

# The Effects of Collagen and Colostrum on Longevity

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## 1. Introduction

Collagen and colostrum have recently emerged as two of the most promising supplements for fighting aging and supporting overall health and immunity. As research continues to reveal the multifaceted therapeutic potential of these two naturally occurring compounds, they have become the subject of great interest and investigation. Collagen is the most abundant structural protein in the human body, making up the majority of connective tissues in skin, bones, muscles, tendons, and blood vessels. Collagen production declines around age 25, gradually leading to common outward signs of aging like wrinkles and joint deterioration. Supplementing with hydrolyzed collagen peptides has increased collagen density in the dermis and effectively rewinds the clock on skin aging. The health properties of collagen extend far beyond skin aesthetics, with mounting evidence pointing to cardiovascular, bone, joint, and digestive benefits [1]. Colostrum is the first nutrient-dense milk produced by mammals immediately after giving birth, before mature breastmilk. Bovine colostrum from cows contains high antibodies, antimicrobial compounds, and growth factors that provide passive immunity until the newborn's immune system matures. An increasing body of research indicates that bovine colostrum may confer similar protective and regenerative effects in humans. From infectious diseases to autoimmunity and gut health, the therapeutic scope of colostrums appears remarkably far-reaching [2].

This paper comprehensively reviews the literature on supplemental collagen and colostrum for anti-aging, improved immunity and digestion, and prevention or treatment of various age-related diseases. It analyzes proposed mechanisms behind their multifaceted health benefits, assesses safety and optimal dosing protocols, and evaluates evidence for synergistic effects when combining the two supplements. The overarching aim is to evaluate the potential of collagen and colostrum supplementation as a safe, effective strategy for supporting healthy longevity by strengthening the body's structural integrity and immune defenses against inflammation, pathogens, and deterioration.

### 1.1. Collagen & Colostrum Supplements

Collagen is the most abundant protein in the human body, accounting for almost 30% of its protein content. There are 29 different forms of collagen, with forms I, II, III, V, and XI being the principal elements of connective tissues,

tendons, ligaments, cartilage, bones, blood vessels, and the gastrointestinal tract. Collagen production begins to drop as people reach their mid-20s, adding to visible indications of aging such as wrinkles and joint degeneration [3]. A bioactive matrix of collagen's component amino acids, including hydroxyproline and glycine, is provided by supplements from bovine, porcine, or marine sources. Randomized controlled experiments show that taking collagen peptides for 60-90 days can improve skin hydration, suppleness, and dermal collagen density while reducing wrinkles [4]. Supplemental collagen has been shown to improve bone mineral density, arthritic pain, nail health, and cardiovascular health through vascular collagen formation, mucosal healing in the gastrointestinal tract, and its aesthetic benefits [5].

Hydrolyzed collagen absorbs more than intact collagen because of its decreased molecular weight [6]. Collagen supplements come in various formats, including powders for simple integration into drinks or smoothies and pills, which are frequently coupled with vitamin C to boost collagen synthesis. Joint compositions comprising collagen, glucosamine, and chondroitin sulfate are recommended daily dosages ranging from 2-10 grams. Extensive research trials have found no evidence of morphological concerns connected with various supplement formulations and dosages.

Colostrum, the postpartum pre-milk fluid released by mammals, provides passive immunity until the newborn's immune system matures. Bovine colostrum, obtained from pasture-raised cows between 12-24 hours of birth, contains many immunoglobulins, lactoferrin, growth hormones, vitamins, and minerals. Colostrum supplements can improve children's and adults' immune function [7]. Colostrum supplements, available in capsules, powders, sublingual tablets, and liquid extracts, contain different quantities of bioactive components according to the time lag between harvest and production. Without adequate stabilization, growth hormones such as IGF-1, known to stimulate tissue healing and regeneration, demonstrate a rapid drop post-harvest. For overall wellness, daily dosages of 500-1500mg are recommended. Colostrum has an excellent tolerability profile with no proven upper limits. However, caution is advised due to potential immunomodulatory interactions with immunosuppressive medications [8].

## 1.2. Collagen: The Body's Structural Foundation

As the most abundant protein in the human body, collagen is the fundamental building block for critical structural components such as skin, connective tissues, bones, and the vascular network. The extensive diversity of collagen is evidenced by identifying 29 distinct types, with types I and III being among the most prevalent forms [9]. Together, types I and III collagen dominate the composition of the dermis, forming the fibrous collagen present in tendons, ligaments, muscles, and blood vessels. However, the synthesis of these crucial collagen types peaks in early adulthood, gradually diminishing with the inevitable passage of time. Oral supplementation endeavors to counterbalance this natural decline in endogenous collagen synthesis [9].

In the intricate dermal matrix, the crosslinking of heterogeneous fibers comprising types I and III collagen provides the essential structure, stability, and elasticity necessary to support the epidermis. Yet, as intrinsic and extrinsic aging processes unfold, collagen synthesis falters compared to the accelerating enzymatic degradation, leading to hallmark manifestations such as wrinkles, sagging, and loss of elasticity [10]. Rigorous investigations through double-blind placebo-controlled trials consistently demonstrate that ingesting bioactive hydrolyzed types I and III collagen peptides for 60-90 days significantly enhances dermal collagen density and skin elasticity. Notably, these supplements exhibit a remarkable reduction in wrinkle depth compared to control groups. Quantitative analyses underscore the effectiveness of oral collagen supplementation in amplifying both collagen production and the extracellular accumulation of types I and III collagen. Clinical enhancements in skin hydration, tone, and texture establish collagen peptides as efficacious agents in mitigating the visible signs of chronological and photoaging, promoting a more youthful complexion [11].

Osteoarthritis, characterized by the gradual erosion of articular cartilage rich in type II collagen, manifests in joint stiffness, pain, and compromised mobility, predominantly affecting the knees, hips, and hands. Recognizing the compositional similarity between supplemental collagen peptides and type II collagen, researchers posit the potential for chondroprotective and anti-inflammatory effects within joints [12]. Clinical findings underscore the significant reduction in osteoarthritic pain and improvement in mobility with daily oral collagen peptide intake over 3-6 months compared to placebo. Ultrasonography reveals concurrent regeneration of destabilized cartilage tissue architecture, underscoring the dual capacity of hydrolyzed collagen supplementation to stimulate connective tissue renewal while mitigating inflammation-driven cartilage destruction. This positions collagen supplementation as an effective intervention for the management of osteoarthritis [13].

The dynamic process of bone remodeling, orchestrated by osteoblasts and osteoclasts, involves continuous collagenous extracellular matrix turnover. As early as the fourth decade, an imbalance favoring bone resorption initiates gradual mineral loss, escalating fracture susceptibility and culminating in

osteopenia [14]. Left unchecked, this progression advances to osteoporosis, intensifying morbidity and mortality risks. Collagen peptides, introduced through supplementation, are pivotal in impeding pathological bone loss by promoting osteogenic proliferation and differentiation while inducing osteoclast apoptosis. Clinical studies corroborate the efficacy of daily collagen peptide intake over six months, preserving or increasing total hip, lumbar spine, and femoral neck bone mineral density relative to control groups. This preventive action effectively inhibits the progression from osteopenia to osteoporosis [15].

## 1.3. Colostrum: Nature's Nutrient-Rich Elixir

Bovine colostrum, in particular, garners attention for its remarkable bioavailability of diverse bioactive components. However, the composition of colostrum can vary significantly due to geographical origin, genetics, diet, and husbandry practices. To harness its full potential, stringent assessment is imperative, emphasizing the need for high-quality formulations sourced from pasture-raised, grass-fed cows raised without hormones or antibiotics [16]. Ethical harvesting within the critical 12-24 hours postpartum ensures the retention of ephemeral immune and growth factors, which rapidly decline without proper processing and storage. Analyzing macronutrient content and the levels of growth factors, immunoglobulins, lactoferrin, and additional components provides crucial qualitative metrics. Meeting or exceeding benchmarks in these indices ensures the efficacy of a given colostrum product, distinguishing it from inferior preparations or substitutes like porcine colostrum [16].

A wealth of research spanning in vitro studies, animal models, and human clinical trials attests to colostrum's remarkable capacity to enhance the immune response against a spectrum of pathogens. Oral colostrum supplementation emerges as a powerful modulator, elevating salivary IgA levels to fortify mucosal defenses and increasing serum IgG concentrations for enhanced systemic pathogen recognition. Beyond these adaptive responses, colostrum exhibits direct antimicrobial activity through its rich pool of leukocytes, secreting effector molecules that disable or destroy invasive microorganisms [17]. Specific components like lactoperoxidase contribute additional anti-pathogenic effects, particularly within the gastrointestinal tract. Prophylactic daily doses of 500-1500mg of bovine colostrum powder significantly reduce the incidence and severity of upper respiratory infections in athletes and act as a preventive measure against opportunistic infections in immunocompromised patients undergoing chemotherapy. Athletes benefiting from reduced downtime due to illnesses highlight the substantial advantages of ongoing colostrum supplementation in strengthening the immune response [17].

Supplemental colostrum is pivotal in promoting and preserving gastrointestinal health by supplying growth factors, immunologic factors, and amino acids essential for structural, protective, and regenerative roles within the intestinal mucosa [18]. Transforming growth factor beta-2 (TGF- $\beta$ 2) contributes to tissue healing and repair processes, while insulin-like growth factors 1 and 2 (IGF-

1, IGF-2) stimulate cellular growth, differentiation, and metabolism, clinically proven to counteract gastrointestinal injury induced by non-steroidal anti-inflammatory drugs. Colostrum activation of cytokine production regulates inflammatory pathways implicated in conditions such as leaky gut syndrome, irritable bowel disease, and chronic gastrointestinal distress. Moreover, colostrum's nourishing properties help create an intestinal environment less hospitable to potentially pathogenic bacteria. The multifaceted pathways induced by short-term colostrum supplementation alleviate problematic symptoms like intestinal hyperpermeability, conferring lasting benefits to overall gastrointestinal structure and function [18].

#### 1.4. Bioactive Components of Colostrum

Immunoglobulins, particularly IgG, are the stalwart guardians in colostrum, representing the most abundant antibodies with a pivotal role along mucosal surfaces. Their function is paramount—they recognize and bind to specific harmful particles like viruses and bacteria, creating a formidable defense mechanism to prevent penetration of vulnerable barriers and infection. IgG handles different pathogens, eliminating bacterial toxins and viral particles in the blood and tissues through complement activation, opsonization for phagocytosis, and other processes. Colostrum boasts drastically higher levels of all immunoglobulin classes than ordinary milk, endowing immediate protection. Supplementation provides concentrated pre-formed antibodies, fortifying systemic immune defenses against a spectrum of pathogens the mother cow has triumphed over, imparting preparedness against similar exposures [19].

Lactoferrin, another vital component of colostrum, possesses multifunctional properties that contribute to its status as a formidable shield against pathogens. Its capabilities range from directly binding to and disabling pathogenic particles to recruiting and activating other immune cells once a threat is detected. Beyond these actions, lactoferrin plays a crucial role in maintaining the structural integrity of the gut mucosal barrier. Its iron-binding capacity is particularly noteworthy, as it sequesters this essential growth medium away from iron-dependent bacteria, exerting broad-spectrum antimicrobial effects, especially within the gastrointestinal tract. Working synergistically with immunoglobulins and other components, lactoferrin ensures amplified protection, making it a key player in colostrum's robust immune-boosting arsenal [20].

Growth factors, the proteins orchestrating cellular growth, healing, and regeneration, constitute a crucial component of colostrum's bioactive ensemble. Major players in this category include insulin-like growth factors 1 and 2 (IGF-1 and IGF-2) and transforming growth factor beta-2 (TGF- $\beta$ 2). Research illuminates the ability of colostrum growth factors to counter gastrointestinal cellular damage caused by factors such as NSAIDs or chemotherapy drugs by stimulating the growth of new, healthy intestinal cell tissue. However, their efficacy hinges on swift processing protocols after colostrum production, as these growth factors decline rapidly unless stabilized through techniques like flash pasteurization

followed by spray drying into a powder format. Ensuring the presence of these key growth factors is vital for colostrum's regenerative and anti-inflammatory benefits. It guarantees the supplement's potency against inferior products where labile growth factors may have diminished over time. The symphony of immunoglobulins, lactoferrin, and growth factors within colostrum epitomizes nature's sophisticated defense strategy, offering a holistic and potent arsenal against many health challenges [21].

#### 1.5. Bioactive Components of Collagen

As the simplest and most abundant amino acid within collagen, glycine is foundational, constituting approximately one-third of collagen's total amino acid content. Its significance lies in contributing to collagen's tightly coiled triple helical structure, where it interacts with hydrogen atoms, stabilizing and strengthening the folds. This unique structural arrangement is crucial for collagen's role as a firm yet flexible matrix within the body. Beyond its structural duties, glycine demonstrates anti-inflammatory properties by enhancing the release of the antioxidant glutathione. This internal antioxidant protects the body against oxidative damage to cells and tissues. Moreover, glycine supports hepatic function and the availability of other glutathione precursors, such as cysteine, thereby optimizing collagen structural integrity and synthesis rates. Supplemental glycine reinforces collagen's structural integrity through these multifaceted pathways and combats age and inflammation-related deterioration [22].

Constituting around 15% of collagen, proline is a pivotal amino acid that collaborates with glycine to form sequential triplets, stabilizing collagen's characteristic triple helix configuration. Hydroxylation transforms a portion of proline into hydroxyproline, allowing the formation and stabilization of collagen fibers via hydrogen and hydrophobic interactions. In addition to its structural functions, proline plays essential roles in protein folding, maintaining cell redox balance, facilitating tissue repair, and modulating immune responses. Its significance in wound healing is particularly noteworthy, as proline status directly links to the generation and degradation of collagen matrices following injury. Supplementing with proline ensures ample raw materials to up-regulate collagen synthesis rates, especially in response to factors like UV radiation, inflammation, or trauma [23].

While representing only 5% of collagen's total amino acid content, hydroxyproline plays a disproportionately critical role in maintaining the structural integrity of collagen. Positioned strategically within the helicoidal sequences, hydroxyproline's hydroxyl groups extend from pyrrolidine rings, facilitating the folding of chains into ultra-stable triple helical motifs through hydrogen bonding between strands. This unique molecular configuration imparts the endurance necessary for collagen to withstand tension and pressure across bodily structures daily for decades without failure. Disorders characterized by unstable collagen matrices, such as those affecting the skin and skeleton, show substantial improvement with oral hydroxyproline supplementation. By influencing collagen morphology and extracellular

accumulation, hydroxyproline becomes a therapeutic powerhouse, directing collagen's helical structure and promoting the recovery of structural stability in aging or damaged tissues [24].

### 1.6. Benefits of Collagen & Colostrum Supplements

Colostrum, renowned for its immune-boosting properties, is a formidable defense mechanism against pathogens. With immunoglobulins, lactoferrin, leukocytes, and other bioactive compounds, colostrum provides the body with tools to recognize and eliminate invading microorganisms. Elevating systemic antibody concentrations through colostrum supplementation primes the immune system to respond rapidly to future infections. Beyond the physiological benefits, a reduced incidence of illnesses translates to fewer interruptions in exercise training and increased productivity in various facets of daily life [25].

The intricate composition of colostrum extends beyond immune support to foster optimal gastrointestinal health. Packed with various growth factors, colostrum becomes a catalyst for repairing and regenerating damaged gastrointestinal tissue. Transforming growth factors contribute to the stability of the intestinal barrier, while insulin-like growth factors enhance nutrient absorption. This harmonious interplay not only addresses issues related to leaky gut but also provides relief from food sensitivities, showcasing the holistic impact of colostrum on gut wellbeing.

Collagen, a rich source of glycine, unfolds its potential as an inhibitory neurotransmitter crucial for mood stability and a sense of calm. In an era where glycine deficiency is prevalent in modern diets, collagen supplementation is a valuable source to ensure sufficiency. Beyond mood regulation, glycine optimization facilitated by collagen intake plays a role in enhancing focus and concentration. The concurrent stimulation of glutathione production, aiding in detoxifying neurotoxic heavy metals, adds a nuanced layer to collagen's impact on mental wellbeing [25].

The ingestion of bioactive collagen peptides heralds a transformative journey for aging skin. The comprehensive improvements in moisture retention, smoothness, elasticity, and firmness underscore the profound impact on dermal collagen density. Scientifically quantifiable reductions in wrinkles and expression lines paint a vivid picture of collagen's prowess in restoring a more youthful complexion. This skin-centric facet of collagen supplementation delves into aesthetics with tangible and measurable outcomes [26].

Hydrolyzed collagen takes center stage in weight management and body composition. Its role in up-regulating energy expenditure and enhancing fat oxidation is complemented by its appetite-suppressing effects mediated through peptide YY release. The multifaceted impact on metabolic dynamics and glycine's role in mitigating elevated core body temperature indicative of metabolic dysfunction positions collagen as a valuable ally in pursuing metabolic wellbeing. Collagen's glycine content steps into sleep optimization, acting as an inhibitory neurotransmitter that

facilitates deeper and more restful sleep. Scientific evidence underscores glycine's ability to shorten the time required to fall asleep, increase the duration of REM sleep, and reduce nighttime awakenings, contributing to overall sleep quality. The intersection of collagen supplementation and sleep hygiene offers a holistic approach to addressing the complexities of sleep-related challenges.

Colostrum unveils its role as a conductor in the symphony of energy regulation. Laden with cytokines, colostrum becomes a potent modulator of hypothalamus activity, governing energy levels, physiologic homeostasis, and circadian rhythms. This orchestration translates into heightened wakefulness during daylight hours and facilitates sounder sleep when desired, contributing to a nuanced and balanced approach to energy optimization [26]. In athletic performance, bovine colostrum emerges as a superior ally, outperforming whey protein in inducing muscle hypertrophy, increasing peak anaerobic power, and shortening recovery periods between exertions. The multifaceted pathways through which colostrum enhances strength endurance and reduces perceived exertion during physical activity present a compelling narrative for its integration into performance optimization strategies. The robust scientific support positions bovine colostrum as a cornerstone in pursuing elevated athletic prowess [27].

### 1.7. How Collagen & Colostrum Reverse Aging Processes

#### 1.7.1. Anti-Aging Effect of Collagen

Song utilized an animal model of intrinsic skin aging, employing 13-month-old mice to investigate the effects of bovine-derived collagen peptides on chronologically aged skin [28]. Quantifying impacts over 8 weeks of daily oral administration, measurements found collagen peptides preserved skin elasticity and robustness compared to age-matched controls not receiving supplementation [28]. Through histological examination of the dermis, the researchers also documented enhanced structural integrity evidenced by repaired collagen architecture, elevated overall collagen content, and normalization of the ratio between type I and type III collagen versus supplemented mice [28]. These biological impacts indicate that orally ingested collagen peptides can stimulate extracellular matrix regeneration to functionally counteract gradual structural deterioration seen as part of the skin's intrinsic aging process [28]. While not significantly altering hyaluronic acid levels, collagen density and morphology improvements directly map to enhanced hydration and elasticity - delaying key aging attributes that worsen skin appearance and function [28]. The study provides compelling evidence that the oral administration of CPs from bovine bone or proline can potentially ameliorate the laxity associated with chronologically aged skin. The quantitative and qualitative alterations in skin collagen and improvements in antioxidative enzyme activities accentuate the promising role of CPs as functional foods in the battle against skin aging in the chronologically aged process. This research contributes valuable insights to the burgeoning field of anti-aging interventions, particularly focusing on intrinsic aging processes in the skin.

West and Lephart compiled and analyzed evidence on natural compounds and minerals administered orally to enhance skin health, with implications for modulating the skin microbiome [29]. Multiple skin parameters saw significant improvement with nutritional interventions. Collagens and colostrum elicit particular interest given their structural and immunoregulatory roles [29]. As the predominant structural protein family maintains dermal architecture, declining collagen production with aging manifests as wrinkles, sagging, and loss of elasticity. Across both animal models and human trials, ingested collagen peptides increased fibroblast proliferation, expanded vascular networks, and amplified extracellular matrix deposition, restoring youthful structural integrity. A measured reduction in wrinkle depth accompanies quantifiable increases in skin hydration, thickness, and elasticity [29]. These trophic effects result from bioactive collagen peptides up-regulating the endogenous synthesis of new collagen. Stimulating collagen production provides building blocks to counteract degradative aging processes by regenerating skin integrity from within. Beyond cosmetic applications, optimized collagen matrices protect against ulcer formation and accelerate the healing of wounds and lesions [30].

Colostrum delivers growth factors like TGF- $\beta$ 2, which activate fibroblasts, coupled with immunoglobulins and lactoferrin regulating immune cell activity, modulating inflammation and structural deterioration causally implicated in skin aging. Early research confirms oral colostrum produces analogous benefits to topical growth factors for skin rejuvenation. Though mechanisms require further elucidation, collagen and colostrum supplementation can restore youthful skin integrity and appearance [29].

Pyun substantiate the anti-aging benefits of oral collagen tripeptide (CTP) supplementation [31]. Hairless mice receiving daily CTP treatment for 14 weeks exhibited significantly reduced UV radiation-induced wrinkling, erythema, skin loosening, and loss of structural integrity versus UV controls. Quantifiable protection in vivo mirrors earlier vitro findings on enhanced extracellular matrix regeneration with CTP. Through up-regulating new collagen production, supplemental collagen peptides stimulate renewal of the dermal layer to counteract photoaging. Increasing proliferation and functionality of fibroblasts and other skin cells produce denser, healthier matrices structurally akin to younger skin. Subsequent gains in dermal elasticity, hydration levels, and cohesion confer measurable aesthetic improvements to smooth appearance and texture while fortifying UV-susceptible epidermis [31].

Beyond direct stimulation of growth and repair processes, additional research illuminate's collagen's antioxidant and anti-inflammatory activities in mitigating molecular aging cascades precipitated by UV damage [32]. By supplying raw materials for regeneration and modulating the intercellular signaling governing structural homeostasis, oral CTP enhances skin integrity from within - functionally rewinding visible aging manifestations. Combined with colostrum's immuno-regulatory factors, which similarly modulate

inflammation, oral CTP, and bovine colostrum represent a comprehensive dual strategy to regenerate aged skin by addressing causes rather than symptoms [31].

Gao revealed that ethanolic extracts of the Ayurvedic medicinal plant *Pterocarpus santalinus* (EPS) protect human skin fibroblasts against ultraviolet B radiation-induced damage [31]. By attenuating oxidative stress, inflammation, and extracellular matrix deterioration, EPS exhibits a multifaceted capacity to maintain structural and functional skin integrity [32]. Likewise, supplemental collagen peptides stimulate endogenous regenerative pathways that functionally restore youthful collagen density, hydration, and elasticity to rejuvenate aged skin, manifesting wrinkles and fragility intrinsically. Colostrum's growth factors and immunoglobulins further modulate inflammation and immune response - together combatting drivers of deterioration, including UV-generated reactive oxygen species [32]. While the detailed bioactive constituents differ between *P. santalinus*, collagen, and colostrum, all three natural products converge on similar endpoints via interconnected mechanisms - upholding fibroblast viability, spurring tissue growth and repair processes, and tempering destructive inflammation cascades. This biological orchestration elicits quantifiable structural and aesthetic enhancement alongside photo-protection to synergistically combat dermal aging. Though additional research is warranted, the current evidence supports the therapeutic potential of supplementing collagen and colostrum with botanicals like EPS to promote healthy, resilient skin from within [32].

A recent white paper by Mobasheri reviewed evidence on hydrolyzed collagen supplements for managing osteoarthritis symptoms [33]. Across clinical studies, collagen peptide intake for 60-90 days improved joint function and reduced arthritic pain versus control by stimulating connective tissue anabolism, supplemental collagen balances the catabolic deterioration of articular cartilage associated with aging and osteoarthritis progression [33]. Coupled with anti-inflammatory effects, collagen shows the potential to both alleviate osteoarthritic pain and slow disease advancement [33]. However, more research is needed to confirm disease-modifying capacity and optimize dosing protocols.

In light of growing concerns about epidermal aging, a phenomenon that transcends chronological maturation, there has been a noticeable increase in the use of nutricosmetics as adjuvant therapies. To investigate this phenomenon, De Miranda systematically investigated hydrolyzed collagen supplementation's effects on the senescence trajectory of human skin tissue [34]. A detailed examination of randomized, double-blind, and controlled studies follows, orchestrated by a thorough search of several databases such as Medline, Embase, Cochrane, LILACS, and the Journal of Negative Results in Bio Medicine. The intervention's main focus is oral administration of hydrolyzed collagen, with a targeted evaluation of relevant outcomes such as cutaneous wrinkling, hydration status, dermal elasticity, and structural rigidity. The academic pursuit conducts a comprehensive

metaanalysis of 19 selected research from a large collection, including a demographically diverse cohort of 1,125 participants (95% females between the ages of 20 and 70). The subsequent data support the therapeutic efficacy of hydrolyzed collagen, revealing significant improvements in skin hydration, elasticity, and wrinkle reduction over 90 days compared to a placebo. These empirical findings, as elaborated on by De Miranda, corroborate the compelling potential of hydrolyzed collagen in moderating the numerous elements of epidermal aging [34].

Effective, evidence-based strategies to address skin aging become paramount as life expectancy rises. The study by de Miranda not only substantiates the benefits of hydrolyzed collagen but also underscores the importance of scientific rigor in evaluating nutricosmetic interventions [34].

### 1.7.2. Anti-Aging Effects of Colostrum

Mero conducted a study to explore the influence of bovine colostrum supplementation, specifically Bioenervi, on various physiological markers during strength and speed training [35]. The research aimed to evaluate the effects of colostrum on concentrations of serum insulin-like growth factor I (IGF-I), immunoglobulin G, hormones, amino acids, and saliva immunoglobulin A in male sprinters and jumpers exposed to rigorous training. In a carefully designed experimental setup, nine participants underwent eight random training sessions, with a 13-day gap between interventions. The primary variable involved daily consumption of a 125 ml drink containing either Bioenervi or a placebo (normal milk whey). Results revealed noteworthy post-training increases in serum IGF-I concentrations, particularly in the 125-ml Bioenervi treatment compared to the placebo. This substantial enhancement in IGF-I concentration indicates a potential influence of bovine colostrum on the insulin-like growth factor system during demanding training periods [35]. As per Mero, bovine colostrum supplementation, specifically Bioenervi, might contribute to increased blood IGF-I concentrations in athletes undergoing strength and speed training [35].

Han investigate the potentially beneficial benefits of bovine colostrum-derived exosomes in combating UV-induced aging and damage in skin cells [36]. The study focuses on keratinocytes, melanocytes, and fibroblasts, important contributors to skin health. Colostrum exosomes protect epidermal keratinocytes from UV damage. Notably, they significantly suppress the production of intracellular reactive oxygen species, hence reducing oxidative stress, which is a characteristic of skin aging. Moving to melanocytes, these exosomes emerge as potential regulators, significantly reducing melanin production, the pigment responsible for skin darkening. This modulation carries the potential to forestall hyperpigmentation disorders linked to excessive melanin formation. In the realm of fibroblasts, pivotal for skin structure, colostrum exosomes showcase their reparative prowess. They suppress the expression of matrix metalloproteinases, which play a role in collagen degradation. Concurrently, there is a notable increase in cell proliferation and collagen production, emphasizing a dual action of mitigating factors contributing to aging while

promoting essential skin matrix components [36].

## 1.8. Collagen & Colostrum on Autoimmune Diseases: Research Studies

### 1.8.1. Collagen Effects on Autoimmune Diseases

Rheumatoid arthritis, characterized by inflammatory synovial involvement, is postulated to originate from T cell responses to an antigen localized within the joint. In this autoimmune disorder, type II collagen, a predominant protein in articular cartilage, emerges as a potential autoantigen. The seminal investigation undertaken by Trentham sought to examine the impact of orally administered chicken type II collagen in ameliorating severe, active rheumatoid arthritis [37]. Drawing inspiration from successful animal models wherein oral tolerization to autoantigens suppressed T cell-mediated autoimmune diseases, including rheumatoid arthritis, the researchers translated their approach into a randomized, double-blind clinical trial involving 60 patients. The outcomes yielded noteworthy results. Over 3 months, individuals who received oral administration of chicken type II collagen exhibited a significant reduction in the number of swollen and tender joints compared to those administered a placebo. Particularly striking was the observation that four patients in the collagen intervention group achieved complete remission of the disease, underscoring the clinical efficacy of the oral tolerization strategy [37].

The findings underscore the potential of harnessing the body's natural tolerance mechanisms to modulate immune responses and mitigate the severity of autoimmune diseases. This not only addresses the specific context of rheumatoid arthritis but also lays the foundation for broader applications of oral tolerization strategies in autoimmune disease management. Pedchenko illuminate new dimensions of how collagen underscores the pathogenesis of the organ-specific autoimmune disease Goodpasture syndrome [38]. The principal autoantigen in Goodpasture syndrome is the  $\alpha3\alpha4\alpha5$  network of collagen type IV, limited to basement membranes of the kidney and lung. The interplay between genetic factors governing immune recognition and posttranslational changes regulating network assembly and collagen structure provides the mechanistic foundation for the aberrant immune targeting of alveoli and glomeruli, which define this syndrome [38]. Findings demonstrate the critical role of specific collagen forms in localizing sites of pathological autoantibody attack. This elucidation of immunological drivers delineates routes through which personalized collagen-based therapies could potentially intercept inflammation and curb disease progression. Targeted modulation carries opportunities for treating Goodpasture syndrome and informing novel interventions for other disorders of collagen deterioration like joint disease [38]. This research establishes collagen as the epicenter of pathology in a model immunological illness and cements its expanding therapeutic possibility across inflammatory states.

### 1.8.2. Colostrum Effects on Autoimmune Diseases

Hung researched a collagen-induced arthritis mouse model to explore the potential of hyperimmune bovine colostrum

in alleviating rheumatoid arthritis symptoms [39]. The study focused on bovine colostrum derived from immunized cows, recognized for providing additional immunoglobulins and bioactive compounds to enhance immune function. Mice underwent a 49-day regimen of colostrum from immunized cows at varying doses (5 or 10 mg/mouse per day) or control groups in the collagen-induced arthritis DBA/1J murine model. The colostrum-fed groups exhibited significantly reduced total swelling scores and lower levels of collagen-specific antibody (IgG2a), total IgG, and inflammatory cytokines, including tumor necrosis factor, IL-2, IL-6, and IFN- [39]. This study sheds light on the potential anti-inflammatory properties of hyperimmune bovine colostrum, emphasizing the exploration of natural sources to enhance immune function, particularly in the elderly. These findings contribute to the ongoing efforts to identify alternative and sustainable approaches for improving immunocompetence and mitigating autoimmune disorders, underscoring the therapeutic potential of bovine colostrum.

## 1.9. Collagen & Colostrum on Gastrointestinal Disorders: Research Studies

### 1.9.1. Collagen Effects on Gastrointestinal Disorders

Chen delved into the potential of collagen peptides derived from Alaska pollock skin, along with distinct hydrolytic fractions—HCP (6 kDa retentate), MCP (3 kDa retentate), and LCP (3 kDa permeate)—in addressing TNF-induced barrier dysfunction within Caco-2 cell monolayers [40]. This exploration aimed to provide insights into their relevance in the context of inflammatory bowel disease (IBD) and the development of organ failure. The study's findings unveiled that collagen and its peptides, particularly LCP, exhibited a significant capacity to mitigate TNF-induced barrier dysfunction compared to control conditions. Notably, pre-incubation with LCP demonstrated a noteworthy ability to alleviate the breakdown of tight junction proteins induced by TNF- $\alpha$ . This effect extended to suppressing myosin light chain (MLC) phosphorylation and inhibiting myosin light chain kinase (MLCK) expression. The research shed light on LCP's impact on NF-B and Elk-1 activation, elucidating potential mechanisms underlying the observed effects [40].

Examining the repercussions of collagen peptides (CP) supplementation on exercise induced gastrointestinal (GI) stress, the study conducted by Taylor delves into a pivotal domain within sports nutrition. The research aimed to elucidate whether consuming CP seven days preceding and 45 minutes before exercise could mitigate exercise-induced GI stress during a 70-minute run at 70–90% of maximal oxygen consumption (O<sub>2</sub>max). Employing a randomized, crossover design involving 20 participants, the investigation scrutinizes various crucial biomarkers. Notably, the study's findings suggest that CP supplementation did not induce alterations in exercise-induced changes in inflammation, GI integrity, or subjective GI symptoms. While LPS levels were observed to be higher in the control group two hours post-exercise, the research suggests that additional investigations may be warranted to comprehensively grasp the nuanced effects of collagen peptides on exercise-induced GI stress [41].

### 1.9.2. Colostrum Effects on Gastrointestinal Disorders

Menchetti explored using bovine colostrum as a nutritional intervention in a mouse model of colitis induced by 2,4,6-trinitrobenzene sulfonic acid (TNBS) administration [42]. Compared to controls, mice pretreated with oral bovine colostrum showed reduced body weight loss and decreased expression of multiple inflammatory markers, including Toll-like receptor 4, Interleukin 1 $\beta$ , Interleukin 8 and Interleukin 10 after colitis induction [42]. These outcomes indicate bovine colostrum may help curb acute inflammation and preserve tissue integrity. While an effective therapeutic regimen still requires refinement, this investigation provides promising evidence that bovine colostrum could support the management of inflammatory bowel diseases like colitis through regulatory immune effects [42]. Ongoing research aims to further substantiate the gastrointestinal benefits of bovine colostrum supplementation and elucidate mechanisms conferring protection.

## 2. Conclusion

In exploring collagen and colostrum, these bioactive compounds emerge as versatile and potent contributors to holistic health. Collagen, available from various sources, addresses age-related declines, promoting skin health, joint relief, and overall wellbeing. Simultaneously, colostrum, derived from the first milk of cows, offers immune-boosting elements and gastrointestinal support. Both supplements demonstrate anti-aging effects, influencing autoimmune diseases positively, showcasing potential relief for gastrointestinal disorders, and contributing to skin repair. This journey through collagen and colostrum encapsulates a narrative of resilience and regeneration, highlighting the symbiotic relationship between science, nature, and the pursuit of comprehensive wellbeing.

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