

Protein is the most important nutrient for humans and animals. The nutritional quality of proteins are often measured by their digestibility and biological values (BV). Whey proteins possess a number of properties that make them superior to most other protein sources. When it comes to digestibility, the digestion of whey proteins start almost immediately after they enter the stomach. Whey proteins have a higher BV due to the content of essential amino acids (EAA), and they enhance immunity and auto-oxidation due to high levels of sulfur-containing amino acids (Cysteine and Methionine). In addition, whey proteins are one of the most efficient promoters of muscle synthesis because they have a high concentration of branched-chain amino acids (BCAA), leucine, isoleucine, and valine among all dietary protein sources. Whey proteins play an important role in supporting digestive and immune health and aiding muscle syntheses and lean body composition. In addition to the above mentioned nutritional benefits of whey protein products, specialty whey protein products have been developed through further modification or fractionation of the whey proteins.

During digestion of proteins, the enzymes (proteases) in the digestive tract convert proteins into small peptides and amino acids before they are absorbed into the body through intestinal cells. This conversion can be partially achieved prior to consumption. Whey proteins can be industrially hydrolyzed with proteases to convert them into a mixture of peptides and amino acids. "Pre-digested" whey protein products are called whey protein hydrolysates. Protein hydrolysates provide additional nutritional benefits. As opposed to intact proteins, hydrolysates accelerate protein absorption by making the digestive process easier and more effective. This is particularly important for humans and animals dealing with digestive health conditions. Hydrolysates are an effective solution for those struggling to gain and maintain muscle mass.

Many potential bioactive peptides from whey proteins have been reviewed by Madureira et al (2010) and their bioactivities and physiological effects described. There are many bioactive peptides in whey protein hydrolysates which, when released, can trigger physiological effects in humans and animals. These peptides can help prevent certain health conditions like atherosclerosis. Nakamura et al (2013) compared diets containing milk derived peptides having angiotensin-converting enzyme (ACE) inhibitory activities to a control diet in an atherosclerotic mouse model to examine the effects of these peptides on the development of atherosclerosis. In this study apoE(-/-) mice received control diet or one of the test diets (control diet with added fermented milk, a protein hydrolysate with same ACE inhibitory activity, synthetic peptides, or prescription drugs of ACE inhibitor) for 31 weeks and afterwards blood biochemistry, aortic atherogenesis, and gene expression were evaluated. The study found no significant difference in plasma lipid levels among all the diet groups. The area ratio of intima to media of aortic arch, as a measure of extent of atherosclerosis, was significantly lower in fermented milk and protein hydrolysate group than the control group. The authors observed reduction in mRNA expression of inflammatory cytokines when compared to the control group. These results suggest that continuous intake of milk derived ACE inhibitory peptides might be beneficial for preventing atherosclerosis caused by hypercholesterolemia.

Whey proteins have many different protein fractions. These protein fractions can have different amino acid profiles and thus different nutritional and functional properties. Through protein fractionation technologies, some of these protein fractions can be isolated or enriched into whey protein products with special protein profiles tailored to achieve specific nutritional and health benefits such as stress reduction, gut health, and anti-inflammatory activity.

For example, Bouthegourd et al. (2002) compared preexercise meals of different compositions (to fasting) daily over 5 weeks in rats and monitored body weight and composition, energy expenditure (through oxygen consumption and CO₂ release) and metabolic rate and substrate oxidation. The preexercise meal is enriched with glucose (Glc), whole milk protein (WMP), or alpha-lactalbumin-enriched whey protein (CP α L). Compared with fasting, the Glc meal increased glucose oxidation and decreased lipid oxidation during and after exercise. In contrast, the WMP and CP α L meals preserved lipid oxidation and increased protein oxidation, the CP α L meal increasing protein oxidation more than the WMP meal. The authors concluded that the potential of the CP α L meal to preserve lipid oxidation and to rapidly deliver amino acids for use during exercise improved the efficiency of exercise training to decrease adiposity.

Alpha-lactalbumin is one of the fractions that has shown unique benefits. For instance, in an experimental gastric ulcer model, ethanol-induced gastric ulcer formation was strongly inhibited by alpha-lactalbumin administration. Stress-induced gastric ulcer was also prevented by alpha-lactalbumin administration. Ushidat et al (2007) have used a rat gastric epithelial cell line and used a rat model to demonstrate that the gastric protective activity of alpha-lactalbumin was through the mechanism of stimulating mucin synthesis and secretion in mucus producing cells, resulting in increased thickness of the mucus gel layer in gastric mucosa.

Milk fat globule membrane (MFGM) is another minor fraction in milk and in whey which is rich in membrane proteins and polar lipids such as phospholipids and sphingolipids. These lipids are known for their roles in infant brain and gut development, immune-mediated anti-carcinogenic effects and anti-inflammatory activity. These neurocognitive effects of MFGM have been demonstrated in infants as well as in rat and piglet models. Recently, Huang et al (2019) reviewed these studies on health impacts of the milk phospholipid fractions.

The studies relevant to pet well-being demonstrate the benefits of MFGM for animal neuromuscular development and endurance capacity. Markworth et al. (2017), used post-natal growing rats as a model to study the effect of dietary supplementation with MFGM on neuromuscular development. They found that supplementation with MFGM enriched in polar lipids changed plasma and muscle polar lipids profiles. Rats receiving higher level MFGM supplementation displayed a slow-to-fast muscle fiber type profile shift that was associated with elevated expression of genes involved in myogenic differentiation and neuromuscular development. They concluded that dietary supplementation with bovine-derived MFGM can promote neuromuscular development in growing rats, leading to shifts in adult muscle phenotypes.

Haramizu et al (2014) studied, using a mice model, the effects of dietary supplement of MFGM on animal's endurance capacity. They found that dietary supplementation with

MFGM combined with regular exercise in mice markedly improved endurance capacity and increased expression of genes associated with energy metabolism. This leads to up regulated fatty acid oxidation in skeletal muscle during exercise and increase lipid utilization. The authors also conducted an experiment using a purified sphingomyelin supplementation in the same mice model and found that dietary supplementation with sphingomyelin, a constituent of MFGM, when combined with regular exercise, markedly increased endurance capacity and similarly increased expression of genes associated with energy metabolism. It was concluded that sphingomyelin is one of the active components responsible for the beneficial effects of dietary MFGM.

There is sufficient evidence that specialty whey protein products, including whey protein hydrolysates and fractionated whey proteins have a beneficial effect on animals' well-being and support muscle development, immune and digestive health, and increase energy metabolism. These conditions can positively impact a pet's quality of life. New research will continue to yield new insights into other potential health benefits for animals. Hilmar Ingredients anticipates more requests of specialty whey proteins from formulators in the pet food industry. Hilmar Ingredients is prepared to work with formulators to provide whey protein health and nutritional benefits to companion animals.

Hilmar Ingredients delivers the promise of dairy – whey protein and lactose, powerhouse ingredients contributing nutrition and function to the world's food and beverages. Hilmar Ingredients supplies whey protein made from sweet whey. Its primary source is our parent company's large-scale cheese operations at two state-of-the-art locations – the freshest, highest quality whey stream available. From this we produce Hilmar Whey Protein Specialty Ingredients that positively impact the health and well-being of humans and animals. Sufficient evidence demonstrates the nutritional impacts of specialty ingredients on immunity, cardiovascular health, skeletal integrity, digestive health, weight management, cognitive health, muscle synthesis, and weight management. Committed to continuous improvement, innovation and sustainability, Hilmar Ingredients provides informative and technical capabilities to support growth in specialty food offerings to companion animals. www.hilmaringredients.com

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