



Introduction to GRINDOX™ Antioxidants

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Why use GRINDOX™ Antioxidants?

GRINDOX™ Antioxidants used in foods improve product quality and shelf life considerably by delaying lipid oxidation and rancidity.

Lipid oxidation and rancidity develop when food products come into contact with atmospheric oxygen during processing and storage.

Rancidity often follows oxidation in food products, causing an unpleasant smell and taste as well as loss of nutritional value - and this is unacceptable to modern consumers.

Benefits of the GRINDOX™ Antioxidant range

All components of the GRINDOX™ Antioxidant range have specific functions in individual GRINDOX™ Antioxidant blends. The main benefits are described below in table 1.

Extension of shelf life by delaying lipid oxidation

The main function of antioxidants is to extend the shelf life of food products by delaying lipid oxidation. Antioxidants delay lipid oxidation because they prevent lipid free radicals from initiating the self-accelerating oxidation process that takes place when the radicals come in contact with oxygen.

Maintaining product quality

By delaying lipid oxidation, antioxidants also make it possible to maintain initial product quality for a longer period, ensuring a minimum of change or deterioration in taste, odour, texture and nutritional value.

Consistent product quality

Antioxidants also function as a quality assurance, enabling consistent quality to be obtained from batch to batch. In this way, it is possible to compensate for initial differences between raw material lots.

Components		Functions
Antioxidants, vitamin-based	Ascorbyl palmitate Tocopherols	Delay lipid oxidation. Prolong shelf life. Maintain product quality. Ensure consistent quality from batch to batch.
Antioxidants, traditional	Propyl gallate BHA BHT TBHQ	Ensure synergistic effects between selected antioxidants. Give good handling and working conditions when blends are used.
Chelators	Citric acid Citric acid mono-glyceride ester	Prevent traces of metal ions from initiating oxidation.
Carriers	Emulsifiers Vegetable oil Others	Ensure uniform distribution and optimum effect of antioxidants. Facilitate incorporation in liquid, paste or powder forms. Present the choice between fat-soluble or water-dispersible blends.

Table 1: Typical compositions and functions of GRINDOX™ Antioxidants.

Blends of antioxidants

Danisco Cultor strongly recommends the use of blends of several different antioxidants with suitable chelators and carriers to obtain the optimum, most cost-effective results. Some of the interesting advantages of using blends are mentioned below.

Uniform distribution of antioxidants

GRINDOX™ Antioxidant blends are homogeneous products because optimum dissolution of the antioxidant components is obtained by means of carefully selected carriers.

The main advantage of this uniform distribution of antioxidants in the blends is that the full effect of the antioxidants is only achieved when they are well dissolved from the outset. Secondly, it is easier for food manufacturers to incorporate and disperse GRINDOX™ Antioxidant blends optimally in end products.

Synergistic effects

Synergistic effects can be obtained by combining various antioxidants. This means that, when a blend of antioxidants is used, each antioxidant boosts the effect of the others. The result is greater stability than that achieved when the equivalent dosage of a single antioxidant is used.

Synergistic effects are of particular interest when vitamin-based antioxidants are combined, for instance when ascorbyl palmitate and tocopherols are used together.

Synergy can also be obtained by using substances which are not antioxidants themselves but which are able to enhance the effect of antioxidants. For instance certain chelators are often used as synergists.

Prevention of metal-catalysed oxidation

Metal-catalysed oxidation can occur in food products in the presence of trace metal ions such as iron and copper. GRINDOX™ Antioxidant blends often include chelators which are able to bind these trace metal ions so they do not initiate oxidation processes.

Water-dispersible and fat-soluble blends

The GRINDOX™ Antioxidant range comprises blends which can be incorporated via fat or water phases. These application options are obtained by means of carefully selected carriers.

Water-dispersible blends present a special application option. They can be recommended for products consisting of multi-phase systems, such as potato crisps, mayonnaise, dressings, etc.

For application in oil or fat phases, on the other hand, fat-soluble blends can be offered.

GRINDOX™ Antioxidants in the form of liquid, powder or flakes are also available.

Good handling and working conditions

Good working conditions can be obtained and dust problems minimised when paste and liquid blends are used. Thus the risk of eyes, skin and lungs coming into contact with aggressive components is reduced.

It is also possible to avoid time-consuming weighing and other handling operations in production when one blend is used instead of several individual antioxidants.

Components of the GRINDOX™ Antioxidant range

The three main groups of components in the GRINDOX™ Antioxidant range are antioxidants (traditional and vitamin-based), chelators and carriers as described below.

Traditional antioxidant blends

Traditional antioxidant blends are mainly based on traditional phenolic antioxidants such as BHA, BHT, TBHQ and propyl gallate. They are normally easily available, have a consistent quality and have proven to be highly effective.

Vitamin-based antioxidant blends

Vitamin-based antioxidant blends are based on combinations of tocopherols and ascorbyl palmitate. Tocopherols (vitamin E) can be both synthetic and natural (the latter occurring in vegetable oil in particular), whereas ascorbyl palmitate is an ester of an edible fatty acid and ascorbic acid (vitamin C). They all have the same effect as vitamins, and the body treats them as such.

Vitamin-based antioxidants are modern consumer-friendly alternatives to traditional antioxidants and are particularly efficient when used synergistically.

Ascorbyl palmitate

Ascorbyl palmitate is a special vitamin-based antioxidant which is very potent and possesses a number of special properties.

Ascorbyl palmitate has full vitamin C effect and, due to its vitamin-based nature, satisfies a variety of modern consumer demands.

Ascorbyl palmitate has the special property of being both fat-soluble and water-dispersible. This means it has a very widespread effect since it functions simultaneously in both fat and water phases of complex products. In emulsions, ascorbyl palmitate has the special ability to place itself at the interface between fat and water where there is an increased risk of oxidation and, thus, an increased need for protection.

Ascorbyl palmitate is able to strengthen the effect of other antioxidant components in a synergistic way. This is especially the case in combination with tocopherols.

It is also capable of chelating metal ions so that they do not function as initiators of oxidation processes. In addition, it can prevent colour reversion (toco red).

Danisco Cultor's ascorbyl palmitate is available both in a pure form as GRINDOX™ ASCORBYL PALMITATE and as part of GRINDOX™ Antioxidant blends. More information is available on request.

Chelators

Chelators are used to prevent metal-catalysed oxidation. In the GRINDOX™ Antioxidant range, they mainly consist of citric acid and citric acid ester of monoglycerides, but, in some cases, ascorbyl palmitate is also used. Chelators are also called sequestrants or synergists.

Carriers

With regard to carriers, many different products are used as co-solvents, for example vegetable oil, lecithin and propylene glycol. But, in GRINDOX™ Antioxidants, Danisco Cultor's own emulsifiers are the most important carriers. Based on our comprehensive knowledge and understanding of emulsifiers, it is possible to create GRINDOX™ Antioxidants with individual features.

Which products need shelf life protection?

Since lipid oxidation occurs when fats or oils come in contact with oxygen, all food products containing fats or oils, even in very small quantities, are prone to oxidative deterioration.

Danisco Cultor has worked with aspects of lipid oxidation for many years and mainly focus on the following application areas:

Fats and oils

This industry comprises oil refineries working with pure vegetable or animal oils and fats for direct consumption and frying purposes, as well as for use as ingredients in processed food products such as margarine, shortenings, mayonnaise and dressings.

Potato products

Here it is mainly a question of potato flakes or granules for use in mashed potato powder, potato croquettes and various other potato products.

Pet food

This area comprises raw materials for pet food production such as pure fats and oils, particularly rendered or melted animal fats, but also meat and digest products. Antioxidant protection is needed both at the raw material supplier level and in the production of, for example, extruded pet food.

The road to longer shelf life

The influence of oxidation on product shelf life is illustrated in figure 1. This shows that, under "normal" handling conditions (i.e. where no special precautions are taken to avoid lipid oxidation), a given product has a certain shelf life before it is destroyed by oxidation.

The illustration also shows that shelf life can be prolonged to a certain extent simply by improving handling and processing conditions. This improvement can be increased considerably by also adding antioxidants at appropriate stages of storage and production. At the same time, the antioxidants improve product quality because oxidation is maintained at a lower level throughout the storage period.

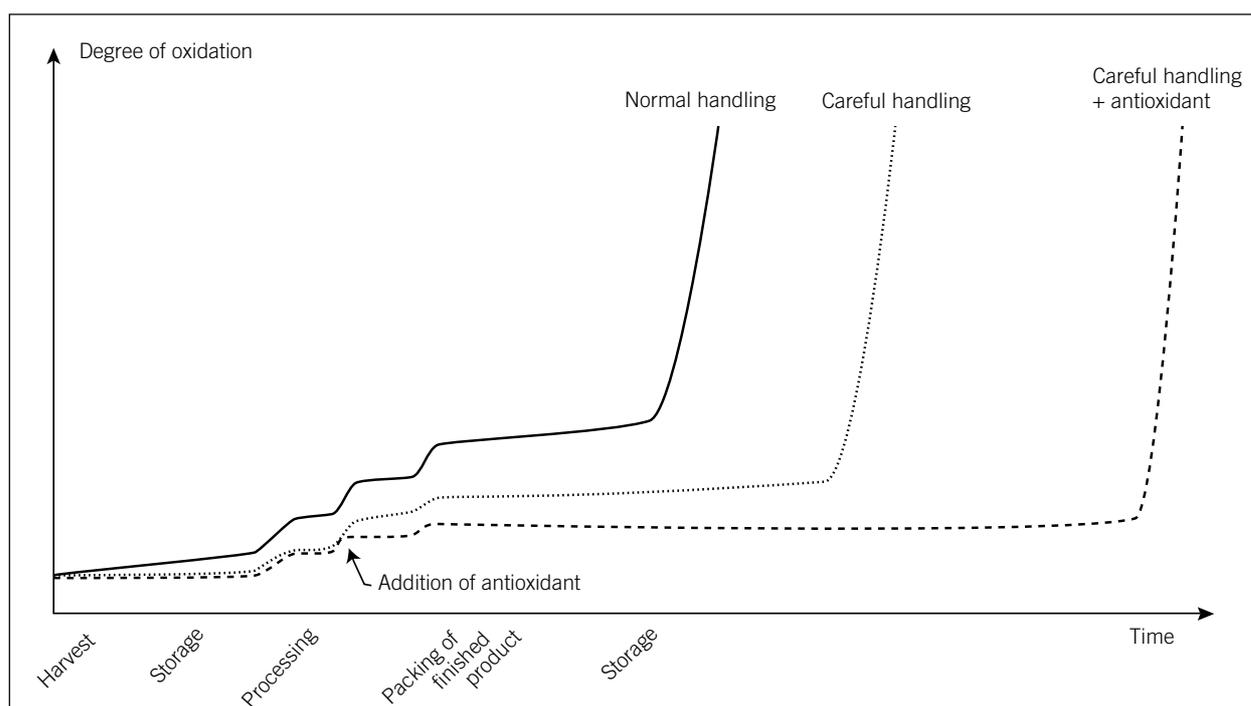


Fig. 1: Extension of shelf life by careful handling and use of antioxidants (source: H. Lingnert, SIK, Sweden).

Consequently manufacturers can do a lot to assure good conditions and produce food products with an optimum shelf life.

Good quality raw materials

Good quality raw materials should be used. This means for instance the type of oil or fat to be used should be carefully selected. It is also important not to damage the raw material, for instance by destroying oil seeds during harvesting so they are open to the influence of oxygen.

Raw material quality can be checked by means of parameters such as iron content (preferably below 1 ppm), copper content (preferably below 0.1 ppm), peroxide value (preferably below 2) and anisidine value (preferably below 4). The natural content of tocopherols is also an important parameter. Tocopherol content varies from oil to oil, but it should always be as high as possible.

Good storage conditions

Careful handling should be continued during raw material storage, for instance by maintaining a low storage temperature away from light and oxygen.

Suitable production processes

During processing, much can be done to avoid lipid oxidation and rancidity. Production processes should be arranged in such a way that heating times and temperatures are reduced and intermediate storage times are as short as possible. Unnecessary exposure to oxygen and light should also be avoided as well as contamination with metals from equipment or other raw materials.

Good conditions for finished products

Finished products should of course be protected during storage and distribution in the same way as during production. Packaging should be able to protect against oxygen, heat and light, for instance by avoiding transparent materials where light can penetrate. Another possibility is to use nitrogen cover.

Addition of antioxidants

As illustrated in figure 1, the addition of antioxidants considerably enhances the effect of careful handling and storage.

It is important to add antioxidants as early as possible since, once the oxidation process has started, it cannot be stopped, and damage caused by rancidity cannot be repaired! Consequently it is often a good idea to add antioxidants at the supplier's premises to obtain this early effect.

With regard to the production process, it is also important to add antioxidants as early as possible. Even when antioxidants have been added to raw materials by the supplier, it is often necessary to add more during production to obtain optimum shelf life. The

reason is that antioxidants are used up as they exert their influence. This means they should constantly be present in sufficient quantities. Exactly when to add a specific GRINDOX™ Antioxidant blend should be determined individually. In connection with frying, for instance, it may be a good idea to add antioxidants during the pauses between cooling and heating.

When applying GRINDOX™ Antioxidants to food products, it is very important to ensure the antioxidants are carefully dissolved and dispersed in the food product so the antioxidants can function optimally.

In the product descriptions for individual GRINDOX™ Antioxidants, directions for use are suggested. Normally we recommend they are added via a pre-dispersion to the fat and/or water phase of a product. For this purpose, fat-soluble and water-dispersible antioxidants are available.

The use of predispersions is an advantage if, for instance, addition requires the oil to be heated. In such cases, it is only necessary to heat a small part of the total oil quantity. At the same time, it is easier to disperse the antioxidants when an adequate pre-dispersion is used.

However, addition directly to the bulk of the product may be recommended for certain products, as well as spraying, dipping, kneading, injection or similar methods. The choice of method depends on factors such as the production process, nature of the food product and production equipment and must be determined in each individual case.

Important factors when selecting the right GRINDOX™ Antioxidant

When Danisco Cultor receives a customer request for a new antioxidant, we use a combination of our knowledge and technical service facilities to select the most cost-effective GRINDOX™ Antioxidant blend.

It is important for us to know as much as possible about the product and production process in question, since individual conditions vary from customer to customer. If sufficient information is not available from the outset, we will often procure it via our technical service.

The following list comprises the most important factors.

End product information

- Which product (fat/oil, potato product, pet food, etc.)?
- Requested shelf life (is protection needed during production and/or during distribution and consumption)?
- Traditional or vitamin-based antioxidant?
- Existing antioxidant system (are antioxidants applied already)?
- Carriers (are certain carriers desired or should certain ones be avoided)?

Raw material information

- Type of oil/fat? For instance whether it is sunflower, rapeseed, etc. The type of oil/fat can be indicated by the fatty acid composition. Knowledge of the product type will also indicate the degree of unsaturation (the more unsaturated, the more prone to oxidation).
- Fatty acid composition (to indicate product type)?
- Natural amount of tocopherols (to indicate initial protection)?
- Amount of metal ions (which would initiate oxidation)?
- Peroxide value and anisidine value (to indicate whether oxidative rancidity is already present)?

Information about the production process

- Can antioxidants be added to fat phases or water phases?
- Heating time and temperature?
- Batch-wise or continuous production (for instance, will there be cooling and heating processes)?
- Other compounds in the product (which might, for instance, contain metals or other initiators)?
- Nature of production equipment (which might, for instance, leak metals)?

Information concerning legislation

- To be consumed in which country?
- Permitted dosage of antioxidant?
- Intermediate or end product (will effect be carried over to end product or not)?

Technical service

Danisco Cultor has established a system of technical service which enables us to analyse the current product quality and document the effect of GRINDOX™ Antioxidants on customer products by using accelerated screening tests. The tests include OXIDOGRAPH™ and OXIPRES™ measurements as well as other advanced testing methods.

For pure fats or oils, analyses of the raw material can be made in our laboratories. We can also add various GRINDOX™ Antioxidant types and dosages and measure the effect. For fats and oils, we normally need a 1 kg sample.

For complex products (for instance mayonnaise) we cannot add antioxidants directly to the end product without disturbing the structure of the product. But we can supply GRINDOX™ Antioxidant samples to the customer for addition during production. Using such product samples, we can measure the effect of added antioxidants by means of accelerated tests. Another possibility is to test the fat or oil used as a raw material.

Together with our knowledge of legislation and application possibilities, these analyses enable us to select

the optimum GRINDOX™ Antioxidant blends to suit individual customer requirements.

Legal advice

The GRINDOX™ Antioxidant range complies with the relevant specifications issued by FAO/WHO and the EU. However, local regulations should always be consulted concerning the status of GRINDOX™ Antioxidants, since legislation regarding their use may vary from country to country. Advice regarding the legal status of GRINDOX™ Antioxidants is available on request.

Guide to GRINDOX™ Antioxidant applications

When selecting the right antioxidant, first of all it is necessary to select an antioxidant which is suitable for the customer's end product. The lists included in this brochure mention a number of main applications together with the GRINDOX™ Antioxidants which are typically recommended. The GRINDOX™ Antioxidants suggested reflect various compositions of traditional and vitamin-based antioxidant blends. In cases where several blends can be used for the same application, our first choices are indicated in the list, and more advice is available on request.

The list can be used as a basis for discussing individual customer needs. For specific applications, other blends from the GRINDOX™ Antioxidant range or tailor-made solutions can be offered. In such cases, it is especially important to obtain as much information as possible about the food product, production process and other parameters concerned. Together with our technical service, this knowledge will make it possible to find the most cost-effective solution to customer problems.

A guide to GRINDOX™ Antioxidant applications can be found on the following pages.

Vitamin-based GRINDOX™ Antioxidants

GRINDOX™	Fat-soluble			F + W	Water-dispersible		
	539	1021	TOC050	AP	1029	1031	1032
Main applications							
Vegetable oils	★	★		★			
Partially hardened fats	★	★		★			
Animal fats	★	★	★				
Marine oils	★	★	★				
Margarine and spreads							
Frying oils/fats		★	★	★			
Snacks, deep fried		★	★	★			
Snacks, extruded					★		
Mayonnaise/dressings							
Dehydrated potatoes				★			
Pet food		★			★		
Ingredients							
Ascorbyl palmitate (AP)							
Natural tocopherol mix							
Alpha-tocopherol							
Propyl gallate							
BHA							
BHT							
TBHQ							
Citric acid							
Citric acid ester							
Food-grade emulsifier							
Lecithin							
Vegetable oil							
Propylene glycol							
Physical form (25°C)	liquid	paste	liquid	powder	paste	liquid	liquid



★ Excellent choice in most cases



■ Excellent choice in some cases



■ Ingredient

Traditional GRINDOX™ Antioxidants										
GRINDOX™	Fat-soluble								Water-disp.	
	105	106	109	117	204	210	320	422	121	379
Main applications										
Vegetable oils				★	★			★		
Partially hardened fats				★	★			★		
Animal fats	★	★	★	★			★			
Marine oils				★						
Margarine and spreads	★	★	★		★		★	★		
Frying oils/fats				★	★	★		★		
Snacks, deep fried						★				
Snacks, extruded									★	★
Mayonnaise/dressings										
Dehydrated potatoes										
Pet food			★						★	
Ingredients										
Ascorbyl palmitate (AP)										
Natural tocopherol mix										
Alpha-tocopherol										
Propyl gallate										
BHA										
BHT										
TBHQ										
Citric acid										
Citric acid ester										
Food-grade emulsifier										
Lecithin										
Vegetable oil										
Propylene glycol										
Physical form (25°C)	liquid	liquid	liquid	paste	liquid	liquid	liquid	liquid	liquid	paste
<p>  Excellent choice in most cases  Excellent choice in some cases  Ingredient </p>										

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