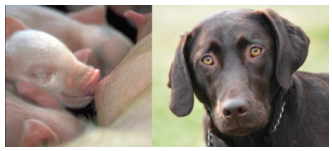
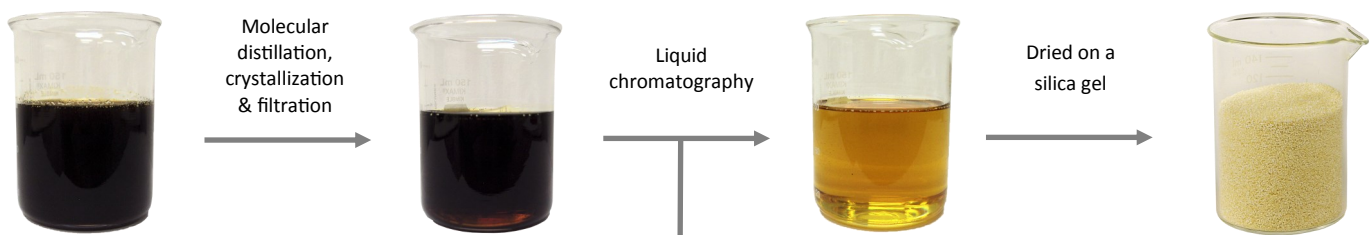
Nova-E™ Natural-Source Vitamin E Usage Guide



ADM Nova-E™ Natural-Source Vitamin E is produced by extracting α-tocopherol from oilseeds and then stabilizing the molecule as α-tocopheryl acetate for use in animal feed. Synthetic vitamin E has always held a cost advantage compared with vitamin E extracted from natural plant sources. Just within the last few years, however, science has shown that the chemical differences between naturally-sourced and synthetic vitamin E vary greatly in their impact on health of humans and livestock. This guide will help the user understand the biology of Nova-E and aid in developing a supplementation strategy that optimizes the return on investment for this unique molecule.

Processing time = 90 days



Facts about the production of Nova-E:

Natural-source vitamin E represents about 5% of the total vitamin E market.

It takes almost three months to isolate and process Nova-E into feed-grade, d-α-tocopheryl acetate.

One ton of Nova-E 405 requires processing of three million pounds of vegetable oil or about 7,000 acres of soybeans.

The unique biology of natural-source, Nova-E:
Internet check: Querying "RRR" and "tocopherol" in any search engine will generate extensive information for further education.

The molecular tail of α-tocopherol has three chiral carbons that can be rotated to either the left (S-form) or right (R-forms) to create eight *stereoisomers* of α-tocopherol. In natural-source vitamin E, all carbons are rotated to the right, hence the term RRR-α-tocopherol. Synthetic vitamin E contains all eight possible stereoisomers, occurring at 12.5% each.

BIOLOGICAL IMPLICATIONS:
The liver discards 50% of synthetic vitamin E. Alpha-tocopherol Transfer Protein (ATTP) selectively retains the carbon-1 right-handed molecules. This means that the four R-forms (RRR, RRS, RSR, RSS) are retained by ATTP whereas the four L-forms (SSS, SSR, SRS, SRR) are all excreted in about 24 hours (Figure 1). Across species, extensive research shows natural-source vitamin E is at least 2X more potent than synthetic vitamin E and natural-source vitamin E may be legally labeled for this potency in humans, as discussed below.

Cellular membranes may poorly retain non-natural stereoisomers. Even beyond the 50% loss of S-form stereoisomers due to liver ATTP selection, some agricultural species show still greater preferences for natural-source vs synthetic α-tocopherol, as evidenced by tocopherol accumulation in various tissues. This may relate to how well cellular membranes retain the conserved R-forms over longer periods of time. Research in dairy cattle given an injection of synthetic vitamin E (Jensen, 2005) shows that, although it takes several days, the other three carbon-1 right-handed stereoisomers (RSS, RSR, RRS) are eventually cleared from the body; whereas, the RRR form is apparently retained (Figure 2).

AAFCO labeling of natural-source Nova-E:
Both Nova-E and virtually all synthetic vitamin E used in animal feed are sold as stabilized α-tocopherol acetate. Supplemental vitamin E acetate may appear on a feed label in three ways:

- ***Synthetic vitamin E*** can be listed as ***dl***-α-tocopherol acetate
- ***Natural-source Nova-E*** can be listed as ***d***-α-tocopherol acetate
- ***Vitamin E supplement*** can be used for any vitamin E source over 10,000 IU per lb

AAFCO labeling and potency for Nova-E vs synthetic vitamin E: A 2X potency for natural-source vs synthetic vitamin E acetate is now recognized for humans by the Institute of Medicine (2000) and

Figure 1

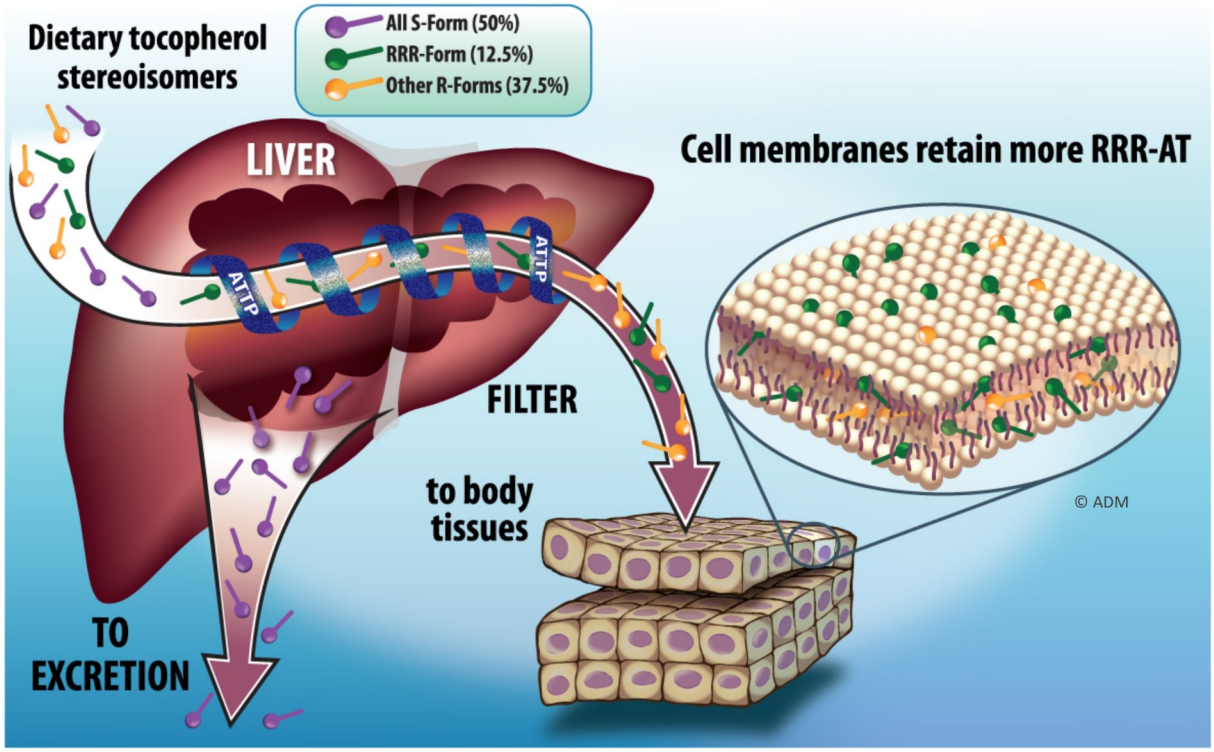
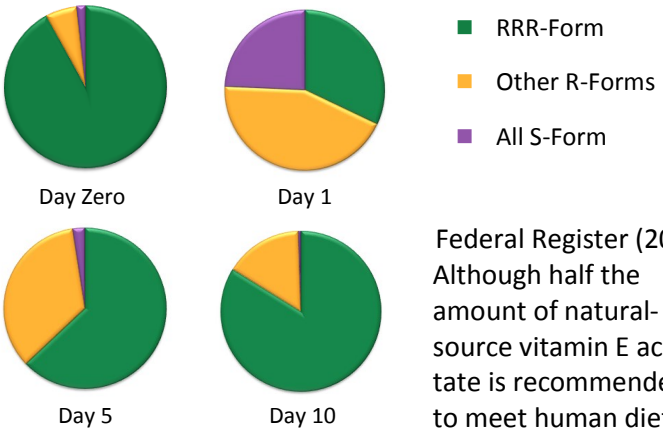


Figure 2

Blood stereoisomer distribution after injecting lactating cows with a pulse-dose of 2.5 grams of synthetic vitamin E (Jensen, 2005)



Federal Register (2014). Although half the amount of natural-source vitamin E acetate is recommended to meet human dietary requirements, human food supplement labeling may not fully reflect this change for some time. In labeling of livestock feed, the 1.36 IU/mg potency value or natural-source vitamin E acetate is not likely to be modified by FDA/AAFCO in the foreseeable future.

All ADM Nova-E products will be labeled in IU, based on the 1.36 conversion factor. As such, blended products containing Nova-E should also be labeled accordingly. Unfortunately, all research literature references the potency of RRR-α-tocopherol acetate in terms of multiples of potency per milligram of active vitamin relative to synthetic vitamin E. To easily relate to the value proposition of Nova-E for feed usage, research-based multiples can be multiplied by 0.735 to obtain relative potency per AAFCO IU, as shown in Table 1.

- **Synthetic (dl-α-tocopherol acetate):**
  1 milligram = 1.00 IU vitamin E activity
- **Natural-source (d-α-tocopherol acetate):**
  1 milligram = 1.36 IU vitamin E activity

Practical chemical and physical attributes of Nova-E:

Dry Nova-E is a vitamin E absorbate.

Feed-grade Nova-E is dried identically to synthetic vitamin E by absorbing the active oil onto a silica gel. Physical handling is identical to synthetic vitamin E.

Nova-E has equal stability as synthetic vitamin E.

Nova-E is chemically identical to synthetic vitamin E for all aspects of shelf-life and stability and will be equal to that observed for synthetic vitamin E acetate.

Laboratories cannot differentiate Nova-E from synthetic!

Detection of differences in chiral rotation cannot be accomplished by standard AOAC laboratory methods. Standard laboratories will assume all α-tocopherol activity is synthetic vitamin E acetate and use a 1.0 multiplier. As such, vitamin laboratories must be informed of the concentration of naturally-sourced, d-α-tocopherol acetate, so that the appropriate 1.36 multiplier can be applied to the proportion of the blend that is Nova E.

Applying the value of Nova-E:

The scientific literature most often reports the relative potency of natural-source vitamin E in terms of potency ratios or "multiples" which are typically 2 to 3 times higher for natural-source than synthetic vitamin E on a milligram for milligram basis (Table 1). These multiples are largely based on blood and tissue accumulation of tocopherol in animals fed vitamin E acetate in studies where naturally-sourced or synthetic forms of vitamin E were directly compared.

Here are some general guidelines that can be used with Table 1 to apply the value of Nova E:

- Using the IU shown on the label for straight products (Nova E 405, Nova E 450), Nova E will cost approximately 2.0 to 2.5 times more per IU than synthetic vitamin E.
- Nova E may have slightly less value for use in creation of high tocopherol end-products, such as meat, milk, and eggs. The goal of these applications is simple accumulation of tissue tocopherol, regardless of stereoisomer form, rather than optimum animal health.
- The highest value level for Nova E may be a blend with synthetic vitamin E. Tissues appear to vary greatly in their relative abilities to discriminate among the synthetic vitamin E stereoisomers. As such, a blend may be the best economic compromise between the general antioxidant roles for vitamin E stereoisomers in feed and less critical tissues and the health-critical roles for the RRR stereoisomer in tissues which exhibit a high level of discrimination against non-natural vitamin E stereoisomers.

Table 1. Predicted potency and other health value considerations for Nova-E in livestock and poultry

Possible multiples of potency for Nova-E vs synthetic vitamin E for use in formulation*

Specie	Per milligram	Per I.U. Shown on label	Criteria or references	Special applications
Poultry	2.0	1.5	Ognik and Wertelecki, 2012; Field experience	Breeders
Swine	2.5	1.8	Howard et al., 1990; Lauridsen et al., 2002; Yang et al., 2006; Shelton et al., 2014	Mulberry heart; health challenges
Dairy	3.0	2.2	Eicher et al., 1997; Hidiroglou et al., 1997; Flick, 1997; Jensen et al., 2005; Meglia et al. 2006; Weiss et al., 2009	Preweaning calves; health challenges
Beef cattle	2.5	1.8	Hidiroglou et al., 1988	Health challenges
Horses	3.5	2.6	Field experience; Pagan, 2006; Kane, 2009	Health challenges; exercise recovery; neural myopathy

*Much of the scientific literature discusses the relative potency of RRR-α-tocopherol vs synthetic vitamin E in terms of potency ratios which are typically two to three times higher (multiples) on a milligram for milligram basis. The multiples given above for different species are based primarily on blood and tissue accumulation of tocopherol in animals fed either naturally-sourced or synthetic vitamin E acetate.

Nova-E product options:

Nova-E 450 (642572AJ)	204,300 IU/lb, d-alpha-tocopheryl acetate
Nova-E 405 (642570AJ)	183,708 IU/lb, d-alpha-tocopheryl acetate
Super E 20 (79210014)	10,000 IU/lb, d-alpha-tocopheryl acetate 10,000 IU/lb, dl-alpha-tocopheryl acetate

Key References

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Product information is only applicable to domestic (U.S.) market.

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