GPS

SKIN & COAT CARE

A SCIENTIFIC SUPPORT PAPER

75% of the pet owners who participated in the feeding trials reported seeing improvements in their dogs' skin and coat conditions.

Vista Pet (2021) Study Report R20DG1218 Dry Dog Food Study

PEPTIDE+

THE POWER OF PEPTIDES

CONTENTS

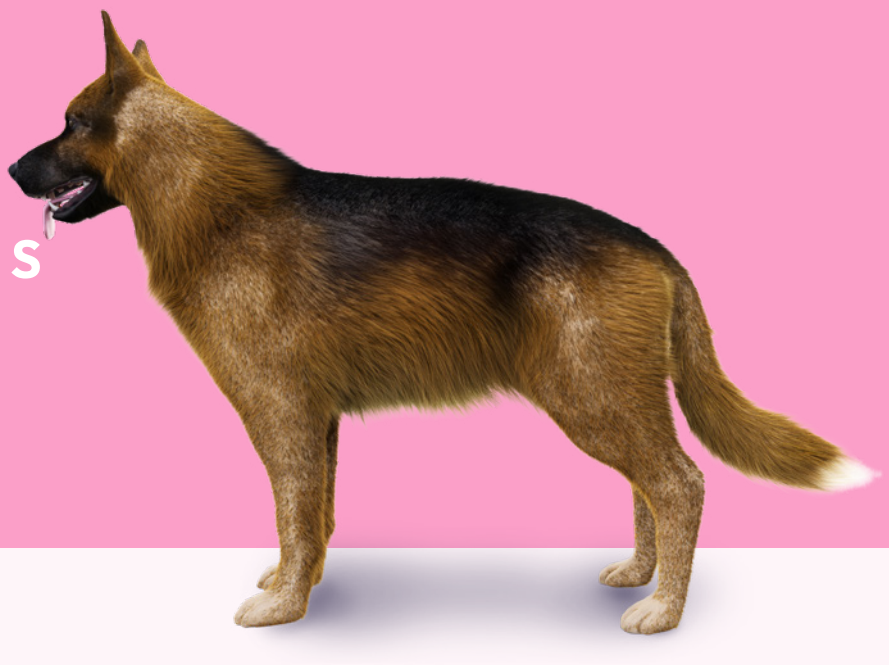
WHY IS SKIN AND COAT HEALTH IMPORTANT?

A dog's skin and coat can be perceived as an immediate indicator of their health and wellbeing. A healthy coat is described as soft and shiny, while healthy skin should be smooth, with no breaks in the surface. Canine dermatological disorders have been recognised by veterinary surgeons to be a major issue in small animal practice, with an estimated 15-30% of the dog population worldwide affected by skin conditions (Scott et al., 2001).

The maintenance of a healthy skin and coat is vital to the maintenance of a healthy body. Skin and coat conditions can be complex and can occur due to a number of factors including, but not limited to, stress or illness, hormone imbalances, metabolic problems, parasites (both internal and external) and allergies.

Signs of these issues can include red, itchy patches of skin, excessive licking, biting and scratching and in some cases, hair loss, which may cause further irritability and lead to stress for both the pet and its owner.

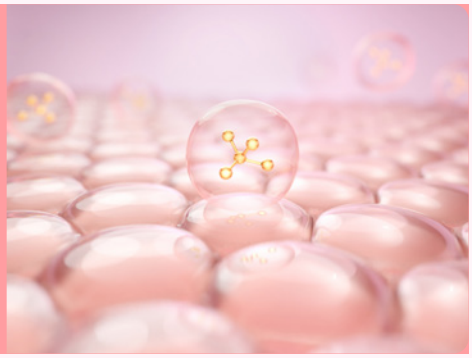
STRUCTURE AND FUNCTIONS OF THE SKIN AND COAT



Both the skin and coat are integral to providing a physical barrier that protects a dog from external objects as well as physical, chemical and environmental stressors that may cause harm internally.

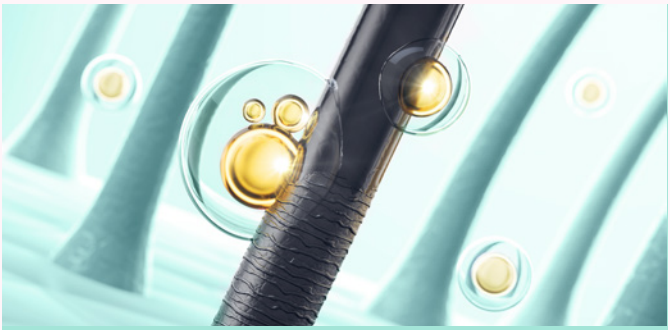
A PHYSICAL BARRIER & MOISTURE RETENTION

As well as providing a physical barrier to help keep out pathogenic microorganisms and other harmful substances, the skin also helps to keep moisture in, which is important for skin hydration status and the integrity of the skin barrier function.



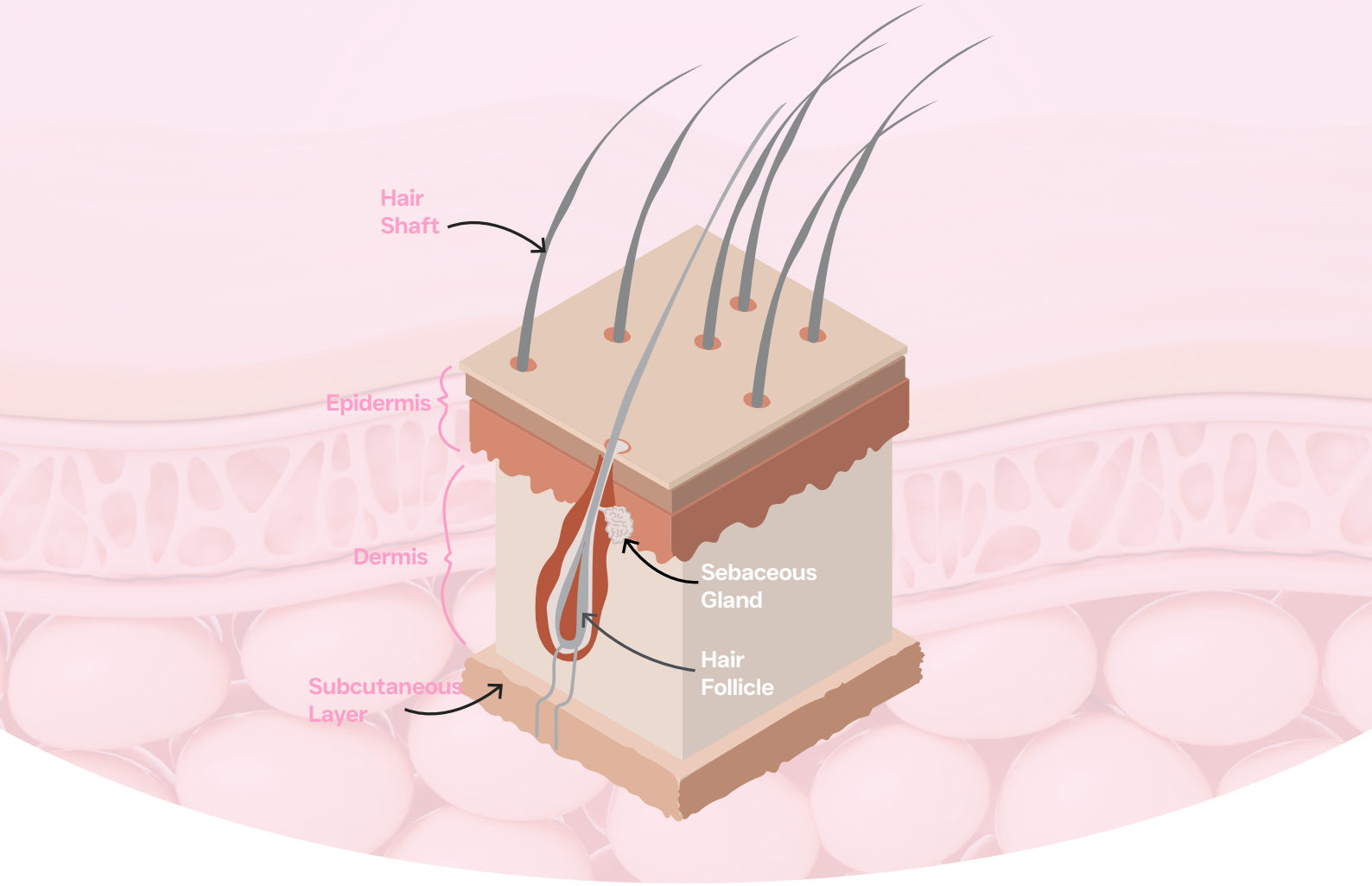
THE COAT

The hair coat covers the outer surface of the skin, and the type and length of hairs varies widely among dog breeds. The coat provides an insulating layer between the dog's skin and the external environment, e.g. helping to maintain warmth in cold weather and providing the skin with some protection against contact with hot or cold surfaces and physical abrasion.



KERATIN

Hair is mainly composed of keratin proteins, which provide strength, elasticity and structural integrity to the hair fibre. Hair keratin also plays a role in moisture retention. The outermost layer of the hair (cuticle) consists of overlapping scales formed by keratinised cells. This protective layer helps prevent excessive water loss from the hair shaft while also protecting against external damage such as heat, ultraviolet radiation and chemicals/environmental pollutants.



WHAT IS THE STRUCTURE OF THE SKIN, AND WHY IS IT IMPORTANT?

The skin is structured in three main layers: the epidermis, dermis and hypodermis (or subcutaneous layer) The hypodermis is the deepest layer and consists mainly of fat cells held in connective tissue. The fat in this layer provides some padding to protect underlying tissues, provides insulation to help regulate body temperature and serves as a store of energy.

The **dermis** is the middle and thickest layer of the skin, which contains hair follicles, sebaceous (oil) glands, sensory nerves and blood vessels that deliver nutrients to skin cells via the blood. Cells in this layer, known as **fibroblasts**, synthesise **collagen** and **elastin**, which are two important proteins for healthy skin, providing both flexibility and strength.
The **epidermis** is the outermost layer of the skin and is made up of layers of cells called **keratinocytes**. New keratinocytes form and proliferate in the basal layer of the epidermis and slowly migrate up towards the outer surface of the epidermis. Once the keratinocytes reach the skin surface, they are gradually shed and replaced by new cells from below.

Keratinocytes produce keratin and other proteins, and they synthesise and accumulate lipids. Keratins represent the principal structural protein of the skin epidermis. The best-known function of keratin and keratin filaments is to provide a scaffold, through self-bundling and by forming thicker strands, for epithelial cells to withstand the physical/mechanical stress they often endure (Bragulla & Homberger, 2009).

The outermost layer of the epidermis, known as the stratum corneum, consists of an array of keratinised cells embedded in a lipid matrix (ceramides, cholesterol and fatty acids), which provides a barrier that protects the underlying tissue against potentially harmful substances from the environment and also limits water loss through the skin (Wertz, 2018).

Since the skin and coat play such important roles in protecting dogs from day-to-day physical and environmental stressors, it is obvious to see why it is essential to maintain the health of the skin and ensure the coat is kept in optimal condition.

The Peptide+ Skin & Coat recipe has been developed with specific processes and ingredients to support skin and coat health and maintain healthy coat characteristics.

THE IMPORTANCE OF BIOAVAILABLE AND BIOACTIVE PEPTIDES TO SUPPORT SKIN HEALTH

Proteins are large molecules made up of individual 'building blocks' called amino acids.

After eating food containing protein, the process of protein digestion begins as enzymes released in different parts of the gastrointestinal tract break it down into protein hydrolysates: short chains of amino acids called peptides and free amino acids.

This enables these building blocks to be absorbed into the body, where they can be recombined to build new proteins (such as skin, hair, muscle, antibodies, enzymes, hormones, etc.).

Historically, it was believed that only free amino acids were absorbed from the gastrointestinal tract by specific amino acid transporters, whereas it is now recognised that the majority of amino acids are absorbed as di- and tri-peptides by the broad-specificity peptide transporter PepT1 (Fei et al., 1994).

Di-peptides and tri-peptides are most abundant in the molecular weight range of 0.2–0.25 kDa and 0.3–0.4 kDa, respectively. Research has shown that the intake of proteins that have already been hydrolysed are more readily absorbed from the digestive tract than intact protein and even individual amino acids (Maebuchi et al., 2007; Zhao et al., 1997).

Collagen

Collagen is an abundant structural protein found exclusively in animals, especially in the skin, bones, and connective tissues.

Type I and III collagen is abundant in the skin's dermis layer, providing structural support and elasticity to maintain the firmness and suppleness of this organ.

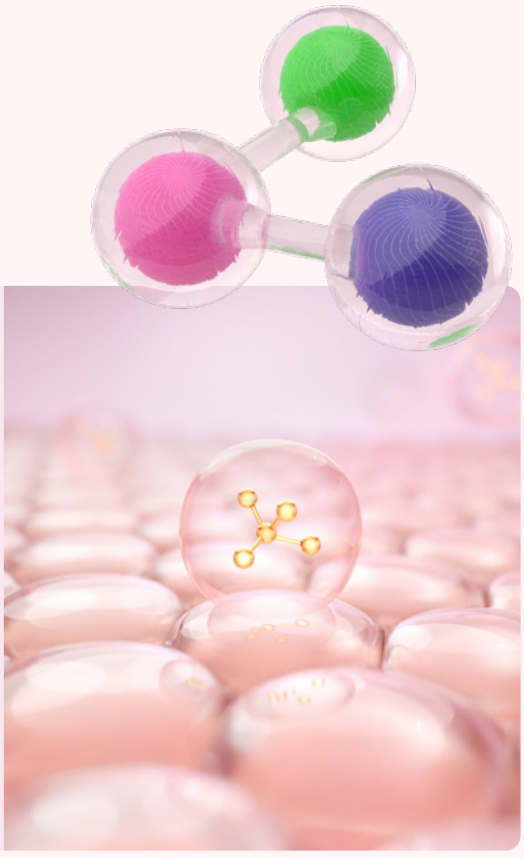
In the body, collagen plays a significant role in repairing tissue and healing wounds.

Hydrolysing the protein collagen to create lower molecular weight collagen peptides increases its digestibility and bioavailability.

In addition, research studies have shown that dietary supplementation with collagen peptides has numerous beneficial effects on skin health, e.g.

- Increased skin hydration
- Increased dermis thickness
- Increased skin collagen content
- Increased skin elasticity

Ingestion of fish collagen peptides were shown to increase hydroxyproline (a quantitative measure of total collagen), hyaluronic acid and moisture content of skin exposed to UV radiation (Song et al., 2017a) as well as protect against some of the damaging effects of repeated UV exposure such as decreased skin hydration, hyperplasia of the epidermis and decreased levels of collagen type I in the skin (Tanka et al., 2009).



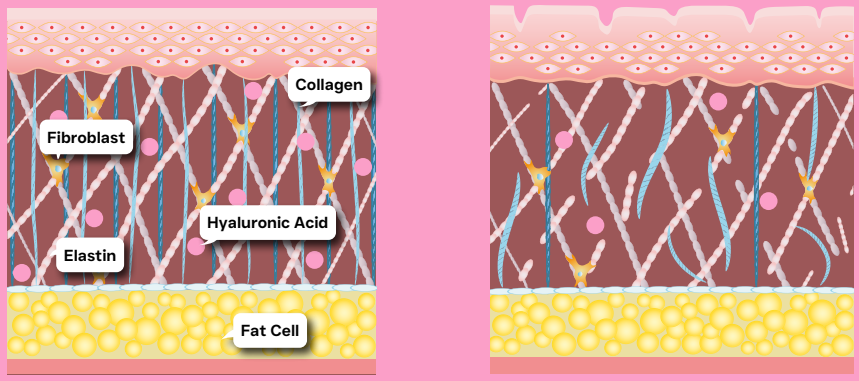
PEPTIDE+ SKIN AND COAT DIET HELPS THE BODY GET THE BUILDING BLOCKS EASIER

Hydrolysed proteins have been shown to be more readily absorbed from the digestive tract than intact proteins and even individual amino acids.

The hydrolysed protein in the Peptide+ Skin & Coat recipe ensures an ideal supply of amino acid building blocks to synthesise key proteins such as keratin, collagen and elastin to maintain and repair the skin and its barrier function. Collagen also plays a significant role in repairing tissue, improving pruritus and healing wounds.

COLLAGEN FOR AGEING SKIN

Animal collagen peptides increase skin collagen content and the ratio of type I to type III collagen, which is associated with improved skin firmness and structure (Song et al., 2017b). **In models of chronologically aged skin, marine collagen peptides increased the dermis thickness and total collagen content in the skin** (Liang et al., 2010).



The increased dermal thickness and collagen content seen in the above studies may have been due to a stimulatory effect of collagen peptides on dermal fibroblast proliferation (Ohara et al., 2010). More recently, collagen peptides were shown to speed up the rate of wound closure in fibroblasts and keratinocytes in vitro, mediated by enhanced cellular proliferation (Mistry et al., 2021).

The skin barrier function is important when considering skin health. Damaged skin may be more easily sensitised by environmental allergens it comes into contact with, particularly in susceptible dogs. **A healthy barrier keeps the skin hydrated and prevents skin penetration by allergenic and microbial proteins.**

CANINE ATOPIC DERMATITIS (CAD)

Canine atopic dermatitis (CAD) manifests in susceptible dogs as a pruritic inflammatory condition resulting from an allergic response to an allergen(s) in the dogs' environment (e.g. dust and storage mites, pollen and mould spores). **Pruritus** is an unpleasant sensation that provokes the need or desire to scratch and, therefore, can commonly be referred to as severe itching. Pruritus is commonly associated with primary skin disorders and dermatological problems, including atopic dermatitis.

There is increasing recognition of the **important role that skin barrier function plays in conditions such as CAD**. This may be because damaged or impaired skin (caused through inflammation, itching or both) may be more prone to absorb what it encounters in the environment and, therefore, more susceptible to developing an allergic response (Marsella et al., 2011; Marsella 2021).

Using cultured human epidermal keratinocytes, stimulated in a way to resemble atopic dermatitis-like inflammation, **collagen tri-peptides** were shown to suppress the expression of specific inflammatory chemokines, such as thymus- and activation-regulated chemokine (TARC), macrophage-derived chemokine (MDC), and thymic stromal lymphopoietin (TSLP) (Hakuta et al., 2017).

Furthermore, characteristics of skin barrier disruption were assessed in a mouse model of dry skin. This included observations of increased trans-epidermal water loss (TEWL), pruritus, and scratching. Oral administration of collagen tri-peptides **significantly decreased TEWL and suppressed scratching behaviour,** indicating that **collagen tri-peptides administration improves dry skin and pruritus** (Okawa et al., 2012).

THE IMPORTANCE OF PEPTIDES FOR DIETARY ALLERGY MANAGEMENT

A food allergy is an inappropriate immune response to a normal food or ingredient (e.g. a protein in the food), which can result in dermatological (e.g. red, itchy skin) and/or gastrointestinal (e.g. diarrhoea, vomiting) signs in dogs (Verlinden et al., 2006).

The ability of a protein to induce an immune-mediated hypersensitivity (allergic) response is dependent on the size and structure of the protein.

By using controlled enzymatic hydrolysis, proteins can be partially or extensively broken down into smaller peptides that can be too small to be detected by the immune system, meaning the hydrolysed proteins have a lower allergenic potential, and therefore making them beneficial for dogs with an allergy to intact dietary protein. Ensuring that a hydrolysate has no peptides ≥ 3 kDa or even 1 kDa would ensure the greatest chance of eliminating any residual allergens (Cave, 2006).

The effectiveness of protein hydrolysis as a means to help reduce food-related allergic reactions has been shown in a study of 12 dogs with adverse skin reactions after consumption of chicken meat; when fed with chicken peptides, all but one showed a reduction in clinical scores (Ricci et al., 2010).

WHAT MAKES THE PEPTIDE+ SKIN & COAT DIET SO UNIQUE?

The development and formulation of the Peptide+ Skin and Coat recipe has centred around the 'Power of Peptides' using the latest Freshtrusion HDP technology.

HDP freshtrusion HIGHLY DIGESTIBLE PROTEIN

Freshtrusion® HDP (Highly Digestible Protein) is the unique process of cooking fresh meat and fish ingredients in the presence of a natural enzyme, which digests (hydrolyses) the protein into a mixture of peptides and free amino acids.

This increases the digestibility and bioavailability of the protein, improves palatability and reduces the allergenic potential of the protein, through what we like to refer it as GA's Goldilocks Principle:

THE GOLDILOCKS PRINCIPLE

Instinctively, it would be assumed that intact protein would be best for a dog to digest as it contains all the nutritional elements together as one. Similarly, individual amino acids, broken down as small as possible, might be considered to be much easier to absorb. However, it has been proven in research studies that the ideal digestibility and absorption rates occur in small-chain peptides (≤ 3kDa). We like to refer to this as the 'Goldilocks principle'.

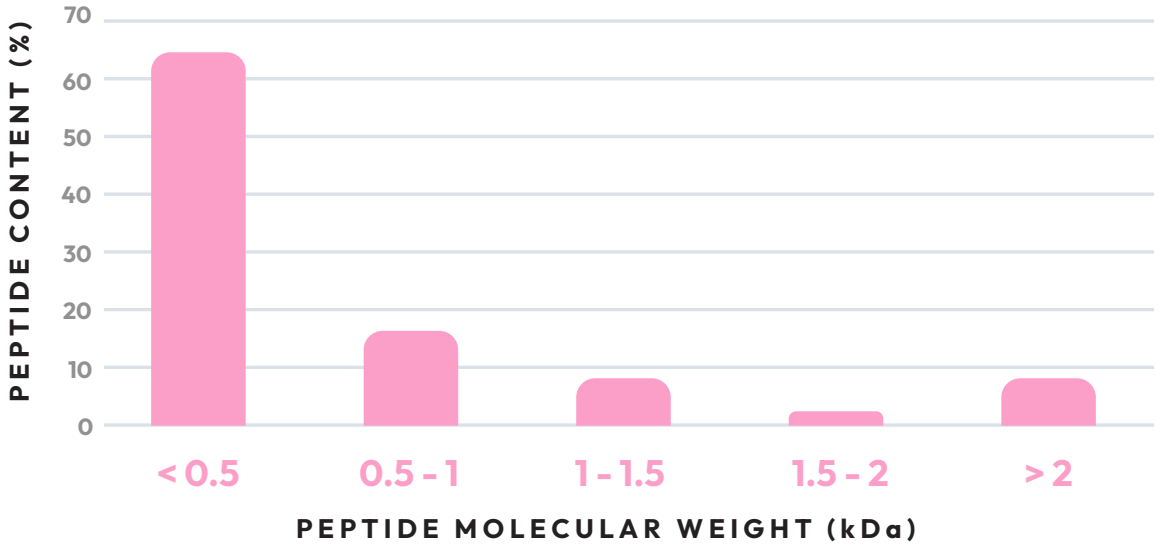
INTACT PROTEIN

DI AND TRI-PEPTIDES

SINGULAR AMINO ACIDS

TOO BIG JUST RIGHT TOO LITTLE

PEPTIDE+ SKIN & COAT RECIPE: PEPTIDE CONTENT (%)



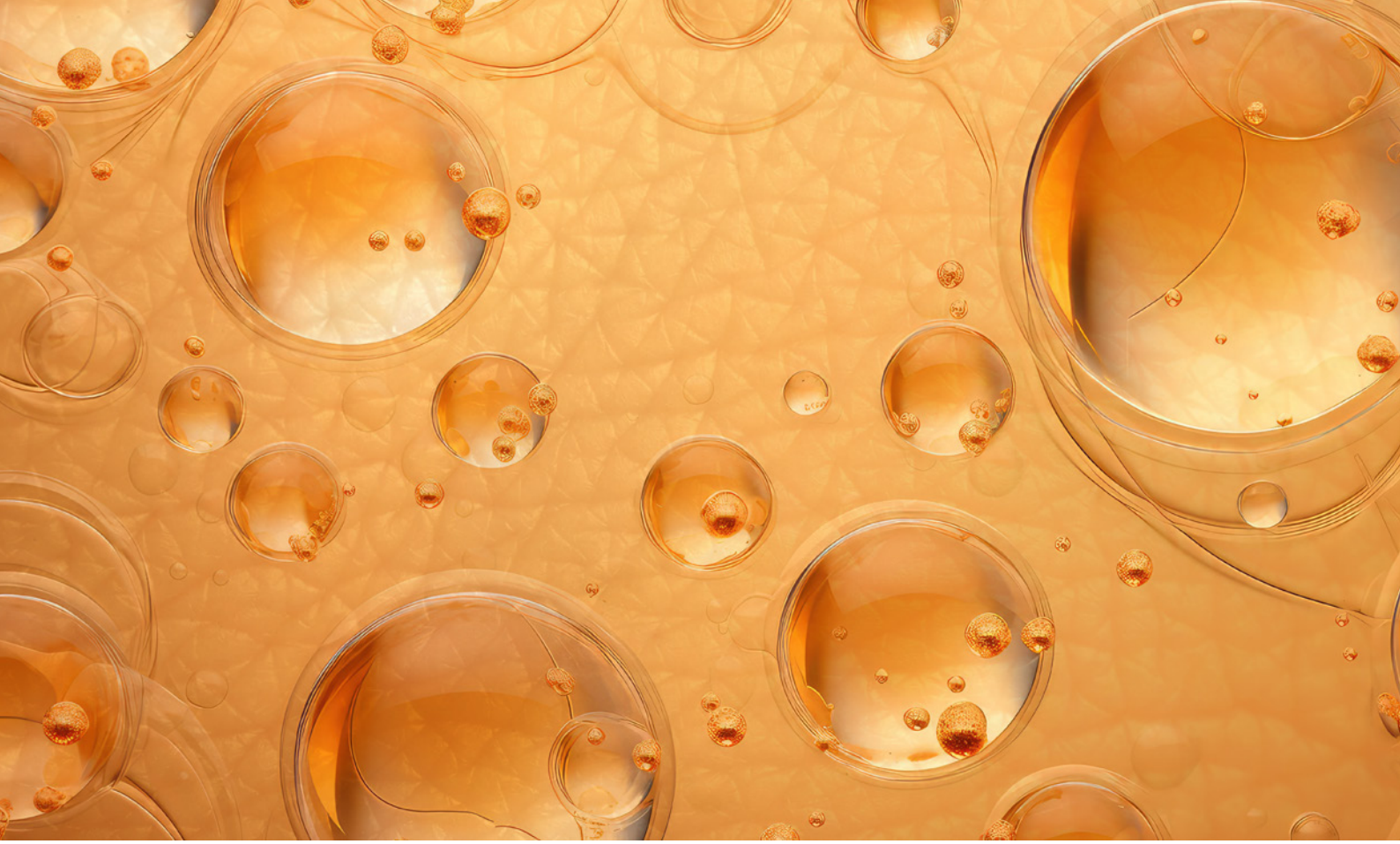
A minimum of 64% of the peptides in this recipe are <0.5 kDa, coupled with just 8% of the peptides >2 kDa.

The results show that the majority of peptides in the finished kibble fall into the < 0.5 kDa category, which includes the highly digestible and nutritionally beneficial di-peptides and tri-peptides, achieving the Goldilocks Principle.

THE POWER OF THE PEPTIDES FOR SKIN & COAT

- ✓ **Increases the digestibility and bioavailability of the protein**
- ✓ **Improves the palatability of the recipe**
- ✓ **Ensures an ideal supply of amino acid building blocks required for the synthesis of key proteins such as keratin (in hair shafts and skin epidermis), collagen and elastin (in skin dermis layer)**
- ✓ **Helps to maintain and repair the skin and its barrier function.**
- ✓ **Increases dermis thickness, skin hydration, elasticity, firmness and structure**
- ✓ **Reduces the allergenic potential of the protein to help reduce food-related allergic reactions**

In addition to the inclusion of hydrolysed protein, the Peptide+ Skin & Coat diet includes a blend of oils to help deliver optimal levels of omega-3 and omega-6 fatty acids that have been shown to have beneficial effects on skin and coat health in dogs.



WHAT IS THE LINK BETWEEN OMEGA-3 & 6 AND SKIN AND COAT HEALTH?

Historically, animals fed a very low-fat diet were found to develop dry, thickened, scaly and/or peeling skin as well as coarse, dry hair and dull coat that could be resolved by incorporation of **linoleic acid** (LA, an omega-6 fatty acid) in the diet (Burr & Burr, 1930; Wiese et al., 1966; Elias et al., 1980).

Since animals cannot make LA it must be provided in the diet and is therefore considered as an essential fatty acid. The introduction of a minimum dietary recommendation for LA was, in part, to prevent the development of abnormal skin lesions and poor coat conditions.

Similarly, the 18-carbon omega-3 fatty acid, α-linolenic acid (ALA), cannot be synthesised by animals, although it is not considered as an essential fatty acid for adult dogs.

Nonetheless, omega-3 fatty acids are considered important to maintain healthy skin and may be particularly beneficial in pruritic/ inflammatory skin conditions.

In epidermal keratinocytes, LA is incorporated into ceramides (Elias et al., 2014), which are essential for the structure and correct functioning of the epidermal water barrier.

Other **omega-6 and omega-3 fatty acids** are also incorporated into the phospholipid portion of cell membranes, where they act as precursors for eicosanoids (e.g. prostaglandins and leukotrienes) that are **important for modulating normal physiological skin processes** as well as playing an **important role in immune and inflammatory reactions**.

Dietary intake of different fatty acids will influence the fatty acid composition of cell membranes. Since different fatty acids give rise to different eicosanoids - some of which may promote inflammatory processes while others **exhibit anti-inflammatory effects** - the aim is to enrich cell membranes with fatty acids that give rise to anti-inflammatory mediators.

Of the omega-6 fatty acids, γ-linolenic acid (GLA) is converted to dihomo-γ-linolenic acid (DGLA), which gives rise to anti-inflammatory eicosanoids (Ziboh et al., 2000).

In contrast, the eicosanoids that are produced from arachidonic acid (AA) are pro-inflammatory.

For the omega-3 family, the long-chain polyunsaturated fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) give rise to eicosanoids that are associated with **anti-inflammatory properties**.

WHY A BLEND OF OILS?

Essential fatty acids have an integral role in skin and coat health. The Peptide+ Skin and Coat recipe contains a **blend of oils, including borage oil, salmon oil and soya oil**, to ensure the supply of LA, GLA, ALA, EPA and DHA at levels that have been shown to have beneficial effects on skin and coat health in dogs.

For the omega-3 family, the long-chain polyunsaturated fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) give rise to eicosanoids that are associated with anti-inflammatory properties.

WHY BORAGE OIL?

Borage oil is an interesting consideration due to its high GLA content, which is reportedly **2 to 3 times higher than evening primrose oil** (Barre, 2001; Gunstone, 1992).

In a study of dogs with atopy, supplementation with a combination of borage oil and fish oil resulted in a **significant decrease in erythema and self-trauma** and their total score was significantly decreased compared to a control group given an olive oil supplement (Harvey, 1999).

These results support the idea that a mixture of both borage oil and fish oil has the potential to offer beneficial effects on canine atopy.

WHY SALMON OIL?

Fish oil, especially salmon oil, is a rich, concentrated source of omega-3 fatty acids, namely EPA and DHA.

By consuming foods that contain high levels of omega-3 fatty acids, these are incorporated into the fat of the salmon, resulting in oil that is enriched in EPA and DHA.

In dogs with idiopathic pruritus, confirmed atopy, or flea allergy supplementation with fish oil containing high levels of EPA and DHA was shown to result in **significant improvements in pruritus, alopecia, self-trauma and coat character**, whereas none of these parameters were improved in response to supplementation with corn oil (containing LA and DGLA) (Logas & Kunkle, 1994).

In another study, clinical scores of pruritus in dogs with **atopic dermatitis were significantly improved** in the group receiving a supplement of EPA + DHA compared to dogs in the control group given a mineral oil supplement (Mueller et al., 2004).

These studies indicate the effectiveness of fish oil, rich in EPA and DHA, as an alternative anti-inflammatory approach to help with the management of pruritic skin disease in dogs.

The Peptide+ skin and coat recipe also contains dried, whole-cell algae (Schizochytrium sp.), which is a rich source of DHA.

WHY SOYA OIL?

Soya oil is a rich source of omega-6 linoleic acid (LA) and omega-3 α-linolenic acid (ALA).

As an essential component of ceramides, LA is involved in the maintenance of the transdermal water barrier of the epidermis.

Ceramides are the major lipid component of the epidermis, in which LA and protein-esterified ceramides are crucial in **maintaining the structure and integrity of the skin barrier** (Rabionet, 2014).

Lipid components such as this enhance skin cell cohesion, which allows for an effective water barrier of the epidermis.

One study found that dietary supplementation with ALA fed to normal healthy dogs **significantly reduced transepidermal water loss and significantly increased skin condition score** (Rees et al., 2001).

In another study, clinical scores of pruritus in dogs with atopic dermatitis were significantly improved in the group receiving a supplement of ALA + LA compared to dogs in the control group given a mineral oil supplement (Mueller et al., 2004).

The exact mechanism for this beneficial effect is unknown – it may be that, like LA, ALA is also incorporated into skin ceramides, or it may be that increased dietary levels of ALA 'spares' LA from further metabolism, allowing an increased supply of LA for ceramide production.

WHAT ARE THE RESULTS?

Vista Pets, on behalf of GA, conducted a feeding study using the Peptide+ Skin and Coat recipe to assess the benefits of the formula of dry dog food on the health of the dogs' skin and coat, as well as the palatability of this dog food.

Results from skin and coat evaluations show **a benefit perceived by the pet owners on all measured criteria**. The benefits became visible and significant by the end of the second week and increased significantly between the second and fourth week of the study.

Pet owners noted coats to have qualities including **increased gloss, softness and shine**. The results are also indicative of increased skin softness and a decrease in hair loss and itching behaviour.

Skin redness, skin oiliness, skin odour and dandruff also show improvements, but to a lesser extent compared to the other criteria. The final evaluations of the study established that feeding the **Peptide+ Skin and Coat dry food recipe had strong beneficial effects on the conditions of the skin and coat as well as a high level of satisfaction of the pet owners**.

75% of the pet owners declared that they had seen improvements in their dog's skin and coat condition, and 84% declared that they were overall very satisfied with the test diet.

If you'd like to know more about Peptide+ or the study, please contact us:

nutrition@ga-petfoodpartners.co.uk

REFERENCES

Barre, D.E. (2001). Potential of evening primrose, borage, blackcurrant, and fungal oils in human health. *Annals of Nutrition and Metabolism*, 45(2), 47–57.

Bragulla, H.H., & Homberger, D.G. (2009). Structure and functions of keratin proteins in simple, stratified, keratinised and cornified epithelia. *Journal of Anatomy*, 214(4), 516–559.

Burr, G.O., & Burr, M.M. (1930). On the nature and role of the fatty acids essential in nutrition. *Journal of Biological Chemistry*, 86(2), 587–621.

Cave, N.J. (2006). Hydrolysed protein diets for dogs and cats. *Veterinary Clinics of North America: Small Animal Practice*, 36(6), 1251–1268.

Elias, P.M., Brown, B.E., & Ziboh, V.A. (1980). The permeability barrier in essential fatty acid deficiency: Evidence for a direct role for linoleic acid in barrier function. *Journal of Investigative Dermatology*, 74(4), 230–233.

Fei, Y.J., Kanai, Y., Nussberger, S., Ganapathy, V., Leibach, F.H., Romero, M.F., Singh, S.K., Boron, W.F., & Hediger, M.A. (1994). Expression cloning of a mammalian proton-coupled oligopeptide transporter. *Nature*, 368(6471), 563–566.

Gunstone, F.D. (1992). Gamma-linolenic acid—occurrence and physical and chemical properties. *Progress in Lipid Research*, 31(2), 145–161.

Hakuta, A., Yamaguchi, Y., Okawa, T., Yamamoto, S., Sakai, Y., & Aihara, M. (2017). Anti-inflammatory effect of collagen tripeptide in atopic dermatitis. *Journal of Dermatological Science*, 88(3), 357–364.

Hanaoka, K., Kawakami, K., Watanabe, H., & Kato, T. (2019). Characterisation of proteins and peptides molecular weight during the manufacturing of pet food palatants. Retrieved from https://www.diana-petfood.com/emea-en/publications/

Harvey, R.G. (1999). A blinded, placebo-controlled study of the efficacy of borage seed oil and fish oil in the management of canine atopy. *Veterinary Record*, 144(15), 405–407.

Liang, J., Pei, X., Zhang, Z., Wang, N., Wang, J., & Li, Y. (2010). The protective effects of long-term oral administration of marine collagen hydrolysate from chum salmon on collagen matrix homeostasis in the chronologically aged skin of Sprague–Dawley male rats. *Journal of Food Science*, 75(8), H230–H238. https://doi.org/10.1111/j.1750-3841.2010.01782.x

Logas, D., & Kunkle, G.A. (1994). Double-blinded crossover study with marine oil supplementation containing high-dose eicosapentaenoic acid for the treatment of canine pruritic skin disease. *Veterinary Dermatology*, 5(3), 99–104.

Maebuchi, M., Samoto, M., Kohno, M., Ito, R., Koikeda, T., Hirotsuka, M., & Nakano, Y. (2007). Improvement in the intestinal absorption of soy protein by enzymatic digestion to oligopeptide in healthy adult men. *Food Science and Technology Research*, 13(1), 45–53.

Marsella, R., Olivry, T., & Carlotti, D.N. (2011). Current evidence of skin barrier dysfunction in human and canine atopic dermatitis. *Veterinary Dermatology*, 22(3), 239–248.

Marsella, R. (2021). Atopic dermatitis in domestic animals: What our current understanding is and how this applies to clinical practice. *Veterinary Sciences*, 8(7), 124. https://doi.org/10.3390/vetsci8070124

Mistry, K., van der Steen, B., Clifford, T., van Holthoon, F., Kleinnijenhuis, A., Prawitt, J., Labus, M., Vanhoecke, B., Lovat, P.E., & McConnell, A. (2021). Potentiating cutaneous wound healing in young and aged skin with nutraceutical collagen peptides. *Clinical and Experimental Dermatology*, 46(1), 109–117.

Mueller, R.S., Fieseler, K.V., Fettman, M.J., Zabel, S., Rosychuk, R.A.W., Greenwalt, T.L., & Ogilvie, G.K. (2004). Effect of omega-3 fatty acids on canine atopic dermatitis. *Journal of Small Animal Practice*, 45(6), 293–297.

Ohara, H., Ichikawa, S., Matsumoto, H., Akiyama, M., Fujimoto, N., Kobayashi, T., & Tajima, S. (2010). Collagen-derived dipeptide, proline-hydroxyproline, stimulates cell proliferation and hyaluronic acid synthesis in cultured human dermal fibroblasts. *Journal of Dermatology,* 37(4), 330–338.

Okawa, T., Yamaguchi, Y., Takada, S., Sakai, Y., Numata, N., Nakamura, F., Nagashima, Y., Ikezawa, Z., & Aihara, M. (2012). Oral administration of collagen tripeptide improves dryness and pruritus in the acetone-induced dry skin model. *Journal of Dermatological Science*, 66(2), 136–143. https://doi.org/10.1016/j.jdermsci.2012.02.004

Rabionet, M., Gorgas, K., & Sandhoff, R. (2014). Ceramide synthesis in the epidermis. Biochimica et Biophysica Acta (BBA) - *Molecular and Cell Biology of Lipids*, 1841(3), 422–434.

Ricci, R., Hammerberg, B., Paps, J., Contiero, B., & Jackson, H. (2010). A comparison of the clinical manifestations of feeding whole and hydrolysed chicken to dogs with hypersensitivity to the native protein. *Veterinary Dermatology*, 21(4), 358–366.

Scott, D.W., & Paradis, M. (1990). A survey of canine and feline skin disorders seen in a university practice: Small Animal Clinic, University of Montréal, Saint-Hyacinthe, Québec (1987–1988). *Canadian Veterinary Journal*, 31(12), 830–835.

Song, H., Meng, M., Cheng, X., Li, B., & Wang, C. (2017a). The effect of collagen hydrolysates from silver carp (Hypophthalmichthys molitrix) skin on UV-induced photoaging in mice: Molecular weight affects skin repair. *Food & Function*, 8(4), 1538–1546.

Song, H., Zhang, S., Zhang, L., & Li, B. (2017b). Effect of orally administered collagen peptides from bovine bone on skin aging in chronologically aged mice. *Nutrients*, 9(11), 1209.

Tanaka, M., Koyama, Y., & Nomura, Y. (2009). Effects of collagen peptide ingestion on UV-B-induced skin damage. *Bioscience, Biotechnology, and Biochemistry*, 73(4), 930–932.

Verlinden, A., Hesta, M., Millet, S., & Janssens, G.P.J. (2006). Food allergy in dogs and cats: A review. *Critical Reviews in Food Science and Nutrition*, 46(3), 259–273.

Wertz, P.W. (2018). Lipids and the permeability and antimicrobial barriers of the skin. *Journal of Lipids*, 2018, Article ID 5954034. https://doi.org/10.1155/2018/5954034

Zhao, X.-T., McCamish, M.A., Miller, R.H., Wang, L., & Lin, H.C. (1997). Intestinal transit and absorption of soy protein in dogs depend on load and degree of hydrolysis. *Journal of Nutrition*, 127(12), 2350–2356.

PEPTIDE+

THE POWER OF PEPTIDES