



**GUARDIAN® Rosemary Extract**

**TM 36-3e**

**Benefits**

Rosemary (*Rosmarinus officinalis* L.) is traditionally used as a flavour-rich herb in foods. Today, rosemary has gained another role – as a natural antioxidant. The ability of rosemary leaf extract to improve oxidation stability has been investigated for several years.

GUARDIAN® Rosemary Extract contains the flavour,

aroma and antioxidant activity characteristic of rosemary and offers the following benefits:

- Standardised antioxidant activity
- Extended shelf life
- Retarded development of rancid off-flavour and off-taste
- Retarded loss of colour and flavour
- Carrier system which improves handling properties and ensures better distribution of antioxidant compounds in the food product

This technical memorandum describes the opportunities for slowing down the food oxidation process using GUARDIAN® Rosemary Extract.



*Rosmarinus officinalis.*

**GUARDIAN® Rosemary Extract**

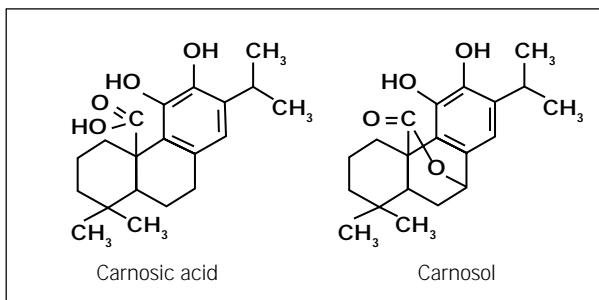
Danisco's range of rosemary extracts offers several solutions for optimising oxidative stability.

PRODUCT	FORM AND SOLUBILITY	COMPOSITION
GUARDIAN® Rosemary Extract 08	Liquid, oil-soluble	Rosemary extract (5% phenolic diterpenes) + carrier
GUARDIAN® Rosemary Extract 09	Liquid, water-dispersible	Rosemary extract (5% phenolic diterpenes) + carrier
GUARDIAN® Rosemary Extract 11	Powder	Rosemary extract (5% phenolic diterpenes) + carrier

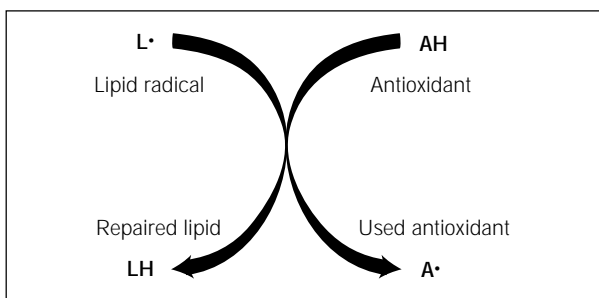
Product descriptions are available on request.

**Functional properties of GUARDIAN® Rosemary Extract**

Rosemary extract contains several components with antioxidant activity. The phenolic diterpenes, e.g. carnosic acid and carnosol, account for nearly all the antioxidant activity in rosemary extract. Other components isolated from rosemary extract are: triterpenic acids, triterpenes, sugars, flavonoids and other phenolics.



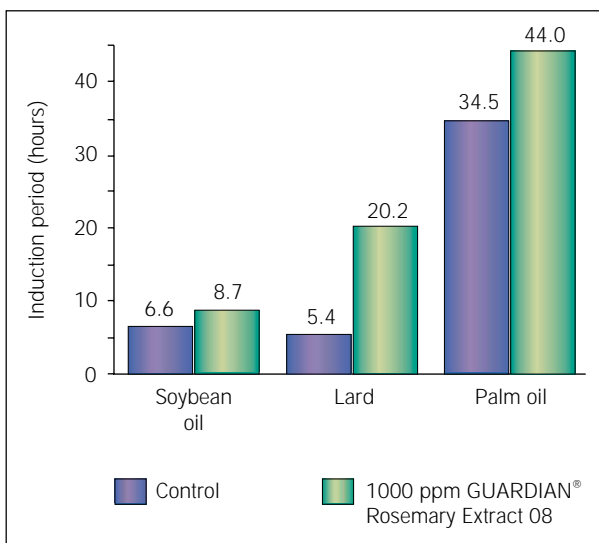
**Fig. 1:** Chemical structure of the carnosic acid and carnosol present in rosemary extract.



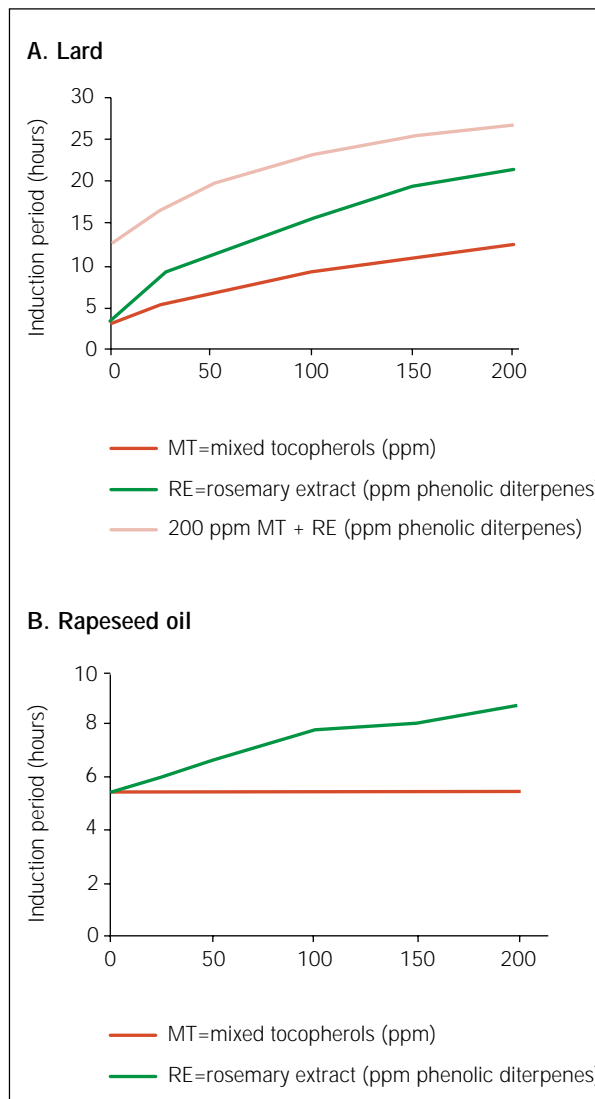
**Fig. 2:** Lipid oxidation starts with the formation of so-called lipid free radicals in oil and fat which react with air (oxygen) to produce substances with a bad smell and taste. The antioxidants (phenolic diterpenes) repair the damaged lipid (fat). As long as antioxidants are present, the fat will be protected and the oxidation process retarded.

### Oils and fats

Rosemary extract can be used for the protection of all types of animal oils and fats (e.g. lard and fish oil rich in omega-3 long chain polyunsaturated fatty acid) and vegetable oils and fats (e.g. soybean oil and hydrogenated vegetable fats) intended for direct consumption, and in industrial applications. Examples of the antioxidant effect of GUARDIAN® Rosemary Extract are shown in figures 3, 4 A and B.



**Fig. 3:** Antioxidant activity can be measured using accelerated test methods, e.g. Rancimat™/OSI™. The figure shows the antioxidant activity determined by the Rancimat™ method at 110°C. The addition of 1000 ppm GUARDIAN® Rosemary Extract 08 to soybean oil increases the induction period from 6.6 to 8.7 hours (32%).



**Fig. 4 A and B:** Antioxidant activity measured in the Oxidograph™ at 110°C. Natural rosemary extract increases the shelf life of lard (low tocopherol content ~ 20 ppm tocopherol), lard with added tocopherols and rapeseed oil (750 ppm tocopherols). In the majority of foods containing substantial amounts of tocopherols, natural rosemary extract provides an additional antioxidant effect compared to natural tocopherols which have a minor antioxidant effect.

### Bakery products

Lipid oxidation is a well-known phenomenon in bakery products. Today much shortening is based on unhydrogenated oils and fats. These oils and fats have a high content of essential fatty acids, linoleic acid (C18:2) and linolenic acid (C18:3) and do not contain trans fatty acids. Unhydrogenated oils and fats, though, have lower oxidative stability than saturated and hardened/hydrogenated fats, which have traditionally been used as shortenings.

Rosemary extract has proven to be a very efficient antioxidant in bakery products. Figure 6 illustrates the antioxidant effect of rosemary extract and other antioxidants in Lincoln biscuits with 20% unhydrogenated rapeseed oil.

See also TM 1033: GRINDOX™ Antioxidants and GUARDIAN® Rosemary Extract for Bakery Products.

ANALYSIS	RESULTS
Peroxide value	0.2
Anisidine value	2.1
$\alpha$ -tocopherol	278 ppm
$\beta$ -tocopherol	64 ppm
$\gamma$ -tocopherol	423 ppm
Fe	< 0.1 ppm
Cu	< 0.05 ppm
Ni	< 0.1 ppm
MAJOR FATTY ACIDS (WT. %)	
C14:0	0.1
C16:0	4.6
C16:1	0.2
C18:0	1.7
C18:1	59.8
C18:2	22.0
C18:3	9.4

Fig. 5: Analytical values of the rapeseed oil used in Lincoln biscuits.

### Dressings and mayonnaise

Rosemary extract is used in oil-in-water emulsions such as salad dressings and mayonnaise. See figure 7.

“Dressing with added rosemary contained a significantly lower level of conjugated dienes compared to the control samples after 4 weeks in storage. Peroxide value and TBARS (thiobarbituric acid-reactive substances) showed a similar picture and confirmed the high antioxidative effect of rosemary, while hexanal analyses were less conclusive due to the low level of hexanal and corresponding large relative standard deviation (samples stored in darkness).

Rosemary is also an efficient antioxidant in dressing samples exposed to light. The level of primary oxidation products, determined as conjugated dienes, in dressing containing rosemary was thus significantly lower for up to 10 weeks of storage compared with the control samples. The level of secondary oxidation products was also lower when compared to the control

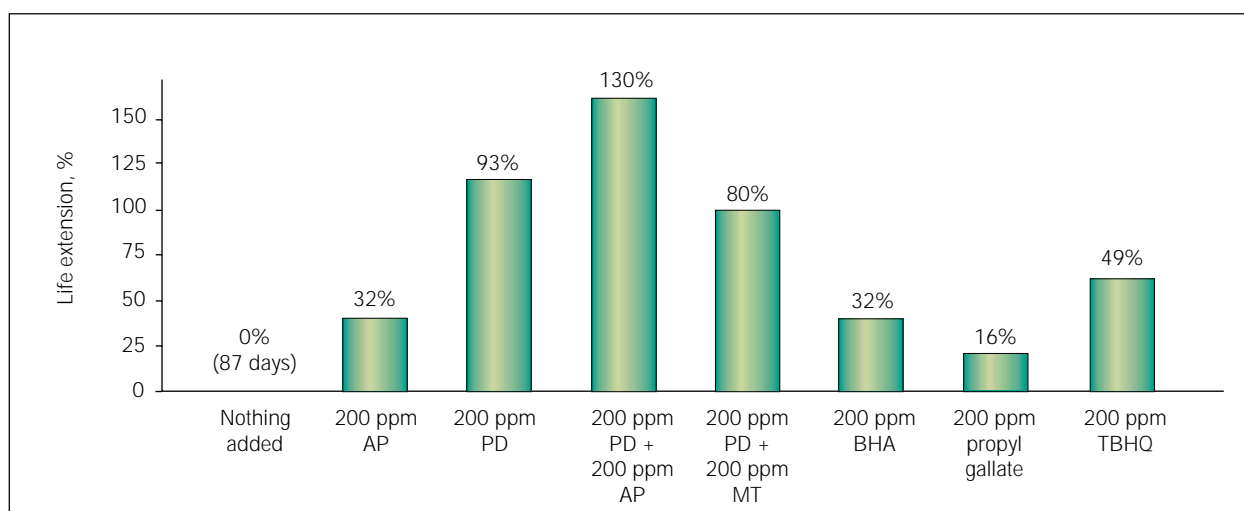
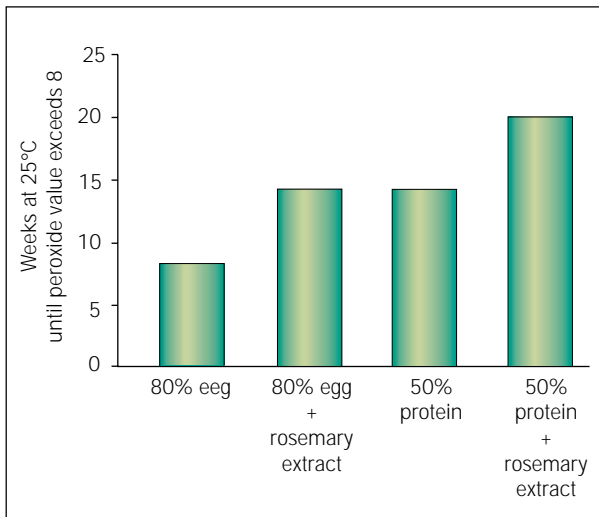


Fig. 6: Lincoln biscuits with approximately 20% unhydrogenated rapeseed oil stored at 40°C (shelf life = time until peroxide value exceeds 50). Antioxidant treatment, see below. Lincoln biscuit formulation: 57% flour, 18% rapeseed oil, 17% caster sugar, 6% water, skimmed milk powder, salt, baking soda and ammonium bicarbonate.

ANTIOXIDANT TREATMENT (ppm active material based on oil content)	PRODUCT ADDED
200 ppm ascorbyl palmitate (AP)	GRINDOX™ ASCORBYL PALMITATE
200 ppm phenolic diterpenes (PD)	GUARDIAN® Rosemary Extract 08
200 ppm AP + 200 ppm PD	GRINDOX™ ASCORBYL PALMITATE GUARDIAN® Rosemary Extract 08
200 ppm PD + 200 ppm mixed tocopherols (MT)	GUARDIAN® Rosemary Extract 08 GRINDOX™ TOCO 50
200 ppm BHA	GRINDOX™ 105
200 ppm propyl gallate	GRINDOX™ 344
200 ppm TBHQ	GRINDOX™ 204



**Fig. 7:** Mayonnaise with 50% and 80% rapeseed oil content. GUARDIAN® Rosemary Extract 08 (3000 ppm) inhibits the development of hydroperoxides in mayonnaise based on egg or protein. The flavour of the rosemary extract limits the dosage to approximately 1000 ppm.

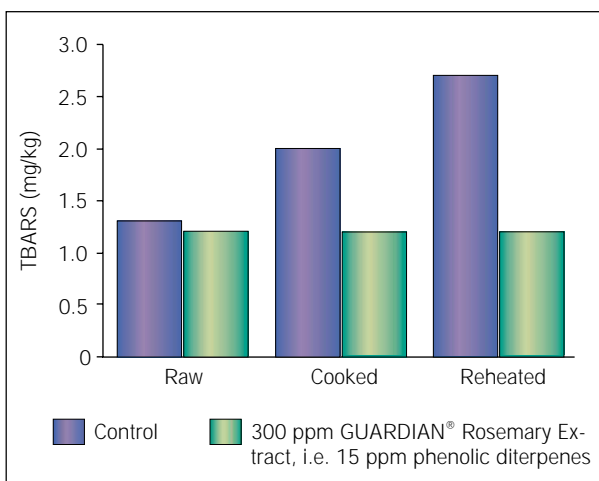
dressing throughout the storage period (hexanal and TBARS analysis)".

*Summary from: H. L. Madsen, B. Sorensen, L. H. Skibsted, G. Bertelsen: "The antioxidative activity of summer savory (Satureja hortensis L.) and rosemary (Rosmarinus officinalis L.) in stored dressing exposed to light or in darkness". In: Food Chemistry Vol. 63, No. 2 (1998), 173-180.*

### Meat and poultry products

Quality problem: WOF

Warmed-over flavour (WOF) is a term used to describe off-flavours and off-smells characterised as "cardboard-like", "paint-like" or "rancid" in meat and poultry products. WOF is unacceptable to consumers and develops quickly in refrigerated or frozen pre-cooked meats within a few days or weeks in contrast to the more common rancidity which requires months to develop.



**Fig. 8:** Inhibiting development of secondary oxidation products (expressed as TBARS) in cooked and reheated turkey sausage.

WOF can also occur in raw meat subjected to membrane disruption.

The term meat flavour deterioration (MFD) is sometimes used to describe the development of off-flavours and off-smells (WOF) as well as the loss of desirable meat flavour characteristics.

WOF starts with the oxidation of polyunsaturated fatty acids located primarily in the cell membrane as phospholipids. The primary oxidation products decompose into secondary oxidation products such as pentanal, hexanal, and 2,4-decadienal which have an off-smell and off-flavour (WOF).

This oxidation is accelerated by the mechanical processes such as grinding, chopping, boning, restructuring and cooking which disrupt meat structure and expose the phospholipids to oxygen, enzymes, metallo-proteins and metal ions.

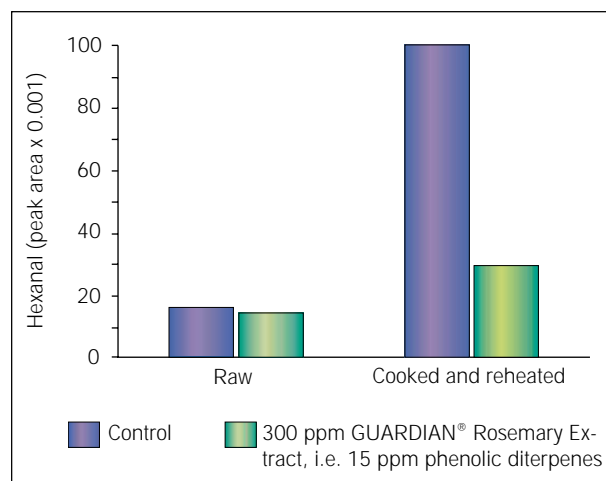
Salt has a known pro-oxidant effect as it displaces iron ions from binding sites within the fresh muscle, thus making iron available to catalyse the oxidation processes further.

WOF development can be effectively retarded by the use of antioxidants.

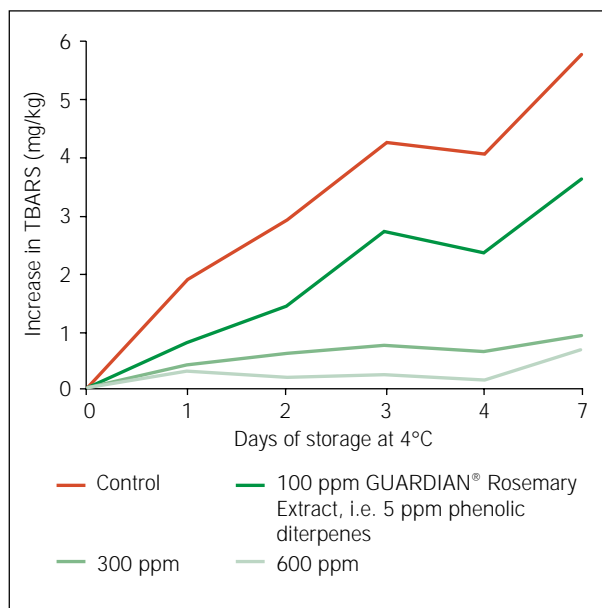
Various methods are available for the quantification of oxidation products in meats. A common method used for quantifying malondialdehyde, a major secondary oxidation product, is spectrophotometric detection of thiobarbituric acid reactive substances (TBARS) from the thiobarbituric acid (TBA) assay. Another method is GC headspace analysis, e.g. of hexanal. The correlation between the development of TBARS or hexanal and the development of rancid flavours, based on sensory analysis, has been observed in various meat and poultry products.

Quality problem: discoloration

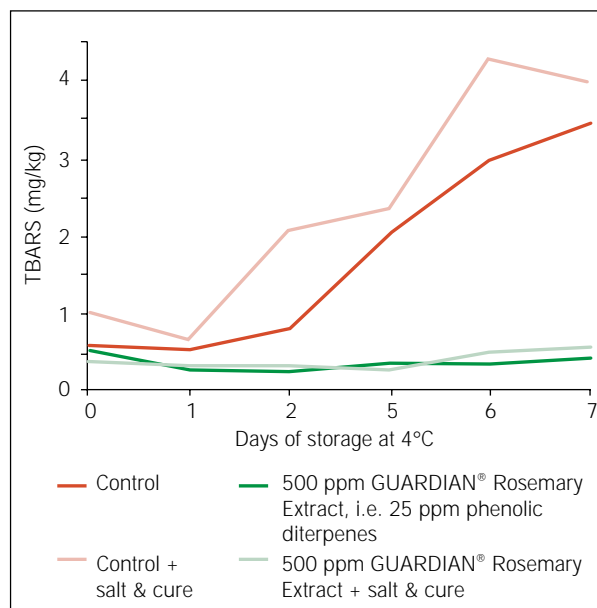
Discoloration or colour loss make products less acceptable to consumers and is characterised by a



**Fig. 9:** Inhibiting development of secondary oxidation products (expressed as hexanal by headspace GC) in cooked and reheated turkey sausage.



**Fig. 10:** Increased dosage of rosemary extract inhibits development of secondary oxidation products (expressed as TBARS) in raw ground turkey patties.



**Fig. 11:** Rosemary extract inhibits formation of secondary oxidation products (expressed as TBARS) in mechanically boned chicken sausage.

#### EFFECT OF ROSEMARY ON OXIDATIVE STABILITY MEASURED BY THE DETERMINATION OF TBARS

HERB	FOOD PRODUCT	STORAGE CONDITIONS	REDUCTION IN TBARS (%)
Oleoresin rosemary	Raw restructured beef steaks	-20°C, 6 months	39
Oleoresin rosemary	Cooked restructured beef steaks	4°C, 6 days	14
Extracts of rosemary	Frankfurters	4°C, 18-35 days	0-72
Oleoresin rosemary	Restructured chicken nuggets	4°C, 6 days	11
Oleoresin rosemary	Restructured chicken nuggets	-20°C, 6 months	1
Rosemary type W	Cooked beef patties	4°C, 2 days	56
Rosemary type O	Cooked beef patties	4°C, 2 days	31
Rosemary oleoresin	Sausages	-18°C, 20 days	46
Rosemary	Cooked meat balls	4°C, 5 days	35
Rosemary	Cooked meat balls	5°C, 10 days	20
Rosemary	Boned turkey meat	3°C, 13 days	82

**Fig. 12:** Rosemary extract inhibits the development of secondary oxidation products (expressed as TBARS) in various meat and poultry products under refrigerated and frozen storage conditions. *Table modified; from: H. L. Madsen, G. Bertelsen: Review: "Spices as antioxidants". In: Trends in Food Science & Technology Vol. 6, No. 8 (1995), 271-277.*

fading of the colour from pink to yellow-brown.

Similar to WOF, light accelerates discoloration, presenting a particular problem for products displayed in retail outlets.

Discoloration is associated with myoglobin oxidation and lipid oxidation and is retarded by rosemary extract (figure 13).

#### Potato flakes

Rosemary extract (700 ppm), evaluated in potato flakes, retards the development of secondary oxidation products from linoleic acid (less pentane found in headspace), hinders carotenoid loss and protects lipids and lipid-like materials from oxygen attack.

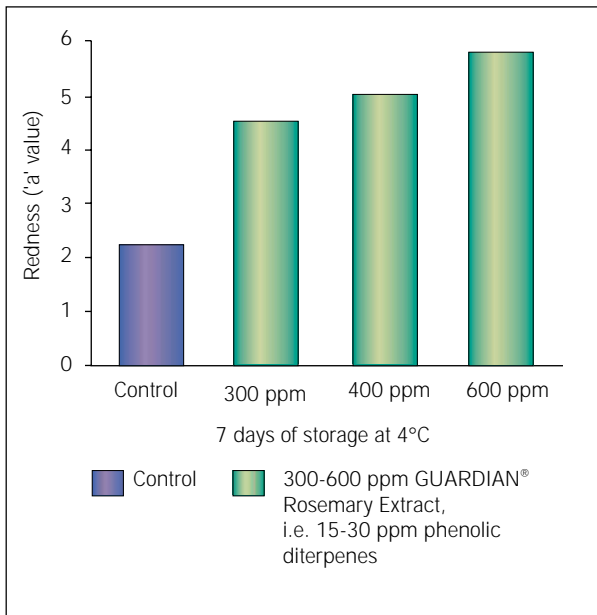
The antioxidant effect of rosemary extract is confirmed by sensory analysis, which shows a satisfactory correlation with the analytical figures.

*Summary from: U. Bracco, J. Löliger, J.-L. Viret, Switzerland: "Production and Use of Natural Antioxidants". In: Journal of the American Oil Chemist Society Vol. 58, No. 6 (1981), 686-690.*

See also TM 1032: GUARDIAN® Rosemary Extract 09 in Potato Products.

#### Recommended applications and dosages

Oil-soluble GUARDIAN® Rosemary Extract 08 is typically used for the protection of animal and vegetable oils and fats, baked products, meat and poultry products, dressings, snack foods, soup bases and similar products.



**Fig. 13:** Maintaining colour of ground turkey patties with rosemary extract.

Rosemary extract can also be applied using water-dispersible GUARDIAN® Rosemary Extract 09, e.g. for the protection of meat products (added to the brine), dressings, potato granules/flakes and cereal products.

Alternatively the powder product GUARDIAN® Rosemary Extract 11 is preferred by some industries.

GUARDIAN® Rosemary Extract contains the flavour and aroma characteristics of rosemary, which can have an impact on food flavour and aroma depending on the finished product. Typically 0.2% GUARDIAN® Rosemary Extract (based on fat content) is recommended. Tests have shown that 0.4% GUARDIAN® Rosemary Extract 08 (based on fat content) in a particular baked product had no noticeable impact on the final flavour. GUARDIAN® Rosemary Extract is, thus, particularly suitable for the protection of meat products, savoury products and similar products.

## Usage levels

The following usage levels of GUARDIAN® Rosemary Extract 08 (oil-soluble), GUARDIAN® Rosemary Extract 09 (water-dispersible) or GUARDIAN® Rosemary Extract 11 (powder form) are recommended for specific applications.

APPLICATION	USAGE LEVEL	INCORPORATION
Processed meat and poultry	0.05 - 0.50%	Direct addition or predispersion into seasoning, colouring, flavouring, phosphate, pumping or injection components/solutions
Fats and oils	0.02 - 0.10%	Direct or dilution addition
Snack foods	0.02 - 0.10%	Direct addition to frying oil or snack, or predispersion into seasoning
Cereals	0.02 - 0.10%	Direct addition
Confectionery products	0.01 - 0.05%	Direct addition to fat, nuts or flavourings
Flavourings and colouring materials	0.02 - 0.20%	Direct addition or predispersion into carrier
Baked products	0.05 - 0.20%	Direct addition
Dehydrated products	0.02 - 0.10%	Direct or dilution addition
Breadings	0.02 - 0.10%	Direct addition or predispersion into seasoning
Frozen foods	0.02 - 0.50%	Direct addition or predispersion into seasoning
Seafood	0.02 - 0.50%	Direct or dilution addition, or predispersion into dipping, glazing or injection solution
Noodles	0.02 - 0.05%	Direct addition to frying oil or dough
Pet foods	0.02 - 0.20%	Direct addition to product or fat
Soups, sauces and gravies	0.02 - 0.10%	Direct addition to oil or aqueous phase
Mayonnaise and dressing	0.02 - 0.10%	Direct addition to oil or aqueous phase
Emulsifiers	0.02 - 0.10%	Direct addition
Aromas and fragrances	0.02 - 0.10%	Direct addition

Usage levels are based on fat content.

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