EASTMAN

Eastman GEM™
retinyl sunflowerate

High-purity pro-retinol antiaging ingredient for cosmetics and personal care

Eastman GEM™ retinyl sunflowerate

INCI: retinyl sunflowerseedate

Eastman GEM™ retinyl sunflowerate is a pro-retinol derivative composed of retinol and sunflower fatty acids. It is a biobased, formulation-stable, easy-to-handle, nonirritating antiaging ingredient. Retinyl sunflowerate is manufactured using Eastman's EPA award-winning GEM technology, which applies the 12 Design Principles of Green Chemistry. At room temperature, it is a pourable liquid and supplied as a high-purity (>95%) assay; therefore, it is free of carriers.

Eastman GEM retinyl sunflowerate is made from sunflower seed oil that contains >70% healthy unsaturated fatty acids.

Key product facts

Eastman GEM retinyl sunflowerate is a yellow, pumpable, flowable liquid at room temperature.

Typical properties:

- Yellow liquid
- Retinyl ester assay >95%
- Average molecular weight: 549.5

Biobased content

Eastman GEM retinyl sunflowerate is 47% based on renewable carbon.

Comparison to retinol:

Product/ingredient	Biobased (renewable carbon)
Retinol (vitamin A)	Synthetic
Eastman GEM retinyl sunflowerate	47%*

**Calculated according to ISO 16128 standard*

Product stability

Shelf life: 2 years

Storage recommendation:

- Store in a dry, cool environment.
- Avoid exposure to UV light and oxygen.

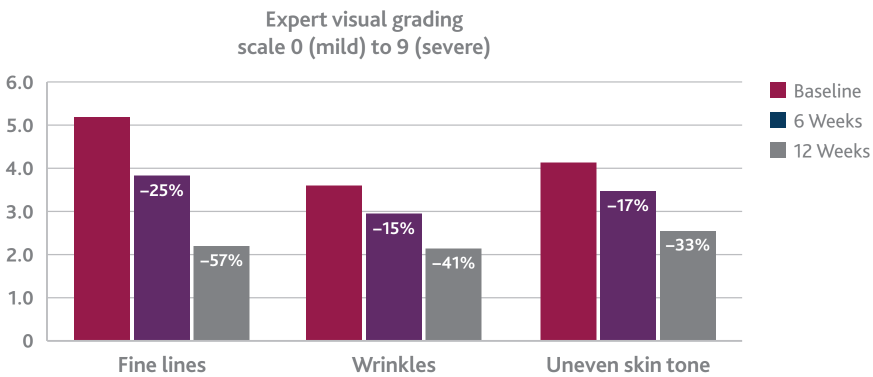
Performance: clinical data results and summary

Eastman contracted Princeton Consumer Research (PCR) to conduct a study to evaluate the efficacy of Eastman GEM retinyl sunflowerate to reduce the signs associated with aging skin.

Method: Thirty-seven subjects were provided with the test article to use twice a day for 12 weeks. Clinical assessments included evaluation of fine lines, wrinkles, and skin tone by a trained evaluator at baseline, week 6, and week 12; profilometry analysis was performed on silicone replicas taken in the crow's-feet area at baseline and week 12. Subjects completed a self-perception questionnaire at week 6 and at the end of the study at week 12.

Clinical test formulation

PCR labs conducted panel testing on an antiaging formula containing 0.1% retinyl sunflowerate.



INCI name	Wt%	Trade name	Manufacturer	Function
Water	60.9	—	—	—
Cetearyl alcohol (and) sodium cetearyl sulfate	10.0	Kolliphor® CS A	BASF	Emulsifier
Propanediol	10.0	Zemea®	DuPont Tate & Lyle	Solvent
Betaine	1.0	GENENCARE® OSMS BA	DuPont	Active
Ethylhexyl palmitate	20.0	Eastman GEM 2-ethylhexyl palmitate	Eastman	Emollient
Retinyl sunflowerseedate	0.1	Eastman GEM retinyl sunflowerate	Eastman	Humectant
Acacia senegal gum	1.0	KerrPoly GA	Kerry	Polymer
Caprylhydroxamic acid (and) caprylyl glycol (and) glycerin	1.0	Spectrastat™	Inolex	Preservative

Tests included skin irritation (safety) and efficacy (anti-wrinkle). In the efficacy test, 37 panelists completed a 12-week use test. Expert visual grading indicated a reduction in fine lines, a reduction in the appearance of wrinkles, and an improvement in skin tone evenness of 57%, 41%, and 33%, respectively. Profilometry of silicone skin replicas showed an 11% reduction in the depth of fine lines around the eye at the end of 12 weeks. 100% of panelists agreed or strongly agreed that the appearance of their skin had improved—including fine lines, wrinkles, and even skin tone—after both 6 and 12 weeks of use. No panelists reported irritation or redness from the product at any time during the study.

Results of self-perception questionnaire

Sentiment	Agree or strongly agree	
	Week 6	Week 12
The appearance of my skin has improved.	100%	100%
My fine lines appear to be minimized.	100%	100%
My wrinkles appear to be minimized.	100%	100%
My skin tone appears more even.	100%	100%
My skin looks rejuvenated.	100%	100%

Human repeat insult patch test (HRIPT) study

Skin safety was determined by a human repeat insult patch test. No adverse reactions were seen among a panel of 54 volunteers during either the induction or challenge phase. The test article can be considered safe for use under the conditions of the study; further, claims of "dermatologically tested," "clinically tested," "safe for skin," and "dermatologist approved" are substantiated.

Formulation stability data summary

- Retinyl sunflowerate is more stable than retinol during handling and formulating. A formulator does not need to take special precautions to protect the active during manufacture.
- Retinyl sunflowerate is more stable than retinol over time in a finished formulation.
  - Nonaqueous formulation—BHT @ 0.02% significantly prolongs the life of GEM retinyl sunflowerate such that >95% was retained under accelerated aging simulating one year of shelf life. Under the same conditions, only ~50% of retinol remained.
  - Emulsion formulation—An emulsion of BHT, vitamin C, or a combination of both stabilized GEM retinyl sunflowerate such that >90% was retained under accelerated aging simulating one year of shelf life.
- GEM retinyl sunflowerate does not cause formulation discoloration in the oil-phase formulation or the emulsion formulation with additive BHT. Vitamin C, however, did discolor over time.

The ingredients used in formulating emulsions can contribute to both oxidative stability and instability. Every ingredient in the formulation of oil-in-water emulsions—like sugars, alpha hydroxy acids, pigments, oils, and emulsifiers—may act as either a prooxidant or an antioxidant, depending on its chemical nature, how it interacts with other ingredients, and environmental factors.

Heat, light, and oxygen can all degrade retinol and retinol esters over time, as can exposure to strong acids. Retinol esters or other components of the formula, such as plant oils, may also contain unsaturated fatty acids. Instability of retinoids and unsaturated fatty acids can be linked to the system of double bonds in their molecular structures. Protecting these ingredients from oxidation can help stabilize a formula with retinyl sunflowerate, especially in an emulsion.

Prooxidants include some sugars, sunscreens, pigments, and naturally occurring trace metals and should be avoided or controlled in the formula. Chelants like citric acid can help control the effect of trace metals in a formula, while surfactants and emulsifiers may act as a physical barrier between the lipid droplets and the water phase to reduce interaction of lipids with prooxidants.

The presence of antioxidants can dramatically increase the oxidative stability of a retinol ester in the oil phase of a formulation. Antioxidants can prolong the stability of retinol and retinol esters and protect unsaturated fatty acids from oxidation. Oil-soluble antioxidants are especially useful. Food-grade antioxidants like BHT show strong protective effects on a retinol ester when unsaturated fatty acids are present. Other antioxidants that may help preserve retinoid stability are vitamins E and C, especially when formulated together. Vitamin E seems to be most effective at pH 5–6.

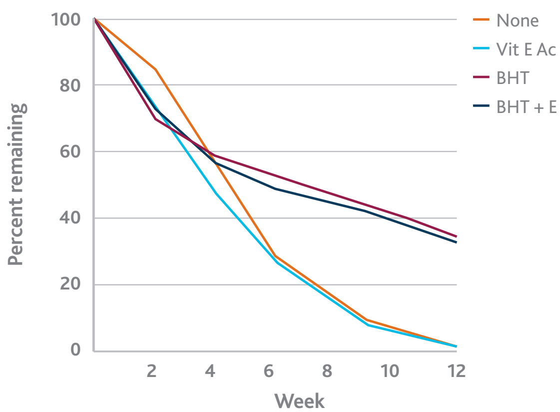
Stability of retinoids in formula over 12 weeks

Duplicate formulas containing 0.1% retinol or retinyl sunflowerate (oil phase and emulsion) were held protected from light either at room temperature (20°C) or at 50°C (122°F) to simulate accelerated aging.

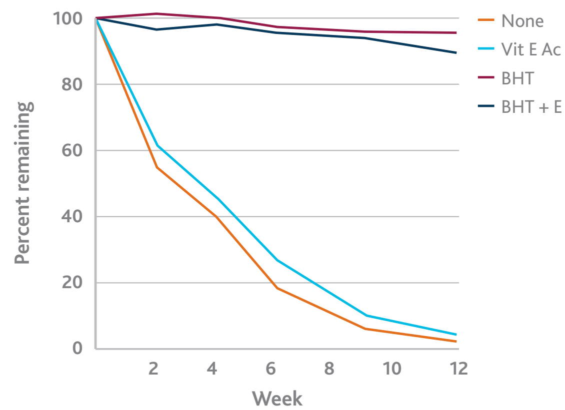
Oil-phase formulations

Accelerated aging at 50°C—Retinyl sunflowerate was stable after at least 12 weeks of accelerated aging with the addition of BHT.

Retinol in oil at 50°C



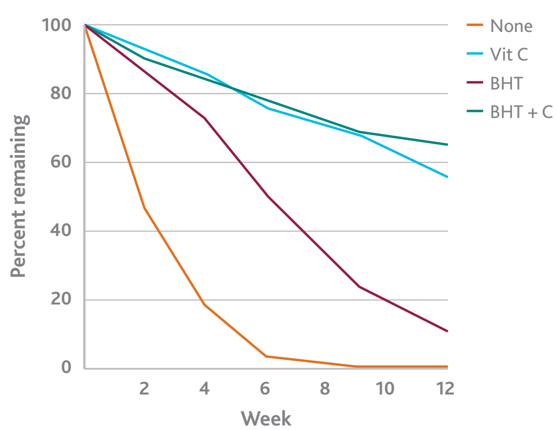
Retinyl sunflowerate in oil at 50°C



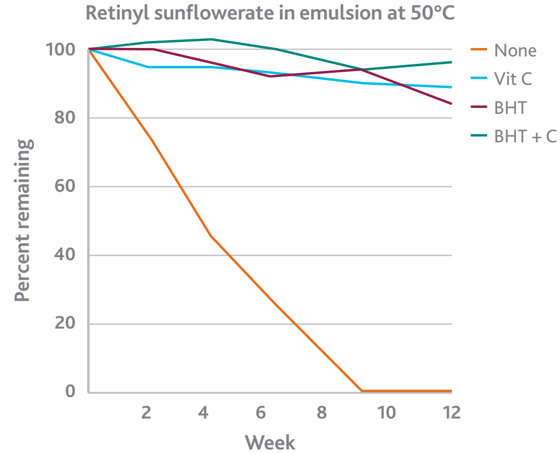
Emulsion formulations

Accelerated aging at 50°C—Over 80% of retinyl sunflowerate remains in the emulsion after 12 weeks at 50°C when either vitamin C or BHT is included. With no additives, only 3% of the added retinol is detected in the emulsion. Even with the protective additives, only 50% to 70% of the retinol remains after 12 weeks at 50°C.

Retinol in emulsion at 50°C



Retinyl sunflowerate in emulsion at 50°C

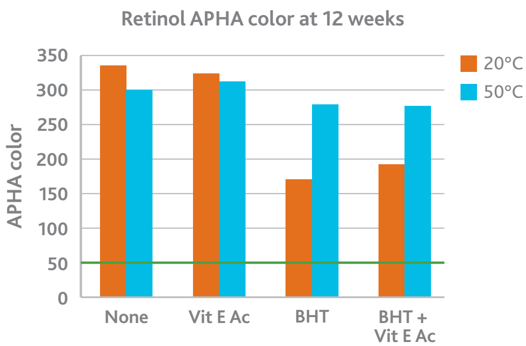


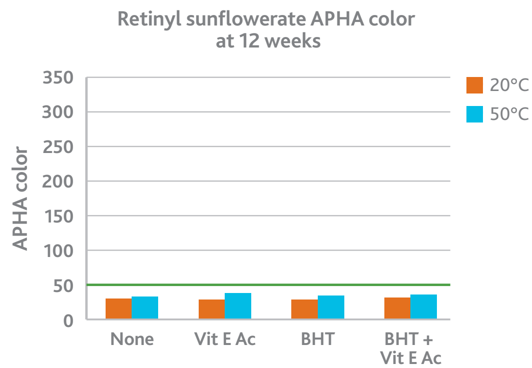
Color stability of formulas over 12 weeks

Oil-phase formulations

The color of the oil-phase formulas and the emulsions was measured after 12 weeks. Color formation in the retinol formulas largely mirrored the degradation of retinol. In contrast, the color of the oil-phase formulas with retinyl sunflowerate changed by only about 20 units, even after accelerated aging at 50°C—a change that would not be perceptible to most consumers. Product color consistency is important to consumers, and a perceptible change in color over time would be a negative for the formulas with retinol.

Final color (APHA) of the retinol (ROL) or retinyl sunflowerate (SUN) oil-phase formulas after 12 weeks

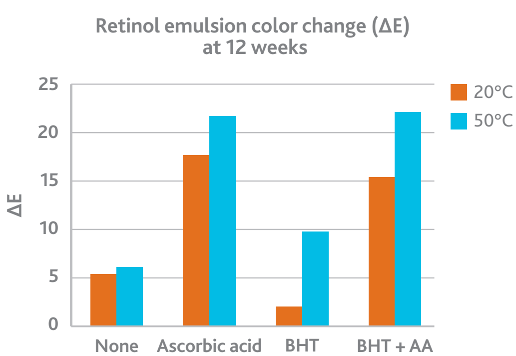


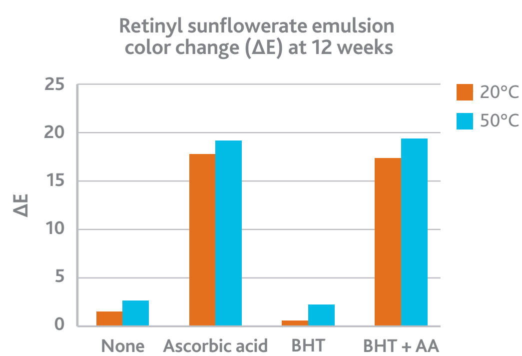


Emulsion formulations

For the emulsions containing retinol, only the formula with BHT and without vitamin C that was held at room temperature had a delta E <5. For the emulsions containing retinyl sunflowerate, color change would be noticeable only when vitamin C was included in the formula. With delta E >5, consumers would perceive all the emulsions containing vitamin C as changing color over the 12-week period, even when the formulas were stored at room temperature. Accelerated aging of the emulsion with both vitamin C and retinol led to the greatest color change.

Color change (delta E) of the retinol (ROL) or retinyl sunflowerate (SUN) emulsions after 12 weeks compared to an emulsion with no retinoids or additives





Key manufacturing facts

Eastman GEM retinyl sunflowerate is manufactured using GEM technology and is protected by U.S. Patent 7,566,795 (preparation of retinyl esters). This process adheres to the 12 Design Principles of Green Chemistry and consumes less energy, uses less process water, and generates less waste compared to conventional manufacturing processes.

Winner of the **2009 Presidential Green Chemistry Challenge Award**

Eastman GEM technology has been recognized and awarded by the EPA. It won the EPA Green Chemistry Challenge for Greener Synthetic Pathways Award in 2009.

Manufacturing sustainability metrics

The calculated reduction in waste, water, and greenhouse gas emissions is found by comparing the manufacturing processes only—a traditional chemical process versus the GEM process.

Waste reduction

E-factor = kg (waste)/kg (product)

Eastman GEM retinyl sunflowerate has an E-factor of 10.6 compared to a chemical process that has an E-factor of 142.0. This is a 92.5% reduction in E-factor by manufacturing using the GEM technology (Figure 1).

Process water reduction

There is a 98.9% reduction in the ratio (kg water/kg product) consumed when compared to the traditional chemical process (Figure 2).

Greenhouse gas emissions reduction

There is a 90.5% reduction in the ratio (kg CO_2 emissions/kg product) consumed when compared to the traditional chemical process (Figure 3).

Figure 1. E-factor of Eastman GEM retinyl sunflowerate compared to a traditional chemical process

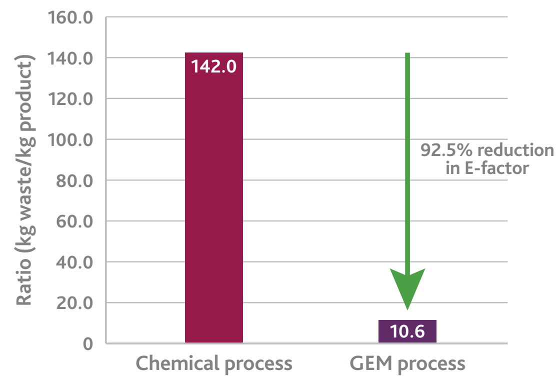


Figure 2. Eastman GEM retinyl sunflowerate ratio (kg water/kg product) compared to a traditional chemical process

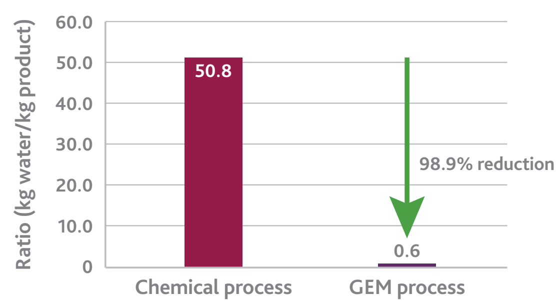
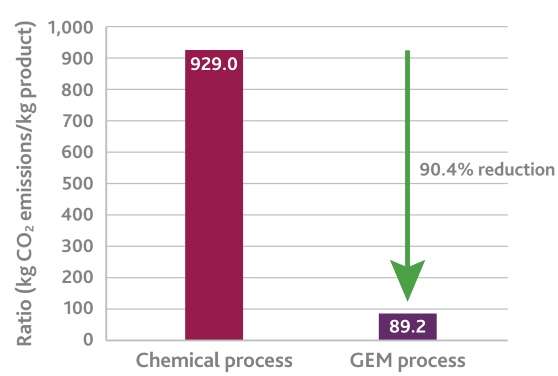


Figure 3. Eastman GEM retinyl sunflowerate ratio (kg CO_2 emissions/kg product) compared to a traditional chemical process



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Eastman Corporate Headquarters
P.O. Box 431
Kingsport, TN 37662-5280 U.S.A.

U.S.A. and Canada, 800-EASTMAN (800-327-8626)
Other Locations, +(1) 423-229-2000

www.eastman.com/locations