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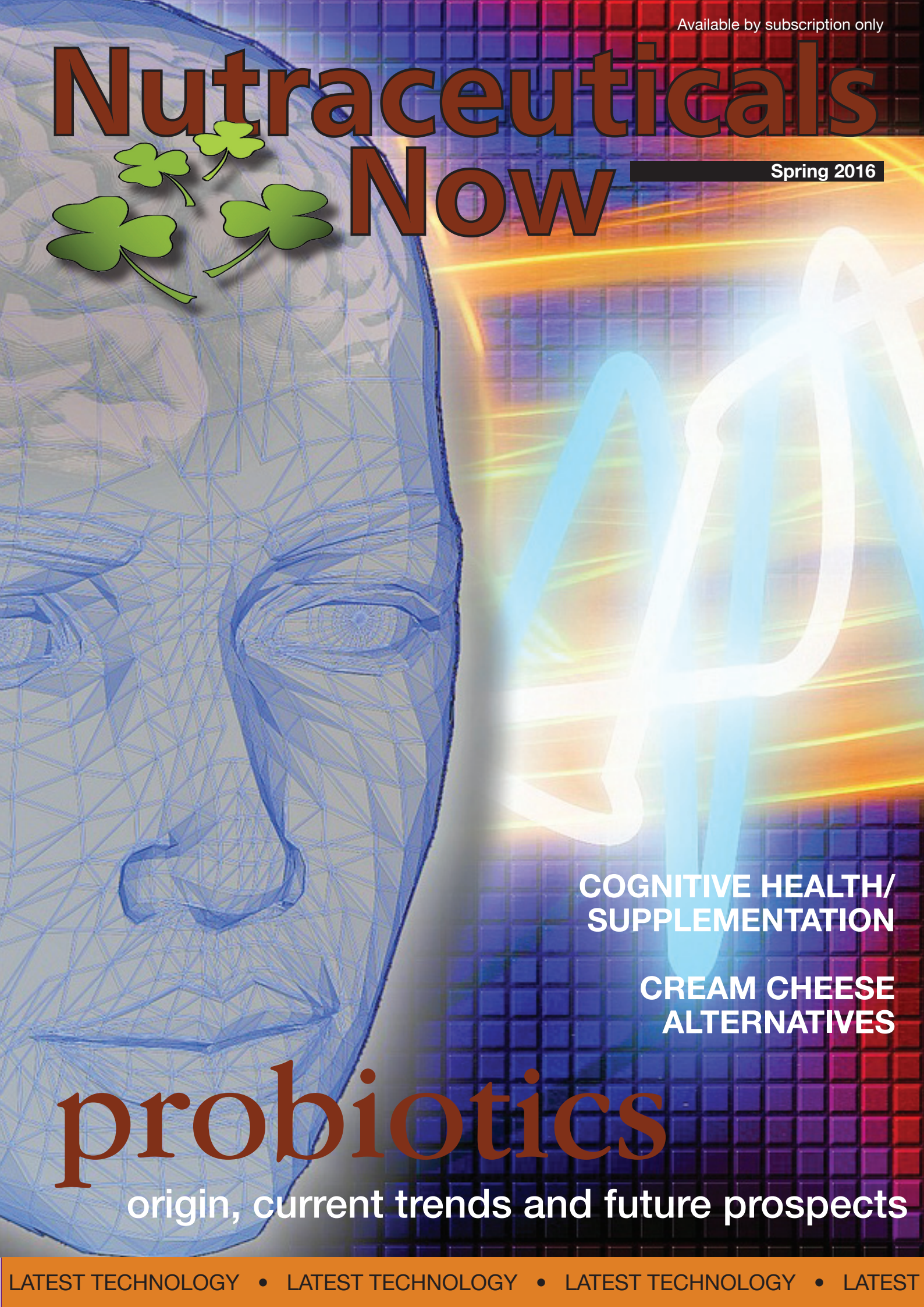


COGNITIVE HEALTH/ SUPPLEMENTATION

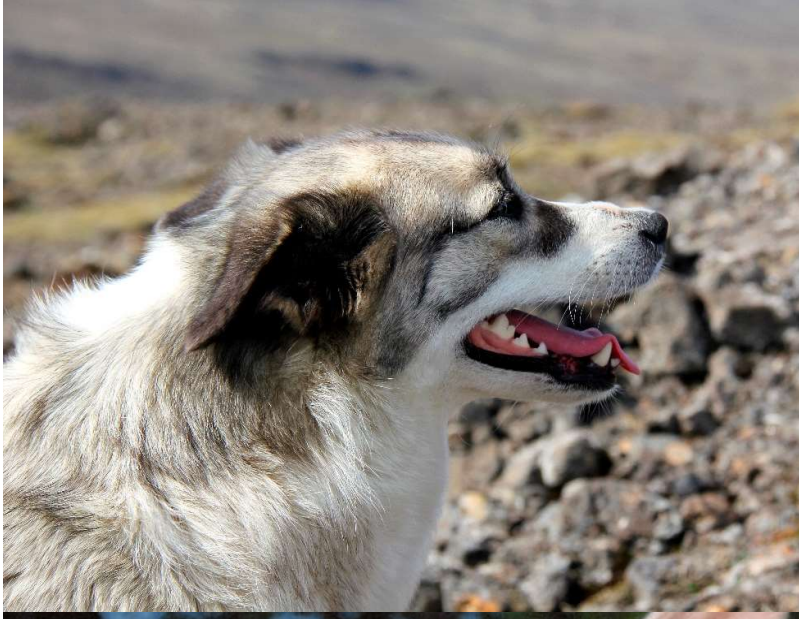
CREAM CHEESE ALTERNATIVES

probiotics

origin, current trends and future prospects

Improving animal health with Chitosan

PRIMEX manufactures high quality and multifunctional chitosan products derived from marine source. ChitoClear® chitosan and LipoSan Ultra® are Primex trademarks.



Animal health and welfare, along a growing pet market, are gaining consideration by consumers. It is therefore important to bring new solutions based on natural alternatives in response to emerging issues, such as quality of life, skin and dental problems, as well as obesity which predisposes companion animals to a variety of health problems.

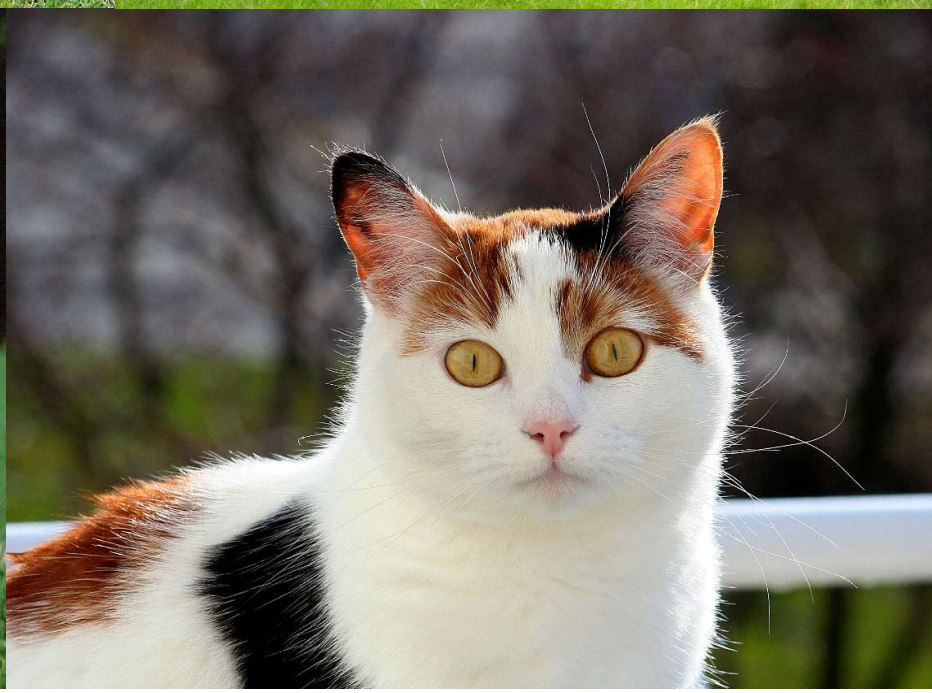
Chitosan is a multifunctional fiber and the most abundant natural amino polysaccharide, obtained by deacetylation of chitin. It is soluble in acidic environment following its protonation, resulting in its unique cationic and bioactive nature. Chitosan possesses several biological properties [1]: biodegradable, biocompatible, antioxidative, emulsifying, flocculating, mucoadhesive, film-forming, permeation enhancing, fat-binding, hemostatic, antimicrobial, stimulating healing and analgesic. These characteristics contribute to its widespread application in different fields. In parallel to its current applications in human health and personal care, chitosan is an inevitable ingredient to benefit animals of all kinds, improving their health and well-being. Most importantly owing to its diversified properties, chitosan can be used in the development of preventive health and care products. Such an approach, including feed supplements and care products, will be discussed here.

Digestive health, growth and immune enhancement

A recent review considers studies evaluating the effects of dietary chitosan on performance and metabolic response in poultry and pigs, that is, haematological, biochemical and immunological blood characteristics, microbiological profile of intestines, intestinal morphology and digestibility of nutrients, as well as on the quality of meat and eggs. It is reported that

Animal Type	Age/Study Period	Daily Dose	Results	Ref.
Broiler chickens	1-day old, 35 days	10.5 mg/bird	Improved growth and FCR	[3]
	1-day old, 6 weeks	0.05-0.1% of diet	Optimal growth and FCR; increased nitrogen retention	[4]
	1-day old, 6 weeks	0.01% of diet	Improved immunity	[5]
	7-day old, 7 weeks	0.06% of diet	Improved growth	[6]
Finishing boars and gilts	65-75 kg, 57 days	1200 ppm (27 mg/kg body weight)	Lower crude fat digestibility, dietary intake and body weight gain	[7]
		300-600 ppm	No such effects	
Weaned piglets	35-day old, 28 days	0.01-0.2% of diet	Improved average daily gain, protein/ nutrient digestibility, amylase activity	[8]



chitosan used as a feed additive for poultry and pigs has some beneficial, biological effects, including immunomodulatory, anti-oxidative, antimicrobial and hypocholesterolemic properties. These properties of chitosan are often reflected in improved growth performance of young animals [2]. The early introduction of chitosan during the growth period is emphasized.

Several chitosan intervention studies have been conducted on livestock, suggesting that a high dietary chitosan level may decrease fat digestibility and reduce weight, but a lower level may result in improved growth performance, nutrient digestibility and immunity. Such improvements are highly desirable and may result in increased product yield and quality as well as enhanced animal health and well-being. Being a source of dietary fiber, chitosan is also a valuable prebiotic which can promote optimal colonic conditions.

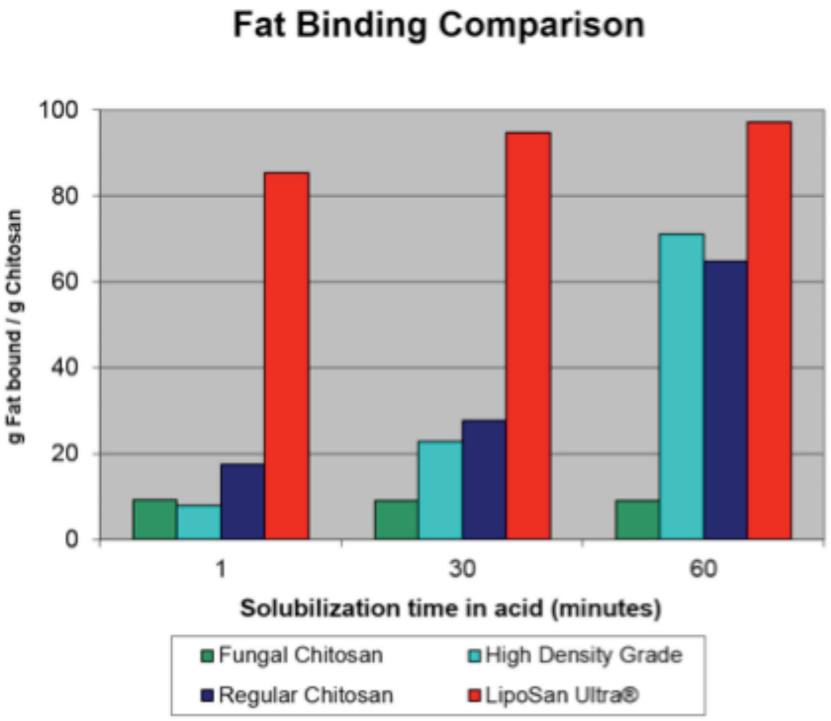
Health and weight management of companion animals

Obesity in dogs and cats is a serious problem. This is much related to their energy imbalance – too many calories in, too few calories burned! Even though this seems simple, it is not easily controlled. Sometimes we all need help. Chitosan is a dietary fiber that can contribute to weight management. Owing to its fat-binding properties, it can be used to supplement feed, increasing fiber content, stimulating digestive health and reducing calorie uptake; or in the form of a treat before a meal. Obesity predisposes companion animals to a variety of health problems, such as metabolic abnormalities, endocrinopathies, orthopaedic disorders, cardiorespiratory disease, urogenital disorders, and neoplasia [9]. As a result, animals have a decreasing quality of life and reduced average lifespan. Chitosan can help prevent such health problems.

Recent studies have demonstrated the antioxidative and renoprotective potential of chitosan supplementation in chronic renal failure using 5/6 nephrectomized rats [10]. Further the ingestion of chitosan results in a significant reduction in the levels of pro-oxidants, which include uremic toxins, in human gastrointestinal tract, thereby inhibiting the subsequent development of oxidative stress in the systemic circulation [11].

Okamoto [12] evaluated the physical changes of chitosan in the gastrointestinal tract of dogs, observing its partial disappearance in the large intestine in presence of colonic contents. This is supported by human studies where chitosan stimulated the growth and activity of colonic bacteria, providing health benefits [13-15]. Chitosan can also increase the absorption of important nutrients. It was shown to significantly enhance the intestinal permeability of glucosamine by reversibly opening the tight junction of intestinal epithelium cells. Further in vivo studies in rats and beagle dogs demonstrated that the presence of chitosan could increase the plasma concentration and bioavailability of glucosamine without altering its elimination. Chitosan can serve as an effective absorption enhancer for glucosamine [16].

LipoSan Ultra® is a unique, patented chitosan product (US Patent No. 6,130,321) that contains succinic acid, a GRAS food additive. As shown by the figure, **LipoSan Ultra**® rapidly dissolves in the stomach, complexes and traps fats and oils



consumed, and reduces the digestion of dietary fat hence limiting the calorie intake. The superior efficacy of **LipoSan Ultra**® implies that it can be taken just before or with a meal to promote digestive health and as a convenient weight management product.

Animal care products

The demand for natural care and antimicrobial solutions is continuously growing. Chitosan is an interesting alternative in animal care because of its potentially beneficial biological properties, and being multifunctional it can greatly contribute to animal care products by replacing undesirable chemicals. **ChitoClear**® can stabilize emulsion, modify viscosity and has antimicrobial properties. It can therefore be used as a natural alternative to other preservatives. Its film-forming properties can maintain moisture, improve hair suppleness and reduce static electricity [17]. Being mucoadhesive, chitosan may serve in different applications: be the active ingredient and/or act as the delivery system, enhancing the penetration of active agents in a long-term controlled manner. In more, **ChitoClear**® chitosan is not a skin sensitizer [18]. Based on allergen prick-testing of sensitive humans, **ChitoClear**® can only very rarely, if at all, cause immediate skin reactions in the general population [19].

Dental disease is a common problem in companion animals. Chitosan can be used to reduce undesirable bacterial accumulation on teeth, either in the form of crunchy foods and treats that help sweep plaque build-up from teeth or as dental care products to prevent tooth erosion and reduce bad breath.

Wound care

Primex offers wound care products based on **ChitoClear**® **chitosan** both as a gel and a spray, to suit different applications. The use of a natural and safe antimicrobial compound in wound care is of great interest because infection of wounds as well as improper conditions will retard healing and interfere with the natural skin repair process. Furthermore the use of antibiotics may delay healing.

ChitoClear® **gel and spray** require no preservatives or other substances necessary for its proper functioning. Challenge tests have demonstrated the natural preservative capacity of the products. **ChitoClear**® chitosan is the key ingredient in the natural solution prepared as a spray or gel which is smooth and easy to apply, clear and non-staining, and will rapidly dry as a film covering the wound. Its antimicrobial properties reduce the risk of infection, otherwise delaying normal healing. Application of chitosan on burns has also been studied. **ChitoClear**® gel and spray have been tested and used by veterinarians on different animals; pets, horses, and livestock. **ChitoClear**® gel and spray have good healing properties, and are useful in contaminated as well as old and chronic wounds; they reduce infection and scar formation, and have anti-pruritic and anti-inflammatory properties [20-21]. Wound healing related studies applying chitosan products have demonstrated increases in fibroblast attachment and proliferation [22], activation of peritoneal macrophages [23], increased neovascularization and mRNA for vascular endothelial growth factor in dog wounds [24] and increased collagen synthesis and prolyl hydroxylase activity in rat wounds [25].

More information on Primex chitosan products at www.primex.is and www.liposan.com

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