, and release of new viral particles. This direct effect of SF is complemented by its more indirect effects on prevention of initial infection via the support of healthy inflammatory and anti-oxidative responses. Moreover, SF’s ability to increase GSH production simultaneously enhances the functional activities of T cells, natural killer cells, and macrophages. In fact, SF has long been known to inhibit replication of certain viruses such as Herpes Simplex Virus-1 and HSV-1. [Please note: although under study, at this time, there is no significant evidence that sulforaphane may be a part of treatment or prevention of COVID-19, other than supporting a healthy immune system overall.]

SF derived from broccoli seeds, TrueBroc®, confers robust, broad-spectrum immune health benefits via diverse mechanisms that are applicable to individuals of all ages.