Handary

Natural Shelf Life Specialist

2018

FOOD & BEVERAGE
NATURAL SHELF LIFE SOLUTIONS

MICROBIAL SPOILAGE, PATHOGENIC RISK, DISCOLOURATION, OFF-FLAVOUR, TEXTURE CHANGES, NUTRITION LOSS

NATAP®, NATALAC®, NATASAN™, EPOLYLY®, NISINA®, NISINZ®, WHITE NISINA®, LYSOCH®, CHITOLY®, PROTERIA®, BEFRESH®, PLANTÉRIA™, DUCKWEERIA™, MUSHRIA™, GUARDOX™, PHAGEX™, AMYLAX™, KOATILM™, WHITE FIBER™, ANTIMIX™, SHELFEX™, FIXOLOR™, CANTOLY™, ANTIPACK™

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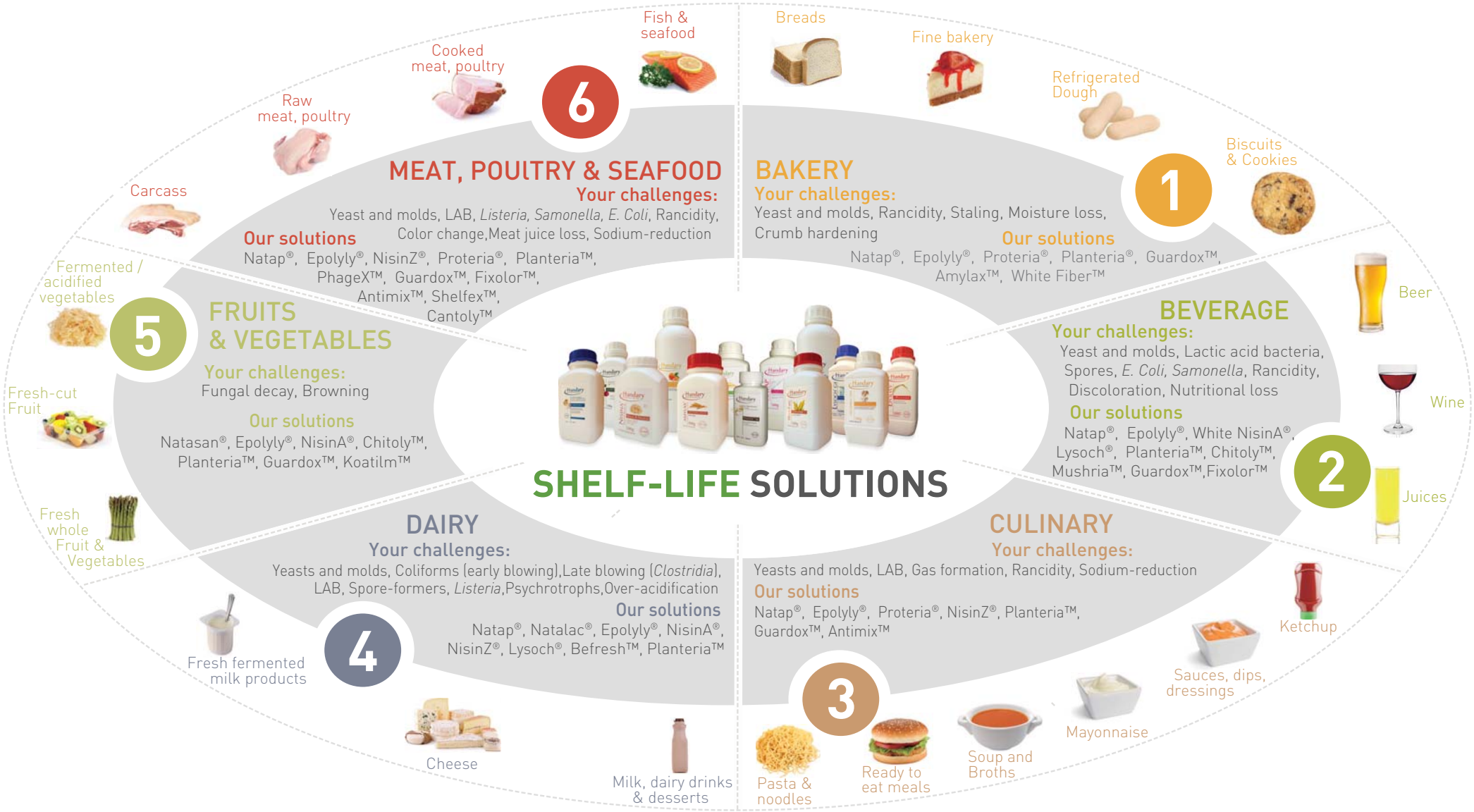
www.handary.com

10 Years *Expertise*

HANDARY S.A.

Freshcare *for* quality ™


SHELF-LIFE SOLUTIONS
6
MEAT, POULTRY & SEAFOOD
Your challenges:
Yeast and molds, LAB, Listeria, Samonella, E. Coli, Rancidity, Color change,Meat juice loss, Sodium-reduction
Our solutions
Natap®, Epolyly®, NisinZ®, Proteria®, Planteria™, PhageX™, Guardox™, Fixolor™, Antimix™, Shelfex™, Cantoly™
Fish & seafood
Cooked meat, poultry
Raw meat, poultry
Carcass
1
BAKERY
Your challenges:
Yeast and molds, Rancidity, Staling, Moisture loss, Crumb hardening
Our solutions
Natap®, Epolyly®, Proteria®, Planteria®, Guardox™, Amylax™, White Fiber™
Breads
Fine bakery
Refrigerated Dough
Biscuits & Cookies
2
BEVERAGE
Your challenges:
Yeast and molds, Lactic acid bacteria, Spores, E. Coli, Samonella, Rancidity, Discoloration, Nutritional loss
Our solutions
Natap®, Epolyly®, White NisinA®, Lysoch®, Planteria™, Chitoly™, Mushria™, Guardox™,Fixolor™
Beer
Wine
Juices
3
CULINARY
Your challenges:
Yeasts and molds, LAB, Gas formation, Rancidity, Sodium-reduction
Our solutions
Natap®, Epolyly®, Proteria®, NisinZ®, Planteria™, Guardox™, Antimix™
Ketchup
Sauces, dips, dressings
Mayonnaise
Soup and Broths
Ready to eat meals
Pasta & noodles
4
DAIRY
Your challenges:
Yeasts and molds, Coliforms (early blowing),Late blowing (Clostridia), LAB, Spore-formers, Listeria,Psychrotrophs,Over-acidification
Our solutions
Natap®, Natalac®, Epolyly®, NisinA®, NisinZ®, Lysoch®, Befresh™, Planteria™
Milk, dairy drinks & desserts
Cheese
Fresh fermented milk products
5
FRUITS & VEGETABLES
Your challenges:
Fungal decay, Browning
Our solutions
Natasan®, Epolyly®, NisinA®, Chitoly™, Planteria™, Guardox™, Koatilm™
Fermented / acidified vegetables
Fresh-cut Fruit
Fresh whole Fruit & Vegetables

SHELF LIFE

The "Shelf Life" of food is how long it may be stored (exist on a shelf) before the quality deteriorates. Food spoilage occupies between 10% and 35% of total food supplied (see Figure 1). How to maintain shelf life quality is a key concern – both for consumers and manufacturers.

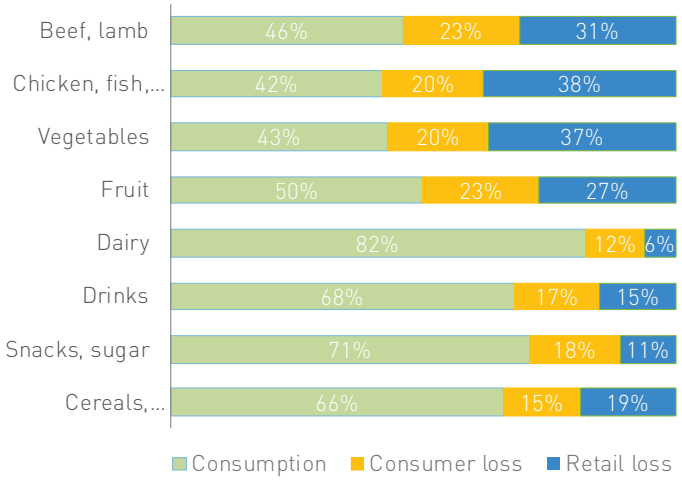
Handary is a natural shelf-life specialist company which provides consumer-friendly ingredient solutions. We focus on stabilizing food shelf life quality by nature's best ingredient solutions, which contributes to meet the increased demands on natural, convenient prepared food and reduce waste and lower the risk of deteriorating food quality. For this purpose,

1) An experimental instrumental and sensory measurements for determining these critical quality attribute;
2) A highly-efficient and label-friendly ingredient range for extending shelf life of foods are considered as two essential reas of Handary mission.

Also a multi-hurdle technics are used to prevent loss of quality of the food product during shelf life.

When developing shelf-life ingredients, consumer demands for natural ingredients, clean labels, health, nutrition, and a satisfying taste and texture. At the same time, manufacturers need to meet their own requirements for performance, ease of use, low cost-in-use and regulatory compliance. Handary's ingredients are adapted and optimised to meet regional and application specific needs, supplementing the good manufacturing practices which are a prerequisite for their use.

Estimated food loss by group 2016



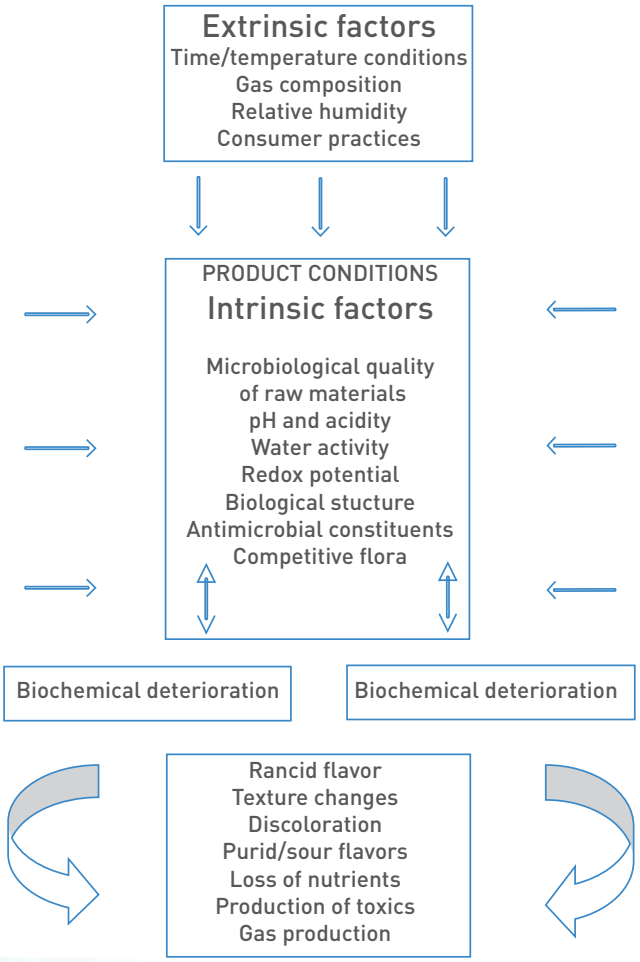
Sources: USDA

Figure 1

FOOD DETERIORATION

Food spoilage means the original nutritional value, texture, flavour of the food is damaged, the food become harmful to people and unsuitable to eat. Main causes of food spoilage include:

Physical changes	a. a_w, temperature, mechanical effects b. Caused by the inappropriate transport, handling and storage
Biological factors	a. Microbiological - Bacteria, yeast, molds b. Macrobiological - Rodents, insects, birds, parasites
Chemical, biochemical factors	a. Oxidation processes (e.g., rancidity of fats and oils) b. Activity of endogenous tissue enzymes (food of vegetable or animal origin)
Consequences/effects of food spoilage	• **Changes in nutritional value** a. Decomposition of proteins, carbohydrates, vitamins • **Changes in organoleptic features** a. Colour, flavor, taste, consistency -mucilaginous surface, unpleasant odour b. Unwholesome effects c. Biogenic amines, toxins, d. Metabolites of microorganisms e. Pathogen microbes
Factors affecting microbial spoilage	• **Intrinsic factors of foodstuffs** a. Physical-chemical properties: aw, redox circumstances, pH b. Chemical composition: Nutrient materials, vitamins, inhibitors c. Biological structure • **Extrinsic factors of foodstuffs** a. Temperature, humidity, atmosphere b. Composition c. Processing effects d. Hygiene, cleaning, disinfections • **Implicit parameters** a. Interactions of microorganisms b. Reproductive potential
Factors affecting the moisture / water requirements of organisms	a. Nutritive properties of the substrate b. pH c. Content of inhibitory substances d. Availability of free oxygen e. Temperature
Factors affecting of chemical, biochemical spoilage	a. Oxidation (effect of oxygen, generally enhanced by light, temperature, metals) b. Enzymatic spoilage



SHELF LIFE SOLUTIONS

Steps to Success

- Control pathogen and / or spoilage control
- Control quality
- Know what you're up against, i.e. the specific organisms, oxidation, enzymatic reaction, staling, moisture loss
- How many are there? If shelf life is a concern, one needs to know how many at the beginning and end of shelf life.

Multi-hurdle Technology

Hurdle technology can be an effective way to prevent loss of quality of the food product during shelf life (see Figure 3,4,5). Several factors can be adjusted to maximize food preservation. These include treatments, such as temperature (T), moisture (a_w), pH, and the inclusion of certain ingredients. Each method, used properly, can help maintain or extend food integrity during shelf life, and can be even more effective when it is combined.

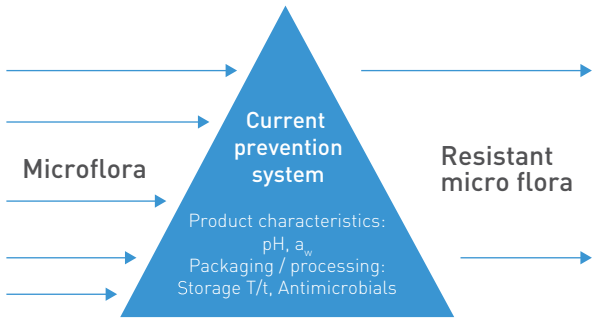


Figure 3

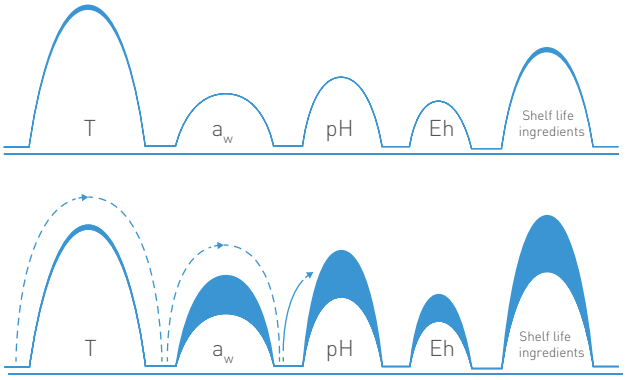


Figure 4

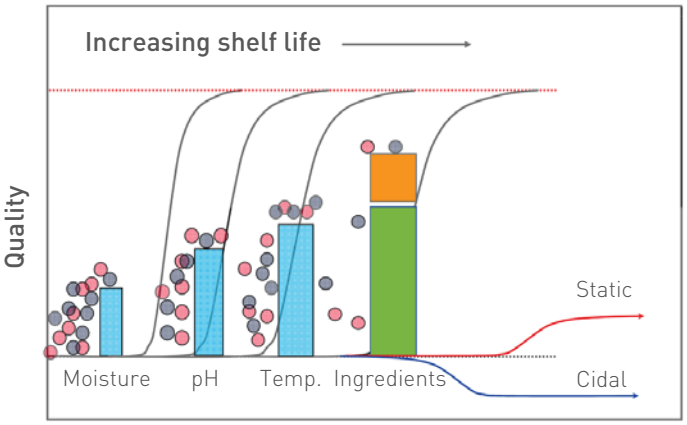


Figure 5

Shelf-life Diagnostics

ANALYSE food quality deteriorating affects
MONITOR the quality deterioration evolution in your products
CONTROL overall quality during shelf life
COMPLIANCE with legality requirements

Shelf-life Evaluation

Food quality is composed of four primary attributes, 1) color and appearance, 2) flavor (taste and aroma), 3) texture and 4) nutritional value. These attributes have been defined, and may be evaluated as either sensory or instrumental measurements, or preferably a combination of the two sensory measurement are generally more useful in the development of new products and determining product standards while instrumental methods are superior in measuring quality on a routine basis. (See table 1 and figure 7)

Table 1 Scales used in the evaluation of food quality

Hedonic	Purchase	Acceptability
9 – Like extremely	5 – Definitely would	3 – Tastes great
8 – Like very much	4 – Probably would	2 – Acceptable
7 – Like moderately	3 – Might or might not	1 – Unacceptable
6 – Like slightly	2 – Probably would not	
5 – Neither like or dislike	1 – Definitely would not	
4 – Dislike slightly		
3 – Dislike moderately		
2 – Dislike very much		
1 – Dislike extremely		

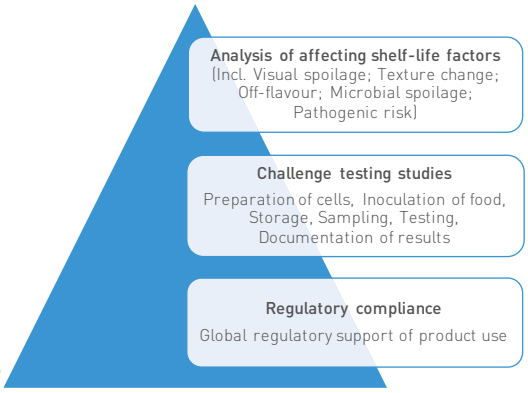


Figure 6

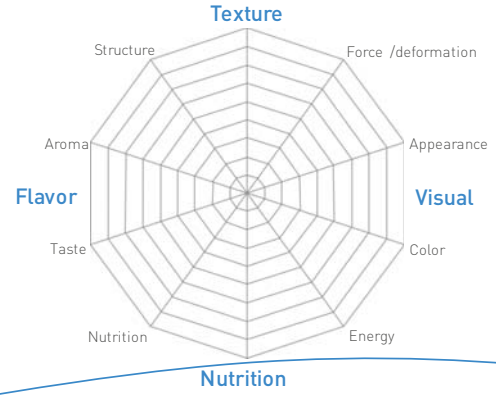


Figure 7

SHELF LIFE INGREDIENTS

Handary's natural food shelf life ingredients span four product ranges:

- **Antimicrobials** – protect food and beverages against unwanted bacteria, yeasts and molds throughout their shelf life.
- **Antioxidants** – delay the onset of rancidity and increase color,flavour, texture and nutrition stability.
- **Fresh-keepers** – keep food fresh from the decay, staling, browning and moisture loss.
- **Shelf-life extenders** - extend the shelf life of foods by preventing multi-factorial-deterioration.

Antimicrobials

Antimicrobials are used to prevent biological deterioration by inhibiting or killing unwanted bacteria, yeasts and molds throughout food shelf life.

Food products can be subjected to contamination by bacteria and fungi. Many of these microorganisms can cause undesirable reactions which deteriorate flavor, odor, color, sensory, and textural properties of foods. Microbial growth is a major concern because some microorganisms can potentially cause food-borne illness. The growth and survival of common spoilage and pathogenic microorganisms such as *Listeria monocytogenes, Escherichia coli O157, Salmonella, Staphylococcus aureus, Bacillus cereus, Campylobacter, Clostridium perfringens, Aspergillus niger,* and *Saccharomyces cerevisiae* are affected by a variety of intrinsic factors, such as pH and presence of oxygen or by extrinsic factorssuch as pH and presence of oxygen or by extrinsic factors associated with storage conditions, including temperature, time, and relative humidity.

To prevent growth of spoilage and pathogenic microorganisms in foods, a multi-hurdle preservation technics, such as heat treatment, salting, acidification, drying and antimicrobials have been combined to use in the food industry.

Main natural compounds are natural antimicrobial substances derived from plants (e.g., citrus fruit, mushroom extract, duckweed extract, raisin), and microbial sourced fermentates (e.g. natamycin, nisin, polylysine, lysozyme, chitosan, phenyllactic acid, cultured sugar and vinegar, protective cultures, bacteriaphages).

At Handary, we provide all natural range of antimicrobials, as they are Generally Recognized as Safe (GRAS), which have been identified and formulated to aim against specific food-borne pathogens and spoilage bacteria in varieties of foods.

Fungicide

Fungicides are biological organisms used to kill fungi or fungal spores. At Handary, we provide **Natap®, Natalac®, Natasan®** natamycin, primary functionalities include:

- Growth control of yeast and mold

Bacteriocin

Bacteriocins are small bacterial peptides which show strongantimicrobial activity against closely related bacteria. At Handary, we provide two bacteriocins – **NisinA®** and **NisinZ®** Vegetal Nisin A and Z include:

- Growth control of Gram-positive pathogens such as heat-resistant bacterial spores of *Clostridium botulinum* and against food-borne pathogens such as *L. mococytogenes, S. aureus,* or *B. cereus.*

Table 2 An Overall View of Natural Shelf-life Solutions

Nature's best materials	Nature's process	Natural shelf life ingredients	Natural shelf life solutions
❑ Bamboo ❑ Beet ❑ Cane ❑ Celery ❑ Cherry ❑ Citrus fruits ❑ Corn ❑ Food cultures ❑ Green tea ❑ Mushroom ❑ Olive pulp ❑ Rosemary ❑ Tapioca	❑ Blending ❑ Fermentation ❑ Filtration ❑ Concentration ❑ Separation	❑ **Antimicrobials** • Antifungal (Natap®, Natalac®, Natasan™) • Bacteriocin (NisinA®, NisinZ®) White NisinA®) • Polymers (Epolyly®, Chitoly®) • Lysozyme (Lysoch®) • Fermentates (Protéria®) • Protective cultures (Befresh™) • Bacteriophage (PhageX™) • Packaging (Antipack™) • Plant antimicrobial (Planteria™, Duckweeria™, Mushria™) • Antimicrobial blends (Antimix™) ❑ **Antioxidants** • Antioxidants (Guardox™) ❑ **Fresh-keepers** • Anti-staling enzyme (Amylax™) • Coating (Koatilm™) • Moisture retention Fiber (White Fiber™) ❑ **Shelf life extenders** • Preventives (Shelfex™) • Color retention agent (Fixolor™) • Control-released antimicrobial capsule (Cantoly™)	❑ **Visual spoilage** • **Gas formation** (e.g. Bloaters, Bubbles, Fisheyes, Holes) • **Surface growth** (e.g. Mouldy, Cloudiness) • **Discolouration** (e.g.Blackening Browning, Greening, Pigments Red spot) ❑ **Texture change** (e.g. Slime, Ropiness, Bittiness, Holes, Softening/rotting, Curdling) ❑ **Off-flavour** (e.g. Alcoholic, Fruity, Garlic, Mustiness, Nitrogenous, Pigsty, Potato-like, Souring) ❑ **Moisture and nutrition loss** ❑ **Microbial spoilage** • Gram-positive spoilage (e.g. Heterofermentative LAB, LAB) • **Gram-negative spoilage** (e.g. *Enterobacteriaceae, Pseudomonas*) • **Yeasts and molds** ❑ **Pathogenic risk** • **Gram-positive pathogens** (e.g. *Listeria, B. cereus, C. botulinum, S. aureus)* • **Gram-negative pathogens** *(e.g. Salmonella, Campylobacter, E.coli)*

SHELF LIFE INGREDIENTS

Polymers

Antimicrobial polymers are a class of polymers with antimicrobial activity, or the ability to inhibit the growth of microorganisms such as bacteria, fungi or protozoans. Antimicrobial polymers commonly kill bacteria immediately on contact by causing the bacterial cell to burst, or by depleting the bacteria's source of food preventing bacterial reproduction. At Handary, we provide **Chitoly™** fungi-sourced chitosan and **Epolyly™** Polylysine. Primary functionalities include:

- Growth control of Gram-positive bacteria, Gram-negative bacteria and fungi

Enzymes

Antimicrobial enzymes are ubiquitous in nature, playing a significant role in the defence mechanisms of living organisms against infection by bacteria and fungi. Hydrolytic antimicrobial enzymes function by degrading key structural components of the cell walls of bacteria and/or fungi.

Handary provides two-sourced lysozyme under the trademark of **Lysoch™** whose primary functionalities are :

- Growth control of fungi
- Growth control of Gram-positive bacteria such as *Clostridium tyrobutyricum*
- Growth control of Gram-negative bacteria such as *e. coli, salmonella*

Fermentates

Fermentates are natural metabolites produced by fermenting selected food grade cultures on sugar-based ingredients. **Proteria™** products are effective against fungi and bacteria for overall improvement of food shelf life quality.

- Increase microbial stability
- Control *Listeria* and *Clostridium botulinum*
- a_w and pH management

Protective cultures

Protective cultures are bacteria especially selected and developed for their ability to control the growth of pathogenic and/or spoilage microorganisms in fermented foods, improving food safety and shelf life. The bacteria involved are mainly strains of *L. plantarum, L. rhamnosus, L. sakei, L. paracasei* and *P. freundenreichii subsp. shermanii.*

Handary provides a range of protective cultures for dairy and meat applications under the trademark of Befresh™ whose primary functionalities are:

- Growth control of Gram-positive pathogens such as *Listeria*
- Growth control of spoilage microorganisms such as yeasts and mods, heterofermentative lactic bacteria, enterococci

Phages

Phages are the natural enemy of bacteria and therefore are logical agents for the control of bacterial pathogens, such as S. aureus (including MRSA), Pseudomonas, Listeria, Salmonella, E. coli, Campylobacter, etc. Phage is composed entirely of proteins and nucleic acids, so their breakdown products consist exclusively of amino acids and nucleic acids, both of which are present in abundance food products, so distribution within a given environment can be seen as a natural proces. At Handary, we provided **PhageX™** Bacteriophages whose primary functionalities are:

- Break down *Listeria* and *Salmonella*

Plant antimicrobials

Plant antimicrobials are as novel compounds obtained from plants which delay microbial growth of pathogens and spoilage organisms in food. At Handary, we provide a range of natural extracts under trademark of **Plantéria™** derived from plant, e.g. citrus fruits, mushroom, duckweed) whose primary functionalities are:

- Growth control of Gram-positive bacteria, Gram-negative bacteria and fungi

SHELF LIFE INGREDIENTS

Antimicrobial active packaging

Antimicrobial active packaging is a kind of biodegradable active antifungal film used to prevent the mold growth by releasing gradually PLA and chitosan-containing antimicrobial activities onto the surface of solid foods. Handary provides highly-effective **Antipack™** biodegradable active antifungal film.

- Growth control of mold

Antioxidants

Antioxidant is used to help preserving foods by delaying development of rancidity, deterioration and discoloration due to lipid oxidation.

Oxidation is one of the major causes of quality deterioration in food, Oxidative deterioration in any type of food manifests in form of discoloration, development of off flavour, formation of toxic compounds, poor shelf life, nutrient and drip losses, respectively. For examples,

- Fruit from browning
- Fats and oils from turning rancid
- The breakdown of nutrients and natural food flavors and colors

An antioxidant is a compound which eliminates undesirable effects of reactive oxygen in foods and neutralizes free radicals which retards lipid oxidation either by inhibiting initial free radical formation or by preventing them from producing more free radicals which can disseminate the oxidation reaction. There are two main categories of antioxidants in relation to their mechanism of action: primary antioxidants and secondary antioxidants. Primary antioxidants disrupt the oxidative free radical chain reaction by donating electrons or hydrogen atoms from the phenolic hydroxyl groups and, therefore, stabilize lipid free radicals, as a result, inhibit or slow down the initiation phase. And disrupt the propagation stage of autoxidation. Secondary antioxidants. deactivate singlet oxygen, chelate metal ions (i.e., iron, copper), absorb ultraviolet radiation, scavenge oxygen and help regenerate primary antioxidants. For better effectiveness, primary antioxidants are often used in combination with secondary antioxidants.

Rancidity

Rancidity in food products is caused by lipid oxidation, which follows exposure to light, heat, oxygen or enzyme activity, or contact with metal ions, for example in pipes or packaging. The international food industry has invested years of research in exploring ways to delay or prevent rancidity. As a result, stainless steel pipes, airtight, gas, vacuum packaging, and refrigeration have been introduced. But rancidity always occurs sooner or later as the oxidative resistance of food products is broken down – and once started, rancidity cannot be stopped. Then the only possibility is to reduce its speed.

Although increasingly looked upon as healthier alternatives to saturated fats, unsaturated fats are more prone to rancidity. This has amplified the need for effective solutions against lipid oxidation.

Antioxidants are considered essential elements in many of today's food products. Handary provides 4 kinds of natural antioxidants under brand of **Guardox™** : 1) Bamboo leaf extract, 2) Acerola extract, 3) Rosemary extract, 4) Olive pulp extract.

Fresh-keepers

To keep food fresh by retarding the decay, staling, browning and moisture loss.

Main natural substance derived from microbial anti-staling enzyme (e.g. maltogenic amylase), Anti-decay & browning coating (e.g. fungal chitosan-based coating), Moisture retention fibre (e.g. corn fibre).

Fresh-keeping enzymes

Staling is a chemical and physical process in bread and other foods that reduces their palatability. Bread staling is associated with the changes in the hydrophilic properties of the crumb that occurs during aging. These properties include the solubility of colloids and the degradation of other components such as lipids and proteins. Thus, staling is often a measure of crumb softness. Anti-staling enzymes modify the amylopectin in flour starch during baking. The result is soft, resilient and cohesive bread with an improved freshness.

At Handary, we provide **Amyalx™** maltogenic amylase which lowers the rate of amylopectin retrogradation, slowing down the bread staling process. The result is substantial crumb softening and moistness combined with improved resilience and elasticity.

SHELF LIFE INGREDIENTS

Fresh-keeping coating

Browning is the food process of becoming brown through either non-enzymatic or enzymatic processes. Non-enzymatic browning is a chemical process that produces a brown color in foods without the activity of enzymes. The two main forms of non-enzymatic browning are caramelization and the Maillard reaction. Both vary in reaction rate as a function of water activity. Enzymatic browning is a chemical process, involving polyphenol oxidase, catechol oxidase, and other enzymes that create melanins and benzoquinone from natural phenols, resulting in a brown color. In general, enzymatic browning requires exposure to oxygen. For example, the browning that occurs when an apple is cut. Enzymatic browning is often detrimental to fresh fruit and vegetables, including apples, potatoes, bananas and avocados, and seafood such as shrimps.

At Handary, we focus on providing anti-enzymatic browning products under the trademark of **Koatilm™** and **Guardox™** to delay the time of becoming brown in fresh-cut fruits (salads).

Moisture retention fibers

Moisture retention fibre is used to extend the shelf life by limiting moisture migration, reduces syngenesis and effectively binds coatings.

Water is one of the most important component of food products, and water activity can be used to help control quality attribute such as texture, flavor and appearance, as well as characterize physical, chemical and microbial stability.

At Handary, we focuse on providing moisture retention fibre under the brand of **White Fiber™** to extend the freshness of Bakery, Meat, Poultry & Fish.

Shelf-life extenders

Shelf-life extenders are an all-natural range of tailored blends used to increase the shelf life of foods by stabilizing multi-deteriorating factors or inhibiting a multi-spoilage factors.

Combinations of selected ingredients create optimal functionality for a broad assortment of food and beverage applications. Handary's tailored blends draw on a comprehensive toolbox of natural protective ingredients. Advanced product, application and processing know-how bring these ingredients together and maximise their synergies to address overall consumer needs, contributing to end products that are fresh, tasty, appealing, healthy and safe.

Handary tailored blends range from traditional dry blends to advanced integrated and microencapsulated blends based on novel manufacturing technology.

Antimicrobial blends

Our "multi-hurdle" proprietary **Antimix®** antimicrobial blend are dosage-efficient solutions which combine known natural antimicrobial ingredients to achieve a synergistic effect against a multi-spoilage bacteria or multi-pathogens. whose primary functionalities are;

- Growth control / inhibition / killing of multi-spoilage microorganisms
- Killing the multi-pathogens

Shelf life extenders

Affecting factors mainly causing food spoilage are microbial including bacteria, yeasts, molds and oxidation processes (e.g., rancidity of fats and oils). A multi-hurdle preservation is necessary.

Shelf-life extenders are an all-natural range of tailored blends used to increase the shelf life of foods by stabilizing multi-deteriorating factors or inhibiting a multi-spoilage factors. At Handary, we formulate natural antimicrobials (e.g. vegetal nisin, Polylysine, citrus fruit extract, etc.) and antioxidants (e.g. bamboo leaf extract, olive pulp extract, Rosemary extract etc.) to achieve a multi-functional preservation against both microbial and oxidative spoilage.

In addition to standard off-the-shelf products under the brand of **Shelfex™**, Handary produces many blends which are specifically designed to meet the needs of individual customers.

Multi-spoilage inhibitor

Multi-spoilage inhibitor is used to delay the spoilage caused by both microbial and oxidative sources.

Color stabilizer

The first impression consumers have of any food is its color and thus color is of utmost importance. For examples, fresh and cured meat color both depend on myoglobin, fresh fruit and vegetable and their concentrate color depend on anthocyanins. Unfortunately, the color of these products is unstable and easily susceptible to degradation, leading to discolouration (e.g. Blackening, Browning, Greening, Pigments, Red spot). Our color stabilizer is **Fixolor™** natural alternatives to artificial color stabilizer such as citric acid and nitrate.

- Stabilize Anthocyanin (color) Killing the multi-pathogens
- Enhance pink color

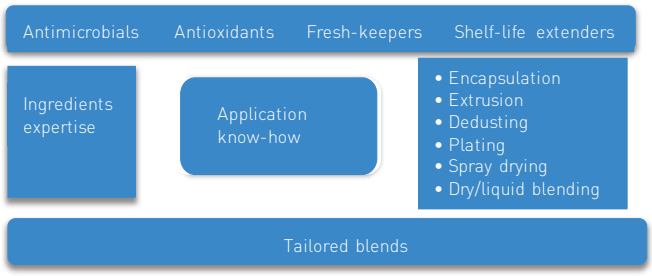
Antimicrobial capsule

Microorganisms of canned solid foods can be killed at high temperature and high pressure to achieve long-term shelf life.

However, the process will lead to taste loss. **Cantoly™** is Chitosan microcapsules containing Nisin as active ingredient and the kinetic release antimicrobial activities to inhibit Gram-positive bacteria in canned solid foods.

- Inhibit total plate count

Tailored blends model



CLEAN LABEL IN TERM OF SHELF LIFE

Globally, above 70% of consumers regularly check food labels before purchasing a product. They rely more on food labels to make their choices and look for 'friendlier' labels on products. 'Clean label', 'free from' and 'real food' foods have all gained traction and moved on to the next level. Food producers are responding by replacing artificial ingredients with natural or organic alternatives and are repositioning mainstream products and lines to have cleaner labels.

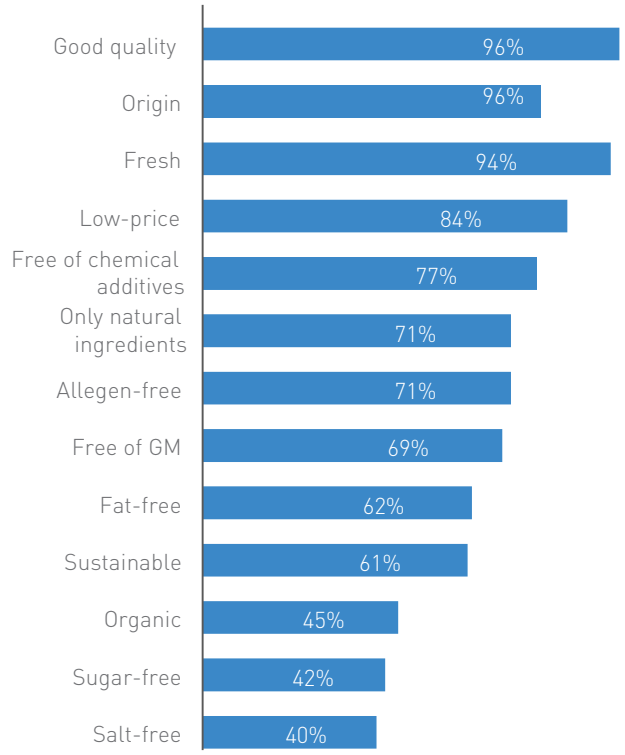
What is clean label ?

Although the exact definition of what constitutes a "clean" label remains unclear, consumer perceptions of it can relate to a number of claims, As a result, declarations such as 'natural', 'organic', 'fresh' 'simple', or free-from' of fat, sugar, allergens, GMO, Gluten-free or artificial additives have become ubiquitous across the entire food food chain. However, one of the declarations mostly associated with a clean label is the term "natural", which can be found on a wide variety of food products.

Clean label challenges in shelf life extension

One major challenge for manufacturers is the shelf life and stability of their products. Consumers now demand clean labels with no artificial ingredients, while longer shelf-lives and stability in foods are also expected. This means, chemical conditioners and straighteners like Azodicarbonamide (ADA), Bromate, diacetyl tartaric acid ester of mono- and di-glycerides, are being replaced by more natural products. However, replacing ingredients which are the basis of a product may not always be that simple. Food manufacturers must offer a quality-tasting product with clean label by reformulating natural, simple functional ingredients. For this, 'label-friendly' solutions for shelf life extension and quality stabilization are directives to combine nature's best protective ingredients with the quality-deteriorating diagnosis.

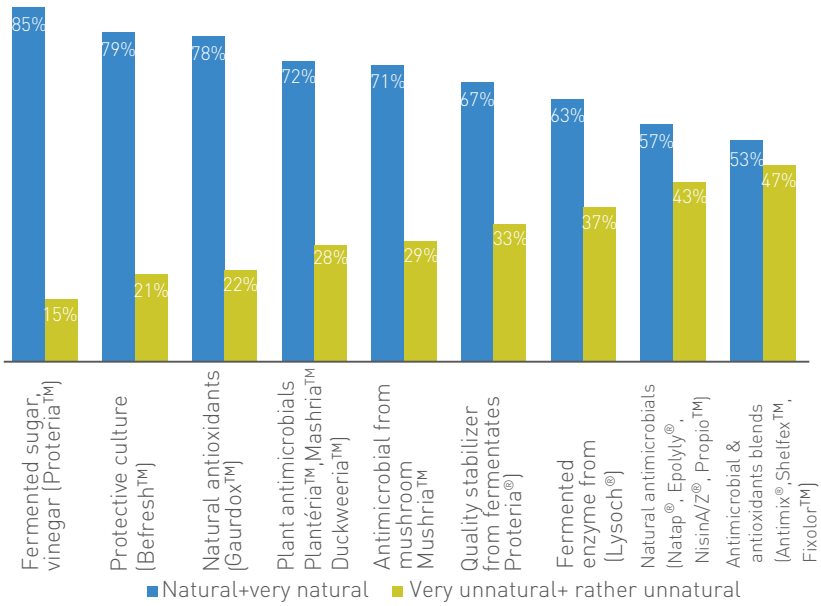
The most important properties of food according to consumer research



Sources : Clean-label 2015, Kampffmeyer

Figure 1

The percentage of how 'natural' consumer think



Sources : 100 food experts 2017

Figure 2

TOP 4
'Clear Eating' Trend

1 CLEAN LABEL
Quality and origin

2 'FREE FROM...'
Free-from artificial additives, allergens, GMO

3 THE 'FLEXITARIAN' EFFECT
Flexible vegetarians

4 NATURAL PROCESSING
Traditional and artisanal minimally processing e.g. Fermentation

Sources : Top 10 trends 2016, Food ingredients

CLEAN-LABEL SHELF LIFE INGREDIENTS ALTERRNATIVES TO E-NUMBER PRESERVATIVES

CHEMICAL PRESERVATIVES	APPLICATIONS	BENEFITS	NATURAL ALTERNATIES	LABELLED AS
Ascorbic acid, Ascorbic acid (E300-304)	Butter, Cheese	Prevent browning and Off-flavor	Guardox™ AE	Acerola extract
	Fruits and vegetables	Prevent browning and spoiling		
	Potato-based products	Prevent browning and discoloration		Acerola extract
			Guardox™ BL	Bamboo leaf extract
	Sausages	Speed the development of the pink cured color containing nitrite	Guardox™ AE	Acerola extract
	Fish and shellfish products	Prevent the off-flavor of unsaturated fatty acids		
	Fruit juice	Prevent browning, off-flavor and discoloration	Guardox™ BL	Bamboo leaf extract
BHA (E320)	Baked goods	Antioxidant	Guardox™ BL	Bamboo leaf extract
Calcium propanoate (E282)	Baked goods	Prevent mold	Proteria™ CP	Cultured wheat
			Planteria™ RJ	Raisin juice concentrate
Citric acid (E330)	Fruit and vegetables	Delay enzymatic browning	Fixolor™ LJ	Lemon juice
	Juice drinks	Stabilize anthocyanins and prevent microbial	Fixolor™ AT	Cultured sugarcane juice
Natamycin (E235)	Cheese	Prevent yeast and mold	Antipack™	No declared as film
			Proteria® CP	Cultured wheat
	Dried sausage		Antipack™	No declared as film
	Yogurt		Befresh™ AF	Lactic acid bacteria
	Fruit juice drinks		Planteria™ RJ	Raisin juice concentrate
	Refrigerated culinary products		Antimix™ MC	Citrus fruits extract, Cultured wheat
NisinZ (E234)	Cooked meat	Prevent microbial spoilage	Proteria® CV	Cultured sugar, vinegar
		Anti-listeria	Proteria® AL	Cultured corn sugar, vinegar
		Prevent *Clostridium botulinum*	Proteria® CL	Cultured sugar, vinegar
Nitrite/ Nitrate (E251– E252)	Cured meat	Prevent botulism toxin	Proteria® CL	Cultured sugar, vinegar
		Launch pink color in cured meat.	Fixolor™ PK	Cherry and chard extract
Phosphate (E338)	Cooked meat	Increase the ionic strength and moisture retention	Shelfex™ MF	Mushroom extract, Fermented vinegar
Potassium sorbate (E202)	Baked goods	Prevent molds	Proteria® CP	Cultured wheat
			Planteria™ RJ	Raisin juice concentrate
	Cheese	Prevent yeast and mold	Proteria® CP	Cultured wheat
	Yogurt	Prevent yeast and mold	Befresh™ AF	Lactic acid bacteria
	Soft drinks and fruit drinks	Prevent Alicyclobacillus Bacteria	Fixolor™ AT	Cultured sugarcane juice
	Grape wine	Prevent yeast inactivation	Mushria™	Mushroom extract
Sodium benzoate (E211)	Salad dressings	Prevent Lactobacillus and yeast	Proteria® CA	Cultured (cane) sugar
	Carbonated drinks	Prevent LAB and yeasts	Planteria™ CF	Citrus fruits extract
	Fruit juices (citric acid)			
	Jam	Prevent yeast and mold	Planteria™ RJ	Raisin juice concentrate
		Prevent LAB and yeasts	Proteria® CA	Cultured (cane) sugar
	Condiments			
Sodium chloride	Cured meat Pickles	Increase microbial, texture and color stabilization	Proteria® SR	Cultured sugar
Sodium diacetate (E262)	Baked goods	Prevent mold	Proteria® CP	Cultured wheat
Sodium lactate (E325)	Cooked meat	Prevent TPC	Shelfex® VC	Cultured sugar, citrus fruits extract

BAKERY

YOUR CHALLENGES

Prevention against mold
Crumb softening
Retarded staling
Moisture retention
Delay of rancidity
Shelf life extension

CLEAN-LABEL ALTERNATIVES

Proteria® CP Cultured wheat
Planteria™ RJ Raisin juice concentrate
White Fiber™ Corn fiber

EXTENDING FRESHNESS SOLUTIONS

Consumers are increasingly demanding bakery products that have better fresh-like qualities. In addition, changes in retail and internationalization of markets have resulted in increased distribution distances, and longer storage times are required. Settinga new standard for sustained and enhanced freshness across the entire life cycle of bakery products.

The ingredients in bakery products such as flour, egg, sugar and salt are usually the sources of spoilage organisms. High water activity, neutral pH and warm or humid storage conditions predisposed these products to fat oxidation and mold spoilage. And staling and moisture loss may become bakery firmer and texture loss.

Our solutions include **Natap®, Proteria®, Planteria™, Guardox™, Amylase™,** and **White Fiber™** have been developed to effectively delay mold growth, staling moisture retention, and oxidation throughout the entire supply chain.

APPLICATIONS


Breads


Fine bakery


Refrigerated Dough


Biscuits & cookies

Prevention against mold

Mold spoilage is common in the bakery industry, mold growth determines product shelf life of both high moisture and intermediate moisture baked goods. Baking destroys most molds. However, during cooling and packaging, bakery recontamination can occur and cause growth to take place.

Natap®, Proteria® CP and **Planteria™ RJ** are used as natural alternative to chemical preservatives such as calcium propionate against mold in bakery products.

Retarding staling

When stored at ambient temperatures, most breads, rolls or products with a moist, spongy crumb undergo a progressive deterioration of quality commonly known as staling. In general, the higher the moisture content of the product in its fresh state, the more pronounced are the changes resulting from staling.

Bread

Yeast-raised baked bread, such as bread, rolls, hamburger buns or baguettes, and are usually baked under conditions that eliminate most common bacteria and have a typical shelf-life of 1-2 weeks. However, due to standard handling operations, mould spoilage is a serious concern for the bread industry.

Tortillas and similar products, such as, tamale wraps or shells, soft and hard taco and burrito wraps or shells, tortilla chips, pitta bread and pizza crusts, have the relatively neutral pH and high water activity that make these products more prone to rapid spoilage by a variety of bacteria and moulds.

Our natural solutions inhibit bacteria and mould growth resulting in an extended shelf life.

In increased efforts to manage water activities, it has been suggested that along with textural changes, flavor changes also are taking place. In most cases, efficient management of water activities also improves flavor losses.

Our solutions include **Amylax™** that could increase crumb softness and longer- lasting freshness of baked goods including bread, buns and rolls, and **White Fiber™** can help maintain crumb softness by reducing moisture migration and starch retrogradation in the case of breads, muffins, cakes, doughnuts and brownies.

Rancidity

Fat and oils are major ingredients for many baked goods. Chances of fat or oil being rancid becomes high if stored for a longer period effect, and affect the quality of baked items.

Guardox™ can delay oxidation and ensuring the original fragrance.

Figure 1 shows that spraying 2µg/cm² **Natap®** is effective to control the mold growth from 8 days to 16 days. **Figure 3** shows that adding 0.6% **Proteria® CP** can extend the freshness of bread from 8 days to 11 days, allowing you to achieve 6 additional days of mold free shelf life.

Meanwhile, most breads products will lose the freshness quality resulting from staling. **Figure 3, 4** shows that adding 15mg/kg **Amylax™** successfully delays the loss of elasticity and development of crumb firmness in white bread stored for 8 days.

Bread

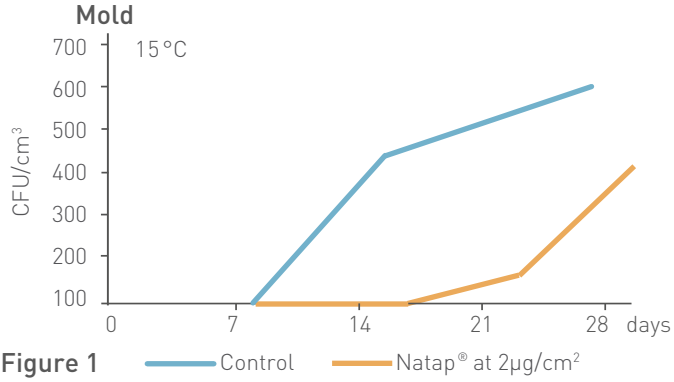


Figure 1

Figure 2

White bread

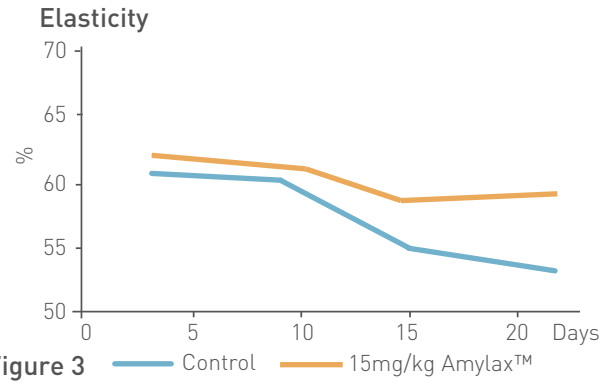


Figure 3

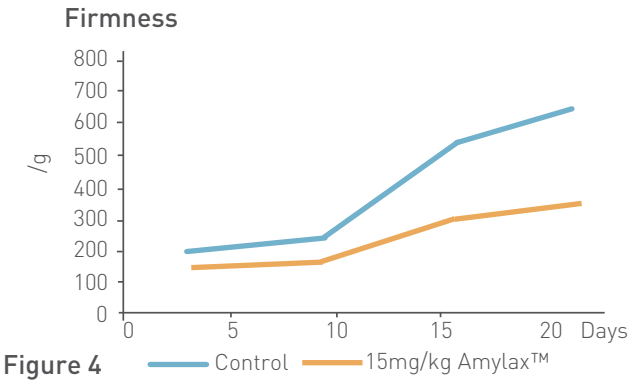


Figure 4

Fine bakery goods

Fine bakery goods, such as cakes, pastries, muffins, waffles, pancakes and sponge cakes, are usually packed and kept at ambient temperatures for two to 10 weeks, or even longer. High water activity, neutral pH and warm and humid storage conditions predisposed these products to mold and yeast spoilage and fat oxidation. Some inclusions, such as chocolate, fruit, jellies and jams, are also instrumental in increasing the level of water activity. Other inclusions such as fruit may even be a source of contamination, for example, Aspergillus niger spores may be present in fruit.

Proteria® CP has been proven sufficient for long-term preservation of packaged fine bakery goods stored at room temperature.

Cookies and Biscuits

Biscuits containing fats are subject to a natural deterioration during the shelf life. **Guardox™ RA** as secondary natural antioxidant activity, applied to biscuit stabilizes the fats, delaying oxidation and ensuring the original fragrance.

Figure 5 shows the addition of **Guardox™ RA** to biscuit, even under a thermal stress at 52°C, (accelerated shelf-life test), inhibits the peroxide value increase by 100%.

Refrigerated Dough Products

Most of refrigerated yeast-raised dough products are sold in a pre-proofed state for immediate baking when the pack is opened. The action of some flour enzymes does not stop and yeast loses some of its viability during freezing.

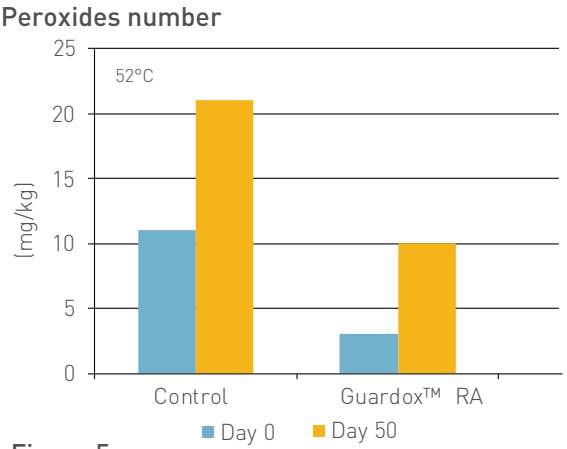


Figure 5

Table 1. Natural shelf life solutions for bakery

Applications		Solutions	Brands	Dosage	Labelled as
Breads	Pan bread, buns, tortillas, sugar-rich breads, steam bread, rye bread and pizza base	Preventing against mold	Natap®	1-5 µg/cm²	Natamycin
			Proteria® CP	0.5-1 mg/kg	Cultured wheat
			Planteria® RJ	0.25%	Raisin juice concentrate
		Crumb softening, retarded staling	Amylax™	15 mg/kg	Maltogenic amylase
		Moisture retention, retarded staling	White Fiber™	20-30 g/kg	Corn fiber
Biscuits & Cookies	Biscuits	Delay of oxidative rancidity	Guardox™ RA	0.3 g/kg	Rosemary extract
Fine bakery	Cakes, pastries, muffins, waffles, and pancakes	Preventing against mold	Natap®	1-5 µg/cm²	Natamycin
		Delay of oxidative rancidity	Guardox™ RA	0.3 g/kg	Rosemary extract
Refrigerated Dough products	Dumplings, steamed bun with fillings	Preventing against LAB and yeast	Epolyly ®HCL	100 mg/kg	Polylysine
			Planteria® CF	0.25%	Citrus fruit extract

BEVERAGE

2

YOUR CHALLENGES

pH regulation
Microbial control
Stabilizing natural colors (anthocyanins)
Delay of rancidity
Shelf life extension

BOOST MICROBIAL AND COLOR STABILITY

Consumers are now demanding more flavoured drinks with a longer shelf life. However, Long term storage stability of sweet and slightly acidic beverages has always been problematic as bacteria, yeast and moulds grow very well in such environments. Additionally, oxidation over time can result in flavour and colour loss.

Traditionally, Ascorbic acid (E300-304) is used to prevent browning, off-flavor and discoloration in fruit juice; Citric acid (E330) is used to stabilize anthocyanins and prevents microbial growth; Potassium sorbate (E202) is used to prevent *Alicyclobacillus* spp. in soft drinks and fruit drinks. and Sodium benzoate (E211) is used to prevent LAB and yeasts in carbonated drinks.

Handary offers natural innovative solutions which enable producers to control microbial spoilage and boost color stability in beverages.

CLEAN-LABEL ALTERNATIVES

Fixolor™ AT Cultured sugarcane juice
Guardox ™ BL Bamboo leaf extract
Mushria™ Mushroom extract
Planteria™ CF Citrus fruit juice

APPLICATIONS


Beer


Wine


Juices

Microbial control

New age beverages are more vulnerable to microbial spoilage due to the neutral pH, sweetness levels and the addition of plant extracts, vitamins, peptides or amino acids, and special fats or minerals. These include yeasts, molds and Gram-positive bacteria such as *Alicyclobacillus acidoterrestris, Lactobacillus* spp. and *Leuconostoc* spp.

Our solutions include **Natap®, Epolyly®, White NisinA®, Chitoly®,** and **Planteria™** that is cost-efficient to prevent bacteria, yeast and mold in all kinds of beverages.

Color stabilization

Natural colors such as anthocyanins (natural red-purple) are commonly acknowledged as unstable by nature and can consequently provide reduction of color intensity or color change (browning) in beverages. Depending on various factors such as pH, temperature and light, anthocyanin stability in acidified beverages can be increased by up to 50% by replacing citric acid with **Fixolor™ AT**.

Beer

Off-tastes and odors are produced most often by wild yeast (e.g. Sacc. cerevisiae and Sacc. pastorianus), lactic acid bacteria (e.g. Lactobacillus and Pediococcus) and oxidation. In addition, strictly anaerobic Gram-negative bacteria including Pectinatus cerevisiiphilius and Megashaera spp. are becoming more and more important as beer spoilers.

Addition of **Epolyly™** or **Planteria™** are effective against yeast and LAB in beer, while **Lysoch®** are effective against LAB and Gram-negative bacteria in beer. **Guardox™ BL** can be used as antioxidant in beer.

Wine

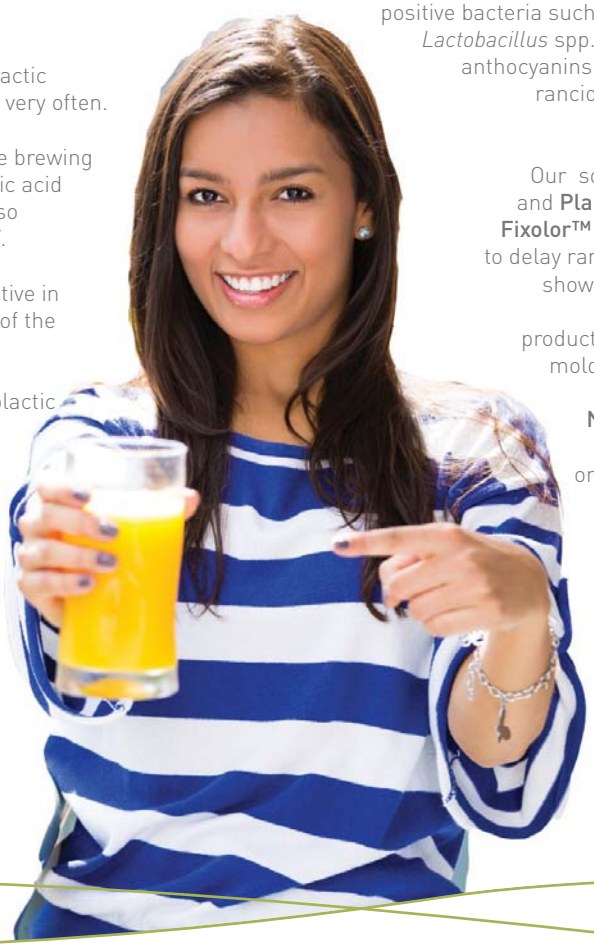
During the process of making wine, Malo-lactic fermentation induced by *lactobacilli* occurs very often.

White NisinA® added in the process of wine brewing which could not only inhibits the malo-lactic acid fermentation induced by *lactobacilli,* but also eliminates the harmful effect of *lactobacilli*.

Addition of 40 mg/L **Chitoly™ AB** was effective in controlling *Brettanomyces* yeast infections of the French pinot noir red wine.

The use of **Lysoch®** in wine stops the malolactic fermentation and reduces the dosage of sulphites. it can control lactic bacteria for making high quality wine. For examples,

In red wines, the main Gram-positive bacteria are lactic bacteria (LAB). Lactobacillus or Pediococcus carry out MLF. The end of MLF, all LAB may start consuming sugars producing high levels of VA, ruining the wine. Figure 3 shows replacing sulphur dioxide, 10 mg/L **Lysoch® G4** has a similar control effect of LAB as 100 mg/L egg-white lysozyme in red wine. (see figure 1)



Lactic acid bacteria

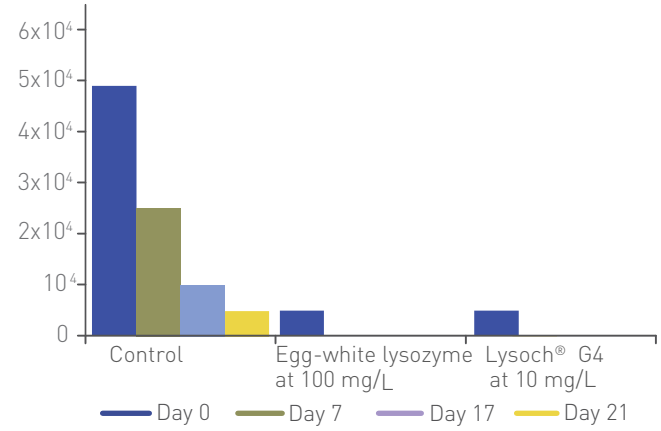


Figure 1

In white wine, **Lysoch®** can be used jointly with SO_2 to block the MLF. A 3-year testing in processes using Lysoch® have proven to reduce 30 to 40 mg/kg of SO_2. In sparkling wines, treated with **Lysoch®** have a better production of bubbles than those that have not been treated with lysozyme. The bentonite reacts with the **Lysoch®** administrated liberates some of the natural wine protein responsible for these small persisting bubbles.

Juice

The major elements of juices and juice-based beverages are sugars and organic acids, microorganisms which tolerate low pH and low water activity may survive and grow after pasteurisation. These include yeasts such as *Saccharomyces, Candida* and *Hansenula* spp., *Zygosaccharomyces* spp., molds such as *spergillus, Penicillium* and *Byssochlamys,* and Gram-positive bacteria such as *Alicyclobacillus acidoterrestris, Lactobacillus* spp. and *Leuconostoc* spp. In addition, anthocyanins are unstable, oxidation will cause rancidity and browning in fruit juice and juice-based beverage.

Our solutions include **Natap®, Epolyly®,** and **Planteria™** to control these bacteria, **Fixolor™ AT** to stabliz the color, **Guardox™** to delay rancidity. For examples, **Natap®** has shown the efficacy in preventing visible spoilage (surface growth or gas production) of a wide range of yeasts and molds in apple, orange, and pineapple juices. The addition of 10 mg/kg **Natap®** at 80°C for 10 minutes had an immediate reduction effect on yeast and mold counts in orange juice. After 1 week of storage at 2.5°C to 4°C, yeast and mold counts were undetectable and the sample remained unspoiled for the 8-week duration of the test. Control samples not containing **Natap®** were spoiled within 1 week.

30mg/L **Epolyly™ HCL** or 60mg/L **Planteria™** was added in fresh corn juice, the shelf life can be extended from 1 day to 2 days. And 50-100mg/L **Epolyly™ HCL or Planteria™** was added in bottled raspberry juice, the shelf life can be up to 30 days, stored at 37 ℃.

The addition of **White NisinA®** at a level of 5mg/l can restrict the growth of *Alicyclobacillus and prvent acidifying* in pomelo juice, fresh apple juice and orange juice which were stored at 21 °C. (see **Figure 2**)

Chitoly® OM shows the highly effective fining agent for apple juice, which can afford less than 15% turbidity products with 0.8 kg/m^3 of **Chitoly® OM** after 120 minutes. (see **Figure 3**)

Figure 4 demonstrates the anthocyanin (color) stability impact **Fixolor™ AT** and citric acid in strawberry and raspberry juice concentrate, the result displays that **Fixolor™ AT** significantly lowers rate of color changing over time, compared with the sample acidified with citric acid.

Guardox™ BL at dosage of 120 mg/L can resist oxidation of orange juice, make anthocyanin stable, and protecte VC more than 12 months at normal storage temperature. While the control showed a darkened color in the 8th month.

Fresh apple juice

Alicyclobacillus acidoterrestris

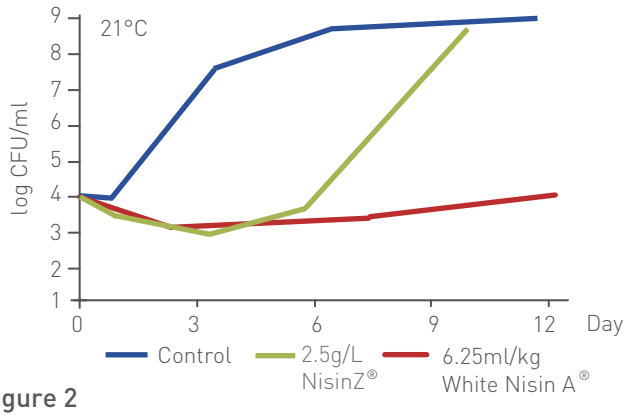


Figure 2

Apple juice

Turbidity

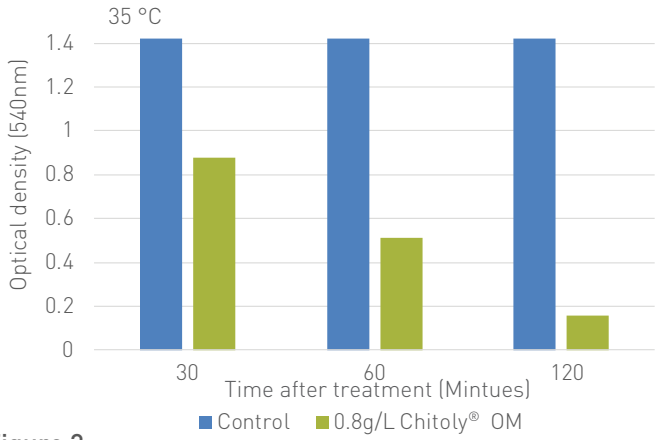


Figure 3

Strawberry and raspberry juice concentrate

Color changing

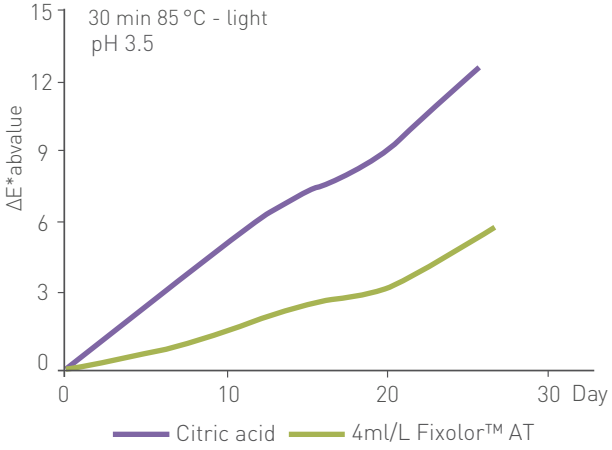


Figure 4

Tabel 1 Natural shelf life solutions for beverage

Applications		Solutions	Brands	Dosage	Labelled as
Beer	Beer	Control of LAB and Gram-negative bacteria	Lysoch®	5-15mg/L	Lysozyme
		Control of yeast and Lactic acid bacteria	Epolyly® HCL	50-150mg/L	Polylysine
			Planteria® CF	100-250mg/L	Citrus fruit juice
		Anti-browning	Guardox™ BL	0.3g/kg	Bamboo leaf extract
Wine	Red wine, White wine	Eliminate *Brettanomyces*	Chitoly™ AB	0.2g//L	N/A
		Control malo-lactic acid fermentation	White NisinA®	30-60mg/L	Nisin
			Lysoch® G4	2-10 mg/L	Lysozyme
Juice	Fruit juice	Control Alicyclobacillus and LAB	White NisinA	30-60mg/L	Nisin
		Clarifications	Chitoly™ OM	20-40ml/L	N/A
	Grape juice, apple juice	Stop Yeast fermentation	Natap®	40-60mg/L	Natamycin
			Planteria® CF	100-250mg/L	Citrus fruit juice
			Epolyly® HCL	50-150mg/L	Polylysine
	Orange juice	Growth control of mold and yeast	Natap®	25 mg/L	Natamycin
		Clarify and prevent mold and yeast	Chitoly™ AB	0.2g/L	N/A
		Clarification	Mushria™ OM	0.2g/L	Mushroom extract
	Juice concentrate	Control *Alicyclobacillus* and stabilize Anthocyanin (color) degradation	Fixolor™ AT	0.12-0.15ml/L	Cultured sugarcane juice

CULINARY

3

YOUR CHALLENGES

pH stability
Increase microbial stability
Enhance taste and flavor
Delay of rancidity
Sodium-reduction
Shelf life extension

CLEAN-LABEL ALTERNATIVES

Proteria™ Cultured sugar
Planteria™ CF Citrus fruit juice
Guardox™ OE Olive pulp extract

CREATING A LONGER LASTING AND TASTE SUPREME PROFILE FOR CULINARY

Clean and taste supreme lead the top consuming trends of culinary product, however, manufacturers face not only the risk of oxidation and the associated off-flavours, but also bacteria, molds, yeasts and, even more malevolent, health-threatening pathogens.

Controlling pH and using antimicrobial in these products is the key hurdles to extend shelf-life stability and preventing spoilage caused by microorganism. Conventional ways of preservation such as acetic acid are to provide strong acidity, but compromising on taste.

Our solutions include **Epolyly®, NisinZ®, Proteria®, Planteria™, Guardox™,** and **Antimix™** can be used to increase the micrbobial stability and enhance flavor for longer shelf life of culinary.

APPLICATIONS

Ketchup | Mayonnaise | Sauces, dips dressings | Soup and broths | Ready to eat meals | Pasta & Noodles

Dips, Sauces and Dressings

Dips, sauces and dressings are generally mixed. In these products, issues such as gas formation and "blowing" or "swelling" of containers, off flavours and rancidity are common problems. Gram-negative bacteria such as *Pseudomonas, Salmonella, E. coli* and other coliforms are killed by pasteurisation. However, heat-tolerant Gram-positive organisms such as some lactic acid bacteria and the spore formers *Bacillus* and *Clostridia,* are naturally present in spices, vegetables and other raw agricultural commodities.

Our solutions include **Epolyly®, NisinZ®, Proteria®** and **Antimix™** for controlling microbial spoilage and pathogens and **Guardox™ OE** for delaying rancidity. for examples,

Case 1. Soy sauce

Spoilage organisms in soy sauce, such as bacteria (e.g. *Lactobacillus* spp.), fungi (e.g. *Mucor* spp. and *Saccharomyces* spp.) are naturally abundant. 80mg/kg **Epolyly® HCL** was added in soy sauce which can significantly inhibit various microbial spoilage and extend the shelf life. And the addition of 40ppm **Antimix™ EV** has a strong inhibition rate against a total bacterial population in soy sauce (see **Figure 1**).

Case 2. Pasta sauce

Pasta sauce is reduced in sodium content by 25% when adding 2% of **Proteria® SR**, which gives a flavor boost to and shelf life extension.

Case 3. Miso

150mg/kg **Epolyly™ HCL** was added in Miso that can significantly inhibit various microbial spoilage and extend the shelf life.

Case 4. Mayonnaise

Mayonnaise is produced with a stable emulsion of oil, egg yolk, vinegar or lemon juice and herbs or spices. Mayonnaise, a high-oil containing product, is susceptible to oxidation resulting in quality deterioration, Growth of heterofermentative *Lactobacillus* results in visible spoilage. Gas formation, and a decrease in pH. Yeasts may cause spoilage by gas formation and formation of brownish colonies on the surface of mayonnaise, which may appear as small oil droplets. *Z.bailii* can cause gassy spoilage (CO_2 and alcohol) in mayonnaise.

Our clean-label solution - **Proteria® CA** present the inhibitory effect against *Lactobacillus* spp. (see figure 2) and yeast. Compared to control, growth of both microorganism is inhibited, and shelf life of mayonnaise is extended to more than 90 days. Mayonnaise prepared without antioxidants had a shelf-life at room temperature of approximately 1 day. **Guardox™ OE** had proven effectively against oxidative off-odor development at room temperature of above 120 days.

Soy sauce

Total bacterial population

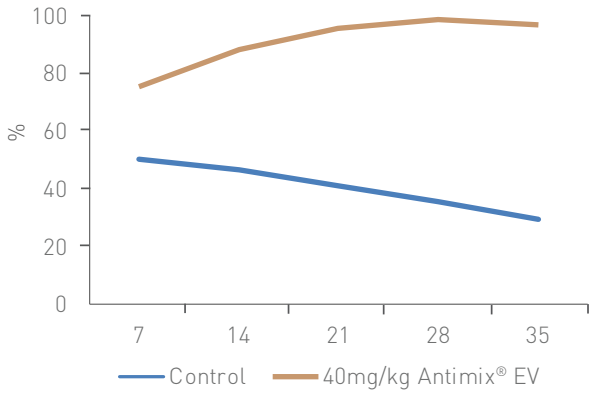


Figure 1

Mayonnaise

Lactobacillus spp.

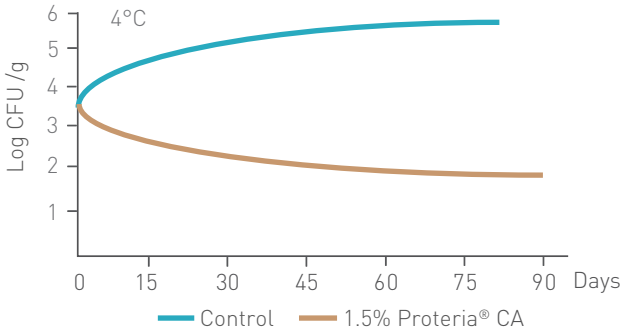


Figure 2

While the flavour of mayonnaise has been improved. Table compares the pH of mayonnaise when applied with vinegar and Proteria® CA

Ingredient	pH of final product	Result
1.0% Proteria® CA	4.5, mild taste	90 days of shelf life
20 ml vinegar (6% w/v acetic acid) per fresh egg yolk	3.6-4, sour taste	40 days of shelf life

Salad dressing

Salad dressings are oil-in-water emulsions stabilized with thickeners. In order to meet consumer demands with a low-fat content, the water phase became a critical microbiological concern when the oil content decreases. The microflora causing salad dressings spoilage consists in a few species of *Lactobacillus, Saccharomyces* and *Zygosaccharomyces. Lactobacillus fructivorans* is the predominant bacterium found in spoiled products. **Figure 1** shows that 0.5% **Proteria® CA** inhibit *L. fructivorans* for 100 days stored at 30°C in model systems containing 230 g/kg oil.

Ketchup

Lactobacilli are the predominant spoilage organisms in ketchup, such as *L. brevis, L mannitopeum* and *L. plantarum*. By stabilizing pH and enhancing the hurdle, **Proteria® CA** can effectively control bacteria spoilage, as well as maintaining freshness and authentic appeal of Ketchup.

Prepared Salads

Commercially prepared salads generally contain cut or shredded vegetables and, sometimes fruits and nuts, mixed together with a dressing. Other salads may contain pasta and meats such as chicken, seafood, and ham.

The typical pH ranges are from 4 to 5.7. While all of these salads will support the growth of spoilage organisms including yeasts and molds, the higher pH and protein-containing salads are particularly vulnerable to *Listeria* growth.

Our clean-label solution **Proteria® CA** and **Planteria™ CF** can inhibit yeast and *lactobacillus* spp. in prepared salads.

Potato salad

Potato salad, stored at 10°C, the first evidence of spoilage was formation of gas caused by *S. exiguus* after 10 days. But the large numbers of *Lactobacillus* spp. which developed may also have contributed. Growth of yeasts identified as *Candida* spp. also occurred and the mold Geotrichum candidum multiplied and formed surface colonies on the potato salad after storage for 18 days.

Figure 2 shows that 1.5% **Proteria® CA** can inhibit *L.lantarum* for 60 days in potato salad.

Salad dressing

Lactobacillus fructivorans

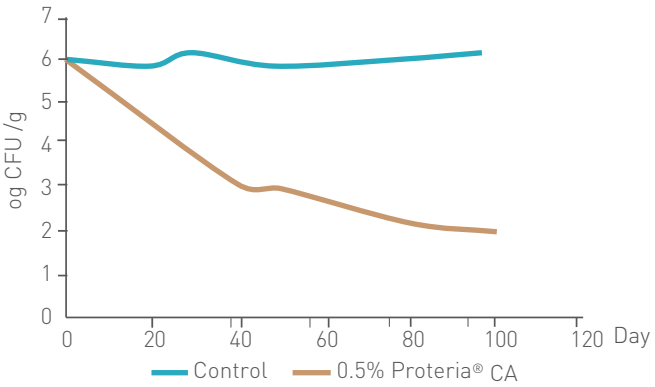


Figure 1

Potato salad

Lactobacillus plantarum

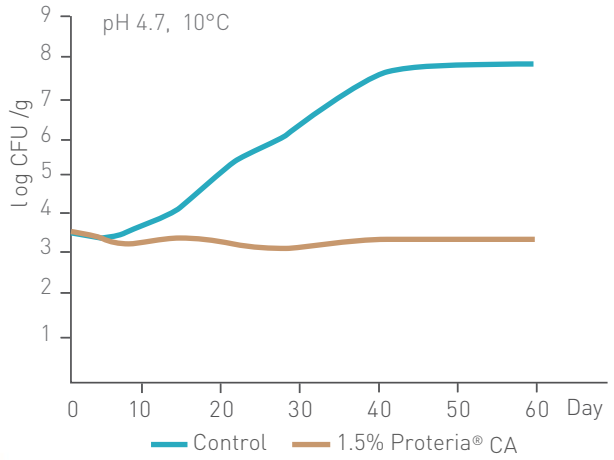


Figure 2

Ready to eat Meals

Ready to eat meals may lose flavor during the heating process. Heat processed products may contain heat-resistant spore-forming bacteria, such as *Bacilli* and *Clostridia*. Cold processed products may be exposed to lactic acid bacteria, *Listeria* and other pathogenic organisms during processing.

Our solutions includes **Epolyly®**, **Proteria®** and **Planteria®** for controlling these microbial spoilage and pathogens, for examples,

Case 8. RTE (Potato, spinach, meat)

Figure 4 shows that 1.5% **Proteria® CA** is effective against *Pseudomonas lundenis* in ready to eat meals (potato, spinach, meat).

Case 9. Surimi

Surimi products are mainly spoiled from spore-forming bacteria and turning yellowish with bad smell. **Figure 5** shows that the addition of **Epolyly™** can reduce the population of total bacteria, and the shelf life was extended to 6 days, while the control was only 2 days, stored at 5°C.

Case 10. Canned Soup

Some soups often contain very heat-resistant spores. Adding **NisinZ®** at 100-200mg/kg will control the reproduction of thermophilic bacterial spores.

Pasta and Noodles

Refrigerated fresh pasta may have a reduced shelf life due to mold and lactic acid bacteria. In a filled product, such as ravioli, the mold tends to grow at the interface between the pasta and the filling.

Our solutions include **Epolyly®** and **Antimix™** can be empolyed as antimicrobial hurdles in both the pasta and the filling.

RTE (Potato, Spinach, Meat)

Pseudomonas lundenis

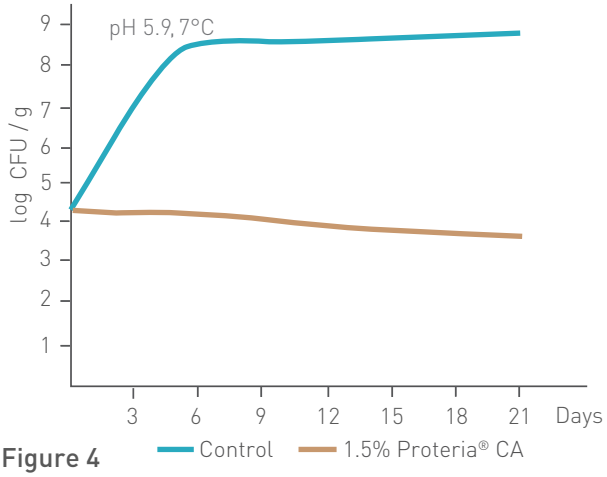


Figure 4

Surimi

Total bacterial population

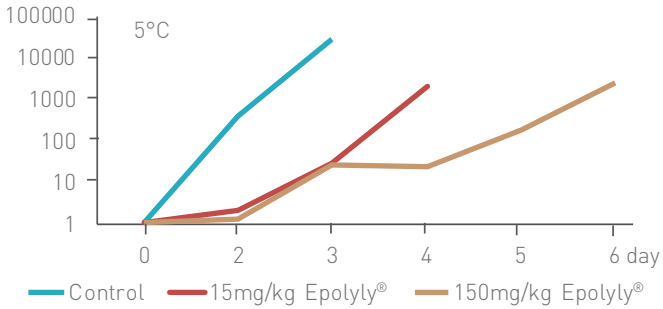


Figure 5

Table 1. Natural shelf life solutions for culinary

Applications		Solutions	Brands	Dosage	Labelled as
Dips, Sauces and Dressings	Soy sauce	Inhibition of Total bacterial population	Epolyly® HCL	80mg/kg	Polylysine
			Antimix™ EV	40mg/kg	Polylysine, Vinegar
	Pasta sauce	Sodium-reduction	Proteria® SR	1-1.5%	Cultured sugar
	Miso	Inhibition of Total bacterial population	Epolyly™ HCL	150mg/kg	Polylysine
	Mayonnaise, Salad dressing, Ketchup	Prevention against *Lactobacillus* and yeast	Proteria® CA	1.5%	Cultured sugar
		Delay of rancidity	Guardox™ OE	0.03%	Olive pulp extract
Prepared Salads	Potato salad	Prevention against *Lactobacillus* spp. and yeast	Proteria® CA	1.5%	Cultured sugar
			Planteria™ CF	150mg/kg	Citrus fruit extract
Ready to eat Meals	RTE meals (Potato, spinach, meat)	Prevention against *Pseudomonas lundenis*	Proteria® CA	1.5%	Cultured sugar
	Ready-to-eat rice (meat, vegetable, sauce)	Inhibition of total bacterial population	Epolyly®	50mg/kg	Polylysine
	Boiled rice	Inhibition of total bacterial population	Epolyly® HCL	125mg/kg	Polylysine
			Planteria™ CF	150mg/kg	Citrus fruit extract
	Surimi	Inhibition of Total bacterial population	Epolyly® HCL	150mg/kg	Polylysine
	Pasteurized chilled soup	Inhibition of *Bacillus* spp.	NisinZ®	100mg/kg	Nisin
	Canned soup (lecso)	Inhibition of Flat sour spoilage bacteria	Epolyly® HCL	125mg/kg	Polylysine
	Dried stewed Tofu	Inhibition of yeast, LAB, *Salmonella*	Epolyly®HCL	90mg/kg	Polylysine
Pasta and Noodles	Fresh pasta (e.g. ravioli)	Prevention against mold and lactic acid bacteria	Antimix™ CV	120mg/kg	Citrus fruit extract, vinegar
			Epolyly®	150mg/kg	Polylysine
	Refrigerated cooked noodles	Inhibition of LAB, *Salmonella*	Epolyly®	80mg/kg	Polylysine

DAIRY

4

YOUR CHALLENGES

Prevention against yeast and mold
Prevent flavor loss
Delay of rancidity
Shelf life extension

CLEAN-LABEL ALTERNATIVES

Proteria® Cultured wheat
Planteria™ Citrus fruit extract
Befresh™ Antifungal culture

ENSURING A LONGER SHELF LIFE AND HIGH LEVEL FOOD SAFETY OF DAIRY

Milk is an excellent medium for the growth of a variety of bacteria, yeast and molds. Even in modern day dairy products operating under good GMPs, re-contamination may also occur after pasteurisation, particularly with yeast and mold spores, *Pseudomonas* and some Gram-positive psychrophiles such as *Listeria* - not to mention *E. coli* and *Salmonella*.

To control spoilage and pathogenic microorganisms, the dairy industry has come a long way, primarily looking at natural alternative to chemical preservatives.

Our natural antimicrobial solutions include **Natap®, Natalac®, NisinA®, NisinZ®, Epolyly®, Lysoch®, Befresh™, Planteria™** and **Antipack™** which provide natural preservation for shelf life extension of dairy products.

Applications

Milk

Cheese

Fresh fermented milk products

The wide array of dairy challenges producers is to find the best ways to prevent the entry of microorganisms, troublesome spoilage include aerobic psychrotrophic Gram-negative bacteria, yeasts, molds, heterofermentative *lactobacilli,* and spore-forming bacteria.

Psychrotrophic bacteria can produce large amounts of extracellular hydrolytic enzymes, and the extension of recontamination of pasteurized fluid milk products with these bacteria is a major determinant of their shelf life. Fungal spoilage of dairy is manifested by the presence of a wide variety of metabolic by-products, causing off-odors and flavors, in addition to visible changes in color or texture. Coliforms, yeasts, heterofermentative lactic acid bacteria, and spore-forming bacteria can all cause gassing defects in cheeses.

With more than 10-year experiences, we can provided a total antimicrobial solutions for a variety of dairy products as shown on **Table 1**.

Tabel 1 An overview of antimicrobial solutions for dairy

Food	Spoilage microorganism	Our solutions
Pasteurized milk	Psychrotrophs, spore formers	Planteria®
Concentrated milk	Spore-forming bacteria, osmophilic fungi	Planteria®
Butter	Psychrotrophs	Lyosch®, Epolyly®, Planteria®
Cultured buttermilk, sour cream	Psychrotrophs, coliforms, yeasts, lactic acid bacteria	Epolyly®, Lysoch®, Planteria®
Cottage cheese	Psychrotrophs, coliforms, yeasts, molds	Natap®, Natalac®, NisinZ®, Lysoch®
Yogurt, yogurt drinks	Yeast, mold, coliforms	Natalac®, Befresh™
Cream cheese, processed cheese	Yeast, mold, spore-forming bacteria	Natap®,Natalac™, NisinZ®, Lysoch®
Soft, fresh cheeses	Psychrotrophs, coliforms, yeast mold, lactic acid bacteria	Natap®, Natalac®, NisinZ®, Epolyly®, Lysoch®, Planteria®
Ripened cheeses	Yeast, mold, lactic acid bacteria, spore-forming bacteria	Natap®, Natalac®, NisinZ®, Lysoch®

Psychrotrophs

Psychrotrophic microorganisms represent a substantial percentage of the bacteria in raw milk, *Pseudomonads* can reduce the diacetyl content leading to a "green" or yogurt-like flavor in buttermilk and sour cream; Cottage cheese is marginally favorable for the growth of Gram-negative psychrotrophic bacteria. And Psychrotrophs can decrease the yield and quality of cheese curd.

Our solutions include **Epolyly®, Lysoch®** and **Planteria™** for inhibiting Psychrotrophic bacteria growth in raw milk-based products.

Lactic Acid Bacteria

Excessive viscosity can occur in buttermilk and sour cream from the growth of lactococci, resulting in a yogurt-like flavor.Heterofermentative lactic acid bacteria such as *lactobacilli* and Leuconostoc can develop off-flavors and gas in ripened cheeses. Lactococcus lactis subsp. lactis can produce small amounts of gas in cheeses. Cracks in cheeses can occur when excess gas is produced by certain strains of *Streptococcus thermophilus* and *Lactobacillus helveticus.*

Our natural antimicrobial solutions include **NisinA®, NisinZ®, Epolyly®, Lysoch®,** and **Planteria™** which provide natural preservation for shelf life extension of dairy products.

Fungi

Yeasts can grow well at the low pH of cultured products such as in buttermilk, sour cream, yogurt and fermented milks, cheese and can produce off-flavors described as fermented or yeasty;

Molds can grow well on the surfaces of cheeses when oxygen is present causing an off-odor and flavor described as "kerosene." For example, Cream cheeses are susceptible to spoilage by heat-resistant molds such as *Byssochlamys nivea.*

Our solutions include **Natap®, Natalac®, Epolyly®, Lysoch®, Befresh™, Planteria™ and Antipack™** inhibit or prevent mold growth in different dairy products.

Spore-Forming Bacteria

Raw milk is the usual source of spore-forming bacteria in finished dairy products. The most common spore-forming bacteria found in dairy products are *Bacillus spp.*. For examples, *B. circulans* was the dominant spoilage microbe in aseptically packaged pasteurized milk. *Bacillus stearothermophilus* can survive ultra-high- temperature treatment of milk. This bacterium produces acid but no gas, hence causing the "flat sour" defect in canned milk products.

In ripened cheeses, like Gouda, Emmental, Swiss, Cheddar, Grana, the growth of clostridia, especially *Clostridium tyrobutyricum*, can produce gas and butyric acid.

Our solutions include **NisinZ®, Lysoch®** and **Planteria™** can inhibit the spores growth in cheese products.

Table 2 Causes of gassiness in different types of cheese

Organism	Cheese	Defective time
Coliforms	Raw milk pasta filata cheese	Early blowing
Yeasts	Raw milk Domiati Egyptian), Camembert, blue-veined, Feta	Early blowing
Lactobacillus fermentum	Provolone, mozzarella	Late blowing
Heterofermentative Lactobacilli	Cheddar, Gouda, Saint Paulin, Oka	Late blowing
Propionibacteria	Sbrinz (Argentinean)	Late blowing
Clostridium tyrobutyricum	Gouda, Emmental, Swiss, Cheddar, Grana	Late blowing
Eubacterium sp.	Cheddar	Late blowing

Milk, dairy drinks and desserts

The growth of multiple spoilage and pathogenic bacteria, yeast and molds and extensive oxidation is particularly unavoidable in many of milk, dairy drinks & desserts products.

Our clean-label solutions include **Planteria™** and **Guardox™** can effectively control the bacterial and oxidative spoilage in these types of milk, dairy drinks & desserts products.

Pasteurised milk

With the addition of 100 mg/l in pasteurized milk, the shelf life can be extended to 7 days at 4 °C and the total bacterial count didn't exceed the standard until the 14th day. Compared with a shelf life of 3 days without **Planteria™**.

Guardox™ BL added in 75 mg/L, the anti-OH capacity of milk is 200% in the control group, endowing products with a new health concept.

Chocolate flavoured milk

When 150mg/kg **Planteria™** was added to Chocolate flavoured milk, it can effectively inhibit *Bacillus stearothermophilus* and thermophilic spoilage organisms the shelf life could be extended to 6 weeks even at 45 °C.

Soya milk

The shelf life of packed soy bean milk extended from 4-10 days at 5-8 °C, with the addition of 100mg/kg **Planteria™**. When boiled, the soy milk maintained full flavor and no sediment was observed.

Dairy desserts

The addition of **Planteria™** to these products, in conjunction with correct heat processes, can effectively improve the shelf life of these products during distribution and storage.

Cheese

Most of raw milk natural cheeses contain lactic acid bacteria, yeast and molds, which are generally harmless. Microfiltration and refrigeration temperatures limit the presence of most of those microorganisms. However, some osmo-tolerant spore-formers, such as *Bacillus* and *Clostridium* spp., Psychrotrophic bacteria such as *Listeria*, and Gram-negative bacteria such as *Salmonella* or *E.coli* may survive the ripening period.

Under refrigerated storage conditions, Psychrotrophic bacteria can continue to grow and produce proteolytic and lipolytic enzymes which breakdown milk protein and fat, giving rise to an off-flavour and off-odour product.

Ripened cheese

Many cheeses are ripened or matured for several months in ripening rooms at temperatures in the range of 10°C to 12°C, and during this period they are very susceptible to mold colonization and surface growth. When **Natalac®** is added by immersion it ensures a complete protection. It is recommended to prevent bacterial growth to add 10% salt in the solution.

Shredded cheese

1.5mg/ml **Natalac®** suspension is used to treat shredded cheese, finely sprayed onto 1 metric ton of shredded cheese using a tumbler and a commercial spray system, will provide protection against yeast and mold spoilage in modified atmosphere or vacuum-packed packs of shredded cheese.

Butter cheese

Natalac® at 60mg/kg was evaluated effective against fungal growth on butter and cheese samples stored 30 days, at 7°C.

Italian caciotta cheese

Italian Caciotta cheese by immersion in 100mg/L **Natap®** was found effective in controlling mold growth, with no effect on the population of desired ripening surface bacteria which produce the red color of Italian caciotta cheese.

Cottage cheese

The **Natalac®** at 80 mg/kg was added through curd wash water or in the cheese dressing of cottage cheese. Studies shows that **Natalac®** in the cottage cheese dressing was the most effective against yeast and mold such as *A. niger* and *S. cerevisiae* to extend the shelf life.

Semi-hard cheese

Figure 1 shows that 20mg/kg **Natalac®** or 10mg/kg **Natap®** effectively inhibit the growth of total yeast and molds on semi-hard cheese.

Processed cheese

Process cheese is susceptible to *Bacillus* spp. and "late blowing" caused by *Clostridia* spp., **Figure 2** shows both **NisinA®** and **NisinZ®** are active against all heat-resistance spores when added into processed cheese. At the same dosage, **NisinZ®** is more efficient than **NisinA®**.

Gouda cheese

Yeast such as *Zygosaccharomyces rouxii* has unusual physiological characteristics which are largely responsible for their ability to cause cheese spoilage.

Figure 3 shows that **Lysoch® F4** at 10 mg/L can strongly inhibit yeast in Gouda cheese.

Butyric fermentation or "late blowing" in Gouda cheese is a ripening defect caused by *Clostridium tyrobutyricum*. Its growth leads to the formation of H_2 and CO_2 gases, cracks and slits in the cheese, and an abnormal aroma and cheese flavour.

Figure 4 shows that of **Lysoch® G4** at 5mg/L has a stronger inhibition of *Clostridium tyrobutyricum* than 40mg/L. **Lysoch® L 4** in Gouda cheese. **Figure 5** shows that addition of 2 g/L **Lysoch® G4** in Gouda cheese effectively inhibits butyric acid bacteria and prevents the pH decrease.

Yeast and mold

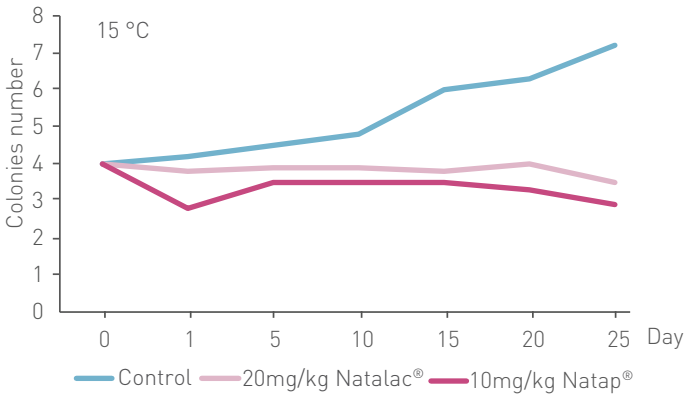


Figure 1

Clostridia

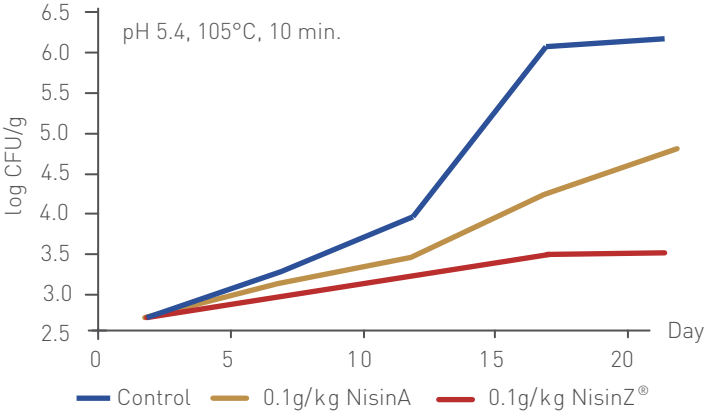


Figure 2

Zygosaccharomyces rouxii

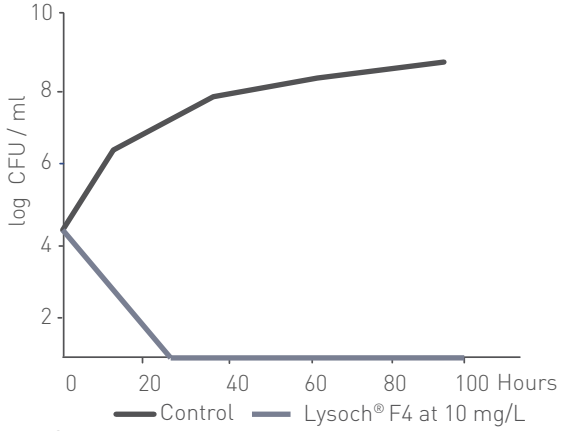


Figure 3

Clostridium tyrobutyricum

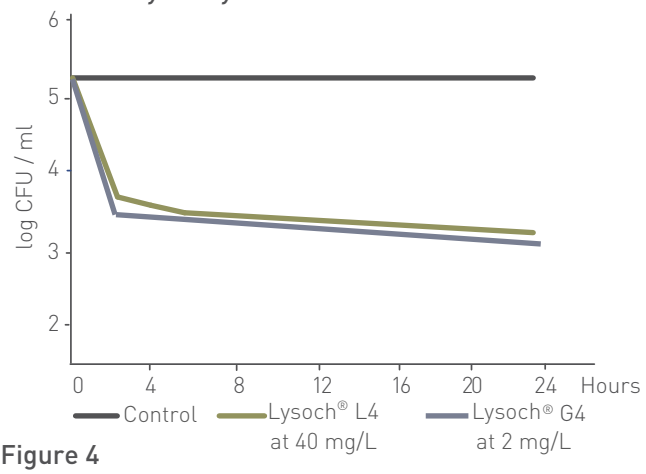


Figure 4

Fresh fermented dairy

Fermented dairy products are produced by starter cultures, such as *Leuconostoc* spp. and yeasts. The low pH level of many of these products and the use of starter cultures inhibit the growth of many spoilage and pathogenic bacteria. However, ubiquitous yeasts and molds are unavoidable spoilage organisms. Additionally, in long, slow lactic fermentations, *Pseudomonas* and Enterobacter may proliferate and spoil the finished product. In sweetened and flavoured fresh fermented dairy products, the use of fruit, chocolate, fibre and other ingredients may promote unwanted heterofermentative rope and gas-forming bacteria and facilitate aerobic yeast and molds growth.

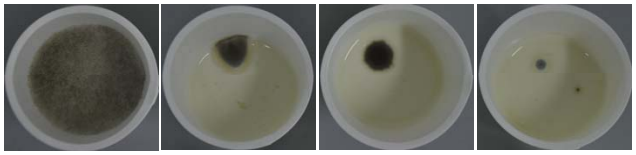
Our solution include **Natap®, Natalac®,** and **Befresh™ AF** effciently against yeast and mold.

Yogurt

Figure 5 shows when 10 mg/kg **Natalac®** or 5 mg/kg **Natap®** was added in yogurt, yeast and mold were completely inhibited.

Figure 6, 7 shows that yogurt made with and without **Befresh™ AF** were held for 60 days at 5°C. the yeast spoilage was inhibited, which leads to blowing, off-flavors and off-odors during the shelf life of yogurt. while Figure 5 shows that the mold such as *Penicillium* spp. was inhibited, which causes highly visible and pigmented growth in yogurt.

Picture 2 shows the inhibiting effect of **Befresh™ AF** on molds in yogurt (7 days at 25°C, inoculate 1-2 mold spores on the surface of each sample).



Control | Befresh™ AF at 10u/100L | Befresh™ AF at 15U/100L | Befresh™ AF at 20U/100L

Picture 2

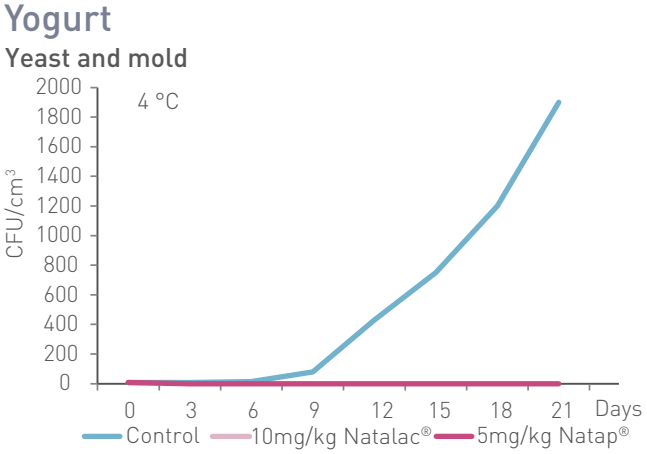


Figure 5

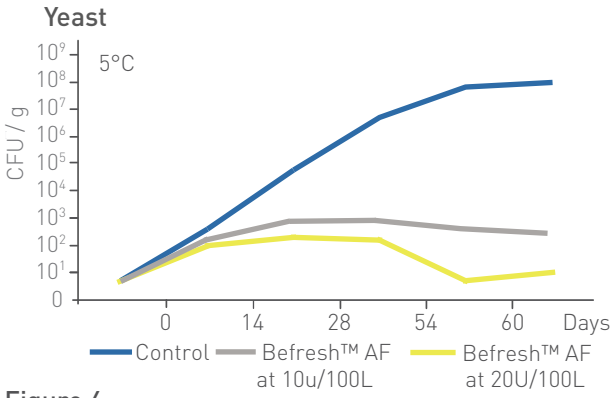


Figure 6

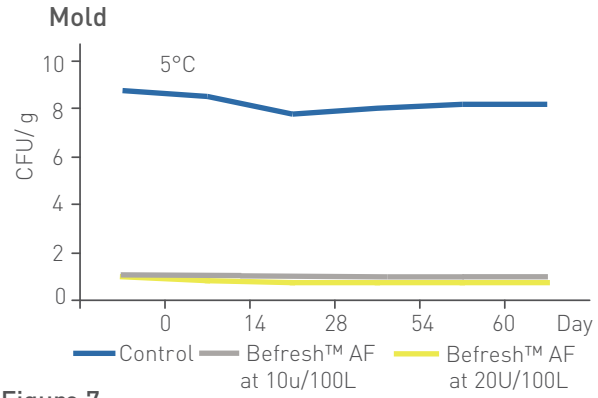


Figure 7

Table 3. Natural shelf life solutions for dairy

Applications		Your challenges	Ingredients	Dosage	Labelled as	Clean-label	Efficiency
Milk, dairy drinks and desserts	Pasteurized milk	Psychrotrophs, spore formers	Planteria™	0.5%	Citrus fruit extract	High	Medium
	Concentrated milk	Spore-forming bacteria, osmophilic fungi	Planteria™	0.5%	Citrus fruit extract	High	Medium
Cheese	Cottage cheese	Psychrotrophs, coliforms Yeast, molds	Epolyly®	150mg/kg	Polylysine	Medium	High
			Lysoch®L4	0.1ml/kg	Lysozyme	Medium	High
			Natap® /Natalac®	20-40 mg/kg	Natamycin	Low	High
			Lysoch® F4	10 mg/kg	Lysozme	Medium	High
	Cream cheese, processed cheese	Yeast, mold, Spore forming bacteria	Natap®/Natalac®	20-40mg/kg	Natamycin	Low	High
			Lysoch® F4	10 mg/kg	Lysozme	Medium	High
			NisinZ®	80mg/kg	Nisin	Low	High
			Lysoch® L4	0.1ml/kg	Lysozyme	Medium	High
	Soft, fresh cheeses	Yeast, mold, Psychrotrophs,Coliforms, Lactic acid bacteria	Natap®/ Natalac®	20-40 mg/kg	Natamycin	Low	High
			Lysoch® F4	10 mg/kg	Lysozme	Medium	High
			NisinZ®	80mg/kg	Nisin	Low	High
			Lysoch® L4	0.1ml/kg	Lysozyme	Medium	High
			Planteria™	0.5%	Citrus fruit extract	High	Medium
	Ripened cheeses	Yeast, mold,	Natap® / Natalac®	20-40 mg/kg	Natamycin	Low	High
			Lysoch® F4	10 mg/kg	Lysozme	Medium	High
		Lactic acid bacteria, Spore-forming bacteria	NisinZ®	80mg/kg	Nisin	Low	High
			Epolyly®	150mg/kg	Polylysine	Medium	High
			Lysoch® L4	0.1ml/kg	Lysozyme	Medium	High
Fermented milk products	Yogurt, yogurt drinks	Yeast, mold, coliforms	Natap® / Natalac®	20-40 mg/kg	Natamycin	Low	High
			Befresh™ AF	10u/100L milk	Lactic acid bacteria	High	High
	Cultured buttermilk, sour cream	Psychrotrophs, Coliforms, yeasts, lactic acid bacteria	Epolyly®	150mg/kg	Polylysine	Medium	High
			Lysoch® L4	0.1ml/kg	Lysozyme	Medium	High
			Planteria™	0.5%	Citrus fruit extract	High	Medium

FRUIT & VEGETABLES

5

KEEPING A LONGER FRESHNESS WITH ORGANIC EXTRACTS

It is also estimated that about 20% of all fruits and vegetables produced is lost each year due to spoilage. Harvested fruits and vegetables are metabolically active, undergoing ripening and senescence processes must be controlled to prolong postharvest quality. while fresh-cut fruits and vegtables have a shorter shelf life than their whole counterparts because of enzymatic browning, texture decay, rapid microbial growth, weight losses and undesirable volatile production. How to hold on the freshness in natural way is becoming a great challenge that manufacturers face.

Our natural solutions include **Natasan™, Koatilm™** and **Antipack™** provide natural preservation for shelf life extension of fruit and vegetables.

YOUR CHALLENGES

- Fungi decay
- Browning
- Ripening and senescence
- Long-lasting freshness

CLEAN-LABEL ALTERNATIVES

- Mushria™ Mushroom extract
- Planteria™ Citrus fruit extract
- Guardox™ Acerola extract
- Chitoly™ Fungal chitosan

Applications

Fresh whole
Fruit & vegetables

Fresh-cut
Fruit & vegetables

Processed
Fruit & vegetables

Postharvest fruit and vegetables

Losses due to postharvest disease may occur at any time during postharvest handling, from harvest to consumption. Fresh fruit and vegetables remain metabolically and developmentally active to growth, maturation, physiological maturity, ripening, and senescence. Fungal decay and browning are important affecting factors in all fresh fruit and vegetables. For examples,

Pineapple and banana are one of the most popular tropical fruits in the world and mainly exported worldwide. However, fungal diseases destroy more than 30% of the crop yield. Traditionally, synthetic fungicides are used to control fungal diseases, but limited to the regulations of exported countries. Fruit packers have to choose natural alternatives to control fungal diseases.

Our solutions include **Koatilm™**, **Natasan™** and **Antipack™** are perfect coating anf film to form complete surface treatment of postharvest fruit and vegetables.

Banana

After cutting the banana hand from the main stem, crown rot disease of bananas, caused by *Colletotrichum musae, Fusarium* spp. and *Lasiodiplodia theobromae* can cause extensive postharvest losses. Figure 1 shows that application of **Natasan™** and **Kotilm™ FV** significantly decreased disease severity.

Disease Severity

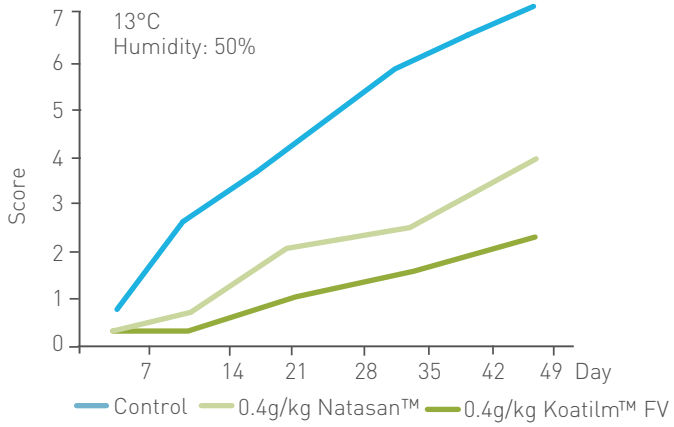


Figure 1

Banana dipping test in different solutions of fungicides like **Kotilm™ FV**, helped maintain a good fruit quality during 25 days of storage in low temperatures and during 8 days at room temperature.

Comparison

Picture 1

Pineapple

Black rot, caused by the fungus *Thielaviopsis paradoxa*, is typically the most common and severe postharvest disease of pineapple. Infestation started at the stalk-end of the pineapple after 8 to 12 hours, after wounding and symptoms begin as a soft, watery rot which later darkens due to growth of the-dark-"otor"a fungal mycelium and spores.

Disease Severity

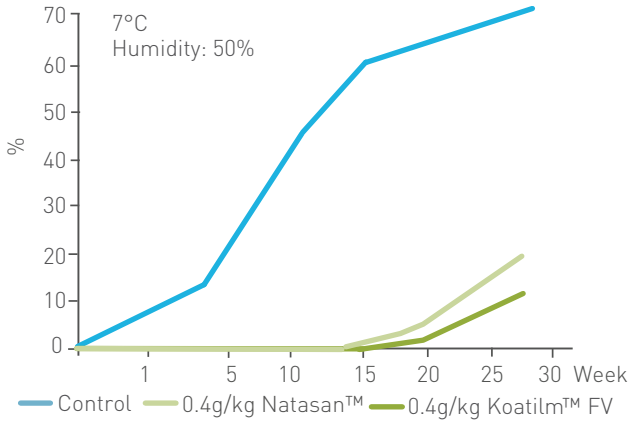
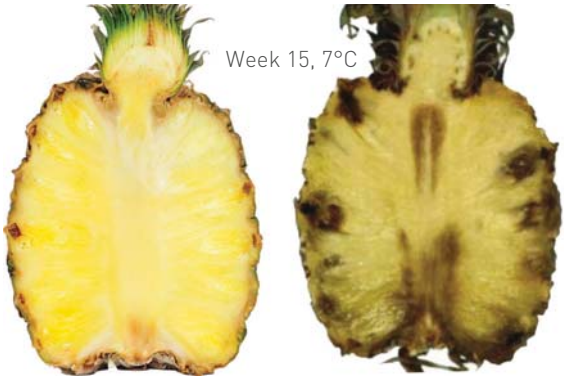


Figure 2

Control of black rot is achieved by minimizing mechanical injury to the fruit coupled with appropriate fungicides. Figure 2 shows that dipping pineapple with 0.4g/kg **Natasan™** or 0.4g/kg **Kotilm™ FV** for 10 seconds within 5 hours after harvest, stored at 7°C, can minimise the black rotting, which helped maintain a good fruit quality during 15 weeks of storage

Comparison



Picture 2

Fresh-cut salads

The increasing demands of fresh-cut salads are due to their fresh-like character, convenience, and human health benefits, but minimally processed products become more perishable.

Our solutions include **Guardox™ AE** and **Koatilm™ FV3** are specially designed to delay decay and browning in fresh-cut salads.

Fresh-cut apple

Figure 3,4 monstrate that **Koatilm™ F V 3** effectively decrease Ppolyphenol oxidase (PPO) activity, enzymatic browning and decrease decay rate of fresh-cut apples during storage.

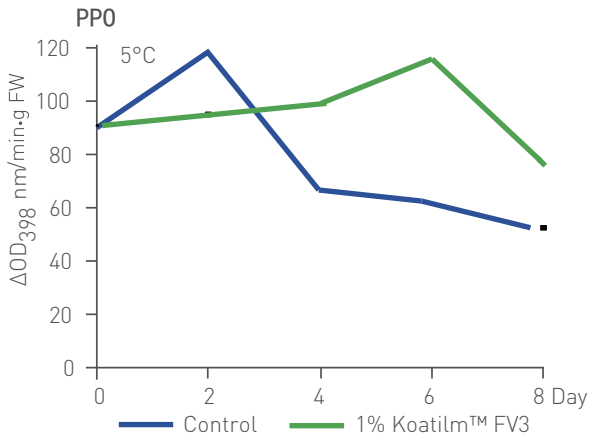


Figure 3

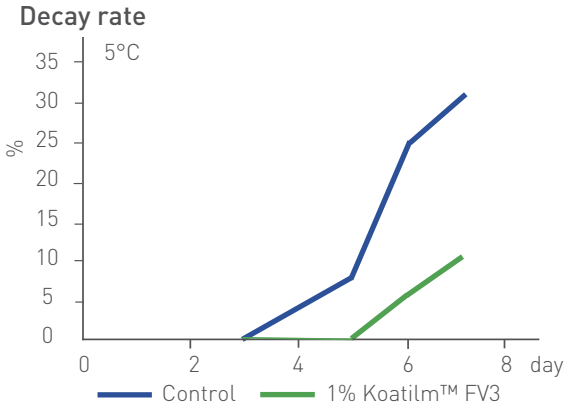


Figure 4

Fermented, acidified and pickled Vegetables

Conventionaly, organic acid and sodium chloride (NaCl) are used as the primary preservatives for most types of products of fermented, acidified and pickled vegetables. However, high salt or sugar will be harmful to consumer's health.

Our clean-label solutions - **Proteria®** and **Guardox™ AE** can be used alone or together to extend shelf life significantly.

Pickled Cucumber

To decrease salt and sugar concentration to 7% with the addition of 0.4% **Proteria® SR** in pickled cucumber, stored at 37 °C. The results can be acceptable after 22 days, when compare to the control group.

Canned mushroom

Bacillus spp. and *Clostridium* spp. are common food spoilage bacteria in canned vegetables. For examples, the addition of **Proteria® CA** was added to low-acid canned mushroom efficient to reduce the heat process time and extend the products' shelf life significantly. and the addition with **Proteria® CA** sterilized at 100 °C for 6-20 minutes still maintained good textures and taste crispy after storage for 2 years.

Table 1. Natural shelf life solutions for fruits and vegetables

Applications		Your challenges	Ingredients	Dosage
Postharvest fruits and vegetables	Apples, pears, Oranges, Lemons, lychee Peaches, Apricots, Cherries, Plums, Nectarines, Jujube, Banana, Figs, Avocadoes, Mangoes, Grape, Strawberries, Tomatoes, Melons, Pineapples	Fungal decay and browning	Koalitim™ FV1	20-400mg/kg
		Control disease and maintain overall quality	Koalitim™ FV2	20-400mg/kg
		Fungal disease	Natasan™	40-150mg/kg
		Mold and oxidation	Antipack™	1 bag
Fresh-cut fruits	Water chestnuts, Fresh-cut apples, Fresh-cut melon, Fresh cut pineapple, Grape, Fresh-cut mango, Fresh-cut lettuce, Fresh-cut cattail, Fresh-cut salad	Retard microbial decay and browning	Koalitim™ FV3	0.8-2g/kg
		Browning	Guardox™ AE	0.03=0.1%
Fermented, acidic vegetables	Pickles, Sauerkraut, Kimchi	Rancidity	Guardox™ AE	0.03=0.1%
		Sodium-reduction, Over-acidification	Proteria® SR	0.5-1.5%

MEAT, POULTRY & SEAFOOD

6

YOUR CHALENGES

Yeasts and molds, LAB, Spores,
Pseudomonas, Aeromonas and
Listeria, Samonella, E.coli, and TPC
Rancidity, off-color, off-flavor
Meat juiciness loss
Sodium-reduction
Nitrite/Nitrate and phosphate replacement

CLEAN-LABEL ALTERNATIVES

Proteria™ Cultured sugar
Planteria™ Citrus fruit extract
Guardox™ Bamboo leaf extract / Acerola extract
Fixolor™ Cherry and chard extract

NATURALLY IMPROVING OVERALL QUALITY

Consumers prefer lean, tender meat with fresh color and authentic flavor. In the meantime, 'chemical' additives such as nitrite, phosphate, benzoic acid and ascorbic acid are avoided by consumers. What's more, with growing awareness on sodium reduction for healthy diet, they tend to choose meat with minimum salt content. How to replace 'chemical' additives without compromising shelf life and overall quality is becoming a challenge for meat producers.

With 10 years of experience, Handary provides all natural range of solutions to replace chemical additives that are used to control spoilage and pathogens, increase color and juiciness retention, and reduce salt, nitrite and nitrate in meat, poultry, fish and seafood products.

Our solutions include **Natap®, Epolyly®, Proteria®, Befresh™, Plantéria®, PhageX™, Mushira™, Guardox™, Antimix™, Fixolor™, White Fiber™, Cantoly™** and **Shelfex™** are shelf life protective systems aimed to improve the overall quality of meat products.

APPLICATIONS

Carcass | Raw meat | Cooked meat | Fish & seafoods

Raw meat

Pathogens elimination

Although animal body is in general sterile, the carcasses are vulnerable to pathogen contamination during processing. Pathogens such as *Listeria, Salmonella, E. coli, Campylobacter* and *Shigella* are potential safety risks for meat, therefore need to be avoided.

Epolyly®, PhageX™ and **Antimix™** are series of natural antimicrobial ingredients, designed to eliminate pathogens therefore ensure the safety of meat products.

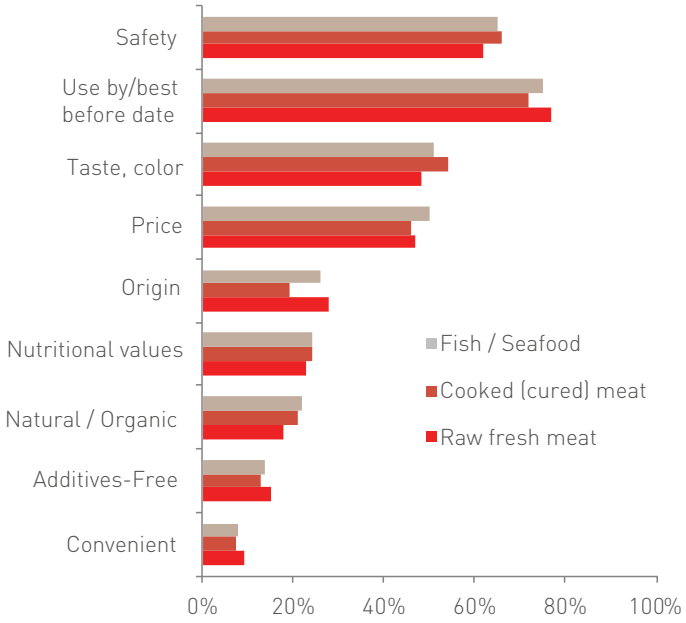
Shelf life extension

Raw meat is susceptible to spoilage bacteria, such as lactic acid bacteria (LAB), *Pseudomonas*, Aeromonas and Enterobacteriaceae, shortening the shelf life of raw meat and decreasing the freshness. **Natap®, Epolyly®, Proteria®, Befresh™, Plantéria®, Mushira™** and **Shelfex™** are shelf life protective systems aimed to inhibit spoilage microorganisms using natural ingredients.

Rancidity

Browning in raw meat is mainly caused by oxidation of myoglobin. Although it does not influence the overall quality, consumers prefer tender red meat. **Guardox™** can effectively retard oxidative rancidity.

Selected meat decision factors according to consumer research



Sources: Meat Ingredients Journal (2017)

Juiciness

Phosphate is mainly used for juiciness retention in meat. However, over dosage brings many potential health risks such as diarrhea, rickets and osteoporosis. **Shelfex™ MV** is composed of mushroom extract and citrus fruit extract to increase the ionic strength and moisture retention. For example, when used in defrosted meat, it can prevent juiciness loss, maintain tenderness and promote digestion in body as a dietary fiber.

Color retention

Color and appearance of fresh meat are major factors in consumer purchase decisions because they are presumed to be indicators of meat quality and freshness. Nitrite used in raw meat inhibits *Clostridum* and provides pink color. But when nitrite interacting with ammonia in meat, carcinogenic substances can be formed. **Guardox™ AE** and **Fixolor™ PK** provides a series of solutions in anti-oxidation, can partially or completely replace nitrite in meat, decreasing health risk, when **Fixolor™ RD** maintain a longer the red color after defrosted beef.

Sodium reduction

Salt (sodium chloride) is a common ingredient for meat flavoring and preservation. However, over ingestion of sodium chloride is a potential health risk for consumers, such as cardiovascular disease (CVD). As cultured sugar and vinegar, **Proteria® SR** can not only function as sodium chloride, bringing salty flavour and extend shelf life, but also decrease health risk for consumers.

Carcass

Although animal body is in general sterile, the beef carcasses are vulnerable to pathogen contamination during processing. Pathogens such as *Listeria, Salmonella, E. coli, Campylobacter* and *Shigella* are potential safety risks for beef, therefore need to be avoided.

Figure 1, 2 showed that applying a pre-chill treatment solution containing 4% **Antimix™ EV** to beef carcasses reduced the counts of *Salmonella typhimurium* and *E. coli* O157:H7 by 5 log cycles. When a water wash only was applied the result was a reduction of just 3 log count.

Fresh meat

Fresh meats are susceptible to a wide range of foodborne pathogenic contaminants, including *Salmonella* and *E. coli;* and spoilage bacteria including lactic acid bacteria, Pseudomonas and Enterobacter. Second, discoloration can occur due to the formation of metmyoglobin from myoglobin, which creates a harmless, yet unappealing, brown color.

Our solutions **Proteria® DV** and **Shelfex™ VP** is used to extend the freshness by controling APC count and stabilizing color.

Fresh chicken (Breasts)

Figure 3 shows that the addition of 0.5% **Proteria® DV** in fresh chicken breasts can extend the freshness of over double of the control.

Chicken skin

To allow the treatment of the samples with a final concentration of lxl0^7 pfu/cm2 and/or 2xl0^{7}pfu/cm2 at 4°C , a dilution of **PhageX™ AS** was prepared in SM buffer. In the fume hood 1/cm^2 were transferred onto the samples. The result shows on chicken skin a Salmonella cell reduction of 97% (-1.6 log reduction) could be achieved when **PhageX™ AS** was applied in a concentration of 1xl0^{7}pfu/cm^2. No significant difference between the different contact times was observed. Additionally no big difference was observed when applying the higher phage concentration of 2x10^{7}pfu/cm2 (98% reduction, corresponding to a log reduction of 1.8).

Beef carcass

Salmonella typhimurium

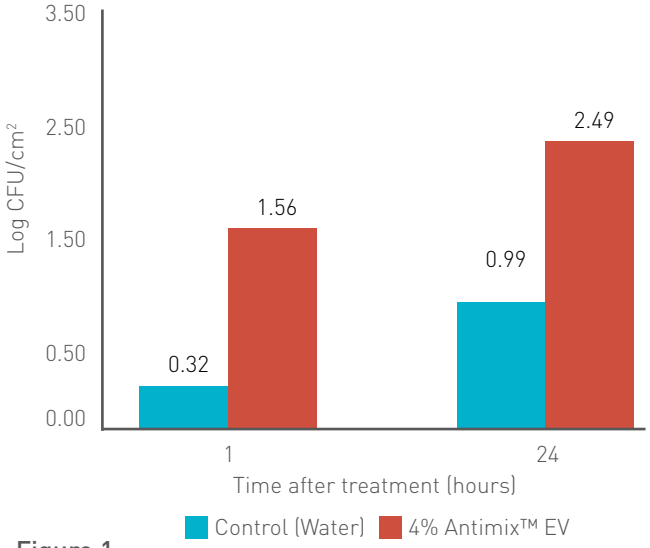


Figure 1

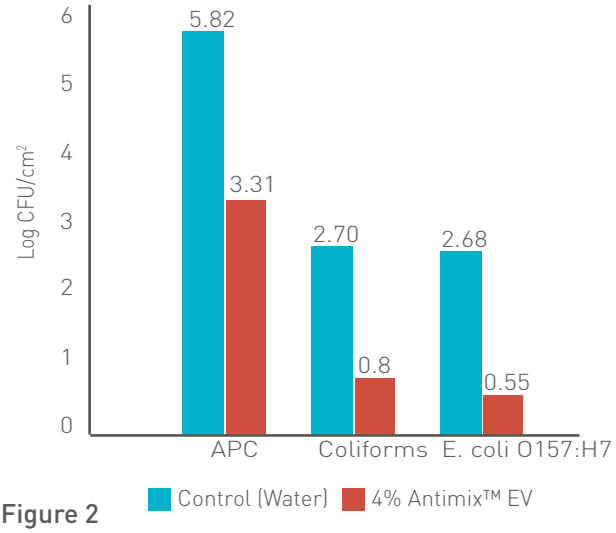


Figure 2

Chicken skin

Salmonella

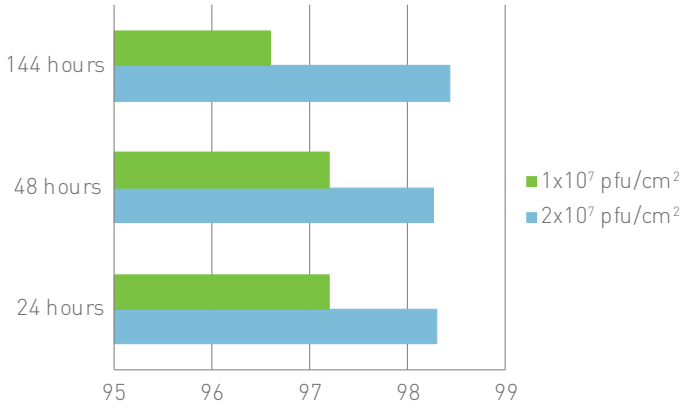


Figure 4

Fresh chicken (Breasts)

Total plate count

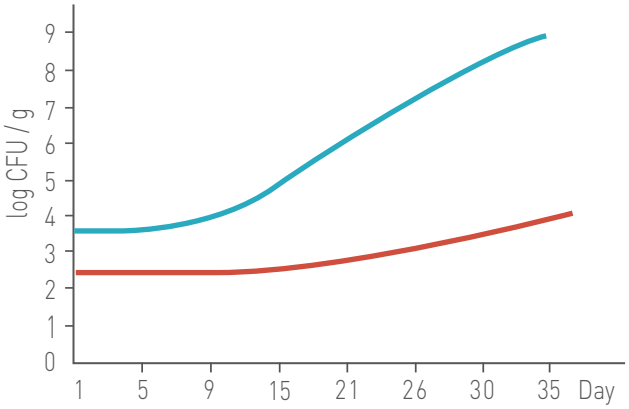


Figure 3

Fresh enhanced meat

Fresh enhanced meat products have a short shelf-life; Putrefactive spoilage is caused by pseudomonads near the surface of ground meat. Inside ground meat products, spoilage will be "souring" from growth of LAB and *Broch. thermosphacta*. Besides, oxidation will cause colour change and rancidity.

Our solutions **Shelfex™** is used to extend the freshness by controling APC count and stabilizing color.

Fresh ground beef

Picture 1 shows the beneficial effect of **Shelfex™ VJ** on fresh ground beef color. In addition, no off flavors were observed after frozen storage of the sausage. **Figure 5** reveals that **Shelfex™ VJ** can stop Aerobic plate count growth during the 15-day study.

High-acid sausage (fermented)

The surface mold growth of high-acid fermented sausage occurs at high relative humidity and rancidity can occur depending on storage time and temperature. Growth of heterofermentative lactic acid bacteria during the fermentation of fermented sausage causes off flavors and aromas (e.g. from acetic acid) or gas pockets or pin-holes from the formation of carbon dioxide in the sausage.

Our solutions include **Natap®** and **NisinZ®** have been proven efficient to control mold and LAB in fermented sausage.

Low-acid dry sausage

Spoilage of low-acid sausage (e.g. Chinese sausage/Lap cheong) results from insufficient drying permitting growth of lactic acid bacteria and souring. Oxidative rancidity can occur depending on storage time and temperature. Besides, salt reduction is a common concerns.

Our solutions include **NisinZ®** and **Proteria® SR** have been proven efficient to control LAB in sausage and maintain the quality when salt is reducted.

Color: Fresh ground beef
Day 6 of storage

Control | 0.2% Shelfex™ VJ

Picture 1

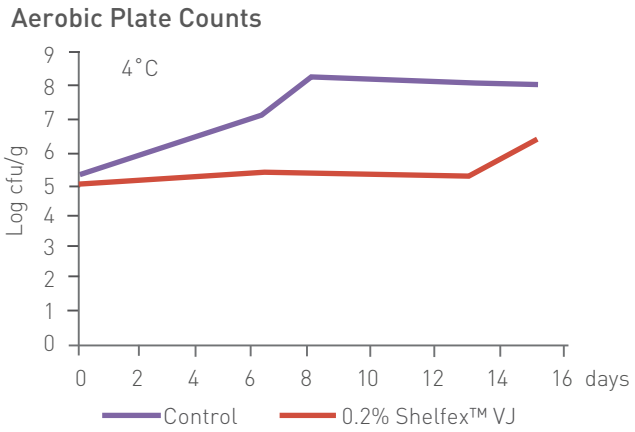


Figure 5

Table 1.Natural shelf life solutions for raw meat

Applications		Your challenges	Ingredients	Dosage	Labelled as	Clean-label	Efficacy
Carcasses	Beef carcass	*E.coli, salmonella*, Aerobic plate count (ATP)	Antimix™ EV	0.15g/kg	ε-Polylysine, vinegar	Medium	Medium
		Salmonella	PhageX™ AS	1×10^7 pfu/cm^2	/	High	High
Raw fresh meat	Casing	Mold	NataP®	2 µg/ cm^2	Natamycin	Medium	High
	Fresh beef	Total Plate Count (TPC)	Antimix™ NS	75 mg/kg	Nisin, Lactate	Medium	High
Frozen meat	Defrosted beef	Browning, moisture loss	Shelfex™ LA	0.2%	Lemon juice, Acerola extract	High	Medium
Ground meat	Ground beef	TPC, Color change	Shelfex™ VJ	0.2%	Vinegar, Tea extract	High	Medium
	Fresh sausage	Mold on casing	NataP®	2 µg/ cm^2	Natamycin	Medium	High
		TPC, Color change	Shelfex™ VJ	0.2%	Vinegar, Tea extract	High	Medium
Raw cured meat	Raw ham	Mold	NataP®	2 µg/ cm^2	Natamycin	Medium	High
		Sodium reduction	Proteria® SR	2-4 ml/kg	Cultured sugar, vinegar	High	High
		Rancidity	Guardox™ OE	0.3-1 g/kg	Olive pulp extract	High	High
	Low-acid dry sausage	Mold	NataP®	2 µg/ cm^2	Natamycin	Medium	High
		Rancidity	Guardox™ OE	0.3-1 g/kg	Olive pulp extract	High	High
	High-acid fermented sausage	Mold	NataP®	2 µg/ cm^2	Natamycin	Medium	High
		Listeria	Proteria™ AL	20µg/kg	Lactic acid bacteria	High	High
		Rancidity	Guardox™ OE	0.3-1 g/kg	Olive pulp extract	High	High

Cooked meat

Cooked meat and poultry products are growing in popularity, with consumers opting for greater convenience. Alongside this trend, demands for safe and healthy products with extended shelf life and clearly understandable labeling are intensifying. Consumers also want an everwidening range of great-tasting products with minimal additives.

Extend shelf life

The shelf life of cooked meats is limited by the growth of spoilage bacteria, such as *Lactobacillus* and spores, as well as pathogens. **Proteria®** helps to extend shelf life in cooked meats and poultry by lowering the water activity and acting as an antimicrobial agent.

Increase food safety

Ensuring food safety is one of the biggest challenges facing meat and poultry processors. While cooking meat and poultry fends o many bacteria, these products are still vulnerable to pathogens, such as *Listeria monocytogenes* and *Clostridium botulinum*.

Listeria monocytogenes is a particular concern for all cooked meat and poultry processors. It can cause the potentially fatal disease Listeriosis. While most pathogens thrive at higher temperatures, Listeria can grow at refrigerated temperatures and at high salt concentrations. To help food processors with this challenge, we have a range of solutions - **Epolyly®, NisinZ®, Proteria® AL, Befresh® AL** and **Planteria™** for controlling these pathogens.

Replace Nitrates

Nitrates are used in many foods, especially cured meats such as bacon, hot dogs, bologna, salami, pepperoni, corned beef, pastrami, and other deli meats such as cured ham, and turkey. The nitrites preserve the attractive pink color and and prevent the growth of bacteria that can cause botulism. However, Nitrates and nitrites may cause cancer.

Our natural innovative formulations - **Fixolor™ PK** and **Proteria ® CL** have been proven effciently to replace Nitrate for boosting pink color and inhibiting botulism.

Reduce sodium

Salt (sodium chloride) is an important ingredient which brings taste and texture to food and adds an antimicrobial hurdle. However, authorities are urging food producers to reduce the levels of sodium in their products because of the health risks associated with excesses. Removing salt affects product qualities, but Handary has developed solutions that enable you to create low sodium products without compromising important qualities.

Our **Proteria™ SR** can preserve the integrity of cooked meat and poultry with minimal taste impact.

Cooked uncured meat

Lactic acid bacteria (Lactobacillus sake and Lactobacillus curvatus) are considered a major spoilage bacteria found on various types of vacuum-packaged cooked meat and produce undesirable sensory attributes, such as sour aroma and taste. The outgrowth of food pathogens, especially *Clostridium botulinum* and *Listeria* spp. may contaminate cooked meat after cooking.

Table 2. Types of spoilage of vacuum-packaged cooked meat

Spoilage type	Detection	Microorganisms
Acidity	Sensory analysis(sour) pH	Various lactic acid bacteria
White liquid, slime	Visual inspection (appearance)	Various lactic acid bacteria
Gas formation	Visual inspection (loosening of packages)	Heterofermentative *la ctobacilli, leuconostocs*
Ropiness	Visual inspection (ropy slime)	*Lactobacillus sake, Leuconostoc gelidum*

Cooked uncured turkey

Figure 6 shows the effectiveness of **Proteria® AL** against *Listeria monocytogenes* in uncured turkey products for more than 90 days.

Listeria monocytogenes

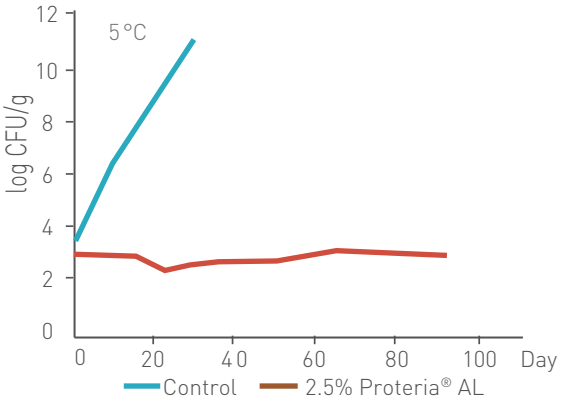


Figure 6

Cooked cured meats

Cooked cured meats include pate, bacon, ham, loin, picnic shoulder, pork belly and emulsion-style sausages (e.g. frankfurters). They usually contain Gram-positive organisms such as lactic acid bacteria, as well as the potential pathogens such as Salmonellae, Staph. aureus, and L. monocytogenes. Heat resistant psychrotrophs like *Lb. viridescens* may survive and can cause spoilage (souring, gas formation or greening). Similarly, surface softening and off-odors from surface growth of B. cereus or B. licheniformis is dependent on oxygen.

Our **NisinZ®** and **Proteria®** and **Guardox™** can preserve the integrity of cooked meat and poultry with minimal taste impact.

Cured ham

Figure 7 shows the acidity level of cured ham became more stable with the addition of 1.5% **Proteria® CV**. **Figure 8** shows the addition of **Proteria® CV** decreased the total plate count of cured ham.

Picture 2 demonstrates the pink color impact of **Fixolor™ PK** and nitrites in ham, the result displays that **Fixolor™ PK** significantly enhances the pink color of ham, when compared with the sample with nitrites.

Cured ham

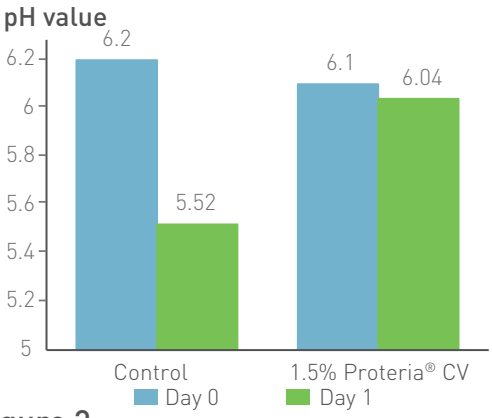
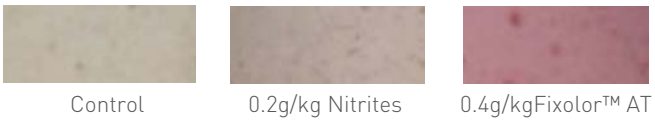


Figure 3



Picture 2

Frankfurter

Figure 9 shows the effectiveness of **Proteria® AL** against *Listeria monocytogenes* in frankfurter sausages for more than 120 days.

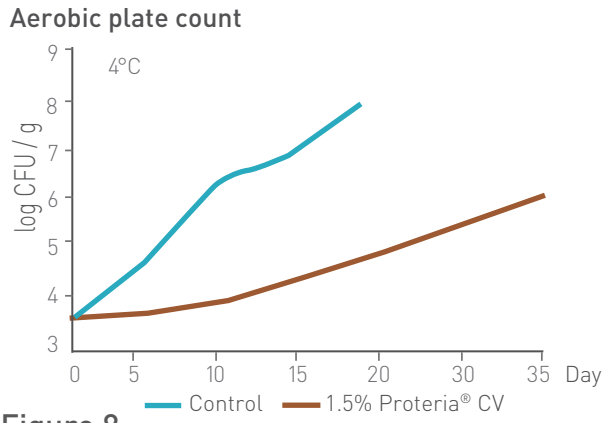


Figure 8

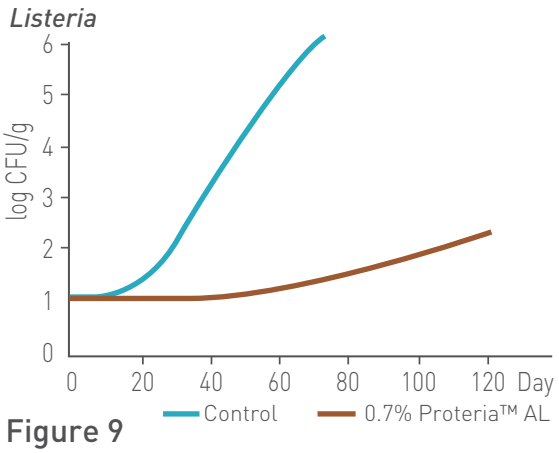


Figure 9

Table 3.Natural shelf life solutions for cooked (cured) meat

Applications		Your challenge	Ingredients	Dosage	Labelled as	Clean-label	Efficiency
Cooked uncured meats	Cooked sausages, Sliced cooked meat, Roast beef, Meat pies, Prepared meat-based meals	Gram-positive bacteria	NisinZ®	100mg/kg	Nisin	Low	High
		Total bacterial population	Proteria® CV	1.5%	Cultured sugar, vinegar	High	Medium
			Proteria® DV	0.8%	Distilled vinegar	Medium	Medium
			Epoyly® HCL	50mg/kg	Polylysine	Low	High
			Planteria CF	80mg/kg	Citrus fruit extract	High	Medium
		Listeria	Proteria® AL	1.5%	Cultured sugar, vinegar	High	Medium
		Cl. Botulinum	Proteria® CL	1.5%	Cultured sugar, vinegar	High	Medium
		Mold	Natap®	40mg/kg	Natamycin	low	High
Cooked cured meats	Frankfurters, Bologna-style sausages, Brawns, Canned cured ham, Gelder smoked sausage, Luncheon meat, Pate, Pressed ham, Lebanon bologna	Gram-positive bacteria	NisinZ®	100mg/kg	Nisin	Low	High
		Total bacterial population	Proteria® CV	1.5%	Cultured sugar, vinegar	High	Medium
		Listeria	Proteria® AL	1.5%	Cultured sugar, vinegar	High	Medium
		Cl. Botulinum	Proteria® CL	1.5%	Cultured sugar, vinegar	High	Medium
		Total bacterial population	Proteria® DV	0.8%	Distilled vinegar	Medium	Medium
		Oxidative rancidity	Gaurdox® AE	0.3%	Acerola extract	High	High
			Gaurdox® BL	0.03%	Bamboo leave extract	High	High
			Gaurdox® OE	0.03%	Olive pulp extract	High	High
			Gaurdox® RA	0.06%	Rosemary extract	Medium	High
		Pink color	Fixolor™PK	2.5%	Cherry and chard extract	High	Medium
		Sodium-reduction	Proteria® SR	1.5-4%	Cultured sugar, vinegar	High	High

NATAP®
Natamycin

NATALAC®
Natamycin blends

NATASAN™
Natamycin coating

1

KEY BENEFITS

- Yeast and mold inhibition
- Shelf life extension
- Cost-efficiency
- Green label

NATURAL YEAST & MOLD INHIBITOR

Fungus in food is a major challenge for global food manufacturers. Natamycin is permitted worldwide as a highly effective antifungal solution. Unlike most antimicrobials, Natamycin is effective at low concentrations and active over a wide pH range (3-9). Because natamycin is used at very low dosage(1-10 ppm), the cost-in-use may be comparable to synthetic preservatives and significantly lower than other natural inhibitors.

Natap® presents the highest standards of pure soluble Natamycin confirming to E235, it minimizes dosage and residues as health food additive. Natalac® is a classic, well-known brand of natamycin as active ingredients for dairy industry. And Natasan™ is a perfect Natamycin coating to form complete surface treatment for solid foods.

Brand

NATAP®
Natamycin

NATALAC®
Natamycin blends

NATASAN®
Natamycin coating

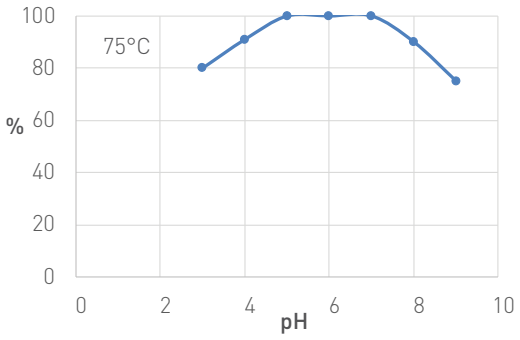
Natap® Minimum inhibitory concentration

Target organismes	MIC (mg/kg)
Molds	
Aspergillus sp.	1-5.0
Botrytis cinerea	1-25
Fusarium sp.	10
Gtoeospodum album	2.5
Mucor mucedo	1.2-5
Penicillium sp.	0.6-13
Rhizopus oryzae 4758	10
Yeasts	
Brettanomyces bruxellensis	1.5
Candida sp.	1.5～2.0
Hansenula polymorpha	1.0
Kloeckera apiculata	3.0
Saccharomyces sp.	1.-5.0
Torulopsis Sp.	2.0-3.0

NATAP®
High soluble natamycin

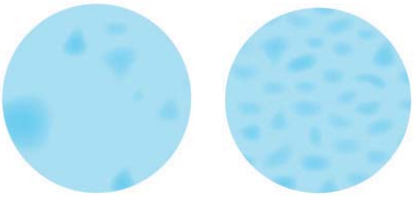
Stability

Natap® is stable and effective between pH 3-9, at 75 °C, the experimental studies also show that Natap® can endure 100°C for 5 minutes.



Solubility

Conventional natamycin has a low solubility and rapid sediments in liquid, therefore reducing effectiveness when applied on or in foods. Innovative Natap® has a higher solubility and dense distribution by minimizing natamycin crystal size.



Conventional natamycin

Natap®

Table 1 Natap® applications

Ingredients	Applications		Solutions	Dosage
NataP®	Breads and rolls	Bread	Growth of mold	1-5 μg/cm²
	Cookies	Crumpets, flapjacks, and pikelets		
	Dough products	Pastry (moon cakes)		
	Juice	Grape juice, apple juice	Yeast fermentation	40-60 mg/L
		Orange juice	Growth of mold and yeast	25 mg/L
	Alcoholic drinks	Fermented wine	Growth of *Brettanomyces*	40 mg/L
	Condiment	Salad dressings	Growth of mold and yeast	20 mg/kg
	Dairy products	Dairy desserts, dips and snacks	Growth of mold and yeast	20 mg/kg
	Cheese	Soft to hard cheese	Growth of mold	40 mg/kg
	Fermented milk	Yogurt	Overgrowth of yeast	10 mg/kg
	Fresh fruits	Banana	Fungal diseases	25 mg/kg
		Pineapple	Fungal diseases	400 mg/kg
		Orange	Growth of mold	200 mg/kg
	Fresh vegetables	Mushroom	Dry Bubble Disease	100 mg/kg
	Processed fruits	Fruit and vegetable preparations	Growth of mold	40 mg/kg
	Dried meat	Dry, cured sausage	Growth of mold	40 mg/kg
	Fermented meat	High-acid fermented sausage		40 mg/kg
	Cooked cured meat	Fried meat, barbecue, sausage, ham		40 mg/kg

Bread

Mold growth occurs in a few days in humid condition during the storage of bread. Study shows that adding 2μg/cm² Natap® is effective to control the mold growth.

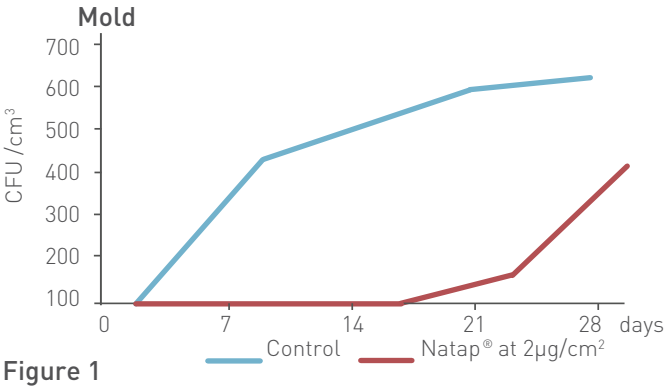


Figure 1

Sausages

Mold growth on the surface of sausages is generally undesired. Figure 2 shows that Natap® at 100mg/kg is efficient in the suppression of mold growth on dry sausage.

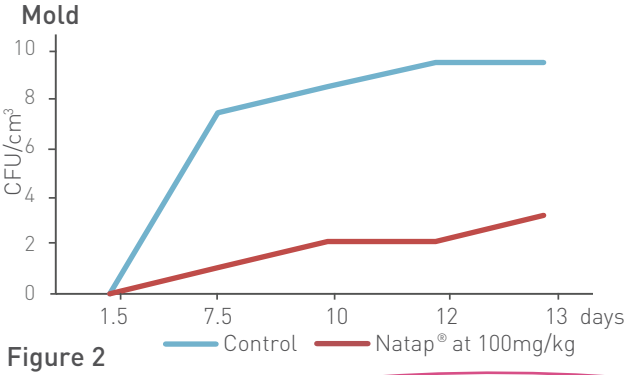


Figure 2

NATALAC®

Natamycin-Lactose Blends

Yeast and mold are a major cause of spoilage of dairy, Natalac® is a classic, well-known inhibitor worldwide that has been upgraded to high-soluble natamycin as active ingredient, and further to increase its antifungal efficacy and save the cost-in-use for dairy industry.

Table 2 Natalac® applications

Ingredients	Applications		Diagnosis	Dosage
Natalac®	Dairy products	Dairy desserts, dips and snacks	Growth of mold and yeast	20 mg/kg
	Cheese	Soft to hard cheese	Growth of mold	40 mg/kg
	Fermented milk	Yogurt	Overgrowth of yeast	10 mg/kg

Yogurt

Figure 3 shows that 10 mg/kg Natalac® or 5 mg/kg Natap® was added in yogurt, yeast and mold were completely inhibited.

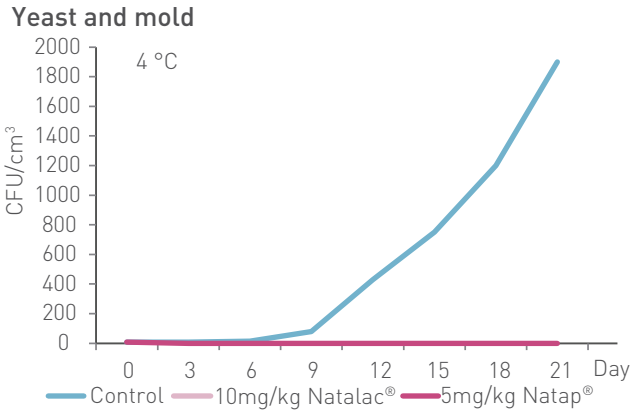


Figure 3

Semi-hard cheese

Figure 4 shows that 20mg/kg Natalac® or 10mg/kg Natap® effectively inhibits the growth of total yeasts and molds on semi-hard cheese.

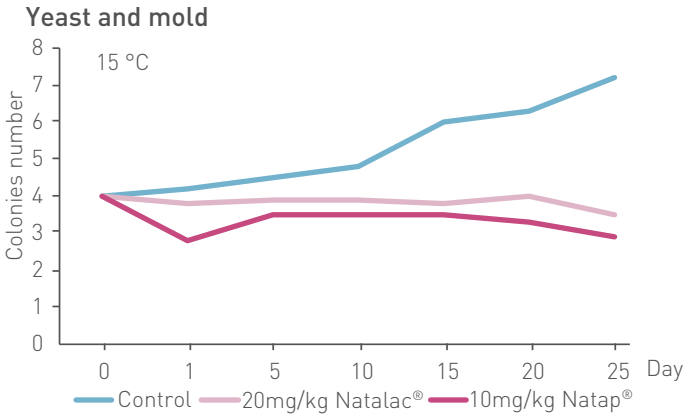


Figure 4

NATASAN™

Natamycin Coating

Mold growth occurs on the surface of foods. Natamycin, in the form of dense crystal, does not have the ability to cover food surface for exerting antifungal activities. Natasan™ is a perfect Natamycin coating by minimizing the natamycin crystal linked though mushroom juice power to form transparent, ultra-thin mesh coating suitable for food surface treatment.

Table 3 Natasan™ applications

Ingredients		Applications	Diagnosis	Dosage
Natasan™	Fresh fruits	Apple	Growth of blue mold	25 mg/kg
		Banana	Growth of crown mold	200 mg/kg
		Pineapple	Fungal diseases	400 mg/kg
		Orange	Growth of grey and blue mold	200 mg/kg
	Fresh vegetables	Mushroom	Dry Bubble Disease	100 mg/kg
	Dried meat	Dry, cured sausage	Growth of mold	40 mg/kg

Orange

Green mold disease of orange, caused by *Penicillium* sp., can cause extensive postharvest losses. Figure 5 shows that application of Natasan™ concentrations significantly decreased decay rate.

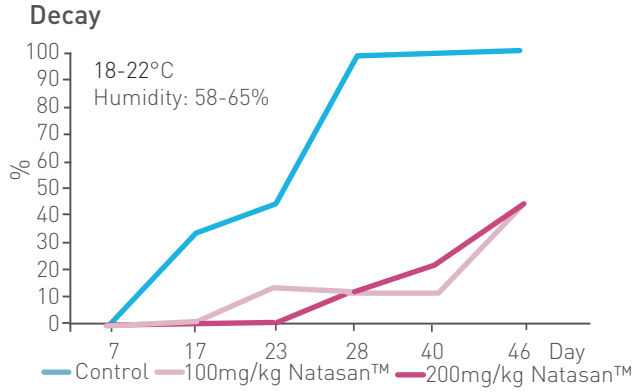


Figure 5

Banana

Crown rot disease of bananas, caused by *Colletotrichum musae*,*Fusarium* spp. and *Lasiodiplodia theobromae* can cause extensive postharvest losses. Figure 6 shows that application of Natasan™ concentrations significantly decreased disease severity.

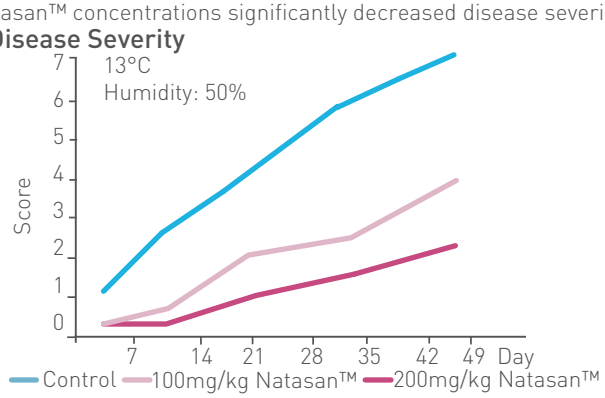


Figure 6

EPOLYLY® EPOLYLY® HCL

ε-Polylysine ε-Poly-l-lysine HCL

2

KEY BENEFITS

Inhibit fungi, Gram-positive and Gram-negative bacteria
Increase safe by minimizing chloride and inorganic contents
Shelf life extension
Green-label

NATURAL TPC INHIBITOR

The control of Total Plate Count (TPC) is major challenge to global food manufacturers. Polylysine has been accepted as food antimicrobial of natural origin and it is acknowledged as label-friendly.

Polylysine shows high antimicrobial activity against fungi, Gram-positive and Gram-negative bacteria and exhibits good water solubility and heat stability, and does not have an unpleasant odor. However, impure Polylysine contains more or less chloride and inorganic contents, increasing the risk of endotoxin and possible interaction with other ingredients. Handary provides two types of ultrapure Polylysine that can overcome these risks for safe usage.

One is Polylysine, available in powder called **Epolyly®**, and in concentrate called **Epolyly® L25**. And the other is Poly-L-lysine HCL, available in powder called **Epolyly® HCL**, and in concentrate called **Epolyly® H25**. In food applications, Polylysine is more suitable for pH 5-8, while Poly-L-lysine HCL is more suitable for pH 3-9.

BRANDS

EPOLYLY®
ε-Polylysine

EPOLYLY® HCL
ε-Poly-L-lysine HCL

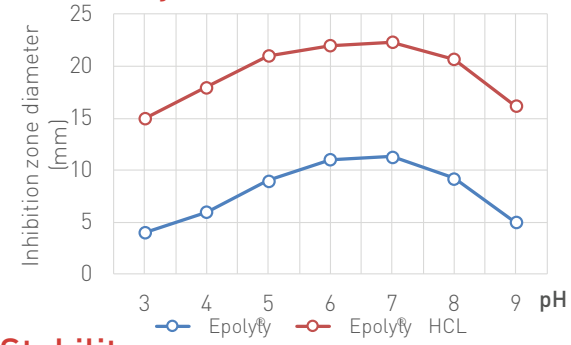
EPOLYLY® L25
ε-Polylysine concentrate

EPOLYLY® H25
ε-Polylysine HCL concentrate

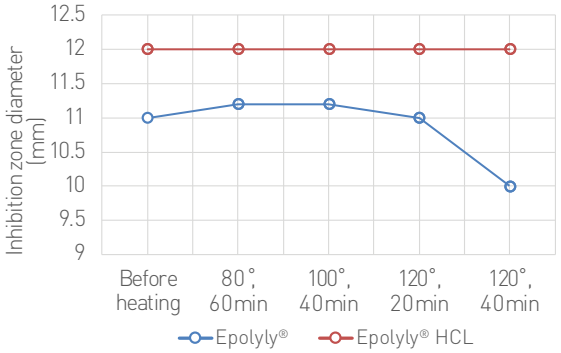
Minimum inhibitory concentration (MIC)

Target microorganisms	Epolyly® (mg/kg)	Epolyly® HCL (mg/kg)
Fungi		
Aspergillus sp.	>250	40-220
Penicillium sp.	>250	>140
Candida sp.	6-10	3-8
Saccharomyces cerevisiae	>50	25-40
Zygosaccharomyces rouxii	150	>75
Gram-positive bacteria		
Bacillus sp.	5-10	5-15
Clostridium sp.	32	5-15
Lactobacillus sp.	5-10	5-20
Listeria sp.	50	40-250
Staphylococcus aureus	12	50
Gram-negative bacteria		
Campylobacter jejuni	100	25
Escherichia coli	50	19
Pseudomonas aeruginosa	3	3
Salmonella typhymurium	16	4

Solubility



Stability



EPOLYLY®

ε-POLYLYSINE

ε-Polylysine is perfect natural inhibitor of Total Plate Count (TPC), especially suitable for shorter shelf life foods. Epolyly® presents the purest ε-Polylysine, derived naturally from submerged aerobic fermentation of *Streptomyces Albulus* PD-1, and purified to negligible chloride and inorganic contents, which greatly minimizes the possible interaction with food ingredients and reduces the endotoxin risk.

Safety

Endotoxin is a component of the Gram-negative bacterial cell wall that is caused by bacterial death cracking or autolysis. Although Gram-negative bacteria can be killed by ε -Polylysine, which has been proven no significant risk for endotoxin growth.

Table 1 Epolyly® Applications

Ingredients		Applications	Diagnosis	Dosage
Epolyly®	Dough products	Dumplings	TPC (*Bacilli*, LAB, Fungi (e.g. *Asp. Flavus, Penicillium*)	40-150 mg/kg
		Filled dumplings	TPC (*Bacilli, Cl. botulinum*, LAB, *Listeria, Salmonellae*)	40-200 mg/kg
		Steamed bun with meat, jam or other fillings	TPC (*Bacilli, Cl. botulinum*, LAB, *Listeria, Salmonellae*)	150-250 mg/kg
	Pasta and noodles	Fresh pasta	TPC (e.g. *Bacillus, A. flavus, Penicillium, Salmonella*)	40-200 mg/kg
		Oriental noodles	TPC (LAB, *Salmonellae*)	40-200 mg/kg
	RTE meals	Prepared meat-based	TPC (*Bacilli, Cl. botulinum*, LAB, *Listeria*)	40-250 mg/kg
		Prepared meat-based meal components	TPC (*Bacilli*, LAB)	40-250 mg/kg
		RTE rice (meat, vegetable, sauce)	TPC (e.g. *B. cereus, P. roquefortii, P. lundensis*)	125 mg/kg
		Soup, chowder and stem	TPC (*Bacilli, Cl. botulinum*, LAB, *Listeria*)	75-200 mg/kg
	Cooked meats, poultry & fish	Roast beef	TPC (LAB, *Salmonellae*)	40-200 mg/kg
		Sliced cooked meats	TPC (*Clostridia*, LAB, *Pseudomonads*)	150-200 mg/kg

* Recommended dosage for Epolyly® L25=Dosage Epolyly®*0.005 (ml/kg)

RTE rice (meat, vegetable and sauce)

Once cooked, rice is perishable. Spoilage organisms, including Gram-positive bacteria (e.g. B. cereus), molds (e.g. *P. roquefortii*) and Gram-negative bacteria (e.g. *P. lundensis*) are natureally abundant. Figure 1 shows that 100mg/kg Epolyly® has a high efficacy against these bacteria for longer shelf life of cooked rice.

Soup/Chowder/Stew

Soup, chowder and stem are spoiled by various microorganisms, such as LAB, *Listerial, Cl. botulinum* and *Bacilli* etc. Figure 2 shows that the addition of 75-125mg/kg Epolyly® is effective against Total plate count up to min. 50 days.

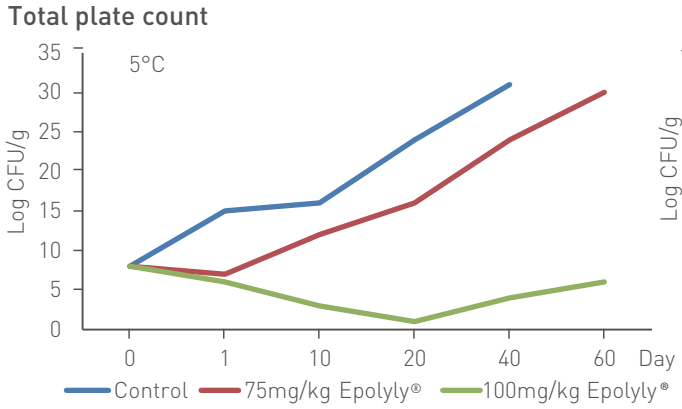


Figure 1

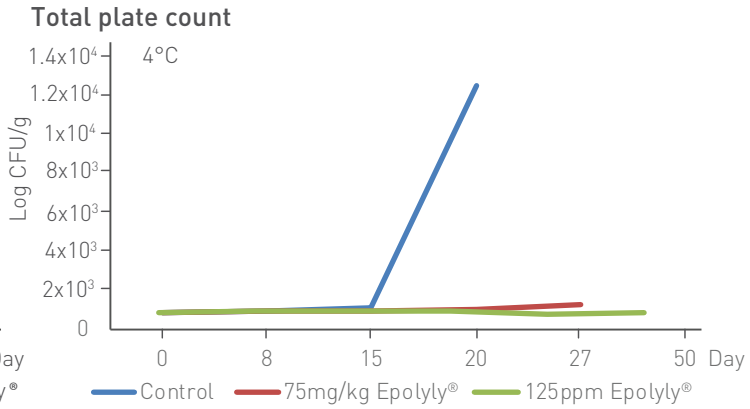


Figure 2

EPOLYLY® HCL

ε-Poly-L-lysine Hydrogen Chloride

Epolyly® HCL is pure ε-Poly-L-lysine Hydrogen chloride, derived naturally from controlled fermentation of *Streptomyces diastatochromogenes*, effective against total plate count in a wide range of food and beverage.

Table 2 Epolyly® HCL Applications

Ingredients	Applications		Diagnosis	Dosage
Epolyly® HCL	Dough products	Mooncake crusts	LAB, molds	60 mg/kg
	Pasta and noodles	Fresh pasta	TPC (e.g. *Bacillus, A. flavus, Penicillium, Salmonella*)	40-200 mg/kg
	Juice	Corn juice	Yeast	30 mg/kg
	Ready-to-eat meals	Boiled rice	TPC (e.g. *Bacillus, Penicillum Pseudomonas*)	125 mg/kg
		New year cake	Fungi *(e.g. Aspergillums* sp.*)*	80 mg/kg
		Sweet rice pudding	Total plat count	150 mg/kg
		Fresh pasta	TPC (e.g. *Bacillus, A. flavus, Penicillium, Salmonella*)	120 mg/kg
		Refrigerated cooked noodles	TPC (LAB, *Salmonella*)	200 mg/kg
	Soya-based products	Dried stewed Tofu	TPC (Fungi, LAB, *Salmonella)*	90 mg/kg
		Soy sauce	TPC (Fungi, LAB, *Salmonella)*	80 mg/kg
		Miso	TPC (Yeast, LAB)	150 mg/kg
	Fresh vegetables	Fresh-cut bamboo shoots	Fungi	30 mg/kg
	Raw meat	Fresh meat	TPC (LAB, *Salmonellae*)	200 mg/kg
		Fresh sausage	TPC (LAB, *Salmonellae*)	200 mg/kg
	Cooked meats, poultry and fish	Cooked chicken	TPC (LAB, *Salmonella* and *Listeria, Cl. Perfringens)*	100 mg/kg
		Surimi	TPC (e.g. *Bacillus, Pseudomonas, S. aureus*)	25 mg/kg

* Recommended dosage for Epolyly® H25=Dosage Epolyly® HCL*0.005 (ml/kg)

Soy sauce

Low-salt soy sauce is susceptible to spoilage bacteria such as Gram-positive bacteria (e.g. LAB, *S.aureus* and *B. subtilis*) and yeasts (e.g.*S.cerevisiae*). Figure 3 illustrates that 100-150mg/kg Epolyly® HCL was added in low-salt soy sauce, the TPC can be inhibited up to 240 days at 15°C.

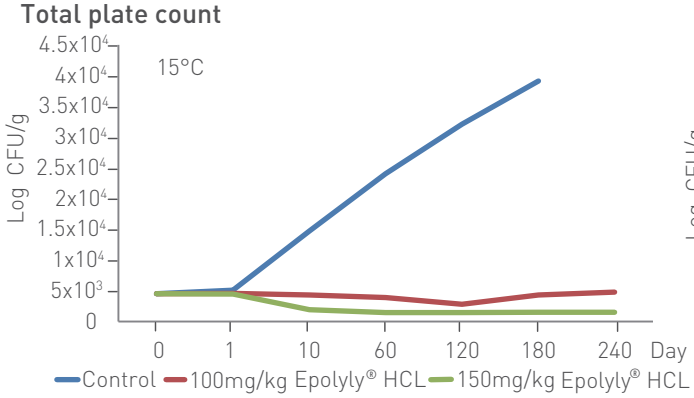


Figure 3

Surimi

Surimi products are mainly spoiled from spore-forming bacteria and turning yellowish with bad smell, figure 4 shows that 150mg/kg Epolyly® HCL was added in Surimi that can reduce the population of total bacteria, and the shelf life was extended to 6 days, while the control was only 2 days, stored at 5 C .

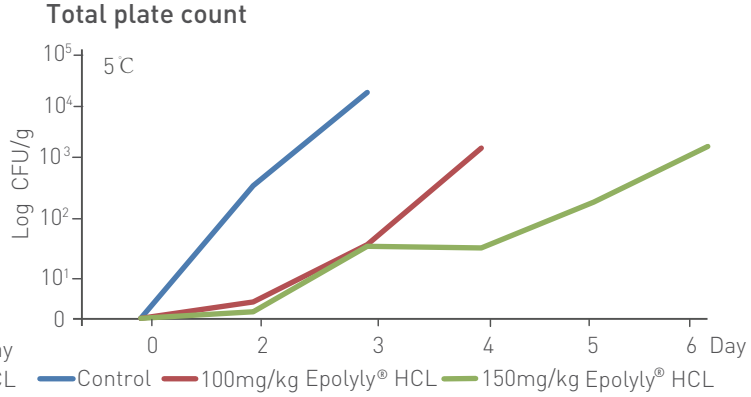


Figure 4

NISINA® NISINZ® WHITE NISINA®

Vegetal Nisin A | Vegetal Nisin Z | Vegetal Nisin concentrate

3

KEY BENEFITS

Inhibit Gram-positive bacteria
Cost-efficient
Natural label

NATURAL INHIBITOR OF GRAM+ BACTERIA

The Gram-positive bacteria is major challenge for global food manufacturers. Vegetal Nisin has been accepted as food antimicrobial of natural origin and it is acknowledged as label-friendly. Vegetal Nisin is effective against Gram-positive bacteria to increase food safety and preservation, and was honored the US IFT Expo Innovation Award.

Vegetal Nisin is available in two different types of **NisinA®** and **NisinZ®**, both are used as high-effective Gram-positive inhibitor in a variety of acidic food and beverages. Besides, Vegetal nisin is also available in concentrate form under the trademark of **White NisinA®**, specially designed for spores' inhibition and pH adjustment in beverages, and was entered 2013 FiE Excellence Award Finalist.

BRANDS

NISINA®
Vegetal Nisin A

NISINZ®
Vegetal Nisin Z

WHITE NISINA®
Clear pure Nisin solution

AN INSPIRATIONAL VEGETAL NISIN INNOVATION STORY

In 2013, Handary created a clear, highly effective pure Nisin solution, and provided a healthier, natural ingredient for food shelf life protection. This technology has entered the FiE Excellence Award Finalist.

In 2012, Handary developed a five-step NaCl elution to remove Nisin impurities. The obtained ultrapure nisin shows high bactericidal activity against both Gram-positive and Gram-negative bacteria and is a tenfold improvement as compared to nisin traditionally obtained via the one-step elution.

In 2010, Handary discovered a safer vegetable-sourced Nisin A, moving away from traditional dairy-based production, exclusively from renewable, non-GMO vegetal sources without allergens, which was honored the US IFT Expo Innovation Award.

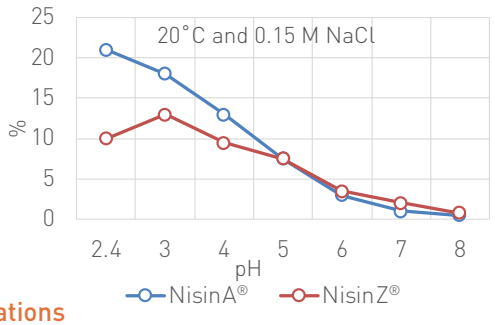
NISINA® NISINZ®

Vegetal Nisin A Vegetal Nisin Z

Comparison

In food applications, NisinZ® has a higher solubility and diffusion characteristics compared with NisinA®, a in high-acid food, while NisinA® ha higher solubility and diffusion than are NisinZ® in weak-acid food, which ood important characteristics for f applications.

Solubility



Stability

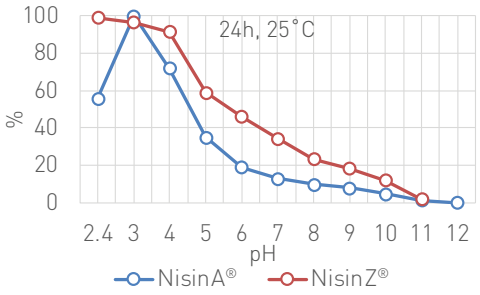


Table 1. NisinA® / Nisin Z® Applications

Ingredients		Applications	Diagnosis	Dosage
NisinA®/ NisinZ®	Pastry	Cakes, pudding	*Bacillus cereus*	120 mg/kg
	Juices	Apple juices	*Alicyclobacillus acidoterrestris*	30-60 mg/kg
		Juice based drinks	*Alicyclobacillus acidoterrestris*	30-60 mg/kg
	Alcohol drinks	Beer, red wine	LAB, *Lactobacillus, Pediococcus*	50-100 mg/kg
	Condiments	Dressings & sauces	LAB, *Clostridium, Bacillus*	50-200 mg/kg
	Liquid egg	Pasteurized liquid egg	*Bacillus cereus, Lactobacillus innocua*	250-500 mg/kg
	Canned meals	Canned (asparagus, mushroom)	*Clostridium sporogenes*	400 mg/kg
	RTE soups and broths	Pasteurized soup	*Bacillus spp.*	50-200 mg/kg
		Canned soup	Flat sour spoilage bacteria	400 mg/kg
	Dairy-based desserts	Soya milk	LAB, *Bacillus*	12.5-37.5 mg/kg
		Milk-based drinks	*Bacillus stearothermophilus*	25-100 mg/kg
		Dairy desserts	*Bacillus spp., Clostridium spp.*	50 mg/kg
	Cream	Clotted cream	*Bacillus ceres, Listeria monocytogenes*	100 mg/kg
	Fermented milk	Yogurt	*S. thermophilus, L. delbrueckii*	5-12.5 mg/kg
	Cheese	Unripened cheese	*Listeria monocytogenes*	250 mg/kg
		Ripened cheese	*Clostridium spp., Listeria spp.*	125 mg/kg
		Cheddar cheeses	*Clostridium spp.*	25-62.5 mg/kg
		Processed cheese	Anaerobic spore formers	25-125 mg/kg
	Raw meat	Fermented sausages	*Listeria monocytogenes*	50-100 mg/kg
	Cooked meat	Sausages	LAB	6.25-25 mg/kg
		RTE turkey bologna	*Listeria monocytogenes*	125 mg/kg
		Cooked ham	*Clostridium sporogenes*	75-100 mg/kg

Processed cheese

Processed cheese are susceptible to *Bacillus* spp. and "late blowing" caused by *Clostridia* spp., Figure 1, 2 shows both NisinA® and NisinZ® are active against all heat-resistance spores when added into processed cheese. At the same dosage, NisinZ® is more efficient than NisinA®.

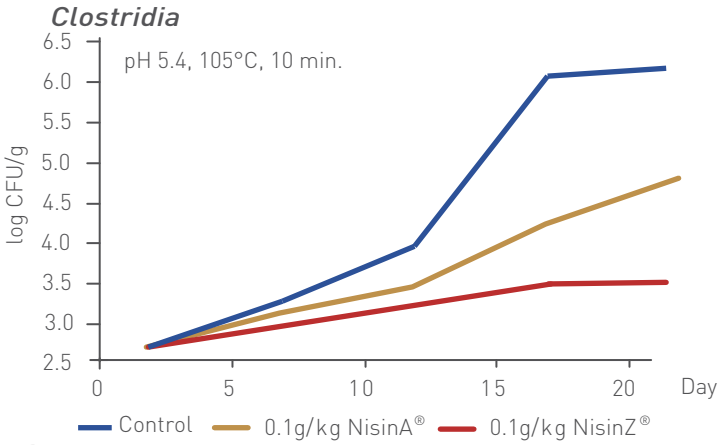


Figure 1

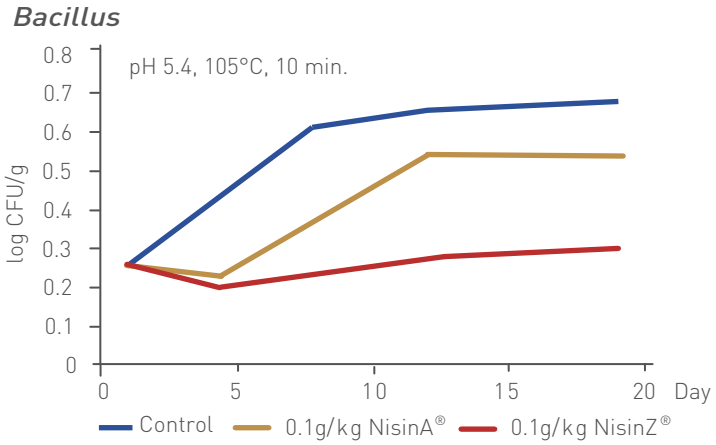


Figure 2

Food ingredients EUROPE EXCELLENCE AWARDS 2013 FINALIST

WHITE NISINA®

Clear Nisin Concentrate

Your benefits	White NisinA®	Conventional Nisin
A healthier ingredient	Ultrapure Nisin A concentrate Minimized interference of food components	High non-nisin protein impurities and sodium chloride content
Increased product shelf life Cost-efficiency	More than 4 times higher protection against gram-positive bacteria Enhanced cluster activities against gram-negative bacteria	Effective only against gram-positive bacteria
Enhanced application to transparent drinks	No- or negligible sedimentation Clear and taste-neutral solution	A high grade of turbidity after dissolution in water and visible particles at the bottom of the bottle

Table 2. White NisinA® Applications

Ingredients	Applications	Diagnosis	Dosage
White NisinA® Drinks	Apple juices	*Alicyclobacillus acidoterrestris*	0.21-0.5ml/L
	Juice based drinks	*Alicyclobacillus acidoterrestris*	0.21-0.5ml/L

Fresh apple juice

Figure 3 shows that White NisinA® provides higher protection against Alicyclobacillus acidoterrestris than NisinZ® when applied in fresh apple juice. In addition, as shown picture 1, a clear solution provided by White NisinA® maintains the visual appeal of fresh juice, unlike the conventional nisin that may appear cloudy and leave sedimentations.

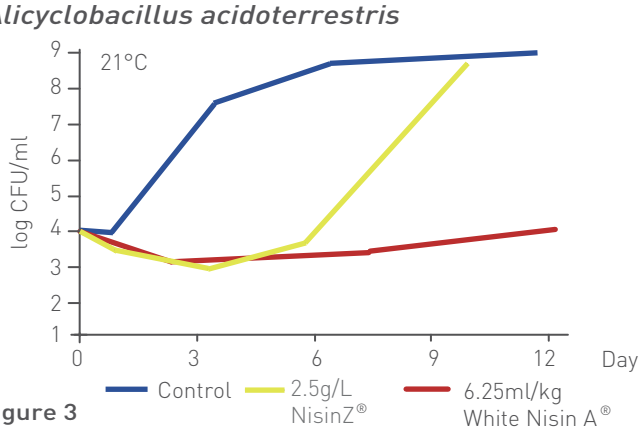
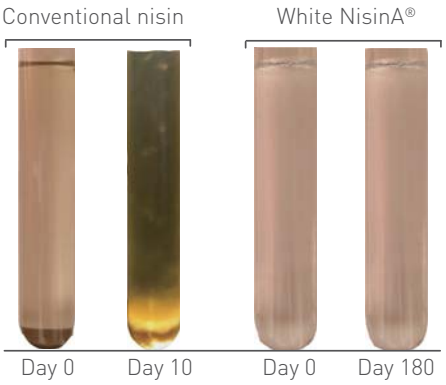


Figure 3



Picture 1

LYSOCH®

NOVEL LYSOZYME

4

KEY BENEFITS

Lyse Gram-positive, Gram-negative bacteria and fungus
Cost-efficiency
Shelf-life extension
Natural label

THE NOVEL MICROBIAL & BEAN SOURCED LYSOZYME

Currently, Lysozyme is commonly used to replace chemical antibiotics and has been accepted as food antimicrobial enzyme of natural origin. Lysozyme is effective against bacteria or fungi in processed foods.

Handary provides two types of Lysozyme, one is **Lysoch® G4** and its concentrate **Lysoch® L4** are produced by fermenting the bacterial of *Streptomyces* sp. G4, used in processed foods to lyse both families of Gram-positive and Gram-negative bacteria, and more specifically, *Clostridium tyrobutyricum* in cheese. In comparison with egg-white Lysozyme, it shows a broader spectrum of activity and higher antibacterial properties. And the other is **Lysoch® F4**, isolated from bean seeds, for use into processed foods to lyse fungus.

BRANDS

LYSOCH® G4
MICROBIAL LYSOZYME

LYSOCH® L4
LYSOZYME CONCENTRATE

LYSOCH® F4
BEAN LYSOZYME

Table 1. Lysoch® Applications

Ingredients		Applications	Diagnosis	Dosage
Lysoch® G4	Alcohol beverages	Beer	Lactic acid bacteria *(Pediococcus,* Lactobacillus and Oenoccocus)	10mg/L
		Grape wine		5-15mg/L
	Cheese	Semi-hard/hard cheese	*Clostridium tyrobutyricum, E. Coli*	5-10 mg/L milk
Lysoch® L4	Cheese	Semi-hard/hard cheese	*Clostridium tyrobutyricum, E. Coli*	0.25-0.5 ml/L milk
Lysoch® F4	Cheese	Semi-hard/hard cheese	Mold and yeast	2.5-16mg/L milk

LYSOCH® G4
BACTERIAL LYSOZYME

LYSOCH® L4
LYSOZYME CONCENTRATE

Gouda cheese

Butyric fermentation or "late blowing" in Gouda cheese is a ripening defect caused by *Clostridium tyrobutyricum*. Its growth leads to the formation of H_2 and CO_2 gases, cracks and slits in the cheese, and an abnormal aroma and cheese flavour.

Clostridium tyrobutyricum

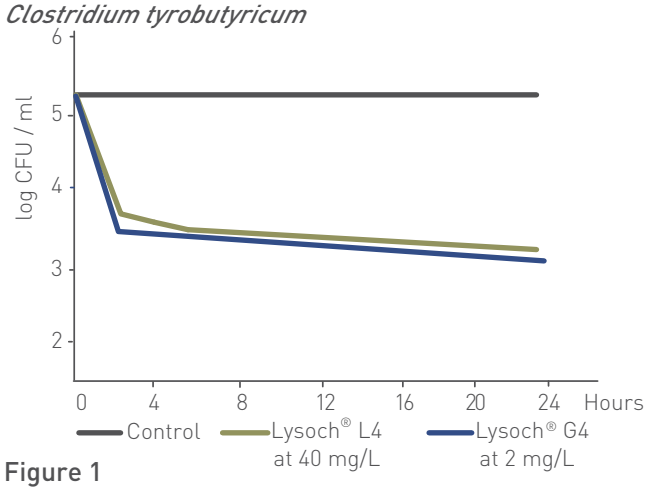


Figure 1

Figure 1 shows that of Lysoch® G4 at 5 mg/L has a stronger inhibition of *Clostridium tyrobutyricum* than 40 mg/L Lysoch® L4 in Goud a cheese. Figure 2 shows that addition of 2 g/L Ly soch® G4 in Gouda cheese effectively inhibits butyric acid bacteria and prevents the pH decrease.

pH

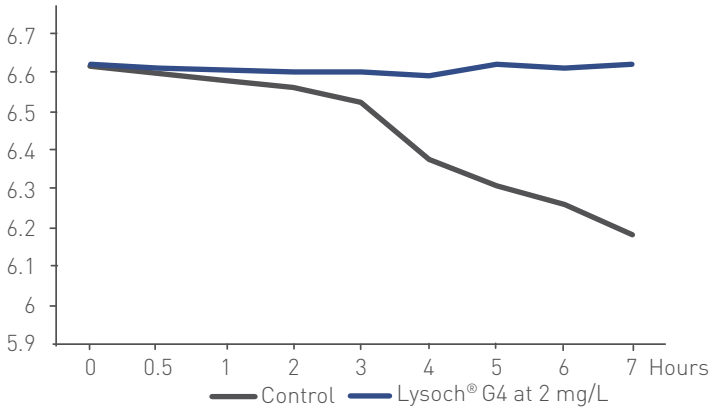


Figure 2

Red wine

In red wines, the main Gram-positive bacteria are lactic acid bacteria (LAB). *Lactobacillus* or *Pediococcus* carry out MLF. At the end of MLF, all LAB may begin to consuming sugars and producing high levels of VA, ruining the wine. Figure 3 shows when replacing sulphur dioxide, 10 mg/L Lysoch® G4 has a similar control effect of LAB as 100 mg/L egg-white lysozyme in red wine.

Lactic acid bacteria

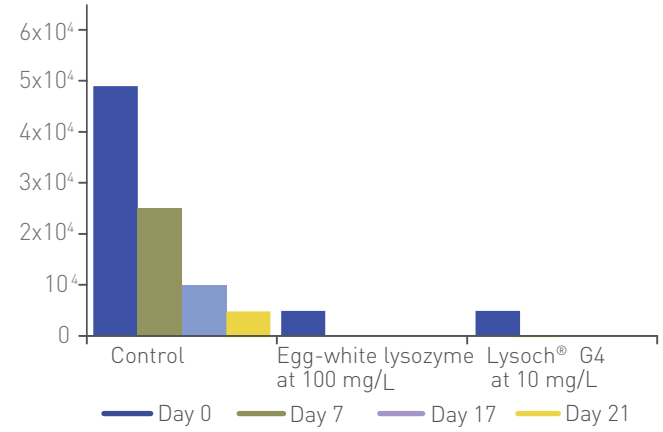


Figure 3

LYSOCH® F4
BEAN LYSOZYME

Gouda cheese

Yeast such as *Zygosaccharomyces rouxii* has unusual physiological characteristics which are largely responsible for their ability to cause cheese spoilage. Figure 4 shows that Lysoch® F4 at 10 mg/L can strongly inhibit yeast in Gouda cheese.

Zygosaccharomyces rouxii

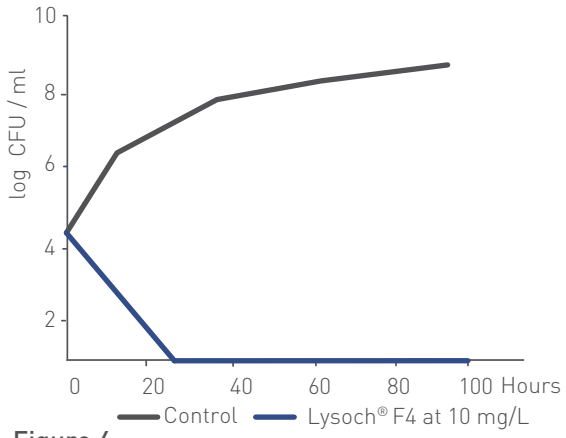


Figure 4

CHITOLY®
MUSHROOM CHITOSAN

5

KEY BENEFITS

Inhibit fungi, gram-positive and gram-negative bacteria
Delay rancidity, browning and ascorbic acid degradation
Reduce turbidity
Shelf-life extension

FUNGAL-SOURCED MUSHROOM CHITOSAN

Chitosan has been proven as a natural health supplement with good antimicrobial, antioxidation and film-forming properties. With the animal-free trends, mushroom-derived chitosan is naturally replacing animal-derived Chitosan.

Handary provides two different types of mushroom chitosan, one is **Chitoly® AB** produced by extracting from Agaricus bisporus. Which shows a board-spectrum antimicrobial effect when only dissolved in acidic solutions, and it also can form a film layer to barrier oxygen on solid food surface. The other is **Chitoly® OM** produced by extracting from Pleurotus ostreatus, Which can prevent microbial and oxidation spoilage when only dissolved in water, and also increase the clarification and reduce the sediments of drinks.

BRANDS

CHITOLY® AB
Agaricus bisporus chitosan

CHITOLY® OM
Pleurotus ostreatus chitosan

Antimicrobial ingredient

Mushroom Chitosan is a basic natural, biodegradable and renewable polysaccharide, and it is also a natural, clean-label, non-toxic food shelf life ingredient. Chitoly® AB has a broad antimicrobial spectrum to which Gram-negative, Gram-positive bacteria and fungi are highly susceptible. However, Chitoly® AB applications are somewhat limited due to being water-insoluble, only can work in acid solutions.

Edible coating

Mushroom chitosan-based coating is considered to be the best edible and biolog ically safe preservat ive coating s wit h functional advantages, such as slower respiration rates, extended storage periods, firmness retention and controlled microbial growth.

Chitoly® AB is soluble in diluted acid solutions, films can be readily prepared by casting or dipping, while Chitoly® OM is water-soluble Chitosan, film can be readilyprep ared by diluting in water.

Clarification

Clarification is an important step in the processing of fruit juice and wine, Chitoly® OM may be used as an natural alternative agent for refining of fruit juices and wine.

Chitoly® AB Minimum inhibitory concentration (MIC)

Targeted microorganisms	MIC
Gram-negative bacteria	
Escherichia coli	0.02-0.1g/kg
Salmonella enterica	2g/kg
Samonella tiphymurium	1-2g/kg
Pseudomonas aeruginosa	0.2-1.7g/kg
Pseudomonas fluorescens	0.25-1g/kg
Shigella dysenteriae	0.2g/kg
Enterobacter aerogenes	0.25g/kg
Gram positive bacteria	
Bacillus cereus	1g/kg
Bacillus megaterium	0.8g/kg
Staphylococcus aureus	0.02-0.8g/kg
Listeria monocytogenes	0.15-0.8g/kg
Lactobacillus plantarum	1g/kg
Lactobacillus brevis	1g/kg
Lactobacillus bulgaricus	1g/kg
Fungi	
Aspergillus fumigatus	2g/kg
Aspergillus parasiticus	2g/kg
Fusarium oxysporum	0.1g/kg
Botrytis cinereal	0.01g/kg
Byssochlamys spp.	1-5g/kg
Candida albicans	0.5-1g/kg
Drechstera sorokiana	0.01g/kg
Microsporum canis	1.1g/kg
Trichophyton mentagrophytes	2.2g/kg

CHITOLY® AB

Agaricus Bisporus Chitosan

Keen to get away from traditional chitosan production using crustacean shells, Chitoly® AB is produced by extracting exclusively from renewable, non-GMO *Agaricus bisporus* without anysynthetic manipulations. Chitoly® AB shows a board-spectrum antimicrobial and film-forming properties. It can achieve a synergistic effect with acidic solutions such as vinegar and lactic acid to prolong shelf-life and preserve quality of acidic foods and skinned postharvest fruits and vegetables.

Table 1 Chitoly® AB Applications

Ingredients	Applications		Diagnosis	Dosage
Chitoly® AB	Bread	White bread	Mold	1-3g/kg
	Acidic drinks	Tea-based drinks	Microbial decay, enzymatic	1-3g/kg
		Juice-based drinks	browning, color stability	1-3g/kg
	Sauces	Soya sauce	Yeast and turbidity	0.5-2g/kg
	Postharvest fruits and vegetables	Oranges, Lemons, Apples, Pears, Peaches, Apricots, Cherries, Plums, Nectarines, Jujube, Bananas, Figs, Avocadoes, Mangoes, Grapes, Tomatoes, Melons, Pineapples	Decay and browning	0.01-0.05g/cm^2
	Cooked cured meat	Sausages	Microbial spoilage and fat oxidation	1-3g/kg

Jujube

Blue mold, caused by *Penicillium expansum*, is one of the most serious postharvest diseases of the Jujube. Figure 1 shows that coating jujube fruit with Chitoly® AB at 3g/kg significantly reduced natural decay during storage at 0 °C.

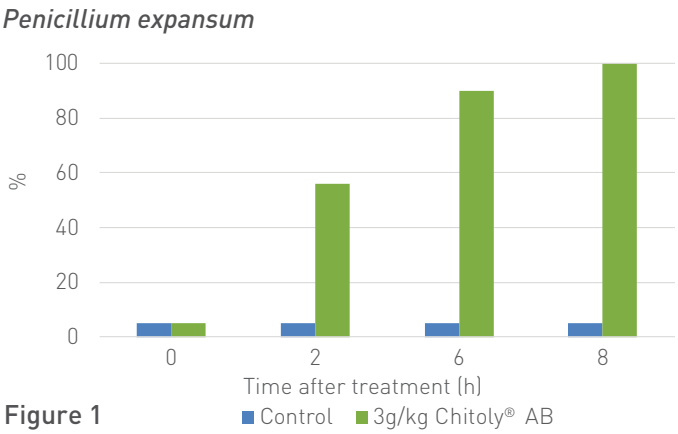


Figure 1

Sausage

Figure 2 shows that dipping 1.0% Chitoly® AB dissolved into 0.5% vinegar onto the surface of sausage effectively inhibits microbial growth and extends the shelf-life.

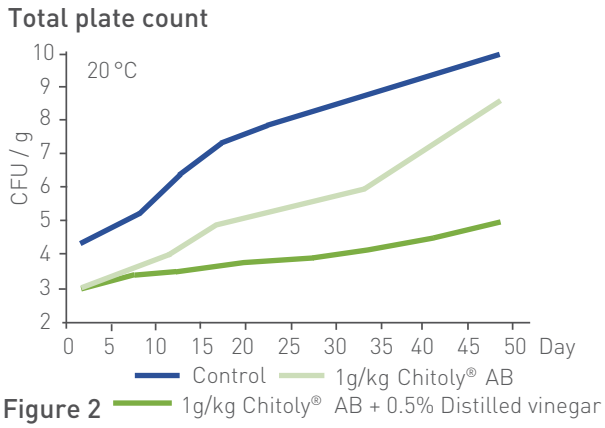


Figure 2

CHITOLY® OM

Pleurotus Ostreatus Chitosan

Keen to get away from traditional chitosan production using crustacean shells, Chitoly® OM is produced by extracting exclusively from renewable, non-GMO *Pleurotus ostreatus*, without any synthetic manipulations. Chitoly® OM has a good water-soluble proterties, but due to its poor antimicrobial activities, so it may formulate with antimicrobials to achieve synergistic effect to prolong shelf-life and preserve quality of fresh foods. For examples, unskinned and peeled fresh fruits and vegetables, fresh cheese etc.

Table 2 Chitoly® OM Applications

Ingredients	Applications		Diagnosis	Dosage
Chitoly® OM	Juices	Orange juice	Clarification	1-3g/L
		Grape juice		1-3g/L
		Apple juice		1-3g/L
		Carrot juice		1-3g/L
		Passion fruit juice		1-3g/L
	Fresh fruits	Strawberries	Fungal decay and browning	0.01-0.05g/cm^2
	Fresh-cut fruits	Fresh-cut apples	Microbial decay and browning	0.5-3g/kg
		Fresh-cut melon		0.5-3g/kg
		Fresh cut pineapple		0.5-3g/kg
		Fresh-cut mango		0.5-3g/kg
	Fresh-cut vegetables	Fresh-cut lettuce	Microbial decay and browning	0.5-3g/kg
		Fresh-cut cattail		0.5-3g/kg
		Fresh-cut lotus root		0.5-3g/kg
	Fresh cheese	Fresh cheese	Oxidation, ripening	0.5-3g/kg

Apple juice

Figure 3 shows that Chitoly® OM show the highly effective fining agent for apple juice, which can afford less than 15% turbidity products with 0.8 kg/ m3 of Chitoly® OM after 120 minutes..

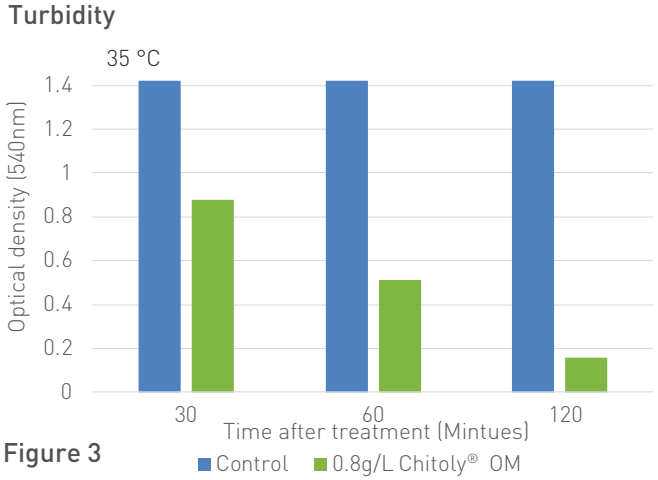


Figure 3

Fresh-cut lotus root

Figure 4 shows that higher activities at the beginning of the treatment while the lowest PPO activities in MAP and Chitoly® OM+ MAP samples were observed during the storage of freshh-cut lotus root.

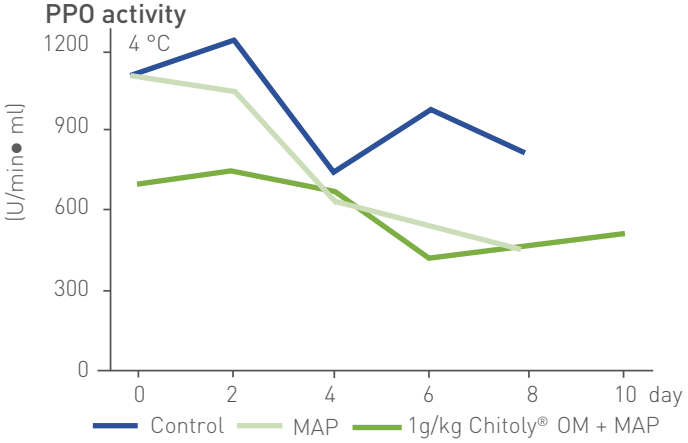


Figure 4

PROTERIA®

CULTURED SUGAR, VINEGAR

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KEY BENEFITS

- Improve microbial stability
- Control *Listeria* and *Clostridium botulinum*
- a_W and pH management
- Maximiz taste and flavor
- Color retention
- Clean-label

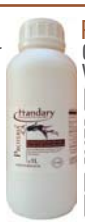
MAXIMIZING OVERALL QUALITY AND MICROBIAL STABILITY

With the increase in consumer demand for clean-labels and more transparency from food sources and process, producer feels the pressure to reformulate by replacing artificial ingredients with natural or organic alternatives, as well as minimally processed ingredients. Sugar and vinegar are easy for both consumers and processors to understand as clean-label ingredients, traditionally used to increase food stability and shelf life.

Proteria® cultured sugar and vinegar are produced by the fermentation of sucrose, originated from cane, beet, or corn. The substrates are fermented to organic acids by *B. coaqulans, L. paracasei, P. freudenreichii* or mixtures of these microorganisms. The products are used to control aW and pH value to form barriers of microorganism growth, maximizing overall quality and microbial stability in a variety of foods.

BRANDS

PROTERIA® CA
Cultured cane sugar



PROTERIA® CV
Cultured cane sugar
Vinegar

PROTERIA® DV
Distilled vinegar

PROTERIA® AL
Cultured corn sugar,
Vinegar

PROTERIA® CL
Cultured sugar,
Vinegar

PROTERIA® SR
Cultured sugar,
Vinegar

PROTERIA® CA

Cultured cane sugar

Clean and taste supreme lead the top consuming trends of salad dressings. Controlling pH in these products is the key to extend shelf-life stability and prevent spoilage caused by microorganism. Conventional methods of preservation such as vinegar is to provide strong acidity, but compromising on taste.

Proteria® CA is natural weak-acidic metabolites produced by fermenting sugar with probiotic *Lactobacillus paracasei*. It provides a high-effective alternative to vinegar against yeast and bacteria, without affecting taste of salad dressings.

Table 1. Proteria® CA Applications

Brand	Labelled as	Applications	Benefits	Dosage
Proteria® CA	Cultured (cane) sugar	Mayonnaise Ketchup Blue cheese vinaigrette French dressing Italian dressing Russian dressing Wafu dressing Vinaigrette	Prevention against *Lactobacillus* spp and yeasts	0.5-1.0%

Potato salad

Figure 1 shows that 1.5% Proteria® CA can inhibit *Lactobacillus plantarum* for 60 days in potato salad.

Lactobacillus plantarum

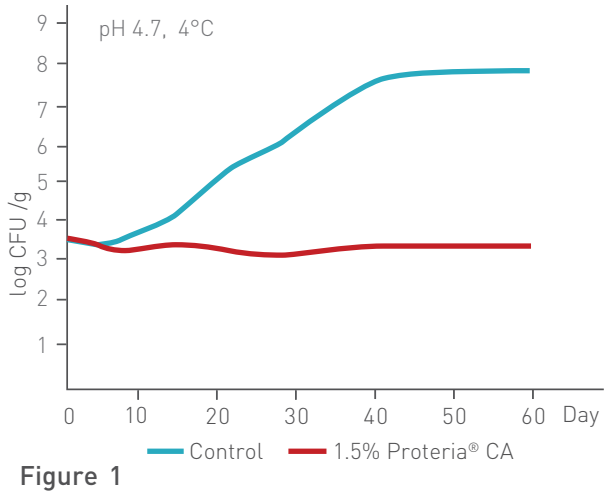


Figure 1

Ready to eat meals

Figure 2 shows that 1.5% Proteria® CA is effective against *Pseudomonas lundenis* in ready to eat meals (potato, spinach, meat).

Pseudomonas lundenis

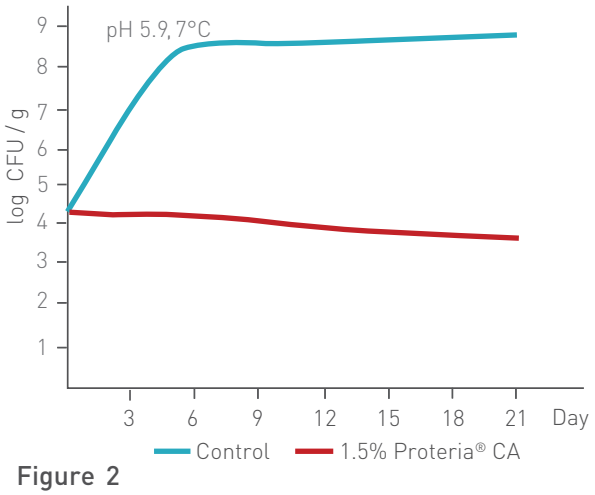


Figure 2

PROTERIA® CV

Cultured cane sugar, Vinegar

Cooked (un)cured meat will lose its stability during the shelf life, for examples pH falls, purge loss, color changes, color loss, lower quality and acidification caused by stability loss. How to maintain product quality stability with natural consumer-friendly ingredients is an important challenge to many meat manufacturers.

Proteria® CV is a label friendly ingredient of cultured cane sugar and vinegar. Cultured cane sugar is produced with specific food cultures used to manage the a_w, which is an important hurdle for the reduction of spoilage bacteria. Vinegar is well known for its antimicrobial properties, specially designed to improve the quality stability and reduce microbial spoilage of cooked (un) cured meat and poultry items.

Table 2. Proteria® CV Applications

Ingredients	Applications		Diagnosis	Dosage
Proteria® CV	Raw meat and poultry	Fresh sausage	Microbial growth and pH stability	0.5-1.5%
	Cooked (cured) meat& poultry	Pate		1.5-2%
		Bacon		1.5-2%
		Pressed ham		1.5-2%
		Frankfurters		1.5-2%
		Hot dogs		1.5-2%

Cured ham

Figure 3 shows the acidity level of cured ham became more stable with the addition of 1.5% Proteria® CV.

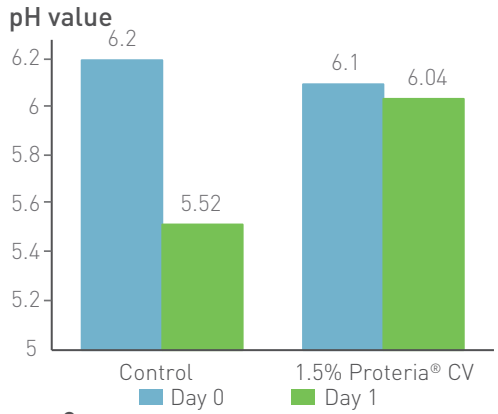


Figure 3

Figure 4 shows the total plate count of cured ham with Proteria® CV. The data indicates that shelf life was considerably improved with the addition of Proteria® CV.

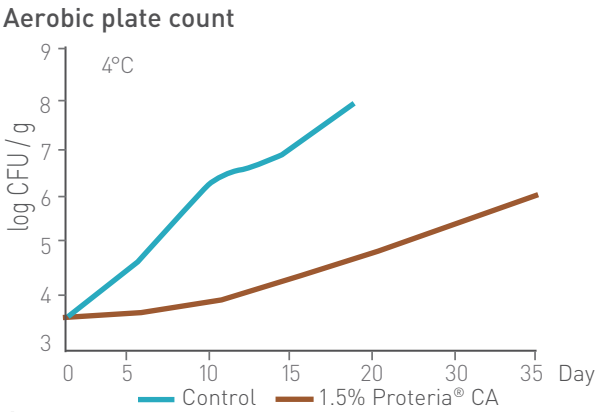


Figure 4

PROTERIA® DV

Distilled vinegar

Vinegar are easy for consumers and processors to understand as clean-label ingredient and is a well-known inhibitor of spoilage organisms and pathogens.

Proteria® DV is clean-label ingredient of crystal distilled vinegar produced by the fermentation of corn or cane sugar with specifically selected food cultures. It is used to enhance safety by inhibiting the growth of *Listeria* and spoilage bacteria in culinary, meat and poultry products.

Table 3. Proteria® DV Applications

Ingredients	Applications		Diagnosis	Dosage
Proteria® DV	Raw meat and poultry	Turkey breast	Spoilage microorganism and *Listeria*	0.5-1.5%
	Cooked (cured) meat& poultry	Smoked ham		1.5-3%
		Turkey breast		1.5-3%
		Roast beef		1.5-3%
		Ham		1.5-3%

Fresh chicken breasts

Figure 5 shows the results of a study measuring the influence of Proteria® DV on the total plate count in chicken breast. The addition of 1.5% Proteria® DV resulted in a shelf life extension of over double of the control.

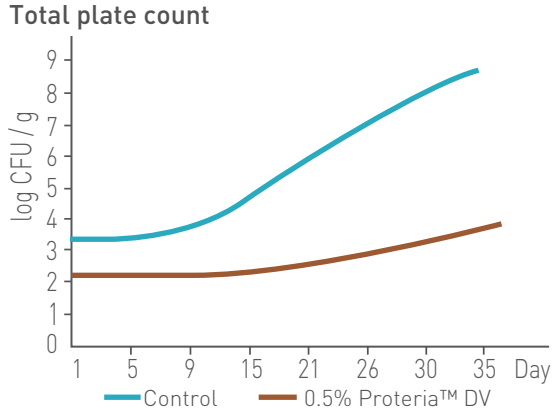


Figure 5

Cured ham

Figure 6 shows the outgrowth of *Listeria* in a typical cured ham formulation. The addition of 0.7% of Proteria® DV is expected to reach 1 log outgrowth for at least 100 days .

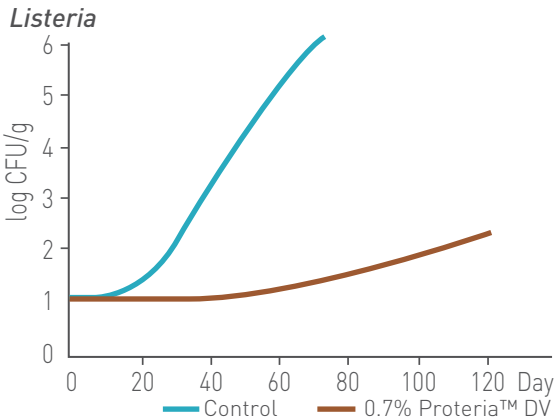


Figure 6

PROTERIA® AL

Cultured corn sugar, vinegar

Today's consumers are carefully checking the labels of the products they purchase. This is especially true when buying meat and poultry, where food safety and spoilage are main concerns, yet an authentic product with a clean label is highly desired.

Proteria® AL is a label friendly ingredient of cultured corn sugar and vinegar. Cultured corn sugar is produced by fermentation with specifically selected food cultures. This unique product is higly effective against a wide range of pathogens including *Listeria* in (un)cured meat.

Table 4. Proteria® AL Applications

Ingredients	Applications		Diagnosis	Dosage
Proteria® AL	Raw meat and poultry	Turkey breast	*Listeria* growth	1.5-2%
	Cooked (cured) meat& poultry	Smoked ham		1.5-3%
		Turkey breast		1.5-3%
		Roast beef		1.5-3%
		Ham		1.5-3%

Uncured turkey

Figure 7 shows the effectiveness of Proteria® AL against *Listeria monocytogenes* in uncured turkey products for more than 90 days.

Listeria monocytogenes

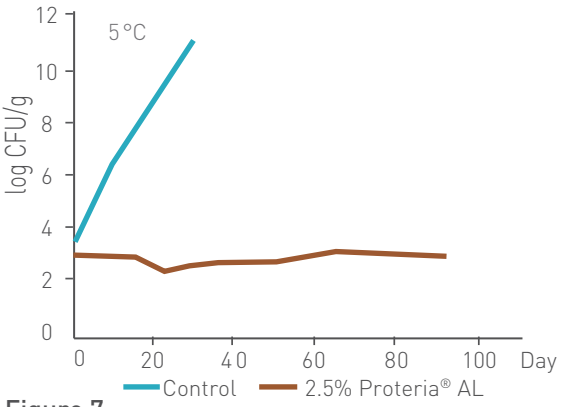


Figure 7

Frankfurter

Figure 8 shows the effectiveness of Proteria® AL against *Listeria monocytogenes* in frankfurter sausages for more than 120 days.

Listeria monocytogenes

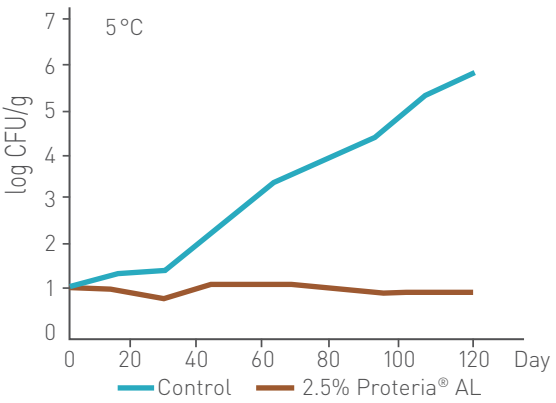


Figure 8

PROTERIA® CL

Cultured sugar, vinegar

Clostridium botulinum produces toxins that can cause serious illness in humans. Nitrite is effective in controlling the growth of *Clostridium*, However cosumers are turning away from nitrite for its side-effects. Specific intrinsic barriers are needed to control the outgrowth of *Clostridium*. Besides, *Listeria* is a major safety concern in RTE foods.

Proteria® CL is a unique blend of cultured cane sugar and vinegar. The neutral pH and balanced flavor of Proteria® CL make it ideal for inhibiting the formation of *Clostridium* toxin in Ready to-Eat uncured meat and poultry products.

Table 5. Proteria® CL Applications

Ingredients	Applications		Diagnosis	Dosage
Proteria® CL	Raw meat and poultry	Turkey breast	*Clostridium botulinum* and *Listeria*	1.5-2.5%
	Cooked (cured) meat& poultry	Cooked turkey roll		1.5-2.5%

Uncured Turkey breast

Figure 9 shows that the effect of 2.5% Proteria® CL in uncured turkey breast, without presence of nitrite, toxin formation occurred within 2 weeks of storage. Presence of 2.5% Proteria® CL delays toxigenesis to more than 8 or more than 12 weeks. This study shows that 2.5% Proteria® CL effectively delays toxin formation in low/no nitrite containing products.

Toxigenesis of *Clostridium botulinum*

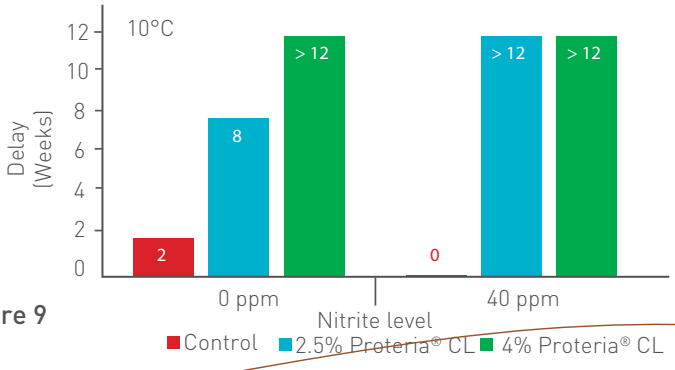


Figure 9

PROTERIA® SR

Cultured sugar

Sodium chloride (salt) is used in most cured meat products for a variety of reasons including enhancing flavor and providing microbial, color and textural stability. However, many consumers seek to reduce the levels of sodium in their diet, due to health risks.

Proteria® SR is a natural flavoring that offers many of the functionalities of salt, providing meat processors with multiple benefits in the production of reduced-sodium products. Proteria® SR mimics meat flavor and helps manage water activity, the key to reducing the growth rate of microbial spoilage.

Taste

Salt is the cornerstone of many flavor profiles, so removing it has an immediate flavor impact (Figure 10). Proteria® SR has a savory flavor that optimizes the effect of taste enhancers and improves the specific taste of the product.

Preservation

Salt lowers the water activity (a_w). The lower the a_w, the bigger the hurdle for microorganisms (Figure 11), such as *Listeria* and Salmonella in meat products. Proteria® SR helps you to control microbial growth by reducing a_w.

Build-up of typical savory profile

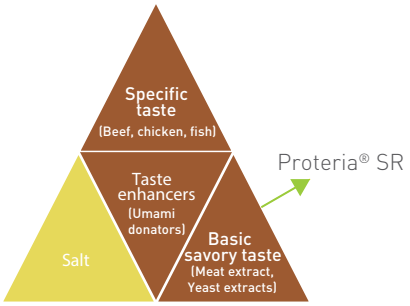


Figure 10

Hurdle technology

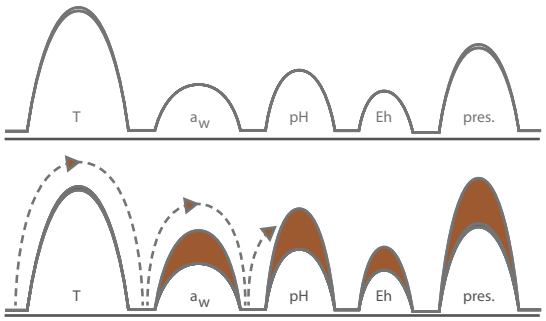


Figure 11

Table 6. Proteria® SR Applications

Ingredients	Applications		Diagnosis	Dosage
Proteria® SR	Cooked (cured) meat& poultry	Pate	Sodium-reduction, instable water activity (A_W) and microbial growth	2-3%
		Bacon		2-3%
		Pressed ham		2-3%
		Frankfurters		2-3%
		Hot dogs		2-3%

Frankfurters

Figure 12 shows that frankfurters added with 3% Proteria® SR have an increased salt and flavor perception and a firmer texture.

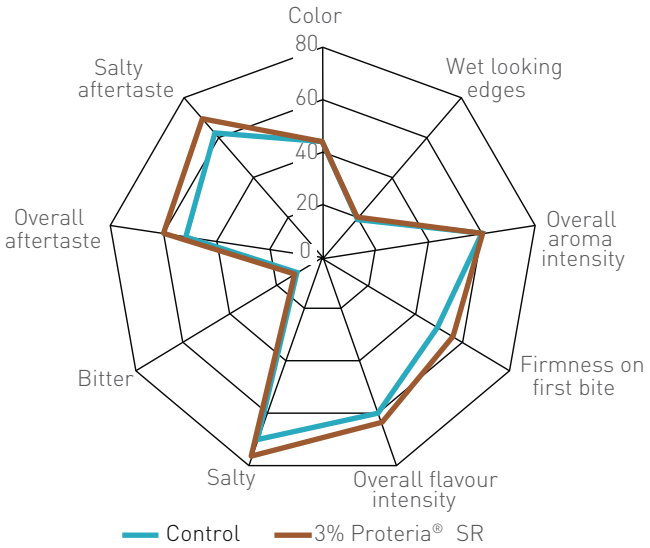


Figure 12

Chicken rolls

Figure 13 shows that chicken rolls added with 3% Proteria® SR have an increased salt and flavor perception and a firmer texture.

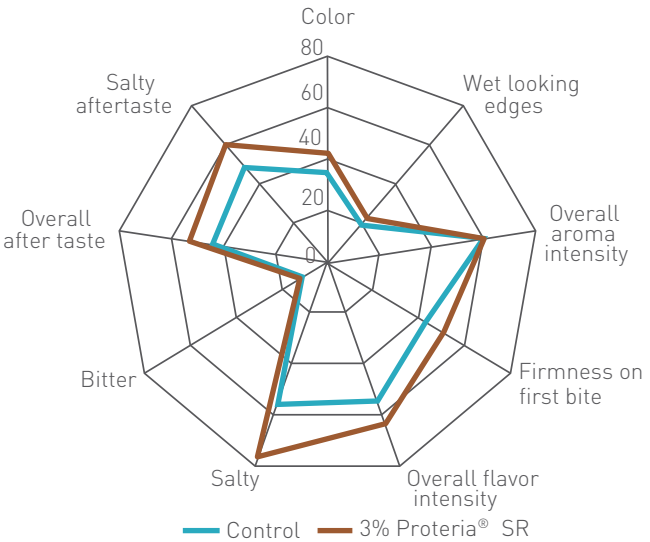


Figure 13

BEFRESH™
PROTECTIVE CULTURES

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KEY BENEFITS

Inhibit *Listeria*, yeasts and molds
Improve overall quality
Shelf life extension
Clean label

BIO-PROTECTIVE CULTURES

Deliberate application of protective culture to control unwanted microorganisms in fermented products without changing the technological and sensory quality of the product considerably.

We provides two different formula of protective cultures, one is **Befresh™ AF** produced by blending the cultured *Lactobacillus Paracasei* and *Propionibacterium freudenreichii subsp Sherman*. Which has a strong inhibitory effect on the yeast and mold, and does not inhibit the normally used starter cultures, or give negative flavour/texture impact in the final dairy products. The other is **Befresh™ AL** produced by blending the cultured *Lactobacillus* Sp., which has a strong inhibitory effect on *Listeria* sp. in fermented meat and cheese products.

BRANDS

BEFRESH™ AF
Antifungal culture

BEFRESH™ AL
Anti-listeria culture

Table 1 Befres™ Applications

Ingredients	Applications		Diagnosis	Dosage
Befresh™ AF	Fresh fermented dairy	Yoghurt	Yeast and mold	10-20u/100L milk
	Cheese	Hard cheese		10-20u/100L milk
Befresh™ AL	Cooked meat	Emulsion sausages	*Listeria*	10-20u/100L meat

Befresh™ cultures are available in frozen concentrated and freeze-dried forms for direct milk inoculation. No adjustment of the manufacturing process is required prior to use. The cultures are simply added to the processed milk together with the starter culture used for fermentation.

BEFRESH™ AF
Antifungal cultures

Yogurt

Yogurt made with and without Befresh™ AF were held for 60 days at 5°C. the result as Figure 1 shows the yeast spoilage was inhibited, which leads to blowing, off-flavors and off-odors during the shelf life of yogurt.

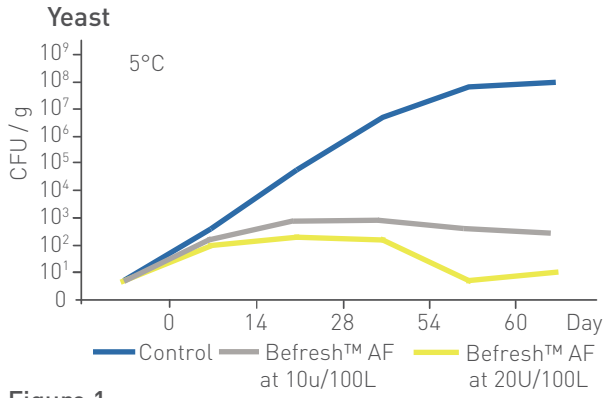


Figure 1

Figure 2 shows that the mold such as *Penicillium* spp. was inhibited, which causes highly visible and pigmented growth in yogurt.

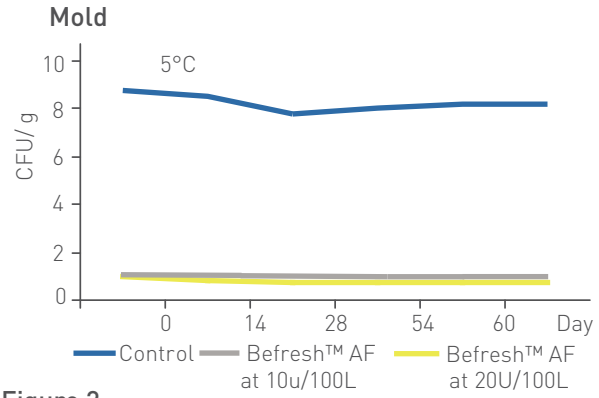
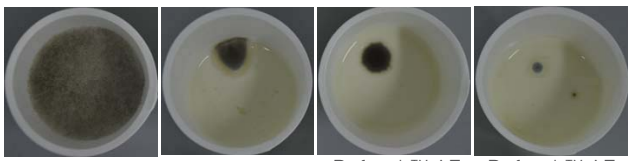


Figure 2

Picture 1 shows the inhibiting effect of Befresh™ AF on molds in yogurt (7 days at 25°C, inoculate 1-2 mold spores on the surface of each sample).



Picture 1

Hard cheese

Picture 2 shows the inhibiting effect of Befresh™ AF on molds in sliced hard cheese. (16 days at 25°C).

Picture 2

BEFRESH™ AL
Anti-*listerial* cultures

Emulsion sausages

Figure 3 shows the outgrowth of *Listeria* in a typical Emulsion sausages formulation. The addition of 10u/100kg of Befresh™ AL is expected to reach 10^3cfu/g outgrowth for at least 35 days.

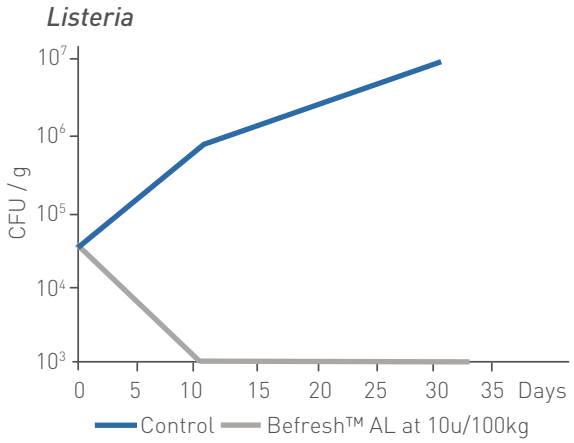


Figure 3

PLANTÉRIA™
FRUIT EXTRACT

DUCKWEERIA™
DUCKWEED EXTRACT

MUSHRIA™
MUSHROOM EXTRACT

8

KEY BENEFITS

Inhibit fungi, Gram-positive and Gram-negative bacteria
Anti-norovirus
Multi-component system provides robust efficacy
Natural, clean label

NATURAL ANTIMICROBIAL PLANT EXTRACTS

The "clean eating" trend has inspired a back to basics approach in product development; food producer feels the pressure to find clean-labeling ingredients to protect food shelf and stability. Fungal and plant-sourced ingredients are a perfect fit for the trend toward clean and healthy eating with antimicrobial activities and enticing flavors that have long been consumer favorites.

Plantéria™ is natural water-soluble extract derived from fruit plant (e.g. citrus fruit, raisin that contains a group of GRAS ingredients of glycerine, bioflavonoids, polyphenols and ascorbic acid, and is mainly used as a multi-hurdle antimicrobial in a variety of foods. **Duckweeria™** is a natural flavonoid extract from Spirodela polyrrhiza. It is mainly used for inhibiting Norovirus and pathogens in seafood products. **Mushria™** is a pleurotus extract that contains water-soluble polysaccarides, rich in chitosan and enzymes. It has a broad-spectrum antimicrobial activity, as well as clarification, antioxidation and thickening activities when applied in foods.

BRANDS

PLANTÉRIA™
FRUIT EXTRACT

DUCKWEERIA™
DUCKWEED EXTRACT

MUSHRIA™
MUSHROOM EXTRACT

Table 1 Plantéria™, Duckweeria™ and Mushria™ Applications

Ingredients	Applications		Diagnosis	Dosage
Plantéria™	Pastry	Cakes	*Bacillus cereus*, yeasts	50-150mg/kg
	Juices	Apple juices	Mold, anti-browning	150-250mg/kg
	Condiments	Dressings & sauces	LAB, *Clostridium, Bacillus*	100-200mg/kg
	RTE meals	RTE soup	*Bacillus spp.*	50-150mg/kg
		RTE rice	Total plate count	150-300mg/kg
	Dairy desserts	Dairy desserts	*Bacillus spp., Clostridium spp.*	100-300mg/kg
	Cream	Clotted cream	*Bacillus ceres, L. monocytogenes*	150-250mg/kg
	Cheese	Unripened cheese	*L. monocytogenes*	120-250mg/kg
		Cheddar cheeses	*Clostridium spp.*	150-250mg/kg
	Fresh vegetables	Fresh salad	*L. monocytogenes*	100-200mg/kg
	Raw meat	Raw ham	*L. monocytogene, E. coli, Salmonella*	75-200mg/kg
		Raw lamb meat	Total viable counts	100-200mg/kg
	Cooked meat	RTE turkey bologna	*L. monocytogenes*	100-250mg/kg
Duckweeria™	Seafood	Oyster	Norovirus	30-150mg/kg
Mushria™	Bread	White bread	Molds, spores	100-200mg/kg
	Juices	Apple juices	Molds, browning	150-250mg/kg

Fresh salad

Fresh salad was inoculated with *L. monocytogenes* culture, and treated with Plantéria™ at 100 or 200 mg/kg after 30 minutes, the result as figure 3 shows that *L. monocytogenes* was below the detection limit of 1 cfu/cm^2 after 12 days storage at 7°C.

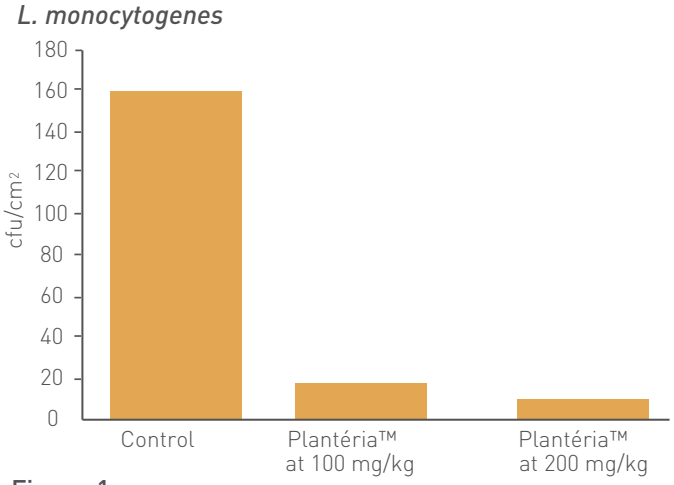


Figure 1

Raw ham

Raw ham was inoculated with *L. monocytogenes* culture, and treated with Plantéria™ at 100 mg/kg after 24 hours at 15°C, the result as figure 4 shows that *L. monocytogenes* was reduced to approx. 20-fold.

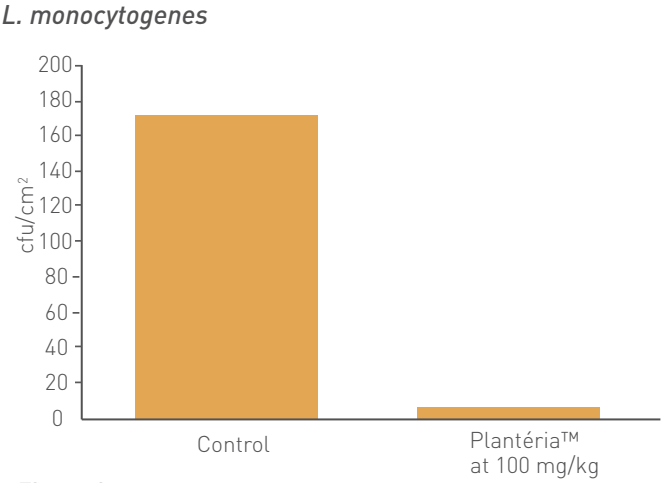


Figure 2

White Bread

Bread is volunerable for molds and spore-forming bacteria. Mushria™ provides a solution for improving the overal quality of bread, as a substitution for calcium propionate for inhibiting molds and spore-forming bacteria, as well as slowing starch aging.

Figure 3 presents that addition of 0.5% Mushria™ to bread avoids the growth of mold for 11 days.

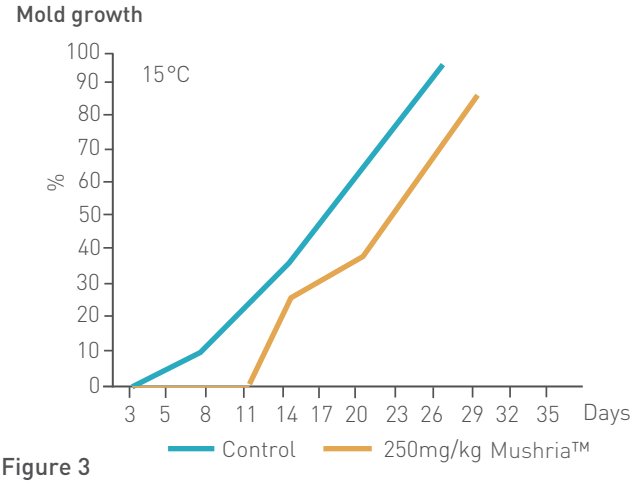


Figure 3

PHAGEX™
Bacteriophages

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KEY BENEFITS

Decompose *Listeria* and *Salmonella*
Prevent cross contamination
No organoleptic influence
Clean label

ANTI-PATHOGENIC BACTERIOPHAGES

Listeria and *Salmonella* have been associated with a large number of food-poisoning outbreaks related to various foods.

Our clean-label solution - **PhageX™** Bacteriophages are novel biocontrol measures to ensure food safety and are composed entirely of proteins and nucleic acids, so their breakdown products consist exclusively of amino acids and nucleic acids, both of which are present in abundance food products, so distribution within a given environment can be seen as a natural process.

BRANDS

PHAGEX™ AL
Anti-listeria phage

PHAGEX™ AS
Anti-salmonella phage

Table 1 PhageX™ applications

Ingredients	Applications		Diagnosis	Dosage
PhageX™AL	Raw meat	Minced meat	*Listeria*	$3x10^7$ PFU/g
	Cooked meat	Ham		
		Cooked turkey breast		
PhageX™AS	Raw meat	Pork meat	*Salmonella*	$1xl0^7 pfu/cm^2$
	Raw poultry	Chicken skins		$1xl0^7 pfu/cm^2$

PHAGEX™ AL

Anti-*Listeria* phage

PhageX™ AL is produced by fermentation using Listeria innocua as a host strain that effectively inhibits outgrowth of *Listeria* on the surface of foods such as RTE meat and poultry.

Minced meat

Minced meat was treated PhageX™ AL, the result as figure 1 shows that the cell number of *L. monocytogenes* was reduced by1.5 log_{10}.

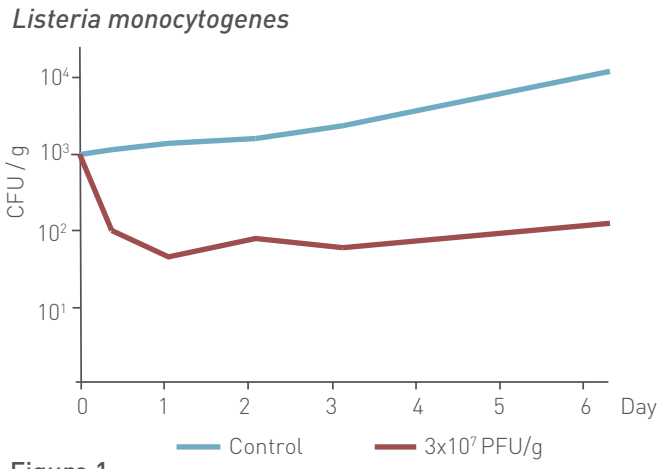


Figure 1

PHAGEX™ AS

Anti-*Salmonella* phage

PhageX™ AS Anti-*Salmonella* phage is produced by fermentation using two *Salmonella* sp. as host strain that effectively inhibits outgrowth of *Salmonella* on the surface of raw meat and poultry.

Chicken skin

Chiken skin was treated with PhageX™ AS concentration of 1xl0 pfu/cm^2 at 4°C on chicken skin, as figure 2 shows *Salmonella* cell number can be redueced by 97% (1.6 log reduction).

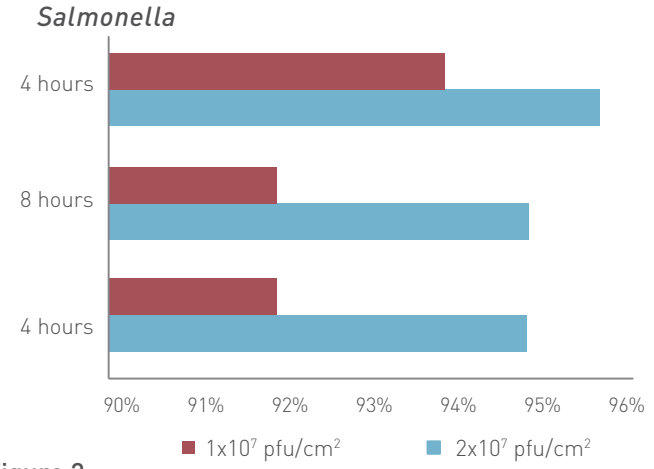


Figure 2

GUARDOX™
NATURAL ANTIOXIDANTS

10

KEY BENEFITS

- Delay oxidation and rancidity
- Anti-acrylamide
- Anti-bacterial and bacteriostatic
- Partly alternative to nitrate or nitrite colorant, ascorbic acid, ascorbate or erythorbate
- Deodorizing and enhanced aroma
- Shelf life extension
- Clean label

PLANT-DERIVED ANTIOXIDANTS

Oxidation and development of rancidity is a major challenge for food manufacturers, reducing shelf-life and altering the quality and nutritional value of their products. Consumers' interest in natural antioxidants has increased dramatically over the past years and the general trend requires the substitution of synthetic molecules (e.g. erythrobates, BHA, TBHQ, BHT, propyl gallate, and Sodium nitrite) with natural compounds. Guardox™ is a group of natural antioxidants derived from plant extracts for preventing oxidation and improving color stability in various foods that can meet the consumer demands of clean-label.

Guardox™ BL bamboo leaf powder rich in flavonoids is used as bamboo antioxidation flavouring. **Guardox™ OE** olive pulp powder rich in polyphenolsis is used as olive antioxidation flavouring, **Guardox™AE** acerola cherry juice powder rich in naturally occurring vitamin C is used as cherry antioxidation flavouring. **Guardox™ RA** Rosemary powder rich in rosmarinic acid is used as rosemary antioxidation flavouring.

BRANDS

GUARDOX™ BL
Bamboo leaf extract

GUARDOX™ OE
Olive pulp extract

GUARDOX™ AE
Acerola extract

GUARDOX™ RA
Rosemary extract

GUARDOX™ BL

Bamboo leaf extract

Guardox™ BL is a pale brown powder extracted from bamboo leaves. It can clear away acrylamide, delay lipid oxidation, and decrease the use level and residue of nitrate or nitrite colorants, as well as increase color stability and removes odor in a wide range of food and beverages.

Table 1 Guardox™ BL Applications

Ingredients	Applications		Diagnosis	Dosage
Guardox™ BL	Potato-based foods	Potato crisps, French fries	Acrylamide formation	10-100mg/kg
	Soft drinks	Orange juice	Oxidation, off-color	120mg/L
	Sauces	Soya sauce	Rancidity	150mg/L
	Cooked (cured) meat	Sausage, ham	Rancidity, Acrylamide, level of nitrite and iso-ascorbate sodium	0.3g/kg

Sausage

Figure 1 shows that lipid oxidation and MDA were inhibited when adding 0.01% Guardox™ BL. The use level of nitrite and iso-ascorbate sodium is decreased to half of the original formula.

Table 2 Rancidity degree in accelerated oxidation test of sausage

Day	0	8	11	13
Group 1: 1% iso-ascorbate Sodium + 1% Nitrite	-	++	+++	+++
Group 2: 0.5% iso-ascorbate sodium+ 0.5% Nitrite + 0.01% Guardox™ BL	-	-	-	+

* - No rancidity + Slight rancidity ++ Obvious rancidity +++ Serious rancidity

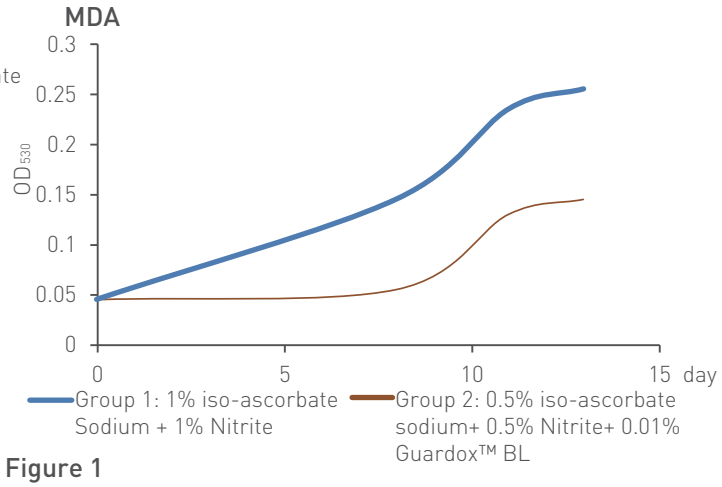


Figure 1

GUARDOX™ OE

Olive pulp extract

Guardox™ OE is a natural extract rich in polyphenols, sourced from fresh and traced olives (Olea europaea L.), solvent-free and with perfect solubility in water. Guardox™ OE provides protection and nutritional benefits while sed in different foods, such as baked products, meat, dressings, seasonings, vegetables, canned products, etc. Guardox™ OE represents a cost effective solution with enhanced protection against deterioration and lipid peroxidation in foods.

Table 3 Guardox™ OE Applications

Ingredients	Applications		Diagnosis	Dosage
Guardox™ OE	Cookies	Biscuits	Rancidity	0.3g/kg
	Ready-to-eat meals	Hamburg	Rancidity	0.3g/kg
		Cooked rice	Rancidity	0.2g/kg
	Cooked (cured) meat	Cooked ham, Bologna ham and sausages	Rancidity, off-flavor and off-color	0.2g/kg

Bologna ham

Bologna ham was added with 0.2 g/kg Guardox™ OE, the resultas figure 2 shows the level of oxidation was lower than A1 since day 1. Figure 3 shows A2 TBA levels remain statistically unchanged from day 1 to day 10, while A1 TBA was increased.

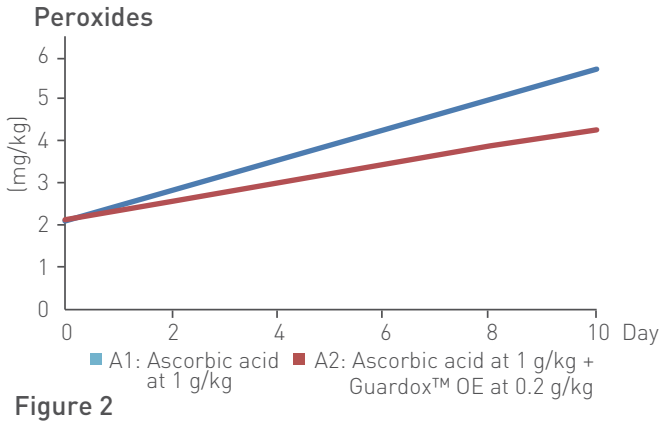


Figure 2

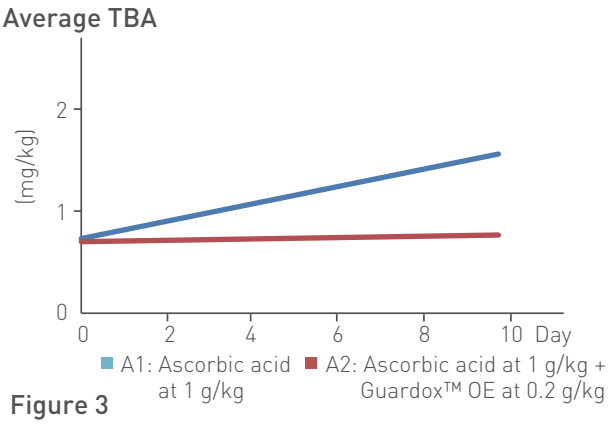


Figure 3

GUARDOX™ AE

Acerola extract

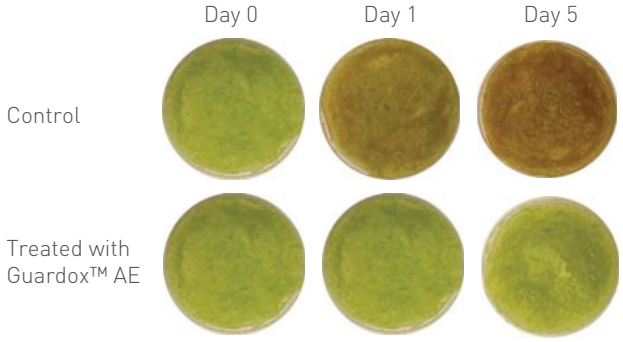
Guardox™ AE is an acerola cherry juice powder with the highest oxidative rancidity and color change in processed fruits, RTE meals naturally occurring ascorbic acid content, it is used as clean label alternative to ascorbic acid, ascorbate or erythorbate for preventing and meat products.

Table 4 Guardox™ AE Applications

Ingredients	Applications		Diagnosis	Dosage
Guardox™ AE	Processed fruits	Apple jam	Rancidity, off-color	0.3g/kg
	Ready-to-eat meals	Hamburg	Rancidity	0.3g/kg
	Fresh meat	Free ground beef	Rancidity, off-flavor and off-color	0.2g/kg

Apple jam

Enzymatic browning occurs naturally in fruits. Picture 1 indicates that when apple jam was treated with Guardox™ AE, it maintained its orginal fresh color.



Picture 1

Chicken burger

Figure 4 illustrates that addition of 0.2g/kg Guardox™ AE to chicken burger can enhance the antioxidative activity.

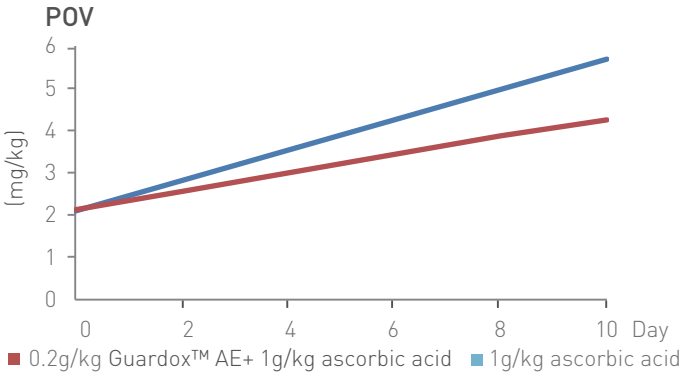


Figure 4

GUARDOX™ RA

Rosemary extract

Lipid oxidation causes the deterioration of critical nutritional and sensory attributes in foods during processing and storage. Rosemary (Rosmarinus officianalis L.) is a popular source of natural antioxidants in beverage and meat.

Guardox™ RA represents the highest grades of rosmarinic acid with minmized odor and bitterness, making it suitable for delaying lipid oxidation or rancidity in a wide range of food and beverage.

Table 5 Guardox™ RA Applications

Ingredients	Applications		Diagnosis	Dosage
Guardox™ RA	Cookies	Biscuits	Rancidity	0.3g/kg
	Soft drinks	Juice-based drinks	Oxidation, off-color	0.12g/L
	Ready-to-eat meals	Hamburg	Rancidity	0.3g/kg
	Cooked (cured) meat	Sausages	Rancidity	0.2g/kg

Biscuits

Biscuits containing fats is subject to a natural deterioration during the-shelf life. Guardox™ RA as secondary natural antioxidant activity, applied to biscuit stabilizes the fats, delaying oxidation and ensuring the original fragrance. Figure 5 shows that the addition of Guardox™ RA to biscuits, even under a thermal stress at 52°C, (accelerated shelf-life test), inhibits the peroxide value increased by 100%.

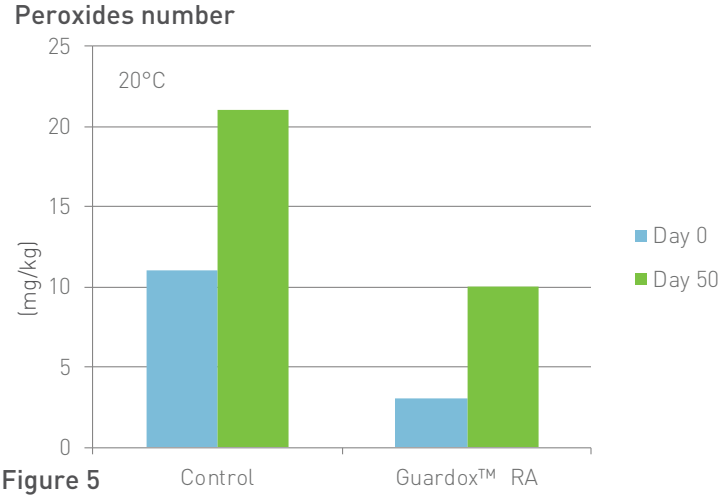


Figure 5

AMYLAX™
Fresh-keeping enzymes

KOATILM™
Fresh-keeping coating

WHITE FIBER™
Fresh-keeping fibers

11

NATURAL FRESH-KEEPING ENZYMES, COATING AND FIBERS

Consumers want to buy natural fresh foods, but these types of foods deteriorate quickly staling, enzymatical browning, water loss and microbiological decay. How to use natural way for fresh-keeping is an important challenge. Handary provides a group of natural enzymes, coatings and fibers for a longer-lasting freshness.

Amylax™ is a group of fresh-keeping enzymes comprising maltogenic alpha-amylase and other enzyme activities that could help you increase crumb softness and longer-lasting freshness of all kinds of baked goods including bread, buns, rolls and sweet goods. **Koatilm™** is a group of fresh-keeping coating comprising mushroom chitosan composited with other antimicrobial substances that could help you control fruit decay and avoiding moisture loss, aromas loss, and inhibit the oxygen penetration to the plant tissue of fresh fruit and vegetable. **White Fiber™** is a group of plant-derived fibers comprising corn and citrus fiber that could help you provide high water holding capacity of moisture-containing foods including bakery, frozen meals and meats.

KEY BENEFITS

- Anti-staling
- Anti-decay and anti-browning
- Moisture retention
- Longer freshness
- Natural, clean label

BRANDS

AMYLAX™
Fresh-keeping enzymes

KOATILM™
Fresh-keeping coating

WHITE FIBER™
Corn fibers

AMYLAX™

Fresh-keeping enzymes

Keep your bread fresher for days longer than any other suppliers on the shelf. Enzymes are invaluable processing aids that give a tender texture and improve freshness in bread.

Amylax™ is a group of maltogenic alpha-amylase-based enzyme that could help you increase crumb softness and longer-lasting freshness of all kinds of baked goods including bread, buns, rolls and sweet goods.

Table 1 Amylax™ MA Applications

Ingredients	Applications		Diagnostics	Dosage
Amylax™ MA-1	Bread	Bread	Staling, short freshness	15mg/kg
		Buns / rolls		15mg/kg
		Pita bread		20mg/kg
Amylax™ MA-2		Steamed bread		15mg/kg

AMYLAX™ MA-1 /2

Maltogenic amylase

Breads, rolls, buns and similar products have a typical short shelflife, the first signs of freshness loss are crumb firming and a reduction in springiness. How to hold on to breads fresh for a few days longer is becoming the most challengings for many industrial bread manufacturers.

Amylax™ MA Maltogenic amylase is prepared by submerged fermentation of *Bacillus subtilis*, effectively break down the flour starch in a highly effective enzymatic reaction thus providing crumb softness and longer-lasting freshness in bread products.

White bread

White bread has a short shelf-life owing to staling. Figure 1, 2 shows that Amylax™ MA -1successfully delays the loss of elasticity and development of crumb firmness in bread stored for 8 days at room temperature.

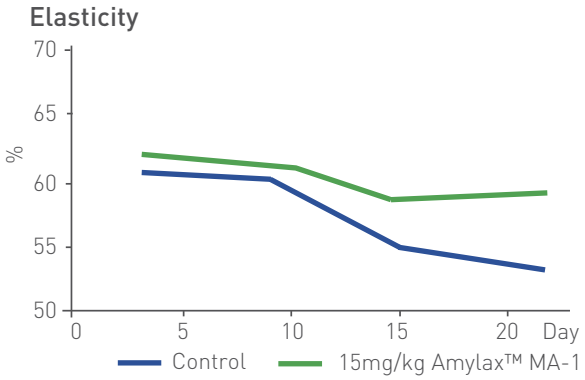


Figure 1

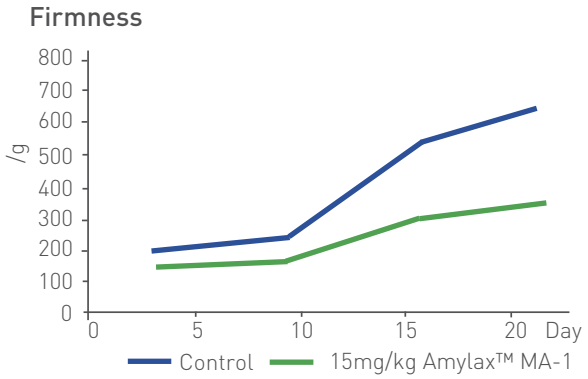


Figure 2

Steamed bread (Mantou)

Mantou is made by steaming dough, adding 55 mg/kg Amylax™ MA can improve softness under frozen conditions. This product enhances the quality of flat bread by increasing moistness, softness and mouth feel leading to improved eating quality. Figure 3 shows the anti-staling effectiveness of a Amylax™ MA-2 in steamed bread.

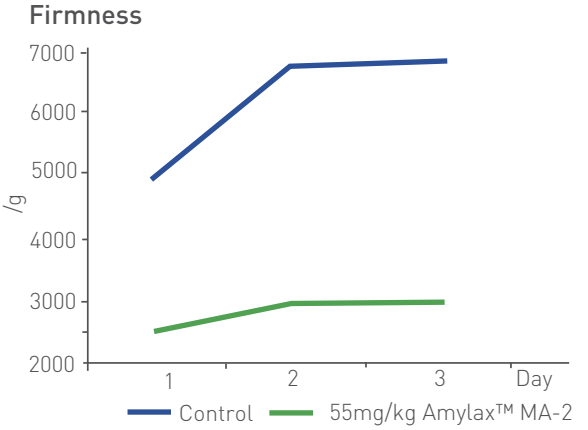


Figure 3

KOATILM™
Fresh-keeping coating

Postharvest fruit and vegetable are living organisms, undertaking metabolism ceaselessly. Their character such as nutrition, flavor, and appearance deteriorated during the process of storage and transportation owing to water loss, browning, decay, and so on.

Koatilm™ is a group of mushroom chitosan-based coating with strong antimicrobial and antifungal activities that could effectively control fruit decay. It could easily form coating on fruit and vegetable, and the respiration rate of fruit and vegetable was reduced by adjusting the permeability of carbon dioxide and oxygen, which could avoid moisture loss and aromas loss, and inhibit the oxygen penetration to the plant tissue or microbial growth.

Tabel 2. Koatilm™ Applications

Ingredients	Applications		Diagnosis	Dosage
Koalitim™ FV-1	Postharvest fruits and vegetables	Oranges, lemons	Retard fungal decay and browning	5-10mg/kg
		Apples, pears		3-10mg/kg
		Peach, apricot		10mg/kg
		Cherries, lychee		5-10mg/kg
		Nectarine		5-10mg/kg
		Fig		4-10mg/kg
		Avocado, mango		10-20mg/kg
		Strawberries		5-10mg/kg
		Grape		3-10mg/kg
		Tomato		2-10mg/kg
		Melon		5-20mg/kg
Koalitim™ FV-2	Postharvest fruits and vegetables	Oranges, lemons	Control disease and maintain overall quality	5-10mg/kg
		Apples, pears		3-10mg/kg
		Peaches, Apricots		10mg/kg
		Cherries, Plums		5-10mg/kg
		Nectarines		5-10mg/kg
		Jujube		8-10mg/kg
		Bananas		5-15mg/kg
		Figs		4-10mg/kg
		Avocadoes		10-20mg/kg
		Mangoes		10-20mg/kg
		Grapes		3-10mg/kg
		Tomatoes		2-10mg/kg
		Melons		5-20mg/kg
		Pineapples		5-20mg/kg
Koalitim™ FV-3	Fresh-cut fruits	Water chestnuts	Retard microbial decay and browning	1g/kg
		Fresh-cut apples		1g/kg
		Fresh-cut melon		1g/kg
		Fresh cut pineapple		1g/kg
		Grape		2g/kg
		Fresh-cut mango		5g/kg
	Fresh-cut vegetables	Fresh-cut lettuce		0.8-1g/kg
		Fresh-cut cattail		1.5-2g/kg
		Fresh-cut salad		0.8-1g/kg

KOATILM™ FV-1 | 2
Postharvest fruit coating

Koatilm™ FV-1 is water-soluble mushroom chitosan combined with natamycin and Koatilm™ FV-2 is acidic-soluble mushroom chitosan combined with natamycin, both of that show dual effectiveness in retarding enzymatic browning and avoiding tissue softening caused by fungal decay in postharvest fruits and vegetables.

Apple

Picture 1

Red grape

Figure 4 shows that Kotilm™ FV-1 effectively reduces decay rate of red grape up to 8.52% after 120 days in cool storage.

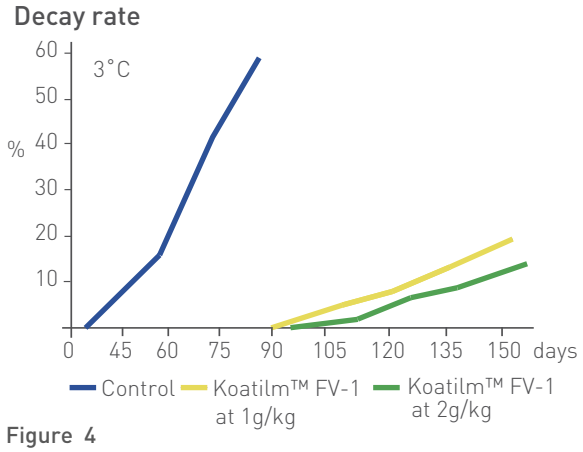


Figure 4

KOATILM™ FV-3

Fresh-cut fruit coating

Koatilm™ FV-3 is mushroom chitosan combined with cultured sugar cane that shows dual effectiveness in retarding enzymatic browning and avoiding tissue softening caused by microbial decay in fresh-cut fruits (salads).

Fresh-cut Salads

The increasing demands of fresh-cut salads are due to their fresh-like character, convenience, and human health benefits, but minimally processed products become more perishable.

Figure 5, 6 demonstrate that Koatilm™ FV-3 effectively retards decrease of PPO activity, enzymatic browning and decrease of decay rate of fresh-cut apples during storage.

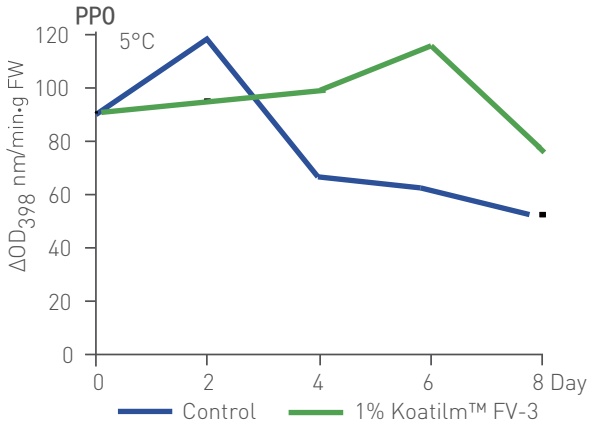


Figure 5

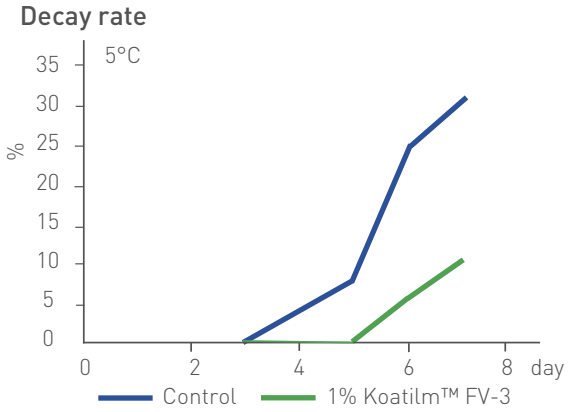


Figure 6

White Fiber™

Corn fibers

Food products with high phosphate contents are damaging to the health of general public. Dietary fibers are a new generation of healthy ingredients to replace phosphates for holding moisture.

White Fiber™ is a multifunctional fiber ingredient made from the bran of the corn kernel, the product has high water holding capacity in bakery products, frozen meals, meat and poultry.

Table 3. White Fiber™ Applications

Ingredients	Applications		Diagnosis	Dosage (w/w)
White Fiber™	Baked goods	Biscuits	Moisture loss	0.25- 0.75%
		Buns /Rolls		0.30- 0.75%
		Cookies		0.20– 0.50%
		Pie Dough / Pizza Dough / Pita Bread		0.50– 1.0 %
	Frozen meals	Frozen ready- to-eat meals	Moisture loss	0.20– 0.50%
	Frozen meat and poultry	Frozen beef	Juiceless loss	0.25-0.75%
		Frozen chicken		0.25-0.75%

Brown bread

Brown bread staling is determined by the water loss and crumb firmness. Figure 7, 8 showed added White Fiber™ in brown bread that decreased firmness on the 5th day after baking and increased water contents during the entire storage period.

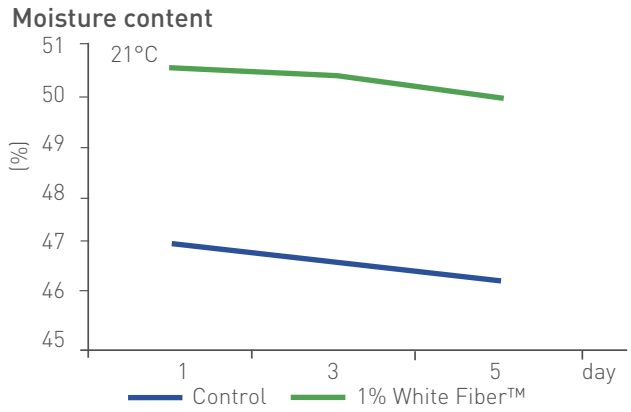


Figure 7

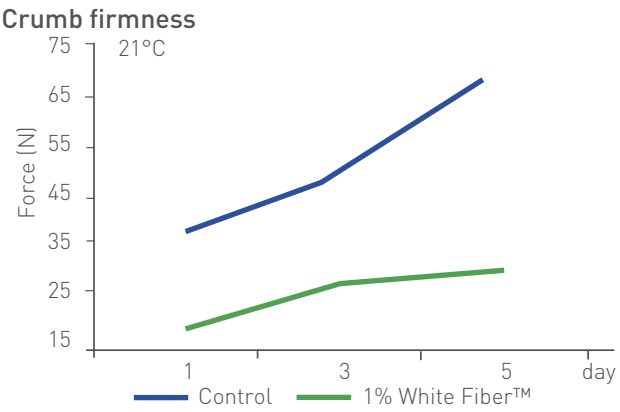


Figure 8

ANTIMIX™ Antimicrobial blends
SHELFEX™ Shelf life extenter
FIXOLOR™ Color stabilizer
CANTOLY™ Antimicrobial capsule
ANTIPACK™ Antifungal film

12

NATURAL SHELF LIFE EXTENDERS

With the current natural and clean label trend, consumers are more aware of ingredients, they are checking food labels carefully before they buy. Handary has been partnering with customers for years to develop formulas free of unwanted ingredients. Our technical team can work with you to increase your product shelf life and stability with natural or clean label formulas.

Antimix™ antimicrobial blends are dosage-efficient solutions that combine known natural antimicrobial ingredients to achieve a synergistic effect against a multi-spoilage bacteria or multi-pathogens. **Shelfex™** shelf life extender is all-natural range of tailored blends that has maximized synergies to increase the shelf life of foods by stabilizing multi-deteriorating factors or inhibiting a multi-spoilage factors. **Fixolor™** color retention agent is to combine all natural ranges of known ingredients to increase the color stability. **Cantoly™** utilizes microcapsule techniques to release antimicrobial activities for shelf life extension in canned foods. **Antipack™** biodegradable active antifungal film used to prevent the mold growth on solid foods.

KEY BENEFITS

Customerised solutions for oxidative and microbial spoilage, browning, staling, moisture loss and color change
Cost-efficiency
Shelf life extension
Natural, friendly labeling

BRANDS

ANTIMIX™
Antimicrobial blends

SHELFEX™
Shelf life extender

FIXOLOR™
Color stabilizer

CANTOLY™
Antimicrobial capsule

ANTIPACK™
Antifungal film

ANTIMIX™

Antimicrobial blends

Our "multi-hurdle" proprietary Antimix™ antimicrobial blends are dosage-efficient solutions that combine known natural antimicrobial ingredients to achieve a synergistic effect against a multi-spoilage bacteria or multi-pathogens, whose primary functionalities are:

- Growth control/inhibition/killing of multi-spoilage microorganisms
- Killing multi-pathogens

Table 1 Antimix™ Applications

Ingredients	Applications		Diagnosis	Dosage
Antimix™ EV	Condiments	Soy sauce	Total plate count (TPC)	50-100mg/kg
		Cooking sauces		
		Deli salads		
		Dips and spreads, fillings and stuffing		
		Refrigerated meals and refrigerated soups		
	Raw meat	Turkey breast		
	Cooked (cured) meat and poultry	Smoked ham		
		Turkey breast		
		Roast beef		
		Ham		
		Chicken rolls		
Antimix™ NS	Raw meat and poultry	Fresh chicken	Total bacteria population	200mg/kg
Antimix™ VP	Condiments	Dressings & Sauces	Total plate count (TPC)	150mg/kg
	RTE meals	RTE soup		
		RTE rice		
	Raw meat and poultry	Raw ham		
		Fresh Chicken breasts		
	Cooked meat	RTE turkey bologna		

ANTIMIX™ EV

TPC Inhibitor

Antimix™ EV is label-friendly antimicrobial blend formulated by ε-Polylysine and distilled vinegar, and has demonstrated a high efficacy against a total plate count (TPC) in sauces, dressings and condiments, meat and poultry products.

Soy sauce

Figure 1 shows that Antimix™ EV effectively inhibits total plate count of soy sauce up to 74.3% during 35 days at 37°C.

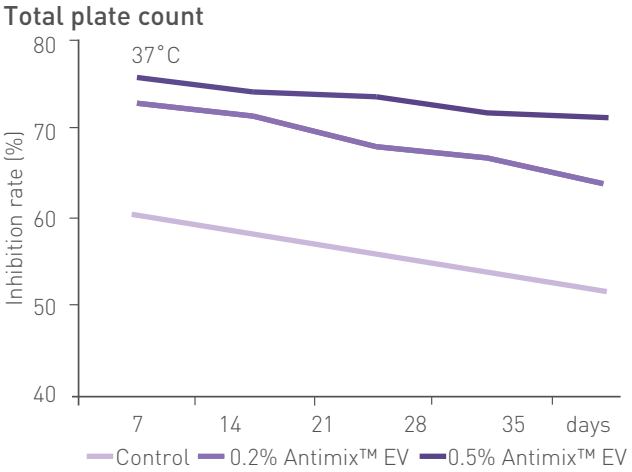


Figure 1

ANTIMIX™ NS

TPC Inhibitor

Antimix™ NS is formulated by Nisin and Sodium lactate to achieve a synergistic antimicrobial effect to reduce the total bacteria population in cooked meat and poultry.

Fresh chicken

Figure 2 shows that Antimix™ NS effectively inhibits Mesophilic aerobic count of fresh chicken.

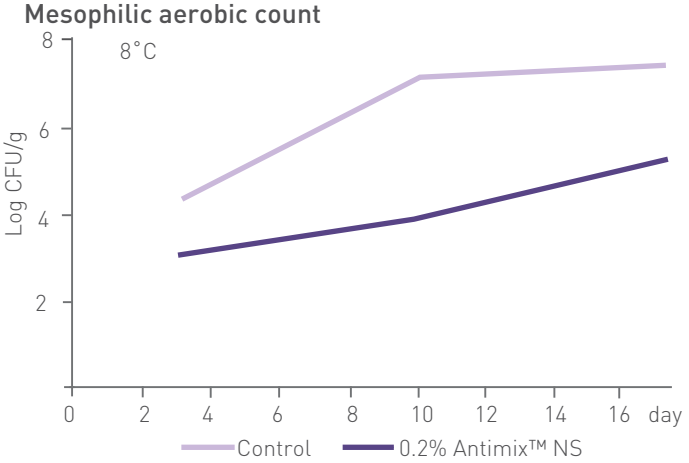


Figure 2

ANTIMIX™ VP

TPC Inhibitor

Antimix™ VP is clean-label antimicrobial blend formulated by citrus juice powder and distilled vinegar, and has demonstrated a high efficacy against a total plate count (TPC) in condiments, RTE meals and raw meat and poultry.

Fresh chicken breasts

Figure 3 shows that the addition of 0.5g/kg Antimix™ VP is effectively against the total plate countin in chicken breast, the shelf life is extended to over double the control.

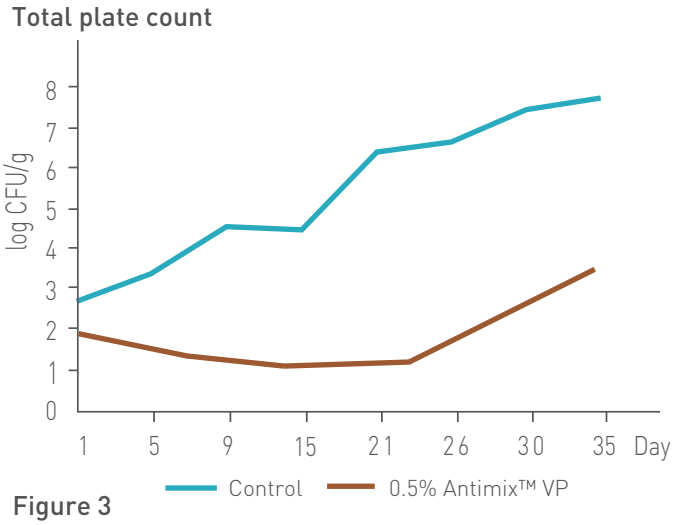


Figure 3

SHELFEX™

Shelf life extenders

Shelf-life extenders are an all-natural range of tailored blends used to increase the shelf life of foods by stabilizing multi-deteriorating factors or inhibiting a multi-spoilage factors.

Combinations of selected ingredients create optimal functionality for a broad assortment of food and beverage applications. Handary's tailored blends draw on a comprehensive toolbox of natural protective ingredients. Advanced product, application and processing know-how bring these ingredients together and maximise their synergies to address overall consumer needs, contributing to end products that are fresh, tasty, appealing, healthy and safe.

In addition to standard off-the-shelf products under the brand of Shelfex™, Handary produces many blends that are specifically designed to meet the needs of individual customers.

Table 2 Shelfex™ Applications

Ingredients		Applications	Diagnosis	Dosage
Shelfex™ NB	Juice	Fruit and vegetable juice	Gram-positive bacteria and oxidation	120-150mg/kg
	Dried meat	Dry and semi-dry sausage		130mg/kg
Shelfex™ NO	RTE meals	Hamburg		200-400mg/kg
	Cooked cured meat	Cooked ham, Bologna ham and sausages, Frankfurters		200-400mg/kg
Shelfex™ ER	RTE meals	Ready-to-eat rice (meat,vegetable, sauce)	Total plate count and oxidation	50-150mg/kg
		Refrigerated cooked noodles		
	Cooked meats, poultry and fish	Surimi		25-80mg/kg
Shelfex™ VJ	Fresh meat	Fresh sausage	Microbial spoilage, off-colour and off-flavor	0.5-1.0g/kg
		Fresh ground beef		0.5-1.0g/kg

SHELFEX™ NB | NO

SPOILAGE INHIBITOR

Shelfex™ NB is the formulation of Nisin and Bamboo leaves extract and Shelfex™ NO is the formulation of Nisin and olive pulp extract; Both are a healthy approach to protecting foods from oxidation and microbial spoilage in processed foods.

Frankfurters

Figure 4 shows that Frankfurters added with 0.2% Shelfex™ NO effectively reduces 1 log *Listeria monocytogenes* on day 1 and 4 log on day 80 at 30°C.

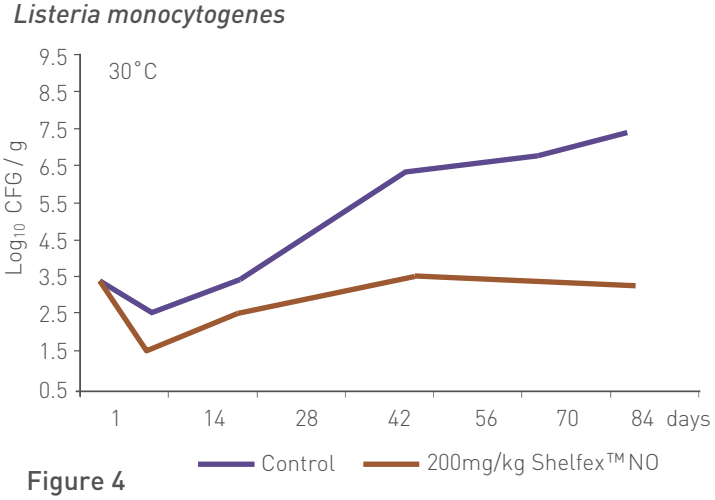


Figure 4

SHELFEX™ VP

SPOILAGE INHIBITOR

Shelfex™ VP is the formulation of vinegar and citrus fruit extract to control oxidation and total plate count in RTE meals and cooked meat, poultry and fish.

Surimi

Data in Figure 5 reveal the prolonged microbial shelf life provided by Shelfex™ VP. Total plate count was inhibited during the 35-day study.

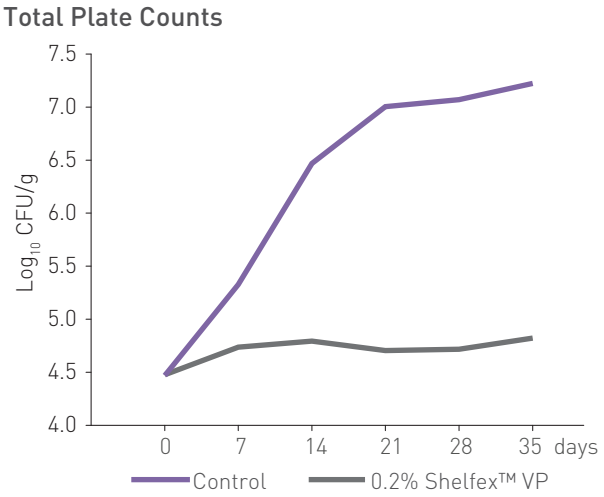


Figure 5

SHELFEX™ VJ

SPOILAGE INHIBITOR

Shelfex™ VJ is the formulation of vinegar and tea extract that provides a total freshness package for fresh sausage and ground meats. It not only controls spoilage organisms, but also provides the additional benefits of maintaining raw meat color and fresh flavor.

Shelfex™ VJ can meet consumer demands for cleaner ingredient statement while improving overall freshness of your meat products and improve profitability.

Fresh ground beef

Picture 1 show the beneficial effect of Shelfex™ VJ on fresh ground beef color. In addition, no off flavors were observed after frozen storage of the sausage.

Data in Figure 6 reveal the prolonged microbial shelf life provided by Shelfex™ VJ. Aerobic plate count did not grow during the 15-day study.

Color: Fresh ground beef
Day 6 of storage

Picture 1

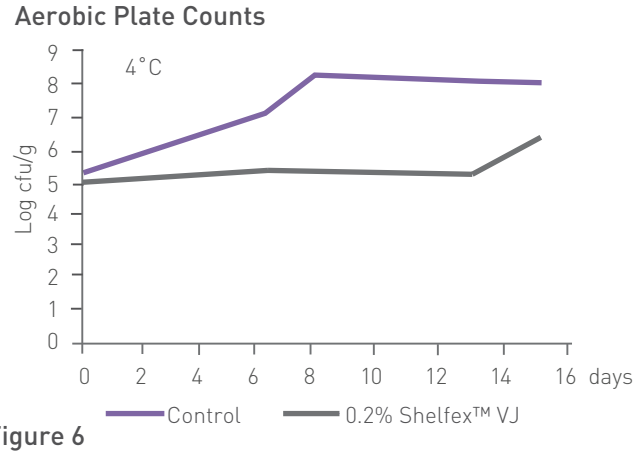


Figure 6

FIXOLOR™

Color stabilizer

The first impression consumers have of any food is its color and thus color is of utmost importance. For examples, fresh and cured meat color both depend on myoglobin, fresh fruit and vegetable and their concentrate color depend on anthocyanins. Unfortunately, the color of these products is unstable and easily susceptible to degradation, leading to discolouration (e.g. Blackening, Browning, Greening, Pigments, Red spot). Our color stabilizer is natural alternatives to artificial color stabilizer such as citric acid and nitrate.

Ingredients		Applications	Diagnosis	Dosage
Fixolor™ AT	Juice	Apple juice concentrate	Anthocyanin (color) degradation	0.12-0.15ml/L
		Strawberry and raspberry juice concentrate		0.13ml/L
Fixolor™ PK	Cured meat	Bologna, Frankfurters, Polish Sausage	Pink color	0.25-0.5g/kg
		Hams, Bacon (Precooked), Cured Poultry, Pastrami, Corned Beef		0.25-0.4g/kg

FIXOLOR™ AT
Anthocyanin stabilizer

Fixolor™ AT is the formulation of cultured sugar cane and fungal chitosan as natural alternative to citric acid, for increasing anthocyanin (color) stability in juice concentrate.

Strawberry and raspberry juice concentrate

Figure 7 demonstrates the anthocyanin (color) stability impact of Fixolor™ AT and citric acid in strawberry and raspberry juice concentrate, the result displays that Fixolor™ AT significantly lower rate of color changing over time, when compared with the sample acidified with citric acid.

Color changing

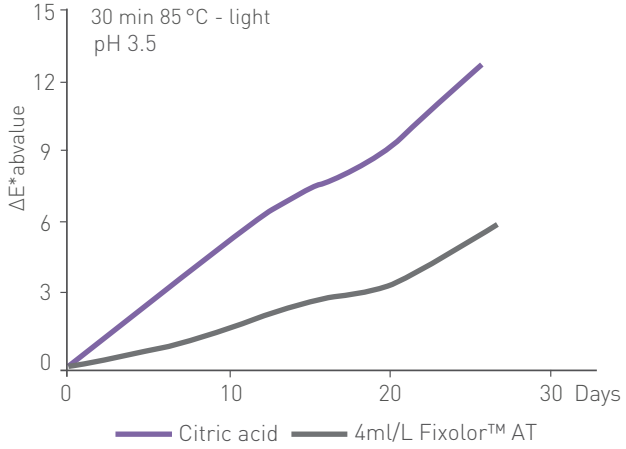


Figure 7

FIXOLOR™ PK
Pink stabilizer

Fixolor™ PK is the formulation of acerola, chard and bamboo leave extract powder as natural alternative to nitrates / nitrites for pink color stability in cured meat items.

Ham

Picture 2 demonstrates the pink color impact of Fixolor™ PK and nitrites in ham, the result displays that Fixolor™ PK significantly enhance the pink color of ham, when compared with the sample with nitrites.

Control | 0.2g/kg Nitrites | 0.4g/kgFixolor™ AT

Picture 2

CANTOLY™
Antimicrobial capsule

Microorganisms of canned solid foods can be killed at high temperature and high pressure to achieve long-term shelf lfe. However, the process will lead to taste loss.

Cantoly™ is Chitosan microcapsules containing Nisin as active ingredient and the kinetic release antimicrobial acitivies to inhibit Gram-positive bacterial in canned solid foods.

Table 4 Cantoly™ Applications

Ingredients	Applications	Diagnosis	Dosage
Cantoly™ AG	Canned foods	Canned beef	Total plate count	60mg/kg

Canned beef (vegetables, beef, spices)

If the temperature is reduced, it is difficult to kill all spores, as shown in Figure 8, 60mg /kg Cantoly™ was added in canned beef at 70°C, the total plate count can be inhibited significantly for long-term storage.

Total plate count

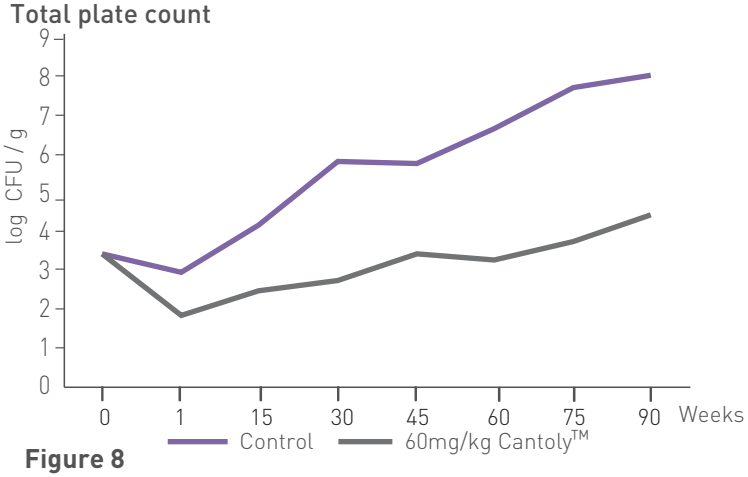


Figure 8

ANTIPACK™
Biodegradable active antifungal film

Antipack™ is a kind of biodegradable active antifungal film used to prevent the mold growth by releasing gradually PLA and chitosan-containing Phenyllactic acid activities onto the surface of solid foods such as semi-hard/hard cheese and dried sausages during the shelf life period.

Picture 3 shows that Antipack™ was filmed on the surface of Gouda cheese after 100 days storage at 30°C, no mold observed, while compare to control group only 28 days, the mold almost covered the whole cheese.

Control | Antipack™

Picture 3

Who we are

With our headquarter located in the heart of Europe - BRUSSELS. Handary is an innovation leader in natural shelf-life solutions. We design and manufacture bio-based ingredients with the experimental deteriorating-quality diagnostics to prolong a safe protected shelf life quality of prepared foods and healthcare products.




Our history

November 2017 Handary developed Antipack™ Biodegradable Active Antifungal Film and honoured the FiE EXPO "Innovation Award ".
September 2017 Handary created systematically clean-label shelf life ingredients alternative to E-number or chemical preservatives.
November 2016 Handary invested its new industrial production base in Fleurus, Belgium.
April 2016 Handary launched Chitoly® mushroom Chitosan.
January 2016 Nisin ZP was proved effective to treat head and neck cancer by university of Michigan.

October 2015 Handary launched Lysoch® microbial Lysozyme.
July 2015 Handary restructured its new organization to create all natural-range of shelf life ingredient solutions.
January 2015 Handary expanded its subsidiary in Suzhou, China.
October 2014 Handary established the first Lab of shelf life diagnostics and evaluation in Brussels.
April 2014 Handary launched Proteria® cultured sugar and vinegar.
December 2013 Handary further developed the 'White NisinA' and honoured the FiE EXPO "Excellence Award Finalist".

February 2013 Handary discovered a controlled-released packaging - Antipack™ and honoured the Dubai Gulfood Expo "Highly Commended Award".
September 2010 Handary built its first antimicrobial plant in Lendelede, Belgium.
July 2010 Handary discovered Vegetal Nisin A and honoured the US IFT Expo Innovation Award.
July 2009 Dr. Aimin He lunched the idea for all natural range of protective solutions and registered handary company in Brussels.

Our awards

NISINA®
2010 IFT FOOD EXPO
"Innovation Award"

WHITE NISINA®
2013 FiE EXPO
"Excellence Award Finalist"

Fi
Food ingredients
EUROPE
FINALIST
AWARDS 2013

ANTIPACK™ AF
2013 GULFOOD EXPO
"Highly Commended Award"

ANTIPACK™
2017 FiE Expo
"Innovation Award"

Fi Food ingredients Europe
Innovation Awards 17
FINALIST

Online Support Service

Beyond guaranteed product quality, We knows an excellent service is essential for customer satisfaction. We are always ready to provide you with the best support, advice and after services, as well as to guide you through all our partners and distributors .

Handary's operations involve projects and objectives of customers and distributors around the world. If you have any questions or would like further information on our projects, products and services, or if you would like to discuss a potential initiative , please don't hesitate to contact us.

For any questions about our company, please do not hesitate to contact us:

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» www.handary.com/contact/

Come to visit our company or factory, talk with our specialists or visit our global exhibitions .

ONLINE CHAT with us (www.handary.com/chat)
follow us on **Twitter, Facebook, LinkedIn, YouTube.**

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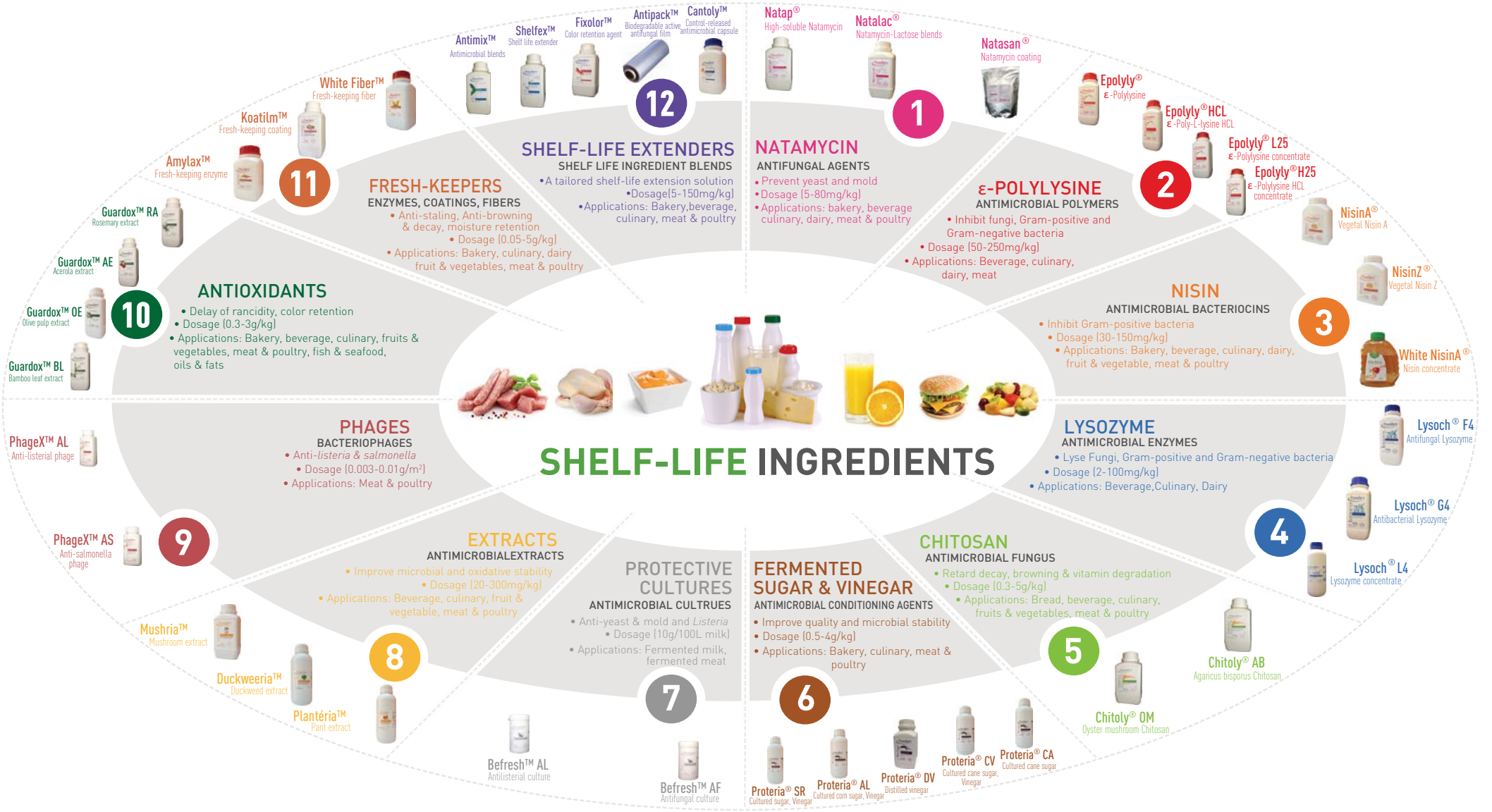
Where to find us:

with 51 distributors covering 91 countries around the world


SHELF-LIFE INGREDIENTS
1
NATAMYCIN
ANTIFUNGAL AGENTS
• Prevent yeast and mold
• Dosage (5-80mg/kg)
• Applications: bakery, beverage culinary, dairy, meat & poultry
Natap®
High-soluble Natamycin
Natalac®
Natamycin-Lactose blends
Natasan®
Natamycin coating
2
ε-POLYLYSINE
ANTIMICROBIAL POLYMERS
• Inhibit fungi, Gram-positive and Gram-negative bacteria
• Dosage (50-250mg/kg)
• Applications: Beverage, culinary, dairy, meat
Epolyly®
ε-Polylysine
Epolyly® HCL
ε-Poly-L-lysine HCL
Epolyly® L25
ε-Polylysine concentrate
Epolyly® H25
ε-Polylysine HCL concentrate
3
NISIN
ANTIMICROBIAL BACTERIOCINS
• Inhibit Gram-positive bacteria
• Dosage (30-150mg/kg)
• Applications: Bakery, beverage, culinary, dairy, fruit & vegetable, meat & poultry
NisinA®
Vegetal Nisin A
NisinZ®
Vegetal Nisin Z
White NisinA®
Nisin concentrate
4
LYSOZYME
ANTIMICROBIAL ENZYMES
• Lyse Fungi, Gram-positive and Gram-negative bacteria
• Dosage (2-100mg/kg)
• Applications: Beverage,Culinary, Dairy
Lysoch® F4
Antifungal Lysozyme
Lysoch® G4
Antibacterial Lysozyme
Lysoch® L4
Lysozyme concentrate
5
CHITOSAN
ANTIMICROBIAL FUNGUS
• Retard decay, browning & vitamin degradation
• Dosage (0.3-5g/kg)
• Applications: Bread, beverage, culinary, fruits & vegetables, meat & poultry
Chitoly® AB
Agaricus bisporus Chitosan
Chitoly® OM
Oyster mushroom Chitosan
6
FERMENTED SUGAR & VINEGAR
ANTIMICROBIAL CONDITIONING AGENTS
• Improve quality and microbial stability
• Dosage (0.5-4g/kg)
• Applications: Bakery, culinary, meat & poultry
Proteria® SR
Cultured sugar, Vinegar
Proteria® AL
Cultured corn sugar, Vinegar
Proteria® DV
Distilled vinegar
Proteria® CV
Cultured cane sugar, Vinegar
Proteria® CA
Cultured cane sugar
7
PROTECTIVE CULTURES
ANTIMICROBIAL CULTRUES
• Anti-yeast & mold and *Listeria*
• Dosage (10g/100L milk)
• Applications: Fermented milk, fermented meat
Befresh™ AL
Antilisterial culture
Befresh™ AF
Antifungal culture
8
EXTRACTS
ANTIMICROBIALEXTRACTS
• Improve microbial and oxidative stability
• Dosage (20-300mg/kg)
• Applications: Beverage, culinary, fruit & vegetable, meat & poultry
Mushria™
Mushroom extract
Duckweeria™
Duckweed extract
Plantéria™
Pant extract
9
PHAGES
BACTERIOPHAGES
• Anti-*listeria & salmonella*
• Dosage (0.003-0.01g/m²)
• Applications: Meat & poultry
PhageX™ AL
Anti-listerial phage
PhageX™ AS
Anti-salmonella phage
10
ANTIOXIDANTS
• Delay of rancidity, color retention
• Dosage (0.3-3g/kg)
• Applications: Bakery, beverage, culinary, fruits & vegetables, meat & poultry, fish & seafood, oils & fats
Guardox™ RA
Rosemary extract
Guardox™ AE
Acerola extract
Guardox™ OE
Olive pulp extract
Guardox™ BL
Bamboo leaf extract
11
FRESH-KEEPERS
ENZYMES, COATINGS, FIBERS
• Anti-staling, Anti-browning & decay, moisture retention
• Dosage (0.05-5g/kg)
• Applications: Bakery, culinary, dairy fruit & vegetables, meat & poultry
Amylax™
Fresh-keeping enzyme
Koatilm™
Fresh-keeping coating
White Fiber™
Fresh-keeping fiber
12
SHELF-LIFE EXTENDERS
SHELF LIFE INGREDIENT BLENDS
•A tailored shelf-life extension solution
•Dosage(5-150mg/kg)
•Applications: Bakery,beverage, culinary, meat & poultry
Antimix™
Antimicrobial blends
Shelfex™
Shelf life extender
Fixolor™
Color retention agent
Antipack™
Biodegradable active antifungal film
Cantoly™
Control-released antimicrobial capsule

SHELF LIFE SOLUTIONS
Highlights 2018

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Natural Shelf Life Specialist

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