1982; Odle, 1997). The MCFAs are oxidized rapidly (Johnson et al. 1990) and provide a rapid source of energy (Bach and Babayan, 1982).

**MCTS** ARE DIGESTED, ABSORBED AND TRANSPORTED MORE **QUICKLY AND EASILY** THAN LCTS WHEN THERE IS A CONDITION REDUCING DIGESTION, ABSORPTION OR TRANSPORT AS IN THE CASE OF **GASTROINTESTINAL DISEASES.**

### » FISH OIL AS A SOURCE OF OMEGA 3

The effects of Omega 3 fatty acids (DHA-EPA) on the modulation of prostaglandin metabolism, reducing the tissue production of pro-inflammatory cytokines, and lowering levels of triglycerides and cholesterol have been widely demonstrated (Wander et al., 1997, Simopoulos, 2002). In some studies with human patients suffering from inflammatory bowel disease, an improvement of symptoms as well as a minimisation of steroid administration has been reported after use of an omega 3 supplement (Simopoulos, 2002).

## GLUTAMINE (GLN)

Glutamine is a nonessential amino acid and de novo synthesis takes place in skeletal muscle, but it is considered an essential amino acid under conditions of stress and inflammation due to an increase in its requirements (Yi et al, 2005; Bartell and Batal,2007). Glutamine (Gln) has important and unique metabolic functions. It is the main energy source of the small intestine enterocytes, lymphocytes, macrophages and fibroblasts (Bartell and Batal, 2007). It participates in the urea and Krebs cycles (Bertolo and Burrin, 2008). It is also a source of carbon and as a nitrogen donor it contributes to acid-base regulation and protects the body from high levels of ammonia (Bartell and Batal, 2007).

Glutamine protects the gut in various situations of stress (trauma, sepsis, burns, diarrhoea, chemotherapy) through diverse mechanisms:

- 1. Preserves the integrity of the intestinal barrier, contributing to the metabolism of the intestinal epithelium.
  - i. Increases the height, area and volume of the intestinal villi
  - ii. Improves the absorption of nutrients (Bartell and Batal, 2007).
- 2. Preserves the immune competence of the intestine:
  - i. Reduces the adhesion of bacteria to enterocytes (Yi et al., 2005)
  - ii. Increases the production of IgA (Bartell and Batal, 2007, Tian et al., 2009)
- 3. Improves transport of intestinal fluids and electrolytes, reducing the osmolarity of the intestinal lumen and diarrhoea (Coeffier et al., 2005).
- 4. Preserves glutathione in the gut under oxidative stress conditions

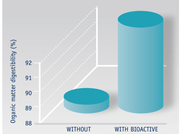
**GLUTAMINE** PROTECTS THE INTESTINE DURING PERIODS OF **STRESS,** PRESERVES THE **INTEGRITY OF THE INTESTINAL BARRIER,** IMPROVES FLUID ABSORPTION, REDUCES BACTERIAL ADHERENCE AND INCREASES ANTIOXIDANT CAPACITY OF THE INTESTINAL EPITHELIUM.

## EASILY DIGESTED NUTRIENTS (> 90% DIGESTIBILITY)

Easily digested foods are important for all gastrointestinal conditions, as they facilitate the absorption of nutrients in an altered intestinal epithelium and in unfavourable osmotic and secretory conditions .

High digestibility is achieved by selected proteins (bioactive plasma protein, hydrolysed soy protein), fat (MCTs) and cereals (especially rice, a source of rapidly and simple energy absorption) that are easily digestible and low in fibre.

**Figure 5.** The inclusion of bioactive plasma proteins and hydrolysed soy facilitates the digestion of food.




## PREBIOTICS (INULIN)

Prebiotics are non-digestible ingredients that benefit the host by stimulating growth and / or activating the metabolism of one or more bacteria beneficial for intestinal tract health. Prebiotics stimulate the growth of beneficial intestinal bacteria such as bifidobacteria and lactobacillus, which reduce the presence of pathogenic bacteria such as bacteroides, clostridia and coliforms (Gibson and Roberfroid, 1995; Kolida and Gibson, 2007). In dogs, prebiotics may reduce the concentration of putrefaction compounds (ammonia, amines, branched chain fatty acids, indoles, phenols, etc.) in faeces, improve gut health (because some of the catabolites of these proteins contribute to carcinogenesis of the colon and stress induced bowel disease) and the smell of the faeces(Swanson et al., 2002).

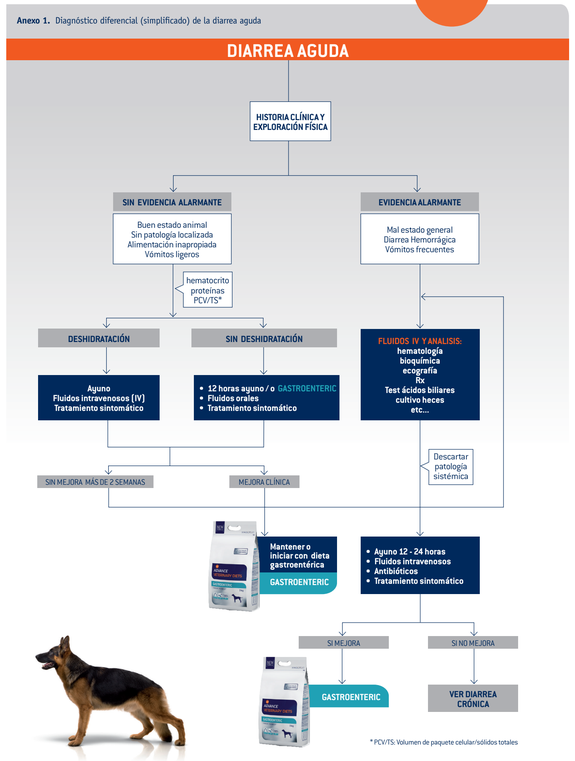
**PROBIOTICS** IMPROVE GUT HEALTH BY INCREASING THE PRESENCE OF **BENEFICIAL INTESTINAL BACTERIA** AND REDUCING THE **PATHOGENIC BACTERIA** THAT FAVOUR IBD, ARD AND DIARRHOEA.

In dogs suffering from diarrhoea that is responsive to antibiotics; while antibiotics cause a rapid but transient improvement, prebiotics act more slowly but continuously over their period of supply. Inulin was shown to attenuate inflammation from colitis, in a trial with rats (Leenen and Dieleman, 2007), and human studies have also shown beneficial effects in preventing and controlling infectious diarrhoea (Verlinden et al., 2006).





**Anexo 1.** Diagnóstico diferencial (simplificado) de la diarrea aguda




* PCV/TS: Volumen de paquete celular/sólidos totales





**Anexo 2.** Diagnóstico diferencial (simplificado) de la diarrea crónica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# Dietary management of canine gastrointestinal disorders

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**Table 1.** Main causes of vomiting and / or acute diarrhoea, serious and minor, in dogs

**» FOOD**
- **Sudden change of diet**
- **Inadequate food, poisoning by food waste**
- **Food intolerance, food sensitivity**
- **Toxins ...**

**» GASTROINTESTINAL INFLAMMATION**
- **Gastritis**
- **Parasites and protozoa** (Cryptosporidium spp, Giardia spp, Coccidia spp, worms, hookworms ...)
- **Bacteria (salmonellosis, colibacillosis, Clostridium spp, Campylobacter spp ...)**
- **Viruses** (canine distemper, parvovirus, enterovirus ...)
- **Ulcers ...**

**» FUNCTIONAL OR MECHANICAL ILEUS**
- **Gastric dilatation-volvulus**
- **Foreign body**
- **Electrolyte imbalance**

**» DRUGS AND TOXIC COMPOUNDS**
- **Caustic chemicals**
- **Some plant products**
- **Heavy metals**
- **Ethylene**
- **Pesticides** (carbamates, organophosphates)
- **Medications** (anti-inflammatory, antineoplastic antibiotics, digoxin, ...)

**» NEUROLOGICAL DISORDERS**

**» EXTRA-GASTROINTESTINAL DISORDERS**
- **Acute Pancreatitis**
- **Liver disease**
- **Renal disease**
- **Hypoadrenocorticism**
- **Pyometra**
- **Peritonitis**
- **Diabetic ketoacidosis**
- **Septicaema ...**

## INTRODUCTION

Gastrointestinal disorders, whose common symptoms in dogs are vomiting and diarrhoea, are one of the main reasons for small animal consultations at veterinarians. In most cases, these symptoms resolve following appropriate therapy, but in some cases, the causes may go on to threaten the life of the animal. This article summarizes the most common causes of canine gastrointestinal disorders and their dietary treatment.

## COMMON GASTROINTESTINAL DISEASES

### » 1. ACUTE GASTROENTERITIS

The wide variety of disorders that can cause acute gastrointestinal symptoms, their diagnosis and treatment are summarized in Table 1.

The stomach, small intestine and / or large intestine may be affected during acute gastrointestinal disorders. Traditionally, a temporary deprivation of food has been recommended to reduce the amount of nutrients that can cause osmotic diarrhoea through non- absorption in the intestine, along with a reduction of bacterial flora and lowered antigenic stimulation of the mucosa. The duration of food deprivation depends on the age, the severity of symptoms and whether there is vomiting or not, but is usually between 24 and 36 hours (up to 12 hours for the puppies).

After the period of fasting, food should be reintroduced. The provision of small but frequent meals (3-4 meals a day) minimises osmotic load on the weakened bowel. It is recommended to feed a highly digestible diet that is low in fat, with no wheat gluten and with an optimum profile of fatty acids and micronutrients (such as diet Gastroenteric Advance Canine), in order to minimize the secretory effect of malabsorption of fatty acids and bile acids.

Currently in human medicine it is considered that prolonged fasting can cause intestinal atrophy, with a loss of intestinal disaccharidase activity and increased gut permeability. The concepts of " food-based oral rehydration " and " nutrition during diarrhoea "are applied in medicine today. Investigating these theories, a study in dogs with parvoviral enteritis has shown that early enteral nutrition (12 hours after admission) allowed a clinical improvement and faster weight gain than with a fasting period up to 48 hours after cessation of vomiting. In the same context, a clinical trial shows that Affinity ADVANCE GASTROENTERIC DIET effectively resolved cases of dogs with acute diarrhoea without a prior fasting period. However, it must be kept in mind that dogs tend to suffer more frequently with osmotic diarrhoea and secretory conditions than people when extrapolating the concepts of nutrition and diarrhoea to veterinary medicine.

FOR **ACUTE** GASTROINTESTINAL CONDITIONS: IT IS RECOMMENDED TO FEED A **DIET LOW IN FAT** AND EASILY **DIGESTIBLE** WITH AN OPTIMAL PROFILE OF FATTY ACIDS AND MICRONUTRIENTS TO **MINIMIZE SECRETORY EFFECTS** FROM POOR ABSORPTION OF FATS AND BILE ACIDS IN THE INTESTINE.

## » 2. CHRONIC GASTROENTERITIS

Chronic diarrhoea and vomiting in a dog (continuous or intermittent symptoms for at least 7 days, usually for more than 3 weeks) are a common problem and frustrating for the owner and veterinarian. To obtain a diagnosis and appropriate treatment there must be comprehensive and detailed examination of the animal and its environment as these symptoms are common to several different diseases (as shown in Table 2).

### CANINE INFLAMMATORY ENTEROPATHIES

Chronic inflammatory enteropathies in dogs such as food sensitivity, antibiotic-responsive diarrhoea (ARD,) and inflammatory bowel disease (IBD) are common in small animals. There is growing evidence that these disorders have a common etiology, involving disturbances to innate and adaptive immune systems of gut-associated lymphoid tissue (GALT) and the enteric microflora. The different inflammatory enteropathies can be considered as different manifestations of the same disease, rather than specific entities.

The canine inflammatory enteropathies can be treated (with antibiotics in the case of the ARD, and immunosuppression in IBD), but conventional drugs have significant side effects. For this reason, a supplementary food therapy helps reduce the treatment time or intensity with which drugs are administered. The differential diagnosis of chronic enteropathies is summarized in Annex 2 (following the guidelines used as a reference in the Veterinary Hospital of the University of Bristol (UK). A routine clinical examination can rule out anatomical causes and infectious diarrhoea and empirically those cases which respond to antibiotics (ARD) can be discarded. Finally, once neoplasia and lymphangiectasia have been ruled out through an intestinal biopsy, there a heterogeneous group of patients is left, of which a small percentage will respond to an exclusion diet. We conclude that they are sensitive to a diet if a dog's condition relapses when exposed to the causative allergens. The remaining dogs that do not react to an exclusion diet can be considered to have an inflammatory intestinal disease of idiopathic origin. Historically dogs with idiopathic IBD have been treated with immunosuppressive drugs, but due to the side effects of long-term therapy it is recommended that a diet low in fat and to easy digest is used to allow a reduction or elimination of drug therapy.

CANINE CHRONIC INFLAMMATORY ENTEROPATHIES ARE FREQUENT AND HAVE A COMMON ETIOLOGY IMPLICATING A **DEREGULATION OF INNATE AND ACQUIRED IMMUNE SYSTEMS**; FOOD THERAPY IS CRUCIAL IN THE DIAGNOSIS AND TREATMENT OF THE DISEASE.

### REACCIONES ADVERSAS A LOS ALIMENTOS: ¿SENSIBILIDAD ALIMENTARIA O INTOLERANCIA?

An adverse reaction to foods is defined as an abnormal reaction from a clinical viewpoint, associated with the ingestion of a particular food or additive. It includes both non-immunological reactions (intolerances) and immunological (allergic). Food intolerance is a non-immunological response to a food that is not digested properly or else is due to

**Table 2.** Common causes of vomiting and / or chronic diarrhoea in dogs

**» GASTROINTESTINAL DISORDERS**
- **Chronic renal failure**
- **Diabetic ketoacidosis**
- **Liver disease**
- **Chronic pancreatitis, exocrine pancreatic insufficiency**
- **Hypoadrenocorticism**
- **Mastocytic enterocolitis**
- **...**

**» GASTRIC DISORDERS**
- **Chronic gastritis**
- **Inadequate nutrition**
- **Immune mediated or part of an immune-mediated inflammation of the intestine** (Plasma-lymphocytic, eosinophilic)
- **Helicobacter spp**
- **Gastric motility disorder**
- **Gastric reflux syndrome**
- **Foreign body**
- **Ulcer**
- **Neoplasia**
- **Pysaloptera spp**
- **Pyloric hypertrophy**
- **Gastroparesis**

**» INTESTINAL DISORDERS SMALL AND / OR LARGE**
- **Parasites and protozoa** (ascaridiosis, hookworm, trichurosis, strongyloidiasis, taeniasis)
- **Adverse food reaction** ( allergy, intolerance, ...)
- **Inflammatory bowel disease** (IBD)
- **Antibiotic-responsive diarrhoea**
- **Bacteria** (Clostridium perfingens, Clostridium difficile, Yersinia enterolitica, Campylobacter spp, Salmonella spp)
- **Gluten enteropathy**
- **Lymphosarcoma**
- **Protein-losing enteropathy**
- **Lymphangiectasia**
- **Histoplasmosis**
- **Ulcer**
- **Partial obstruction** (tumor, foreign body, intussusception, extraluminar obstruction ...)
- **Colitosis** (plasmacytic-lymphocytic or eosinophilic)
- **Enterotoxicosis due to C. perfringens**
- **Colitis that responds to fibre**
- **Irritable Bowel Syndrome**
- **Colon cancer**
- **Histiocytic ulcerative colitis – Boxer**

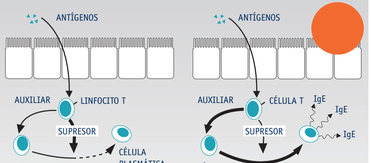




metabolic, toxic or pharmacological causes. True food allergy in dogs has traditionally been considered as hypersensitivity Type I reaction to the ingestion of food antigens (see Figure 1) but may also be caused by a non- immune mediated food allergy. Food allergens are usually proteins or glycoproteins of 10-40 kilodaltons (kD) that are resistant to degradation by heat, acid or enzymes. It is likely that less than 1% of the canine population is affected in this way. The symptoms are frequently seen in the skin, in the form of pruritis caused by self harm and / or secondary bacterial infection; and less frequently they are seen in the gastrointestinal tract in the form of vomiting, diarrhoea, poor appetite, abdominal discomfort and weight loss. Diagnosis is usually made by seeing a resolution of symptoms after following a strict test diet (exclusion test) including a new source of protein and / or carbohydrates, or a hydrolysed protein diet that includes whole protein that has been hydrolysed with enzymes to make small peptides that are less allergenic (such as ADVANCE Veterinary Diet Hypoallergenic) over a period of between 2 and 10 weeks.

However, other diseases (such as idiopathic IBD) may demonstrate improved clinical symptoms following a hydrolysed protein diet, but are not strictly food allergies, so it is recommended to present a food challenge (return to the original diet) to confirm the diagnosis of food allergy should symptoms return. Certain breeds have a genetic predisposition to gluten sensitivity, such as the Irish Setter and Soft-coated Wheaten Terrier.

**Figure 1.** Reaction of the immune system to oral antigens.




ADVANCE VETERINARY GASTROENTERIC CANINE, **LOW FAT** AND EASILY DIGESTIBLE, **ENRICHED** WITH FUNCTIONAL COMPONENTS (**BIOACTIVE PLASMA PROTEINS AND PREBIOTICS**) COMPLEMENTS THE PHARMACOLOGICAL TREATMENT OF ANTIBIOTIC-RESPONSIVE DIARRHOEA.

### ANTIBIOTIC-RESPONSIVE DIARRHOEA (ARD)

Currently the term "antibiotic-responsive diarrhoea '(ARD) is the preferred term for the pathology formerly known as' small bowel bacterial overgrowth" (SIBO), as recent studies have questioned the definition of this disorder based on the detection of amounts elevated bacteria in the duodenal juice, which is technically complicated and impractical. ARD is especially common in young adult German Shepherd dogs. Its typical symptoms are chronic intermittent diarrhoea, often associated with weight loss, and excessive borborygmus.
ARD is diagnosed by eliminating other causes and on the basis of a positive response to treatment with antibiotics, which may also act as immunomodulators. ARD can be secondary to exocrine pancreatic insufficiency (EPI), abnormal motility, decreased gastric acids, etc.

### INFLAMMATORY BOWEL DISEASE

Inflammatory bowel disease (IBD) is not a disease in itself, but a term that encompasses several histopathological descriptions of intestinal mucosal inflammation. If being rigorous, one should speak of idiopathic IBD, as this term more accurately reflects its uncertain etiology. Dogs with IBD often have vomiting and / or chronic diarrhoea, and weight loss or blood in the stools indicates a more severe disease. Again, the German Shepherd dog seems to be predisposed to this condition.

Diagnosis is made by ruling out other metabolic diseases and / or infections and performing intestinal biopsies, which adds an additional classification based on the predominant inflammatory cells. The classifications that are commonly used in dogs are: lymphocytic-plasmacytic enteritis lymphocyte-plasmacytic colitis, eosinophilic gastroenteritis, eosinophilic colitis, eosinophilic granulomas, hypereosinophilic syndrome, histocitic colitis, granulomatous colitis, transmural granulomatous enterocolitis and suppurative colitis.

IBD differs from the human conditions of Crohn's disease (CD) and ulcerative colitis (UC) in the distribution of lesions and progression of the diseases, as well as the type of inflammatory response. Lymphocytic-plasmacytic enteritis (LPE) occurs with much higher frequency in dogs than eosinophilic enteritis. Other inflammatory bowel diseases that have been identified are histiocytic colitis in the Boxer, which is now considered

FOR DIETARY THERAPY WITH IBD A **DIET LOW IN FAT AND EASILY DIGESTIBLE** IS RECOMMENDED. IN SEVERE CASES, A HYPOALLERGENIC DIET WITH HYDROLYSED PROTEIN AND LOW FAT CAN IMPROVE SYMPTOMS.

an infectious disease; protein-losing enteropathy and nephropathy of the Soft-coated Wheaten Terrier; immunoproliferative disease of the Basenji and the enteropathy syndrome of the Shar -pei. Treatment in these cases usually requires a combination of dietary treatment and immunosuppressive therapy with corticosteroids or cyclosporine.

### LYMPHANGIECTASIA

Lymphangiectasia is an abnormal dilatation and dysfunction of the lymphatic vessels of the mucosa and submucosa. It may be primary or secondary (eg. lymphatic obstruction due to intestinal inflammation, fibrosis,





or neoplastic infiltration due to heart or liver disease). In the early stages, chronic diarrhoea with steatorrhoea, weight loss and polyphagia may be seen. Sometimes, there is also vomiting, anorexia and lethargy. There is a protein-rich lymphatic exudation in the bowel (protein-losing enteropathy, or PLE), and severe lipid malabsorption which causes ascites, subcutaneous oedema or chylothorax. Usually a diet low in fat is recommended (Advance Veterinary Gastroenteric canine).

### COLITIS

Typical symptoms of colitis are a more frequent excretion of small amounts of stool or diarrhoea, the presence of mucus or blood in the stool and tenesmus (i.e. frequent attempts to defeacate without success), sometimes urgently. As already mentioned, an advance reaction to food and idiopathic inflammatory bowel disease can affect both the small and large intestine. However, there are conditions that specifically affect the large intestine leading to diarrhoea. The most common are stress colitis, or irritable bowel syndrome (IBS), and colitis that responds to fibre.

**COLITIS RESPONDING TO FIBRE** CAN BE TREATED WITH A DIET RICH IN FIBRE, SUCH AS **ADVANCE VETERINARY DIABETES COLITIS.**

Stress colitis is a little known disease that is commonly seen in "stressed" dogs. Its pathogenesis is little known, although several hypotheses have been suggested.

However, for other causes of large intestine diarrhoea (parasitism, adverse reaction to food, IBD, IBS, etc.) a different dietary treatment is required (a diet low in fat and easily digestible, hydrolysed or low in antigens).

### » 3) EXOCRINE PANCREATIC INSUFFIENCY

Another possible cause of chronic diarrhoea in dogs is exocrine pancreatic insufficiency (EPI). Dogs with EPI often have chronic diarrhoea with a large quantity of stools, yellowish or greyish, and moderate to high weight loss. Also observed in some dogs may be pica, coprophagia, poor hair quality and loss of muscle mass (protein-calorie malnutrition). Malabsorption of nutrients may be especially serious because the pancreas plays a key role in the digestion of the major nutrient components (proteins, fats and carbohydrates) and because it can be complicated by a loss of intestinal enzyme function, proliferation of bacterial (ARD) or related diseases of the small intestine. A diet low in fat and easily digestible is usually recommended.

THE **HYDROLYSED DIET ADVANCE VETERINARY** HYPOALLERGENIC IS ESPECIALLY USEFUL WHEN **FOOD SENSITIVITY** INCREASES DUE TO THE PRESENCE OF UNDIGESTED **ANTIGENIC** MACROMOLECULES.

### » 4) CONSTIPATION

Constipation means difficulty passing stools that are dry and hard. Its main symptom is tenesmus. Constipation can occur for many reasons: diet (a diet low in fibre, bone, hair ingestion, etc.), pain (anorectal pathology, trauma), mechanical obstruction (enlarged prostate, tumour, etc.), neuromuscular dysfunction , metabolic or endocrine diseases (hypothyroidism, etc.), general muscular weakness, etc. Constipation may cause obstipation (secondary degeneration of colonic muscles). Megacolon is a persistent enlargement in the diameter of the colon. It can be congenital or acquired (due to an imbalance between fluids and electrolytes, a diet low in fibre, foreign bodies, painful defaecation, neuromuscular disorders, obstruction, etc..).

A DIET RICH IN FIBRE SUCH AS **ADVANCE VETERINARY DIABETES COLITIS** IS RECOMMENDED FOR CONSTIPATION.

### APPENDIX: Diagnostic algorithms

Almost all cases have the same gastrointestinal symptoms (anorexia, loss of appetite, abdominal discomfort, weight loss, vomiting, diarrhoea, etc..), making it difficult to determine to what kind of disease is present are in a particular case. Algorithms for acute and chronic diarrhoea are used to facilitate the identification of certain problems, assess its severity, rule out certain problems and facilitate the design of a diagnostic plan and / or treatment for each problem (Annexes 1 and 2).

A careful case history and physical examination should be made. The case history should include condition description, vaccinations, environment, diet, drugs, possible exposure to toxins and infectious agents, bodyweight and an assessment of the physical condition of the animal. For example, young animals are prone to inadequate nutrition, infections (parvovirus, distemper) and parasites. Older animals may have metabolic or systemic dysfunction or gastrointestinal permeability. Also bear in mind that some breeds are predisposed to certain diseases (eg. The Miniature Schnauzer is prone to pancreatitis, etc.). Animals that are allowed to go freely in an open environment are more likely to develop parasitic gastroenteritis; toxic or infectious. Environmental stress (police dogs, guide dogs, game shows, etc.) can cause large intestine diarrhoea. Weight loss usually indicates a chronic disease in the small intestine. Some general tests (haematology, biochemistry, radiography, ultrasound, etc.), certain treatments (worming, antibiotics, special diets, etc.) and specific tests (biopsy, endoscopy) also help rule out many possible causes.

In practice, it seems that some dogs with colitis have several different small intestinal diseases simultaneously (e.g. inflammatory bowel disease, colitis and enteritis). Therefore, it is always advisable to examine both the large intestine and small intestine when symptoms of colitis are present. However, when the existence of an isolated colitis is suspected, it can be tested empirically with fibre treatment before an endoscopy, or try a treatment with a high fibre content diet if biopsies indicate that there is only an isolated colitis.





## DIETARY TREATMENT OF CANINE GASTROINTESTINAL DISEASES.

### Bioactive Plasma Proteins

Plasma contains a complex mixture of bioactive compounds, mainly of bioactive proteins such as IgG (Moreto and Perez-Bosque, 2009). It has been shown in recent studies that the use of bioactive proteins as a dietary supplement can reduce the occurrence and / or severity of various intestinal diseases (Abreu et al., 2005; Lerner, 2007). The mode of action of these bioactive proteins is summarised below, and is also shown in Figure 2.

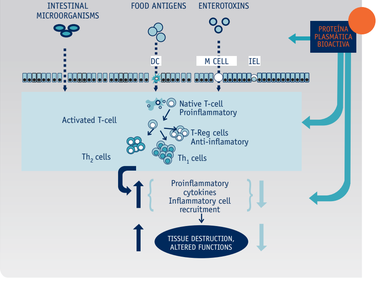
**» 1) COMBATING INTESTINAL PATHOGENES**
- Reducing the adhesion of pathogens to the intestinal mucosa
- Reducing the activity of pathogenic
- Strengthening beneficial fecal microflora

**» 2) REDUCTION OF INTESTINAL I NFLAMMATION**
- Reducing pro-inflammatory cytokines (INF-γ, TNF-α)
- Increasing anti-inflammatory cytokines (IL-10)

**» 3) PRESERVATION OF MUCOSAL INTEGRITY**
- Increasing the height of intestinal villi, the ratio of height: depth of the crypts, area and volume of the villi (Yi et al., 2005).
- Reducing intestinal epithelial permeability and increasing protein binding type "tight junction" during diarrhoea (Pérez-Bosque et al., 2006)
- Reducing water secretion in the intestine (Perez-Bosque et al., 2004).
- Increasing nutrient uptake

**BIOACTIVE PLASMA PROTEINS** PREVENT THE PROLIFERATION OF PATHOGENS (ADHESION AND ACTIVITY) IN THE INTESTINE. REDUCE THE **INFLAMMATORY RESPONSE** IN THE INTESTINE AND PRESERVE THE INTEGRITY OF THE **INTESTINAL BARRIER** (INCREASING ITS AREA AND DECREASING ITS PERMEABILITY) IMPROVING CHRONIC GASTROINTESTINAL SYMPTOMS.

**Figure 2.** Actuación propuesta de las Proteínas plasmáticas bioactivas sobre el intestino. (adaptado de Moreto y Pérez-Bosque, 2009).




### LOW CONTENT OF FAT, MCTS AND POLYUNSATURATED FATTY ACIDS (PUFA-ω3)

**» MEDIUM CHAIN TRIGLYCERIDES (MCTS)**
MCTs are triglycerides with a high content of medium chain fatty acids (C6 (caproic acid) - C12(lauric acid)), one of whose natural sources is coconut oil. Their small molecular weight and size, compared with long-chain triglycerides (LCTs) (16-22C) (Johnson et al., 1990), facilitate the work of pancreatic lipase, which hydrolyses MCTs faster than LCTs (Bach andBabayan, 1982). They ionize significantly at a physiological pH and are more soluble in aqueous biological fluid that long chain fatty acids (LCFAs)(Johnson et al, 1990; Odle, 1997).

MCFAs form the portal system, instead of employing the lymphatic system as do LCFAs, and they are transported in a soluble form bound to albumins (Johnson et al. 1990) unlike the use of chylomicrons by LCFAs, and for this reason they arrive earlier at the liver (Figure 3) (Bach and Babayan,

**Figure 3.** Metabolism of triglycerides of medium and long chain fatty acids in the intestine, liver and adipose tissue. (Adapted from Odle, 1997).