
TruGro™ AOX by layn®
Natural Antioxidants

layn Natural Ingredients

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OXIDATION: A PERMANENT PHENOMENON

Oxidation of substrates is a permanent phenomenon. For this reason, their protection is essential to avoid the loss of functional and nutritive properties.

The oxidation process begins when catalyzers such as light, metals or oxygen affect the double bonds of fatty acids, which lose hydrogen that become free radicals as shown in Figure 1.

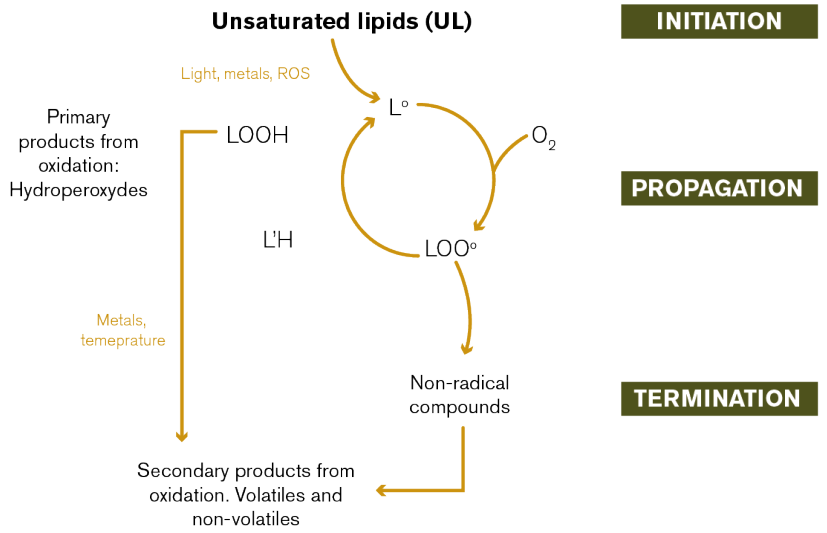


Figure 1. Oxidation cycle of lipids.

The formed free radicals react with oxygen producing peroxides. Theses in turn react with hydrogen from susceptible substrates and are transformed into hydroperoxides, generating a new free radical that speeds up the reaction.

Peroxides and hydroperoxides generate primary and secondary oxidation products, such as, carboxylic acids, aldehydes, and ketones that color and change the sensory profile of fats.

Lipids' oxidation represents a reduction in the nutritive value of foods that have them. It may not just affect the lipids, but also proteins and vitamins, and may cause food rejection.

SENSITIVE SUBSTRATES

Oxidation in substrates is initiated by catalyzers such as light, oxygen, and high temperatures in the presence of double bonds.

The oxidation reaction rate depends directly on how saturated the fatty acids are. For example, the reaction rate of the linolenic acid (three double bonds) versus oleic acid (one double bond) is 100 times faster.

Lipids are not the only susceptible molecules to oxidation; fat-soluble vitamins, natural pigments such as carotenes, and any other fat-rich substrates also are.

When talking about fats, the relation between unsaturated and saturated fatty acids indicates the oxidative risk as shown in Table 1.

	SAT	UNSAT	UN/SAT	RISK
Coconut oil	86.0	7.56	0.09	*
Tallow	49.8	45.8	0.92	*
Cotton oil	25.9	69.7	2.69	*
Palm oil	49.3	46.3	0.94	*
Lard	39.2	56.3	1.44	**
Peanut oil	16.9	78.2	4.63	**
Soy oil	14.4	81.2	5.64	**
Olive oil	13.5	83.9	6.21	****
Corn oil	12.9	82.1	6.36	****
Sunflower oil	9.0	86.2	9.58	****
Chicken oil	29.8	65.6	2.2	****
Canola oil	7.6	87.7	11.52	***
Sardine	29.9	65.6	2.19	***
Yellow grease	29.9	68.9	2.3	****
Herring	21.3	72.1	3.38	****

Table 1. Oxidative risk from common fats and oils for animal nutrition.

Also, it is important to consider the high temperature processes in which fats are subject for industrial purposes.

These effects increase the possibility of oxidative rancidity in fats such as chicken viscera oil or yellow grease, which might be used as ingredients for animal feed or pet foods.

PURPOSE OF ANTIOXIDANTS

The purpose of antioxidant is to extend the initiation period of substrates before the rancidity process cannot be stopped, allowing the consumption of lipids before reaching the termination phase of oxidation. In Figure 2 is possible to observe this phenomenon with the formation of peroxides. During the initiation phase, there are no changes in the nutritive or sensory properties, and the lipid preserves a 100% its characteristics.

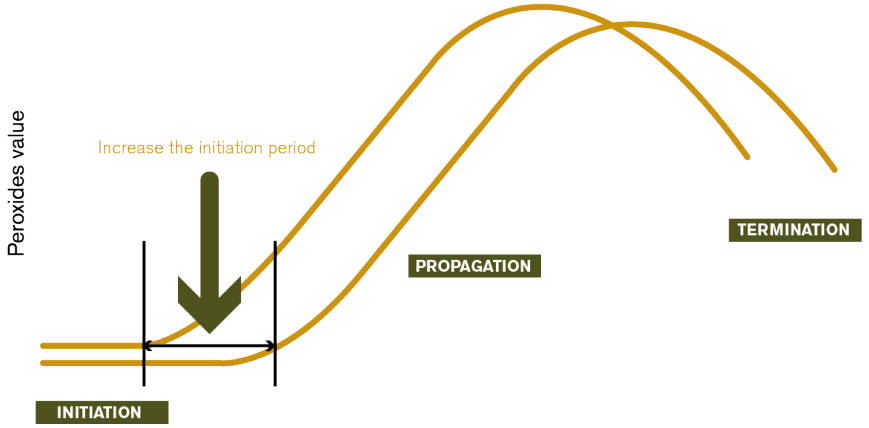


Figure 2. Antixoidants role during lipid oxidation.

Antioxidants protect substrates by donating hydrogen to stabilize the double bound that previously lost another one. In this process, antioxidants become free radicals.

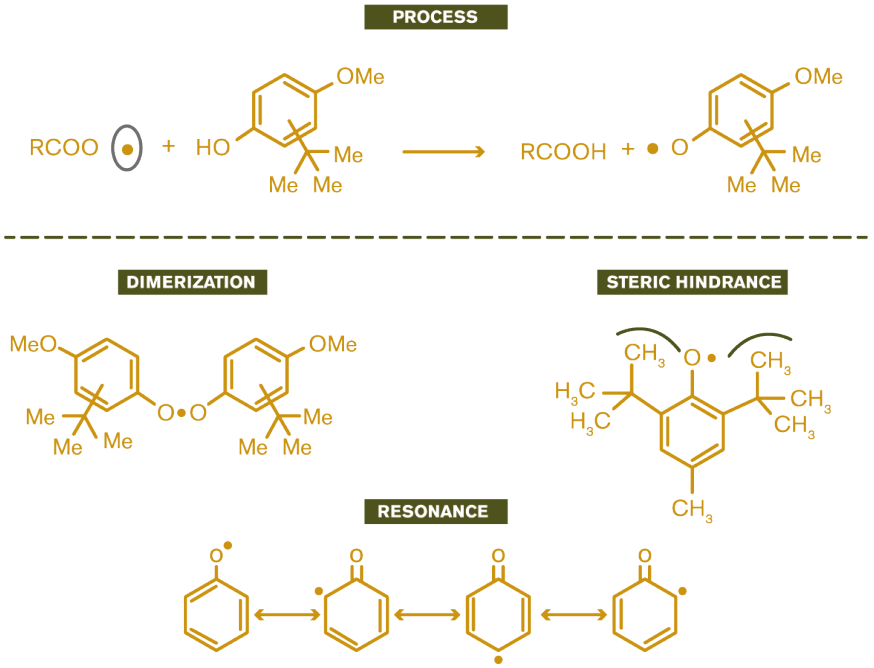


Figure 3. Donation of hydrogen for stabilizing the system (top). Antioxidant neutralization mechanisms (bottom).

Antioxidants do not initiate and oxidation process due to they react by 3 main mechanisms: dimerization, resonance and steric hindrance. The stabilization process of the substrate and the neutralization of the antioxidant are shown in Figure 3.

TruGro™: TECHNOLOGICAL ALTERNATIVE

TruGro™ AOX portfolio was designed to be an alternative for the synthetic antioxidants commonly used in the animal and human nutrition industries.

Their main purpose is to generate an efficient anti-oxidation in substrates that contain lipids, carotenes or fat-soluble vitamin, without the restrictions that BHT, BHA, TBHQ and Propyl gallate have.

Alternatives for the synthetic antioxidants are commonly based on rosemary extract, tocopherols and tocotrienols. Even though they are efficient alternatives, they have limitations like providing flavor, color, taste, and smell to the applications, need of high use dose, and high costs.

Layn has researched different combinations of polyphenol-rich natural extracts as antioxidants for sensitive substrates. The Rancimat procedure according to ISO-6886 is used to test the oxidation in fats and oils. Diagram shown in Figure 4.

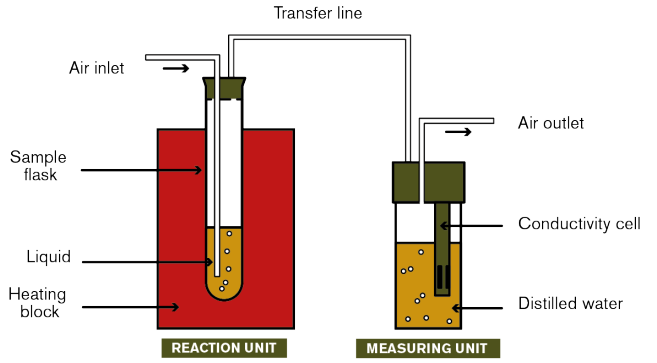


Figure 4. Block diagram of Rancimat system used for testing TruGro™ AOX

For the development program, lipids with different unsaturation degree where used, to cover a wide range of applications, as shown in Table 2.

	Soy	Palmolein	Lard	Tallow
Saturated %	14,42	43,66	44,84	48,76
Unsaturated %	83,78	55,36	52,33	49,83
UnSat/Sat	5,81	1,27	1,17	1,02

Table 2. Unsaturation of experimental lipids.

Several formulations based on polyphenol-rich botanical extracts, including grapeseed and green tea derivatives were tested versus BHT and BHA, two of the most common synthetic antioxidants in the food and animal nutrition industries.

Due to regulations for the use of synthetic antioxidants, the dose used was 150 ppm. Since botanical extracts have no application limit, other than the GMP, 250 ppm was chosen for a first round of trials.

Table 3 shows a summary of the results of the trials over different substrates. H is hours at the end of the procedure and PF is the protection factor that the antioxidant provides to the lipid.

	Tallow		Palmolein		Lard		Soy	
	H	FP	H	FP	H	FP	H	FP
Blank	18,3		25,6		3,1		5,7	
BHA	36,1	1,9	26,0	1,0	11,0	3,4	5,8	1,0
BHT	21,0	1,1	26,4	1,0	8,2	2,6	6,5	1,1
TA 1	51,0	2,8	30,2	1,2	7,7	2,4	7,2	1,3
TA 2	34,3	1,9	37,1	1,4	4,5	1,4	8,2	1,4
TA 3	59,9	3,3	28,8	1,1	10,4	3,3	7,1	1,2

Table 3. Round 1 Rancimat results.

The data shows that a single antioxidant doesn't protect in the same way all of the oils and fats, and that some of the TruGro™ AOX formulations are more efficient than the synthetic antioxidants used as references.

In a second round of experiments, the most efficient TruGro™ AOX formulations were applied to lipids with the highest and lowest ratio of unsaturation at 150 ppm, the same as in the synthetic antioxidants BHT and BHA. Results are shown in Table 4.

	Tallow		Soy	
	H	FP	H	FP
Blank	18,3		5,7	
BHA	36,1	1,9	5,8	1,0
BHT	21,0	1,1	6,5	1,1
TA 2	34,3	1,9	8,2	1,4
TA 4	62,5	3,4	8,1	1,4

Table 4. Summary of Rancimat results. Round 2.

In the most unsaturated oil, soy, the two TruGro™ AOX formulations were a 30 % and a 40% more efficient than BHT and BHA respectively. In tallow, the formulation TruGro AOX 4 was 300% higher that BHT and 175% tan BHA.

Protecting liposoluble vitamins is critic for some food matrixes. TruGro™ AOX was compared with BHT and rosemary extract in the protection of vitamin A using Oxipres.

Oxipres test shows the relation between the oxidation of a heated substrate and consumption of oxygen, measuring the decrease of pressure. Figure 5 shows the results.

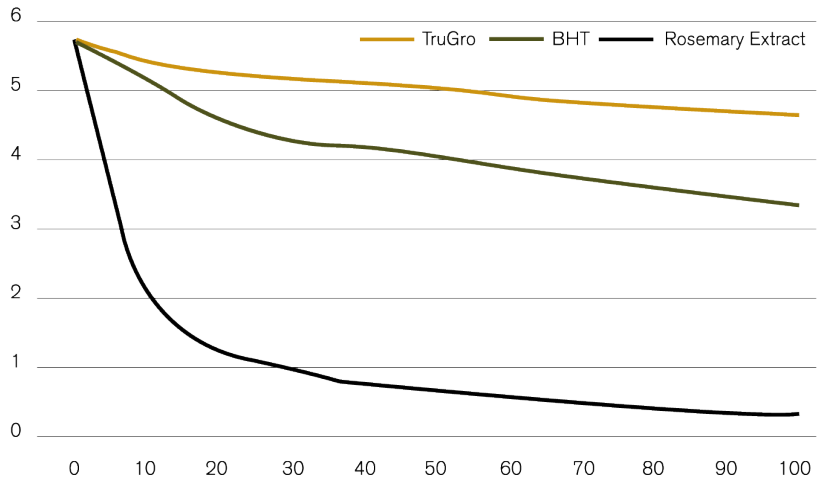


Figure 5. Protection level of Vitamin A in Oxipres with TruGro™ AOX , BHA and BHT.

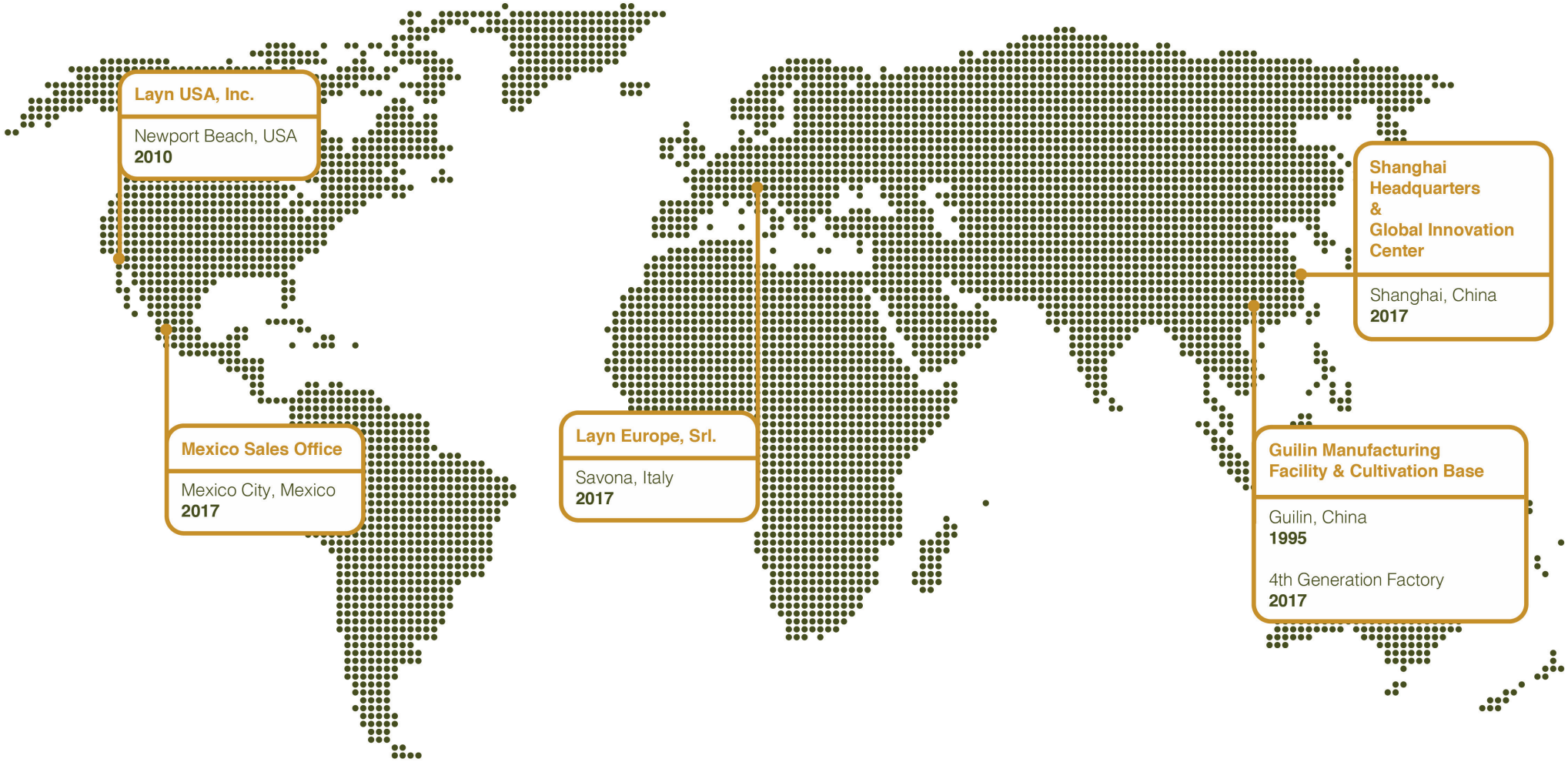
TruGro™ AOX is more efficient tan BHT and much more than Rosemary extract in this application.

CONCLUSIONS

Research shows that TruGro™ AOX can substitute the synthetic antioxidants used in the food and animal nutrition industries with the same or higher efficiency.

TruGro™ AOX allows “Clean Label” products without synthetic antioxidants.

TruGro™ AOX allows circumvent the regulatory limit imposed to synthetic antioxidants, and guarantees food to protected from oxidation under any circumstances.



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